

# ABSTRACTS

## of recent published material on

## Soil and Water Conservation

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"ABSTRACTS of recent published material on Soil and Water Conservation" are abstracted by Charles B. Crook in the Soil and Water Conservation Division of the Agricultural Research Service.

They are issued at irregular intervals, and their purpose is to bring together a summary of current published information about soil and water conservation for ready reference of those actively engaged in soil and water conservation work. Reprints of abstracted articles are generally not available in the Division. Requests for reprints should be sent to authors or institutions - addresses have been appended to abstract.

This abstract consist principally of articles abstracted from 30 periodicals not previously abstracted for "ABSTRACTS", for the period July 1958 through December 1959, and from publications from forty state agricultural colleges for the period 1958 and 1959.

The classification of articles follows the table of contents used for the "Soil and Water Conservation Research Needs" presented by the Soil Conservation Service. Mr. Crook is abstracting completely enough so article need not be consulted unless details are required. In case of a review, or a "how-to-do-it" article then the abstract is not complete. Abstracted articles are not editorialized and the language of the author is used wherever possible. In foreign articles, the units of measure are converted to usual American units. Tables are included where they help to present the information. When an entire number of a publication is devoted to reviewing one subject then the entire publication is abstracted as one article giving title and authors of each paper included in the publication. Abbreviations of journals and addresses are the standard ones set up by the U. S. D. A. Library in U. S. D. A. Misc. Pub. 765, July, 1958.

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# CONTENTS



## WATERSHED ENGINEERING

### Watershed Development

Western Conservation Journal SMALL WATERSHED REVIEW. West. Conserv. J. 15(4), 62 pp. 1959.

This issue of the Western Conservation Journal contains many articles and photographs of small watershed activities. The articles and addresses of the authors' are:

1. Williams, D. A. WATER CONSERVATION STARTS ON THE LAND. SCS, USDA, Washington, D. C.
2. Anonymous FACTS ABOUT PUBLIC LAW 566.
3. Fuqua, N. J. TEAMWORK WILL WIN CONSERVATION BATTLE. SCD, Duncan, Okla.
4. Anonymous ROSTER OF WESTERN PROJECTS.
5. Van Allen, F. V. PLANNERS SIZE UP WATERSHED JOB. International Harvester Co.
6. Boddy, H. COMMITTEES PROBE WATERSHED PROBLEMS. SCS, USDA, Berkeley, Calif.
7. Mark, F. A. NAIL 'EM DOWN BEFORE THEY START. SCS, USDA, Spokane, Wash.

8. Bradshaw, J. R. J. STRUCTURES CHECK WATER. SCS, USDA, Salt Lake City, Utah.
9. Fox, W. W. HOW LAND IS TREATED IN WATERSHED PLANNING. SCS, USDA, Berkeley, Calif.
10. Anonymous COMMUNITIES CONQUER STORM RUNOFFS.
11. Anonymous STRUCTURES CONTROL UTAH'S PLEASANT CREEK.
12. Anonymous WHERE YOU CAN GET HELP.
13. Anonymous DISTRICT THWARTS BOTTOMLAND FLOODS.
14. Anonymous EQUIPMENT DESIGNED FOR SMALL WATERSHED WORK.

Steele, H. A. WATER-RESOURCE DEVELOPMENT IN THE UNITED STATES. International J. Agrarian Affairs 2: 406-424. 1959.

Although substantial advances have been made in the technical solution of water problems, progress in devising and adopting water policies and in adjusting our water resource organizations and laws at the local, State, river basin and national levels has not kept pace with the growing demand on our water resources. The rate at which we are solving these problems indicates that we shall fall further behind in the future unless considerable attention is given to them. Because water is vital to the balanced growth of our economy, accelerated activity at all levels of government will be needed.

FERD, ARS, USDA, Washington, D. C.

Hill, R. G. WATERSHEDS FOR WATER MANAGEMENT. Mich. State U. Coop. Exp. Serv. Ext. B. 364, 15 pp. 1959.

Surface water management begins when the raindrop first hits the ground.

This illustrated booklet discusses some of the problems of surface water use and management, and suggests how Michigan people can band together to solve them on a "watershed basis."

Mich. State U. Coop. Ext. Serv. East Lansing, Mich.

Tolley, G. S. ANALYTICAL TECHNIQUES IN RELATION TO WATERSHED DEVELOPMENT. J. Farm Econ. 40: 653-665. 1958.

This paper concerns the role of objective estimation procedures in the evaluation of, and to some extent the planning of, small watershed development. Most objective estimates of results of watershed development are aimed at measurement of the economic benefits and costs of development. Under the Soil Conservation Service Program--which accounts for the bulk of watershed development--these estimates must be brought together to make an over-all comparison of benefit and cost that can be used in judging a proposed plan. It concerns the relation of benefit-cost analysis to small watershed development.

N. C. State Col., Raleigh, N. C.

Hopkins, W., Sinclair, J. D., and Rowe, P. B. FROM FOREST INFLUENCES TO APPLIED WATERSHED MANAGEMENT IN SOUTHERN CALIFORNIA. Proc. Soc. Amer. Foresters, Salt Lake City, Utah. pp. 36-68. 1958.

The San Gabriel Mountains--predominantly highly fractured, deeply weathered metamorphic and granitic rocks, on slopes steeper than the angle of repose--are some of the steepest, most unstable mountains in the world. These same mountains also claim world records in rainfall intensities and some of the highest unit area flood discharge and erosion rates ever recorded--a real and ever present hazard to the city of Los Angeles and other foothill cities lying immediately below. Supplying water for this thirsty, semi-arid region has always been a struggle.

Through the years, San Dimas technicians have developed the following far-reaching contributions to watershed management and forestry:

1. Developed methods to measure rainfall in the mountains.
2. Developed the San Dimas flume to measure flood flows carrying heavy bed loads of sand, gravel and boulders.
3. Reported that soil erosion was increased 30 fold and flood peaks increased from 16 to 68 times their normal, when only 1/3 of the San Dimas Watershed was burned.
4. Showed that soil erosion and soil movement on brush covered mountain slopes could be reduced by introducing and growing plants that would do a better job of soil stabilization.
5. It has been shown by lysimeter tests, that pine is the first and scrub oak is the last to deplete its water during the winter months, but that they go dormant before the supply is exhausted. Only under grass cover has a ground water (seepage) yield been obtained.
6. Soil moisture runoff plot studies have shown that during a long dry season, evapo-transpiration dried the brush-covered soils to depths of 11 feet, but the grass covered soils to less than 3 feet. When weeds were allowed to grow in the grass areas the soil was dried to a depth of 10 feet.
7. The Colman fiberglass electrical soil-moisture instrument has simplified soil moisture measurements.
8. Rainfall and streamflow have been measured on 17 entire watersheds since 1934. A complete picture of the hydrologic characteristics have been made on most of these watersheds, and predictions can now be made of streamflow performance for one watershed by measuring the streamflow performance of another.
9. Whole watersheds have been placed under intensive management to increase the yield of usable water.
10. Application of intensive management have been concentrated on the following two vegetative conditions where water yield is the most promising: (1) The riparian-woodland zone along the stream channels; and (2) the brush covered side slopes on deep soils.

Pacific Southwest Forest & Range Expt. Sta., FS, USDA, Berkeley, Calif.

Fox, L. NEW JERSEY PILOT WATERSHED COMPLETED--HERE ARE THE RESULTS. Land Impr. 6(3): 14-15. 1959.

The author lists the following benefits from the completion of the Pequest pilot watershed project in northwest New Jersey for truck farmers in the Great Meadows and Alphano muckland areas: (1) No more crop losses because of flooding; (2) earlier spring planting; (3) higher land values, up $300-$700 an acre; (4) water table lowered to desirable level; (5) productive use of rich land that flooding had kept idle, with a reduction, though, in the total area devoted to row crops; (6) more efficient farm drainage patterns; (7) use of winter cover crops to prevent wind erosion; (8) improvement in the whole area's economy; and (9) end of extra labor that flooding caused.

SCS, USDA, Upper Darby, Pa.

Fink, O. E. CITIES ARE IN WATERSHEDS TOO. Land Impr. 6(10): 11-12. 1959.

Water is the supreme need of cities. Water transcends the importance of every other resource. Water is the touchstone of our wealth, the cornerstone of our economy. It is the major factor regulating the future growth and development of our cities. The population is rapidly increasing, and in addition the per capita use of water is also rapidly increasing.

If cities are to depend upon watersheds for this precious water supply, cities must interest themselves in the best possible care of the landscape in the watershed and manage to increase the yield. This means the treatment of the land to reduce the water waste and rapid research to find the information concerning the water intake rates and water storage such as mulch tillage, contouring, strip cropping and crop rotation. Soil moisture management is not just a farmer's problem.

The population forecast for the Continental U.S. in 1975 varies from 206 million to 220 million. The amount of water required for 206 million is estimated at 454.18 billion gallons per day. The estimate of the amount of water that will be required has been divided into categories as follows:

| | | |
|---|---|---|
| Irrigation | 169.78 billion gpd. | 37.4% of total |
| Steam Electric Power | 131.0 billion gpd. | 28.9% of total |
| Industrial and Miscellaneous | 115.4 billion gpd. | 25.5% of total |
| Public Water Supply | 39.8 billion gpd. | 6.6% of total |
| Rural and Farm | 7.2 billion gpd. | 1.6% of total |
| Total | 453.18 | 100.0% |

Some of the published statistics on our water usage in this modern age are: Eighteen thousand gallons of water to make a ton of ingot iron; 65,000 gallons to convert this ton of iron into steel; 7,000 gallons for a barrel of gasoline; 160 gallons for a pound of aluminum or a pound of synthetic rubber; 3,600 gallons for a ton of coke. On a farm a pound of beef on the hoof has required 3,750 gallons of water for the steer and the grass he eats. A slice of bread including the growing grain has used 37 gallons of water; a helping of potatoes involves 1,400 gallons of water. In our homes and farms and factories the use of water amounts to 1,500 gallons a day for each man, woman, and child. All of this must, in the long period, come from the one-fourth of precipitation which is not returned to the atmosphere through evaporation and transpiration.

No address given.

Dexheimer, W. A. MULTIPLE-USE PROJECTS IN DEVELOPMENT OF WATER RESOURCES. J. Irrig. and Drain. Div., ASCE 84(IR 3) 1752: 1-6. Sept. 1958.

Our daily rate of water use is now more than 200 billion gallons but will double by 1975. Multipurpose basin-wide planning and construction will do more than any other approach to the problem if we broaden our thinking and objectives along these lines:

1. Revise our state water codes where necessary to permit maximum development and multi-use of water resources throughout the country.
2. Include long range capacity for tomorrow in facilities being built to meet today's needs.
3. Recognize recreation and fish and wildlife values in our rivers and streams as they exist today, making an honest effort to retain these values to the greatest degree possible and, conversely, give honest recognition to the conservation interests in analyzing the necessity for water development projects, inviting their participation and cooperation in planning for adequate protection or replacement and enchancement of these resources.
4. Evaluate existing single purpose projects to determine how they may be best utilized in a multipurpose basin concept of operation.
5. Recognize that no one agency, public or private, and no one unit of government, local, state, or Federal, can or should undertake the total development but that each must consider the total need in any project planning.
6. Prepare coordinated programs for river basins enlisting State participation and using funds available for public works planning so that a blueprint is worked out to provide for future construction to proceed in an orderly manner towards the agreed-upon goal necessary to supply the tremendous demands of the next two decades.
7. Establish a democratically constructed and selected agency to coordinate planning and operation of individual units in a river basin within the framework of maximum multipurpose development.

Comm. of Reclam., U.S. Bur. Reclam.

Whipkey, R. Z., and Fletcher, P. W. PRECIPITATION AND RUNOFF FROM THREE SMALL WATERSHEDS IN THE MISSOURI OZARKS. Mo. Agr. Expt. Sta. Res. B. 692, 28 pp. 1959.

Precipitation and runoff relationships of three small watersheds in the Missouri Ozarks were studied. The watersheds differed greatly in size and in amount of cover and kind of land use. All three had the Roubidoux as the major geologic formation and Clarksville loam as the major soil series.

It was found that: (1) Annual precipitation for the three watersheds was 38 inches during the period 1948 and 1955. (2) Annual Consumptive use ranged from 24.5 to 27.5 inches. (3) Annual runoff for the smallest watershed was 10 inches and for the two larger watersheds about 13 inches. (4) Annual storm runoff from each watershed was about 7 inches, but baseflow from the smallest watershed was roughly 2.5 inches and from the largest, about 6 inches. (5) Principal annual yield differences between the three watersheds were largely in amounts of total baseflow. (6) For correlation of annual runoff and precipitation, the water year June 1-May 31 gave the best fit of data and the highest correlations. It is felt that this is the period in the Ozarks when storage in small watersheds is near the maximum and changes from year to year are slight. (7) Since storage-carryover changes for the June 1 water year are slight, the uncorrected precipitation minus runoff difference give a good approximation of the annual water balance. (8) Ground-water storage (for baseflow) ranged from 0.14 for the smallest to 0.45 area inches for the two largest watersheds. (9) The period of depletion for the ground-water storage in dry periods was about 20 days for the smallest and about 50 days for the largest watersheds. (10) Major streams on the largest watersheds were never dry in the period 1948 to 1955, but the channel on the smallest watershed was dry for some interval every year. And (11) although the larger streams could be classified as perennial, the minimum flows of 50 to 100 gallons per hour per square mile are too small for direct use by watershed residents in dry periods.

U. Mo., Col. Agr., Agr. Expt. Sta., Columbia, Mo.

## Hydrology

Thomas, R. O. WATER--A LIMITING RESOURCE? J. Irrig. and Drain. Div., ASCE 84(IR 3) 1754: 1-13. Sept. 1958.

This paper emphasizes the probable degree of magnitude of the anticipated demand for water in the United States. It compares the overall availability of water in the United States with the major domestic, agricultural, and industrial demands made upon the supply. It ventures to predict future demands in conformity with past and present trends of use. It is not designed to be comprehensive in scope, as many uses and demands are neglected. It is designed to evoke wide discussion of the implications inherent in the apparent adverse balance between supply and probable demand, and to engender recommendation for present and future action to prevent exhaustion of the supply.

Sacramento, Calif.

Stout, G. E. RADAR FOR RAINFALL MEASUREMENTS AND STORM TRACKING. J. Hydraul. Div., ASCE 85(HY 1): 1-16. Jan. 1959.

During World War II radar was recognized as an excellent instrument for obtaining data on the spatial distribution of precipitation. During the past ten years considerable research has been supported by the Department of Defense at various institutions to determine the application of radar in Meteorology. Efforts have been concentrated on the quantitative measurement of precipitation and on the use of radar for the detection and tracking of tornadoes, severe winds, and hailstorms. As a result of these studies, networks of radar are now being installed by various agencies interested in weather. In some cases radar sets are being procured by industry to improve short-range forecasts of precipitation and weather which are pertinent to their operations.

Illustrations show that radar occasionally detects the initiation of a new precipitation area one to six hours before it reaches a regular hourly reporting weather station. The

areal extent of precipitation is fairly accurately displayed and the relative intensity of precipitation can be determined. Changes in the intensity and nature of the precipitation as well as in exact timing of the event are readily determined. Precise quantitative measurements for all types of rains have not been obtained to date. Despite this limitation, the river forecaster, hydrologist, and meteorologist can make use of radar to improve their skill in short-range forecasting of rainfall and river-stages especially during flash floods.

By observing severe thunderstorms on radar scopes that are associated with tornadoes, the meteorologist is learning to track existing storms and perfect his short-range forecast of areas for future warning. The loss of life during the 1957 tornado season was greatly reduced through use of radar to predict approaching severe storms.

Ill. State Water Survey, Urbana, Ill.

Barnes, B. S. CONSISTENCY IN UNITGRAPHS. J. Hydraul. Div., ASCE 85(HY 8): 39-61. Aug. 1959.

Karnafuli River was chosen as an example because its hydrographs cannot be analyzed by conventional methods. The river is fed by protracted monsoon rains and its flow is sluggish. The flood events are so smoothly compounded that the common methods of deriving the unitgraph are useless. A solution by normal equations or by multiple correlation would have been defeated by the lack of detailed rainfall data or by the variable lag time. Any other established method might have failed to disclose the double crest of the unitgraph. It was interesting to discover that the characteristic second crest was present in all eight unitgraphs that were derived for Karnafuli River by this procedure.

In the practice of flood hydrology there are no good substitutes for experience and judgment. The personal equation, however, should be removed from the actual technical processes as far as it is practicable to do so. It is generally recognized that basic streamflow data of good quality are likely to be much more consistent than the unitgraphs that are obtained from them. If the results of individual studies can be made more comparable, the unitgraph method can be more thoroughly explored. The methods outlined in this paper are submitted as proposed steps in that direction. The writer believes that they can readily be adapted for solution by the electronic digital computer, which would greatly facilitate the processing of large quantities of data.

International Engin. Co., Inc., San Francisco, Calif.

Van Burkalow, A. THE GEOGRAPHY OF NEW YORK CITY'S WATER SUPPLY: A STUDY OF INTERACTIONS. Geog. Rev. 39: 369-386. 1959.

The story of New York City's water supply is one of interactions: between various elements of the earth environment within the watershed areas; between man and the earth environment both locally and in more distant areas; between the city and individuals in the watershed areas; between the city and other political units or agencies (the United States Supreme Court, New York State and adjoining states, state agencies and departments, counties, townships, villages, school districts); and between man's resource needs and government regulations. On the one hand the amount and quality of the water available to the city have been affected by the physical and cultural geography of the watersheds and by the political organization of the main Delaware Valley. On the other hand the development of the city's water supply has affected the physical and cultural geography of the watersheds and of the Delaware Valley. In these more distant areas it has not influenced political organization, but the city's own political organization, resulting from the creation of the Greater City, may have been partly influenced by water needs and developments. And both locally (on Long Island) and in the Delaware Valley the utilization of water resources has resulted in government regulation, which in its turn has influenced the availability of water.

To understand the geography of New York City's water supply, we must know the locational facts of where the water comes from, where it is stored, and by what routes it reaches the city. And we must know descriptive facts about the source areas. But these

facts, locational and descriptive, are only the raw materials of geography. From them must come an understanding of the interactions discussed above, a compound of physical, cultural and political geography.

Dept. Geology and Geography, Hunter Col., New York City, N. Y.

Bagley, J. M., Criddle, W. D., and Higginson, R. K. WATER SUPPLIES AND THEIR USE IN IRON, WASHINGTON, AND KANE COUNTIES OF UTAH. Utah Agr. Expt. Sta. Spt. Rpt. 13, 56 pp. 1959.

A systematic and complete study of water problems of Utah on a watershed basis are urgently needed. With increased use of a limited resource, it becomes increasingly important to know "how much" and "where" the waters of the state are being used. This knowledge will allow for efficient and economical balancing of requirements against supply.

The primary objective of this study was to ascertain and inventory supplies and uses of water available to individual areas in Iron, Washington, and Kane Counties. The location of the study is commonly referred to as the "tri-county area". Once such an inventory is completed, correlations, comparisons, and analyses of all basic data available may be used in the formulation of plans to make most effective and efficient use of the resource.

This study sought to determine the factors involved and how they should be considered in any complete water-use investigation. By analyzing such information, ways of improving existing irrigation systems and institutions might be conceived and an intelligent determination made as to the availability of water for any kind of expanded development.

SWCRD, ARS, USDA and Utah State U. Logan Agr. Expt. Sta., Logan, Utah.

Walton, W. C., and Stewart, J. W. AQUIFER TESTS IN THE SNAKE RIVER BASALT. J. Irrig. and Drain. Div., ASCE 85(IR 3): 49-69. Sept. 1959.

The results of 11 aquifer tests and specific capacity data for 238 production wells indicate that the coefficient of transmissibility of the Snake River basalt ranges from $1 \times 10^5$ gpd per foot to $1.8 \times 10^7$ gpd per foot and averages about $4 \times 10^6$ gpd per foot. The coefficient of transmissibility of the entire thickness of the Snake River basalt probably greatly exceeds the values determined from test data because the wells for which data are available partially penetrate the aquifer. The coefficients of storage computed from test data are all in the water-table order of magnitude and range between 0.02 and 0.06. For the Snake River Plain, the average yield of the basalt to a 16-inch well during a well-acceptance test 8 hours in duration is about 2,100 gpm per foot. The aquifer ranks as one of the most productive in the United States. The average depth of well below land surface is 290 feet and the average penetration below the regional water table is 100 feet.

Engin. State Water Survey, Boise, Idaho.

Nelson, H. T. UPSTREAM IRRIGATION IMPACT ON COLUMBIA RIVER FLOWS. J. Irrig. and Drain. Div., ASCE 85(IR 1): 25-43. Mar. 1959.

The paper represents analyses of long-time Columbia River flows at The Dalles to demonstrate magnitude of peak flow reductions and low flow increases due to upstream irrigation. Irrigation regulations may account for up to 12% increase in low flows through irrigation of 8-1/2 million acres upstream by the year 2010.

U S. Bur. Reclam., Boise, Idaho.

Lara, J. M., and Schroeder, K. B. TWO METHODS TO COMPUTE WATER SURFACE PROFILES. J. Hydraul. Div., ASCE 85(HY 4): 79-94. April 1959.

Two methods derived by the authors in their work with the Bureau of Reclamation are presented for the computation of water surface profiles used for the development of tail water rating curves and backwater profiles. Examples of each method are included which show the computational procedure.

U. S. Bur. Reclam., Denver, Colo.

Smerdon, E. T., and Beasley, R. P. THE TRACTIVE FORCE THEORY APPLIED TO STABILITY OF OPEN CHANNELS IN COHESIVE SOILS. Mo. Agr. Expt. Sta. Res. B. 715, 36 pp. 1959.

The tractive force theory presents a logical criterion by which the problem of the stability of open channels in cohesive soils can be investigated. The purpose of this study was to investigate a number of cohesive soils, both in a soil physics laboratory and in a hydraulic flume, to determine if the critical tractive force could be correlated to the physical properties of the soils.

Eleven Missouri soils were selected for the tests. These soils were chosen to give a wide range in the degree of soil cohesion. The soils ranged from a silty loam soil with little cohesion to a highly cohesive clay soil. The plasticity indexes of the soils ranged from 6.6 to 44.1.

The critical tractive force of each soil was determined from the tests in a hydraulic flume which was 60 feet long, 2.51 feet wide, and 1.5 feet deep. The hydraulic flume was equipped so that soil samples could be placed in the bottom of the flume for the tests. The critical tractive force for each of the soils tested was then related to pertinent physical properties of the soils.

The data from the hydraulic tests and physical tests on the soils were analyzed statistically to determine the significance of the apparent correlation between critical tractive force and pertinent soil properties. For the soils tested, the critical tractive force was found to be well correlated with each of the following soil properties: (1) The plasticity index; (2) the dispersion ratio; (3) the mean particle size; and (4) the percent clay. A less significant correlation existed between critical tractive force and the phi-mean particle size.

The data indicated that the critical tractive force exhibited a logarithmic relationship to the soil properties selected for analysis.

The results of the study indicate that the following conclusions can be drawn: (1) The problem of the stability of open channels in cohesive soils can be studied on the basis of the tractive force theory. (2) The critical tractive force in cohesive soils is related to certain physical properties of the soils. Therefore, the effect of soil cohesion on open channel stability can be determined by physical tests of the soils. And (3), for the soils tested, the critical tractive force is best correlated to either the plasticity index or the dispersion ratio, although good correlation also exists between the critical tractive force and either the mean particle size or the percent clay.

U. Mo., Col. Agr., Agr. Expt. Sta., Columbia, Mo.

Vanoni, V. A., and Nomicos, G. N. RESISTANCE PROPERTIES OF SEDIMENT-LADEN STREAMS. J. Hydraul. Div., ASCE 85(HY 5): 77-107. May 1959.

Experiments were made to determine the relative effects on the friction factor of a flow of the suspended sediment load and the configurations which form on sand beds of streams. Results showed that the friction factor of a stream carrying suspended sediment is less than a comparable one without sediment. They also showed that the reduction of friction factor due to changes in bed configuration is much larger than that due to suspended sediment.

Calif. Inst. Technol., Pasadena, Calif.

Renfro, G. W., and Moore, C. M. SEDIMENTATION IN THE WESTERN GULF STATES. J. Hydraul. Div., ASCE 84(HY 5) 1806: 1-15. Oct. 1958.

A summary of some of the more important reservoir sedimentation surveys made by the Soil Conservation Service in the area is presented. An analysis is made of existing suspended sediment and reservoir sedimentation survey records in a seven-state area which includes 26 physiographic areas. Detailed methods used by the Soil Conservation Service in determining sediment yields are described. The effect of watershed protection measures, including floodwater retarding structures in reducing sediment yield from watersheds is discussed.

Engin. and Watershed Planning Unit, SCS, USDA, Fort Worth, Tex.

Poland, J. F. LAND SUBSIDENCE DUE TO GROUND-WATER DEVELOPMENT. J. Irrig. and Drain. Div., ASCE 84(IR 3) 1774: 1-11. Sept. 1958.

In several areas in California intensive development of ground water has been accompanied by marked subsidence of the land surface. The areas of known substantial subsidence believed to have been caused chiefly by withdrawal of ground water are the Santa Clara Valley in Santa Clara County, the Los Banos-Kettleman City, Tulare-Wasco, and Arvin-Maricopa Areas in the San Joaquin Valley, and the La Verne area east of Los Angeles; and in addition, a special case, the Delta area at the confluence of the Sacramento and San Joaquin Rivers. Subsidence has occurred in many other areas of ground-water development in California, but in general has not been of sufficient magnitude or of such a nature to have created noticeable problems to date. In the areas of known substantial subsidence, the subsidence has created problems, primarily related to construction water withdrawal and in land use.

This paper presents a brief description of the subsidence in the six areas, outlines the principal problems that have developed, describes what is being done at the present time to determine the causes, and suggests additional work needed as a basis for making plans to alleviate or minimize the various problems caused by land subsidence.

The subsidence of greatest vertical magnitude in California is the one at the Wilmington oil field. That subsidence is mentioned only briefly in this paper because it is caused chiefly by decline in pressure in the oil zones due to removal of oil and gas rather than ground water.

U. S. Geol. Survey, Sacramento, Calif.

Upson, J. E. GROUND-WATER PROBLEMS IN NEW YORK AND NEW ENGLAND. J. Hydraul. Div., ASCE 85(HY 6): 1-12. June 1959.

Some ground-water problems in New York and New England involve only a determination of the occurrence and quality of water in geologic formations, and estimates of the productivity of wells. Other problems, such as sea-water encroachment in Long Island, require advanced knowledge of the hydraulics of ground water movement.

Increasingly, the problems involve the interrelationship between ground water and surface water, as in: (1) Estimates of how changes in stream regimen affect ground-water conditions; (2) relative practicability of developing surface water and ground water for particular needs; or (3) measurement of surface discharge to indicate amounts of ground water available.

An example of the first type of problem is that in the Ipswich River drainage basin in Massachusetts. Here, investigations are related in part to indicating the possible effect on nearby municipal wells of artificially lowering the river channel.

An example of the second type is that in the Blackstone River Valley, Rhode Island. The problem is to determine whether it is practicable to obtain additional water for the city of Woonsocket, and for industries downstream, from ground water or from upstream surface reservoirs.

An example of the third type is that in the Pawcatuck River drainage basin, Rhode Island, where a quantitative estimate of ground water available to supply a proposed industrial park is needed. Location of productive water-bearing strata can be based

on ground-water studies alone, but estimation of the total amount of water available can best be done by measuring river outflow and estimating evapotranspiration losses from swamps and lakes.

Water Resources Div., U. S. Geol. Survey, Washington, D. C.

Hoffman, J. F. GROUND WATER UTILIZATION, SUFFOLK COUNTY, L. I., NEW YORK. J. Hydraul. Div., ASCE 85(HY 7): 25-41. July 1959.

Ground water pumped from the aquifers underlying Suffolk County, Long Island, N. Y. for all uses amounted to more than 24 billion gallons in 1955. Water problems that may arise through constantly increasing withdrawals include: (1) Extensive sea water encroachment; (2) marked depletion of storage; (3) industrial contamination; and (4) rises in water temperatures.

U. S. Geol. Survey, Washington, D. C.

Thomas, R. O. LEGAL ASPECTS OF GROUND WATER UTILIZATION. J. Irrig. and Drain. Div., ASCE 85(IR 4): 41-65. Dec. 1959.

This paper discusses: (1) The historical basis of water rights doctrines; (2) their application to rights to the use of ground water; (3) general considerations affecting the regulation of rights; (4) various aspects of ground water utilization, including problems of recharge and water demand; and (5) concludes with a presentation of some of the possible legal problem areas which may arise in planning and administering future ground water operations.

State Dept. of Water Resources, Sacramento, Calif.

## Engineering design

Remmenga, A. J. BRIDGES OUT, INLETS IN: NEBRASKA SAVES MONEY. Land Impr. 5(8): 12-13. 1958.

A watershed protection program initiated in 1935 is estimated by soil conservationists to have saved Nebraska's Washington County more than $450,000 in the past 20 years.

In that time the Washington County supervisors, the Papio Soil Conservation District and the Soil Conservation Service have replaced more than 150 costly county road bridges with drop inlet structures.

The installations, built at a total cost of $150,000, have resulted in an estimated $10,000 saving each year in maintenance costs and have helped reclaim crop land valued in excess of $100,000.

A drop inlet is constructed by an upright pipe on the upstream side of a planned earthen dam and a nearly level pipe of sufficient length to carry water under the dam. The earthen dam becomes the roadbed in place of the former bridge.

Water is backed up behind the dam to the height of the upright pipe and excess water flows down the pipe, under the dam and is safely discharged on the opposite side of the road.

Present costs of replacing an 80-foot bridge is about $20,000 while it costs about $16,000 to install a drop inlet. Total maintenance costs on the 150 drop inlets in use in the county are less than $150 each year.

The conservation program has also resulted in substantial benefits to farmers by having large gullies replaced with grassed waterways.

No address given.

Morris, H. M. DESIGN METHODS FOR FLOW IN ROUGH CONDUITS. J. Hydraul. Div., ASCE 85(HY 7): 43-62. July 1959.

Design curves and methods are presented for determining friction factors for turbulent flow in closed conduits and tranquil open channel flow. The methods are physically realistic, being based on five distinct regimes of turbulence and related to the actual physical dimensions of the boundary roughness elements.

Va. Polytechn. Inst., Blacksburg, Va.

Webster, M. J., and Metcalf, L. R. FRICTION FACTORS IN CORRUGATED METAL PIPE. J. Hydraul. Div., ASCE 85(HY 9): 35-74. Sept. 1959.

A study was made to determine friction coefficients for flow in large corrugated metal pipe by measurement of head losses in pipes 3, 5, and 7 ft. in diameter. Velocity distribution for several discharges in each test pipe were made so that the results could be generalized to show the relationship between friction coefficients and absolute roughness. Data taken during the study are presented together with recommended values of friction and roughness coefficients.

U. S. Army Engin. Dist., Portland, Oreg.

Carlson, E. J. GRAVEL BLANKET REQUIRED TO PREVENT WAVE EROSION. J. Hydraul. Div., ASCE 85(HY 5): 109-145. May 1959.

Surface wave erosion tests were performed in a laboratory hydraulic wave flume on angular talus, and rounded gravel material, and fine base material shipped from Yakima Project, Washington. The tests were made to determine the cover blanket needed to prevent leaching of fine base material.

The most stable cover blanket was formed by screening the talus material on a 3/4-inch screen. The minus 3/4-inch material being placed over the base material with the plus 3/4-inch material on the surface. Motion pictures were taken for a record of the 14 tests.

Hydraul. Lab., U. S. Bur. Reclam., Denver, Colo.

Powell, R. W., and Posey, C. J. RESISTANCE EXPERIMENTS IN A TRIANGULAR CHANNEL. J. Hydraul. Div., ASCE 85(HY 5): 31-63. May 1959.

A 400-ft adjustable-slope triangular flume was tested smooth and roughened with small rectangular battens at various spacings. A comparison is made of Manning's formula with some more recent suggestions, and the velocity distribution, secondary currents, and other phenomena are reported.

Jr. Author, State U. Iowa, Iowa City, Iowa.

Dunn, I. S. TRACTIVE RESISTANCE OF COHESIVE CHANNELS. J. Soil Mechanics and Found. Div., ASCE 85(SM 3): 1-24. June 1959.

A method of estimating the tractive resistance of cohesive channel beds is proposed that uses information obtained from simple soil tests (Atterberg Limits, Particle Size Analysis, Vane Borer Tests). The study was made for soil taken from cohesive channels in Colorado, Nebraska, and Wyoming.

The investigation of cohesive channel beds using the experimental methods described is not limited to the range of soil properties appearing in this study. The same methods could be used with the object of extending the information obtained here to finer and more plastic soils. The same methods could also be used to investigate the critical tractive resistance of beds and banks of ephemeral streams. The strength measured by the vane borer in this case would include apparent cohesion caused by partial saturation. The methods could also be extended to the study of erosion from farm and forest lands which are subjected to water flow during periods of storm.

Colo. State U., Fort Collins, Colo.

Ferrell, W. R. Jr. MOUNTAIN CHANNEL TREATMENT IN LOS ANGELES COUNTY. J. Hydraul. Div., ASCE 85(HY 11): 11-19. Nov. 1959.

This paper presented the background and some of the details of a program of research and developments aimed at reducing the volume of debris that must be handled by the Flood Control District. The stabilization of the main channels of a watershed by mechanical means has emerged as the most practical method of accomplishing debris reduction. Mechanical stabilization by the use of check dams reduces erosion by halting channel downcutting and by reducing the occurrence of bank sloughing. Other benefits also provided are the new debris storage capacity behind each of the check dams and the conservation of water through direct storage and increased percolation opportunity. The Big Santa Anita Project, near Arcadia, which is presently under construction, represents the first full-scale use of this type of treatment in this area. The project, when completed, will stabilize 50,000 feet of main channel in this 11 square mile watershed. The project cost is estimated to be $1,750,000.

Los Angeles County, Flood Control Dist., Los Angeles, Calif.

Benson, M. A. CHANNEL-SLOPE FACTOR IN FLOOD-FREQUENCY ANALYSIS. J. Hydraul. Div., ASCE 85(HY 4): 1-7. Apr. 1959.

Annual flood peaks in New England have been related to many hydrologic factors. The main-channel slope has been found next in importance to drainage-area size. The slope for that part of the main channel between 85 and 10 percent of the total distance above the gaging point provides the best correlation with flood magnitudes.

U. S. Geol. Survey, Washington, D. C.

Wright, K. R. MODEL APPROACH TO A GROUNDWATER PROBLEM. J. Irrig. and Drain. Div., ASCE 84(IR 4) 1862: 1-9. Dec. 1958.

When adverse field conditions preclude a direct field investigation of a groundwater problem, models can often be utilized to advantage to determine directions of flow, velocities, location of hydraulic divides, and to forecast conditions which may occur in the future. Two types of models, electric analog plotter and hydraulic, were found satisfactory for investigation of a groundwater problem located in an unconfined aquifer.

The electric analog plotter was somewhat limited by the necessity of assuming a one-density system, but otherwise it offered good detailed information on the flow patterns. The hydraulic model operated satisfactorily with different density liquids; non-equilibrium conditions were steadily studied; and a time scale was introduced making it possible to forecast future events which would be most difficult to obtain by mathematical analysis.

The result of the two models checked each other in their field of mutual results, which shows their usefulness in the investigation of groundwater problems.

Hydrol. Br., U. S. Bur. Reclam., Denver, Colo.

Lara, J. M., and Schroeder, K. B. REVISED COMPUTATION OF A VELOCITY HEAD WEIGHTED VALUE. J. Hydraul. Div., ASCE 85(HY 9): 69-74. Sept. 1959.

A revised computational procedure is proposed on the determination of a weighted value of the velocity head. An example of the procedure is illustrated by a hydraulic computation of the discharge of a stream using the slope-area method.

U. S. Bur. Reclam., Denver, Colo.

Liu, H. K. and Hwang, S. Y. DISCHARGE FORMULA FOR STRAIGHT ALLUVIAL CHANNELS. Jr. Hydraul. Div., ASCE 85(HY 11): 65-98. Nov. 1959.

The proposed discharge formula contains a discharge coefficient and exponents for hydraulic radius and slope. Both the coefficient and the velocities are given as functions of bed forms and bed material. Velocities computed by the formula check closely with those obtained in the laboratory.

Colo. State U., Fort Collins, Colo.

Wolman, M. G. FACTORS INFLUENCING EROSION OF A COHESIVE RIVER BANK. Amer. J. Sci. 257: 204-216. 1959.

The sinuous channel of Watts Branch in Montgomery County, Maryland, traverses a grassy meadow nearly devoid of trees. The creek has a drainage area of four square miles and the river bank is composed primarily of cohesive silt. Resurveys of cross sections during the five years 1953-1957 have revealed as much as seven feet of lateral erosion. Over the past two years, additional measurements of the amount of erosion around rows of steel pins driven horizontally into the bank have been made at frequent intervals. These observations indicate several combinations of factors primarily responsible for the progressive recession.

Approximately 85 percent of the observed erosion occurred during the winter months of December, January, February, and March. A thickness of as much as 0.4 feet of sediment was eroded from the bank at specific points in a period of several hours during which a bankfull flow attacked banks which had previously been thoroughly wetted. Erosion was most severe at the water surface. Little or no erosion was observed during the summer despite the occurrence of the highest flood on record in July 1956.

Second in erosion effectiveness were cold periods during which wet banks, frost action, and low rises in stage combined to produce 0.6 foot of erosion in six weeks during the winter of 1955-56. Significant erosion also resulted from the combination of moist banks and low rises in stage. Lastly, crystallization of ice and subsequent thawing, without benefit of changes in stage, also produced some erosion as did flashy summer floods even on hard, dry banks. Inasmuch as such summer floods constitute the rare and "catastrophic" events on small drainage basins in this region, present observations suggest that the cumulative effect of more moderate climatic conditions on this process of erosion exceeds the effect of rarer events of much greater magnitude.

This preliminary analysis of several factors responsible for erosion of the cohesive river bank indicates that there is perhaps a crude correlation between precipitation and erosion during selected intervals of time. Precipitation exerts an affect both through increasing discharge in the channel and by increasing the moisture in the bank. Frost action acts similarly both to hold moisture in the soil and to comminute surface material, thus preparing it for erosion.

Dept. Geography, Johns Hopkins U., Baltimore, Md.

Brakensiek, D. L. FITTING A GENERALIZE LOG NORMAL DISTRIBUTION TO HYDROLOGIC DATA. Amer. Geophysical Union Trans. 39: 469-473. 1958.

A statistical distribution is developed which makes it possible to fit a wide range of positively skewed hydrologic data. It is shown that the general least-squares fitting equations will reduce to simple forms for fitting a normal, log-normal or extreme-value distribution to data. Two fitting processes are developed for fitting data by the so-called generalized log-normal distributions. Examples are given for illustrating the fitting procedures.

SWCRD, ARS, USDA, Beltsville, Maryland.

Snyder, F. F. SYNTHETIC FLOOD FREQUENCY. J. Hydraul. Div., ASCE 84(HY 5) 1808: 1-22. Oct. 1958.

A procedure is developed for computing the flood discharge probability associated with a given rainfall-duration-frequency pattern on natural drainage basins, non-channelized overland flow areas and areas with storm sewer drainage utilizing basin

runoff-producing characteristics of area, length, slope, friction and shape. The approach is patterned after the so-called rational method and utilizes the time of concentration concept with a unit hydrograph interpretation, but recognizes and evaluates separately the effect of storage existing in all types of channels or conduits and an average rainfall-runoff relation. The variable factors in this case have been evaluated for application in the vicinity of Washington, D. C.

Hydraul. Engin., Off. the Chief Engin., Washington, D. C.

Thom, H. C. S. A TIME INTERVAL DISTRIBUTION FOR EXCESSIVE RAINFALL. J. Hydraul. Div., ASCE 85(HY 7): 83-97. July 1959.

Although recurrence intervals are of primary interest in frequency analysis of excessive precipitation, present methods average these intervals and thus conceal much design information.

A mean recurrence interval of 5 years for a y-event gives no measure of the risk that y-events will occur in two successive years. The purchaser of a drainage system would be little impressed by a mean recurrence interval if the probability of overloadings spaced one year or less apart were high and overloadings occurred in the first two years of operation.

By relating probability to recurrence interval the distribution of recurrence interval for a preassigned rainfall amount is obtained and this provides additional information for design.

Off. Climatol., U. S. Weather Bur., Washington, D. C.

Israelsen, O. W. THE ENGINEER AND WORLDWIDE CONSERVATION OF SOIL AND WATER. J. Irrig. and Drain. Div., ASCE 84(IR 3) 1775: 1-22. Sept. 1958.

The role of the engineer in worldwide soil and water conservation necessary to meet increasing food requirements is emphasized.

A brief review of progress by construction of drainage systems and irrigation projects is presented. Some of the large surface reservoirs are listed, the volumes of surface-reservoir water stored for irrigation are reported; and the need for more use of groundwater reservoirs is suggested. The necessities for efficient conveyance of water in world canals of more than a million miles in length are stressed. The relationships of efficient application of water on the farms, in the estimate 15 million irrigations per year, to worldwide soil and water conservation are outlined.

Utah State U., Logan, Utah.

MacFarlane, I. C. A REVIEW OF THE ENGINEERING CHARACTERISTICS OF PEAT. J. Soil Mech. and Found. Div., ASCE 85(SM 1): 21-35. Feb. 1959.

This paper represents a resume of information contained in a number of references concerned in some way with physical and mechanical properties of peat. Information is presented under the headings: (1) Classification; (2) percent ash; (3) acidity reaction; (4) density and specific gravity; (5) water holding capacity; (6) void ratio and shrinkage on drying; (7) permeability; (8) shear strength; (9) bearing capacity; and (10) consolidation characteristics and settlement.

From this report it is evident that many gaps exist in the knowledge of engineering properties of peat. What information is available is scanty, sometimes contradictory and confusing. A list of 25 references is included.

Nat l. Res. Council, Ottawa, Canada.

Trask, P. D. EFFECT OF GRAIN SIZE ON STRENGTH OF MIXTURES OF CLAY, SAND, AND WATER. Geol. Soc. Amer. B. 70: 569-579. 1959.

Many factors affect the strength of what engineers call soil. This report deals primarily with the effect of the grain size of sand or silt particles mixed with the clay in the soil. In order to understand the effect of grain size, the influence of (1) Water content;

(2) type of clay mineral; and (3) ratio of clay to sand in the soil must be known. The effect of these four variables was investigated by measuring the strength of a series of synthetic soils in which the water content, clay type, clay-sand ratio, and grain size of admixed sand were changed from one experiment to another. For given water content, kaolin and illite are essentially equal in strength, and both are much weaker than montmorillonite. Ball clay--a kaolin containing organic matter--is intermediate in strength. For all clays the strength increase, for given water content and for given grain size, as the ratio of clay to sand increases. For given water content and given clay-sand ratio, the strength increases as the grain size of the sand decreases below 135 microns. For coarser sand, grain size has little effect. The cause of the greater strength for increasing fineness of sand is ascribed to the well-known principle of greater surface area upon which forces can act.

Dept. Engin., U. Calif., Berkeley, Calif.

Seed, H. B., and Chan, C. K. UNDRAINED STRENGTH OF COMPACTED CLAYS AFTER SOAKING. J. Soil Mechanics and Found. Div., ASCE 85(SM 6): 31-47. Dec. 1959.

Test data have been presented to show that soil structure has a profound effect on a variety of soil properties including shrinkage, swell pressures, permeability, pore-water pressures induced during loading and undrained strength. However, it has also been found that soil structure appears to have little effect on soil strength characteristics expressed in terms of effective stresses, and its influence on the results of undrained strength tests on saturated specimens is therefore due essentially to its effect on the pore-water pressures developed in the samples during the testing process. Saturated samples of compacted clay having flocculated structures tend to develop substantially lower pore-water pressures at low strains in undrained tests than do samples of the same density and water contents having dispersed particle arrangements and consequently exhibit greater resistance to deformation at this stage of the test. As the strain increases, however, these initial differences in pore-water pressure tend to disappear, and specimens with different initial structures but the same dry density and water content therefore tend to have similar undrained strengths measured at high strains.

These facts have been utilized in the present paper to demonstrate and explain the different relationships which may exist between the initial composition and the undrained strength of compacted clays after soaking, both for "strengths" determined at low and high values of strain. However, for samples soaked after compaction the problem is further complicated by the fact that the initial structure of a compacted sample also affects the amount of swelling, as well as the pore-water pressure induced by loading; furthermore, the final composition after swelling is also influenced by the surcharge pressure during the swelling process. Consequently a wide variety of relationships between initial composition and undrained strength after soaking can be found for various soil types and surcharge pressures.

The usefullness of the stress-strain relationship of soil samples compacted wet of optimum by kneading compaction as an indicator of the probable significance of method of compaction, molding water content and strain at failure on the induced strength characteristics of compacted clays is described.

Eng. Materials Lab., U. Calif., Berkeley, Calif.

Seed, H. B., and Chan, C. K. STRUCTURE AND STRENGTH CHARACTERISTICS OF COMPACTED CLAYS. J. Soil Mechanics and Found. Div., ASCE 85(SM 5): 87-128. Oct. 1959.

The authors attempted to demonstrate and explain some of the factors affecting the structure and strength of compacted clays and the relationships between composition and strength in the as-compacted condition. The influence of soil structure on shrinkage, swelling, swell pressures, stress-deformation characteristics, undrained strength, pore-water pressures and effective strength characteristics has been described. It was shown that although soil structure may have a profound effect on undrained 'strengths'

determined at low strains because of its influence on pore-water pressures, it appears to have little or no effect on soil strength characteristics expressed in terms of effective stresses. The influence of the strain at which undrained soil strength is determined on the relationship between composition and strength has been demonstrated, and typical examples of this relationship, illustrating the influence of changes in soil structure on the form of the results obtained, have been presented.

It has also been shown that the structure developed in a compacted soil is greatly influenced by the shear strains induced in the soil during the compaction process; such strains apparently tend to produce a dispersed arrangement of soil particles and thus, for soils in which the interparticle forces are not so great that flocculation occurs under all compaction conditions, methods of compaction inducing shear strains produce a greater degree of particle orientation, lower strengths at low strains in undrained tests, greater shrinkage and less swelling than methods of compaction inducing little shear strain. As a consequence of this effect, different methods of compaction tend to produce similar characteristics in samples compacted dry of optimum to any given density and water content but produce different characteristics in samples compacted wet of optimum. For samples compacted wet of optimum to any given density and water content, particle orientation and shrinkage tend to decrease and strength at low strains tends to increase in the following order of compaction methods: kneading, impact, vibratory, static.

U. Calif., Berkeley, Calif.

## Snow Surveys

Johnson, O. A., and Boyer, P. B. APPLICATION OF SNOW HYDROLOGY TO THE COLUMBIA BASIN. J. Hydraul. Div., ASCE 85(HY 1): 61-81. Jan. 1959.

The significant developments in applied snow hydrology which have resulted from the work of Snow Investigations research and analysis are: (1) A point snowmelt equation based on heat supply from short and longwave radiation, convection and condensation; (2) a general snowmelt formula applicable to any drainage area when overall coefficients characteristic of that basin are evaluated for the degree of exposure to wind and radiation; (3) relative magnitudes of melt components under different sky and forest cover conditions; (4) numerical appraisal of the storage and delay effect of the snow pack on runoff; and (5) runoff forecast procedures based on water balance and on a coastal winter-flow index.

In addition to the above direct applications, numerous investigations were performed which were of the more basic nature. These deal with the theoretical aspects of snow physics, precipitation, snow cover, and soil moisture measurements, forest effects on snow accumulation and evapotranspiration loss, heat exchange between the snowpack and its environment, the distribution of the snowpack in mountainous areas, and the water balance in areas of snow accumulation.

Knowledge of snowmelt is not complete, but enough is known now to supplement the degree-day approach by including humidity, wind speed, and radiation values even if they must be partly estimated, particularly for clear weather melt in open and partly forested areas. Only during a rain in a dense forest, where the wind speed and the solar radiation are small and nearly constant, can the temperature alone define the snowmelt properly.

Direct application of these principles is now being made in estimating design floods for determining the capacity of flood control storage projects and river channels, and the related problems of conduit capacity, revetment design, levee heights, and day-to-day operation of the reservoirs. Seasonal operation is based on results of monthly forecasts of the remaining runoff by the water balance method.

The network of stations is being expanded to include more hydrologic information and better areal coverage. Radiation data are observed at only a few stations and this class of observations should be extended to cover more area. The snow fields in the high mountains are uninhabited, and observations of climatological events in this large and important area are difficult to obtain but steady advances are being made by use of

radio-reporting facilities. The distribution of snow cover during the melt period is also being observed on a systematic basis by means of aerial snow reconnaissance.

Corps. Engin., U. S. Dept. Army, Portland, Oreg.

Zoller, J. H., and Lenz, A. T. SNOWMELT RUNOFF. J. Hydraul. Div., ASCE 84(HY 6) 1834: 1-31. Nov. 1958.

The primary factors relating to the melting of snow were evaluated for the snowmelt periods of 1938 through 1952 for the Big Eau Pleine River basin in Wisconsin. Convection and condensation melt potentials were computed from equations developed by previous investigators. A nomograph was devised for computing radiation snowmelt potential from isolation, as related to sun position determined by date, modified by cloud cover and albedo. The assumption was made that the runoff for any day would be a function of the summation of melt potentials for that day. A snowmelt unit hydrograph was developed and relative daily hydrographs were computed for each day. These relative hydrographs were then combined by a trial and error procedure to reproduce the recorded snowmelt hydrograph for each year. From this process the daily runoff values which contributed to the total hydrograph were computed. These daily runoff values were compared with the total melt potentials for the same days, and the correlation noted was expressed by an equation.

U. N. H., Durham, N. H.

## Ground Water Recharge

Richter, R. C., and Chun, R. Y. D. ARTIFICIAL RECHARGE OF GROUND WATER RESERVOIRS IN CALIFORNIA. J. Irrig. and Drain. Div., ASCE 85(IR 4): 1-25. Dec. 1959.

This paper discusses: (1) Some of the present needs for practice of artificial recharging of ground water in California; (2) describes the major types of artificial recharge projects used in California; (3) summarizes the extent of artificial recharge activities in California; and (4) reviews some of the important factors related to selection of artificial recharge project sites with particular emphasis on infiltration rates.

Calif. Dept. Water Resources, Sacramento, Calif.

Blair, J. F. RECHARGE SYSTEM OFFERS HOPE FOR IRRIGATION WELLS. Land Impr. 6(11): 16. 1959.

Perhaps the biggest problem facing West Texas irrigation farmers is how to prolong the underground water that is now being pumped out by 30,000 wells. Water tables have been lowered throughout the area; and water engineers say the recharge is not great even when it rains. Many of them foresee a time when the water will be too limited and deep to justify continued pumping.

As a result many methods have been originated to save the water. One of the most promising is a combination irrigation-recharge well that the farmer drills on the edge of a wet-weather lake.

He drills the well a few feet to one side of the high water mark, then angles a ditch from the bottom of the lake into the well. In this ditch a pipe is laid to intersect the well pipe a few feet below the surface. Another hole is drilled beside the well, and a valve is installed so that the lake water can flow into the well or be shut off.

When the lake is full of runoff water from heavy rains, the valve is opened and the lake slowly drains into the well to recharge the partially exhausted sands. While this method won't take the place of a completely recharged water strata, it will afford extra water in rainy or off seasons.

There are thousands of these shallow lakes in the Plains area, some of which cover from 30 to 60 acres and fill up to a depth of 3 to 6 feet during unusually wet seasons. Heretofore the water has mostly evaporated, but by draining it back into the ground, a considerable water saving may be made.

No address given.

Crooke, H. W. A METHOD OF FINANCING GROUND WATER REPLENISHMENT. J. Irrig. and Drain. Div., ASCE 84(IR 4) 1860: 1-14. Dec. 1958.

The annual engineering reports on ground water conditions in the Orange County Water District indicate the average water level in wells had lowered from 21.3 feet above sea level in 1940-1941 to 17.2 feet below sea level in 1950-1951. This drop of 38.5 feet in the average water level occurred during a ten-year period in which 148,583 acre feet of Colorado River water were imported to supplement the natural supplies. The reports also indicated an additional drop of the average water level in wells to 21.0 feet below sea level in 1955-1956. This additional lowering of 3.8 feet in the average water level in wells occurred during a five-year period in which 309,852 acre feet of Colorado River Water were imported. The Engineer's Report on Ground Water Conditions for the water year 1956-1957 indicates a rise in the average water level in wells of 5.5 feet during the one-year period from November 1, 1956 to November 1, 1957 in which the total importations of Colorado River water were in the amount of 148,319 acre feet.

Based on the experience to date, the Board of Directors of the Orange County Water District is proceeding in the belief that a well-balanced adequate supply of ground water for all land owners and inhabitants of the District can be financed by the present dual assessment system, and that the replenishment assessment of charge on the production of ground water is fair, equitable, and practical for the area of the Orange County Water District.

Orange Co. Water Dist., Santa Ana, Calif.

Schiff, L., and Johnson, C. E. SOME METHODS OF ALLEVIATING SURFACE CLOGGING IN WATER SPREADING WITH EMPHASIS ON FILTERS. Amer. Geophysical Union Trans. 39: 292-297. 1958.

Methods of preventing or alleviating clogging of soil pores when spreading water on soil surfaces or injecting water into aquifers for recharge are discussed. Observations of methods such as suction cleaning or scraping to remove clogging materials and restore the infiltration rate in some installed systems are pointed out. Certain past experimental work on the subject is reviewed.

Of various filter materials used in infiltrometers at Bakersfield, sand ranging in size from 0.5 to 1.6 mm maintained a higher infiltration rate than 1/8 or 1/4 inch pea gravel or the existing aquifer material. Information is given on particle size distribution of both the filter and aquifer materials. Head losses due to filters and within the underlying aquifer are shown.

SWCRD, ARS, USDA, Bakersfield, Calif.

## WATER MANAGEMENT

### Irrigation

Bryan, B. B. EDUCATION FOR CONTINUOUS IRRIGATION IN THE HUMID AREAS. J. Irrig. and Drain. Div., ASCE 85(IR 3): 1-14. Sept. 1959.

Irrigation engineers inevitably serve as irrigation educators. As educators they should be familiar with the factors effecting costs, production, and consequent net profits. These include irrigation frequency, land surface preparation, drainage and water distribution. This paper presents an analysis of data concerning these and other factors.

U. Ark., Fayetteville, Ark.

Shockley, D. IRRIGATION FARMING BOOSTS LAND'S $ INCOME. West. Conserv. J. 16(6): 62-64, 67. 1959.

About 36.5 million acres are now irrigated in this country, most of which is in the arid and semi-arid western states. More than half of the farmers and ranchers in Oregon, California, Idaho, Nevada, Utah, Arizona, and Washington, irrigate some or all of their crops--some 16 million acres, or nearly half of the U. S. total.

A short history of irrigation in the west is presented along with the improved methods being used today and a forecast of future prospects.

SCS, USDA, Portland, Oreg.

Beck, V. S. FARMING THE DESERT. West. Crops and Farm Mangt. 8(8): 22G-22H. 1959.

Eldon and Max Durk are building a highly productive farm on 887 acres of desert entry land about five miles south of Hazelton, Idaho. In carrying out their conservation program, the Durk brothers are practicing a good crop rotation and have developed a highly efficient irrigation system.

All of the runoff water is caught in three ponds and is pumped back up the slopes to the head ditch for re-use. A mass production method of installing irrigation structures has been developed.

Clearing and leveling the land, drilling the wells, and installing pumps and pipes cost an average of $96 an acre. The land is flat enough that heavy leveling was required on only a few areas. The three irrigation wells average 348 ft. in depth. Drilling costs were around $7,000, and pumps and pipes cost another $16,000, making the cost average about $23,000, for each well. The annual cost of all pumping operation is $11.50 an acre.

Water management, crop rotation, and fertilizers have been the key to the success on this desert farm.

SCS, USDA, Berkeley, Calif.

Kimbrough, E. A. Jr., Ratliff, E. F., and Edwards, F. E. RESULTS OF SPRINKLER IRRIGATION OF COTTON WITH CHECK DAMS IN FURROWS. Miss. Agr. Expt. Sta. Inform. Sheet 584, 1 p. 1958.

A test was conducted in 1957 to determine the feasibility of using check dams in middles to increase the application rate of water by sprinklers.

Check dams were placed at 10-foot intervals along the rows which had a uniform fall of 3 feet per 100 feet. Rows were spaced on 40 inches, and the cross slope averaged 2.86 percent.

The tests showed that use of check dams will allow a very rapid rate of application of water by sprinkler irrigation. It was satisfactory in a test where the rate of 1.4 inches per hour was used and a total 2.2 inches applied. Under the conventional sprinkler system only 0.38 inches in 1 hour could be applied without causing erosion.

Miss. State Col., Agr. Expt. Sta., State College, Miss.

Herpich, R., and McKinney, R. D. IRRIGATION FARMING FOR PROFIT. Kans. Agr. Expt. Sta. C.372, 34 pp. 1959.

"Irrigated Agriculture" means using a program that controls such physical factors of crop production as planting rates, available plant nutrients, varieties of crops, available moisture, insects, etc. For all of those to help, each of them must be controlled and maintained at or near its peak potential for the particular crop being grown.

Irrigation makes farming an intensive enterprise. It does not insure prosperity or stabilization but it can provide assurances of this kind.

Four major resource areas must be considered for successful irrigation: management, capital, labor, and land. Each must be used fully to make the project the most profitable.

Advantages of the Sprinkler Method are: (1) Does not require excessive land grading; (2) makes best use of limited water supply; (3) does not require skilled labor to operate

efficiently; (4) returns full benefits the first year; (5) makes light applications uniformly; (6) requires less or no land for ditches; (7) can be easily and efficiently designed for use on small areas; (8) can be used on soils with high intake rates (.75 inch per hour or more); and (9) is easily adapted to production of specialized crops.

Advantages of the Gravity Method: (1) Costs less to operate; (2) its distribution pattern is not affected by wind; (3) is satisfactory for soils with low (0.1--.25 inch per hour) intake rate; (4) is possible to increase size of project without reducing work efficiency; (5) handles large heads of water at low cost; (6) provides uniform soil surface for all field operations; and (7) increases farm's value.

Disadvantages of the Sprinkler Method are: (1) Requires high investment in depreciable equipment; (2) its distribution pattern is affected by wind; (3) expanding its size affects entire system; (4) its operating costs are high; (5) requires moving laterals--a disagreeable job; and (6) has high labor requirements.

Disadvantages of the Gravity Method are: (1) Requires investment in land grading; (2) land grading often alters uniformity of soil on a field (cut and fill areas); (3) requires skilled irrigator to obtain uniform application and distribution of water; (4) cannot be used satisfactorily on soil of high intake rates (1.0 inch or more); and (5) cannot make uniform small applications of water.

Regardless of the type of system proposed, the owner and/or operator and the design engineer should make sure that it meets these needs: (1) It is the best system for the soil and topographic conditions of the site to be irrigated; (2) it has the capacity to fulfill the needs of the crops planned to be produced; (3) it is simple in design; (4) the system can be operated easily; and (5) the system must be complete--water application control devices and surface drainage facilities.

Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

McCormick, J. A., and Myers, V. I. IRRIGATION OF CERTAIN FORAGE CROPS. Nev. Agr. Expt. Sta. C. 20, 13 pp. 1958.

Seven varieties of forage crops were grown under high, fluctuating, water-table conditions. Irrigation water was applied as the various plots showed the need. The following measurements and data were taken: (1) The amount of water applied; (2) fluctuations of the water table, (3) amount of weed contamination; (4) harvested yields; and (5) rooting depths.

Forage varieties vary in their rooting habits. Shallow-rooted plants require frequent irrigations seldom exceeding one or two inches of water per application. This requirement has been difficult to meet where lands have previously been leveled for alfalfa and irrigation systems purposely designed to permit applying four to six, or more, inches of water each irrigation. This requirement has also been difficult to fulfill in farming areas subject to occasional water shortages or in areas where water is not always available for frequent on-demand delivery.

In the case of shallow-rooted forage crops, it is difficult to maintain ideal moisture conditions throughout the year for continual growth of good stand, and without substantial weed contamination.

At present, shallow-rooted forage varieties do not appear favorably adapted to: (1) Soils which are suitable for and leveled for the production of deep-rooted crops such as alfalfa; (2) irrigation water supplies and delivery system as occur in many areas; or (3) water-table conditions that prevail somewhat generally throughout the state.

Max. C. Fleishman, Col. of Agr., and the Agr. Expt. Sta. U. Nev., Reno, Nev.

Garton, J. E., and Barefoot, A. D. IRRIGATION EXPERIMENTS AT ALTUS AND EL RENO, OKLAHOMA PROGRESS REPORT, 1954-1958. Okla. Agr. Expt. Sta. B. B-534, 19 pp. 1959.

The research results reported in this bulletin indicate that various crops differ in their response to different levels of irrigation. The response of a given crop to a given level of irrigation is related to the amount and timeliness of rainfall.

If an irrigator has an abundant water supply, a higher level of irrigation may be justified on some crops than if he has a scarcity of water. He must determine the level of irrigation according to the limiting resource, whether it be the land or the water.

Generally, cotton yields were higher per acre and per acre-inch of water at a high level of irrigation during dry years. During the wet years, the yields per acre were also higher at high levels of irrigation, but the yields per acre-inch of water were higher at lower levels of irrigation.

Study of the grain sorghum results revealed that the higher moisture levels were not economical. Temporary moisture stresses did not greatly decrease the yields. During the two years of tests on forage sorghum, the higher yields per acre occurred with the higher water levels, but the higher yields per acre-inch of water came with the lower levels of irrigation.

Corn, during the one year it was tested, produced the highest yields per acre and acre-inch at the highest level of irrigation. Castor beans in the one year tested, produced the highest yields with the greater amount of water, but the lower levels of irrigation produced the highest yields per acre-inch of irrigation water.

No significant difference in cotton yields resulted between 2 1/2-inch and 5-inch irrigations, either separately or in combination.

Two years of chiseling produced no significant differences in yield of cotton or grain sorghum.

Even with the high losses using the presently available equipment, machine stripping of irrigated cotton has been economical.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

Gerard, C. J., Bloodworth, M. E., Burleson, C. A., and Cowley, W. R. COTTON IRRIGATION IN THE LOWER RIO GRANDE VALLEY. Tex. Agr. Expt. Sta. B. 916, 14 pp. 1958.

Maximum growth and yield of cotton were obtained when the cotton crop was grown under a high level of moisture.

Maximum demand for moisture by cotton plants started during the flowering period and increased until most of the bolls were mature. Additions of irrigation water during critical water demand periods of plant growth (during and after the bloom stage) increased cotton yields.

Close spacings (6 inches) should be used where it is possible to maintain an ample supply of available soil moisture. Wide spacings (12 inches) may be considered where soil moisture may be limited during the peak demand period in June and July.

Tensiometer data and soil moisture sampling data indicated that the maximum use of moisture was from the upper 2 feet of soil on both Willacy $\ell$ and fsl.

Proper timing in the irrigation of cotton to coincide with stages of maximum use and demand can reduce water use and produce higher yields.

Eighty percent or more of the cotton roots were found in the top 2 feet of soil.

Irrigation schedules under a low and an adequate supply of water are proposed.

Texas Agr. Expt. Sta., College Station, Tex.

Groskopp, M. D., and Albert, A. R. IRRIGATED CORN IN CENTRAL WISCONSIN. Wisc. Agr. Expt. Sta. B. 541, 8 pp. 1959.

Field trials of irrigated corn grown on sandy soils at the Hancock station from 1954 through 1958 gave the following results:

(1) Full Irrigation: (Ample Water) - 126.9 bushels per acre
Plant population averaged 21,578 plants per acre. Irrigation averaged - 5 times per year, with a total of 7.9 acre-inches of water per year.

(2) Moderate Irrigation: (Crop Saving) - 102.2 bushels per acre
Plant population averaged 17,700 plants per acre. Irrigation averaged - 2 times per year, with a total of 3.5 acre-inches per year.

(3) No Irrigation: - 48.0 bushels per acre
Plant population averaged 13,035 plants per acre.

Fertility was high on all plots. Annual application per acre was 12 tons of manure on alfalfa sod, 100 pounds of 5-20-20 starter fertilizer, and 300 pounds of ammonium nitrate side-dressed in three applications.

Thus full irrigation gave 10 bushels more corn for each acre-inch of water applied, and moderate irrigation returned 15.5 more bushels per acre-inch of water.

These results show that, with good fertility and other sound cultural practices, an average of 2 irrigations of 2 acre-inches of water per season, applied at the proper time, will result in an annual average crop of 90 to 100 bushels of corn per acre.

Agr. Expt. Sta., U. Wisc., Madison, Wisc.

Reynolds, C. W., and Rogers, B. L. IRRIGATION STUDIES WITH CERTAIN FRUIT AND VEGETABLE CROPS IN MARYLAND. Md. Agr. Expt. Sta. B. 463, 31 pp. 1958.

VEGETABLE CROPS

Studies of the effects of supplemental irrigation on some vegetable crops were conducted on 2 soil types, a sandy loam and a silt loam, over the 4-year period, 1954-57. Effects of irrigation on yield and quality and interactive effects with other cultural practices, such as fertilization, were studied.

All 4 crops of snap beans on the light soil and 3 of 4 crops on the heavy soil, showed substantial improvement in yield as a result of irrigation. Bean yields were increased about 90 percent by irrigation as an average for the entire period. In addition, irrigation increased the size of pods, decreased the percentage of severely crooked pods, lowered the seed content, and tended to reduce the fiber content of beans. The studies show that irrigated snap beans are likely to respond to a sidedressing of about 20 pounds per acre of nitrogen in addition to a standard application of mixed fertilizer at planting, especially on sandy soils, and that irrigated beans should have a plant population of at least 18 plants per linear yard of row.

Three of the 4 crops of cucumbers on the sandy soil and 1 of 2 on the heavy soil were substantially improved by irrigation. The average increase in yield was 190 bushels per acre or 64 percent over the nonirrigated check plots. Fruits from irrigated plots were darker green in color and were generally longer. Irrigation reduced the percentage of fruits that were seriously crooked or malformed. The incidence of diseased cucumber fruits tended to be larger under irrigated conditions.

One year's results with garden beets on light soil showed that irrigation increased the yield at each of 3 harvest times, increased the number and average weight of marketable roots, and boosted the percentage of roots above 1 1/2 inches in diameter.

PEACHES

During 3 growing seasons, 1955 through 1957, measurements were made of soil moisture and of fruit growth of Sunhigh and Elberta peaches as affected by irrigation and rainfall in relatively shallow soils in the vicinity of Hancock, Maryland.

In 2 out of 3 years, soil moisture became extremely low during the time when many varieties of peaches were undergoing the final swell in the few weeks prior to harvest. In both years Sunhigh fruits, and in 1 year, Elberta fruits were increased around 1/4 inch or more in diameter as a result of irrigation. The results obtained indicated that as little as 3 inches of water, applied within a few weeks of harvest, could be expected to produce satisfactory size, even in an extremely dry year such as 1957.

U. Md., Agr. Expt. Sta., College Park, Md.

Duffin, R. B. SUCCESSFUL PEANUT IRRIGATION. Irrig. Engin. and Maintenance 9(4): 14-16, 31-32. 1959.

Oklahoma peanut growers have made irrigation pay in both wet and dry years, but it takes careful planning and management. In the near normal rainfall year of 1955, irrigated peanuts in Oklahoma tests produced 42 percent more than the dry land trials. In drouth years like 1956, well over half the state's production came from the irrigated

ten percent of acreage harvested. Even in above-rainfall years of 1957 and 1958, peanut irrigators applied water from one to three times. They are finding that two or three years of "on the ground" observation and experience have been the most effective teacher. They have learned that irrigation is not an easy way of farming; but with hard work and good management, their investment is often repaid in one or two seasons.

The total water needed to produce a crop of peanuts is about 25 inches. The average daily requirement during the most active part of the growing season will be about 0.25 inches per day. The maximum daily amounts required during the peak moisture need is approximately 0.33 inches. Considering the benefit from average effective rainfall, the net irrigation requirement would be from 9 to 11 inches. The average gross irrigation requirement at 70 percent efficiency then would be from 13 to 16 inches. Good irrigation practice during flowering and nut formation is a must. This is the peak moisture-requiring time and will prove to be critical if readily available moisture is not furnished to the plant at all times. The sandy textured soils common to peanut land and the medium depth rooting habits will affect the proper time and amount of water to apply.

Successful peanut irrigation goes far beyond the important step of obtaining the properly designed system and putting on the right amount of water at the right time. If maximum returns of high quality peanuts under irrigation are to be realized, fertility, plant disease, weed control, and other production factors cannot be allowed to limit yields.

Ext. Irrig. Spec., Okla. State U., Stillwater, Okla.

Willardson, L. S. WHAT IS IRRIGATION EFFICIENCY? Irrig. Engin. and Maintenance 10(4): 13-14, 18. 1960.

The objective of efficient irrigation is to provide a desirable moisture environment in the soil with the greatest uniformity and the least water loss. Unless these three terms are evaluated together, the true efficiency of irrigation will be unknown.

This article defines, the following efficiency terms: (1) Project water use; (2) farm water use; (3) field water use; (4) water conveyance; (5) farm water application; (6) field water application; (7) water storage; (8) moisture storage capacity; and (9) water distribution.

Utah State U., Logan, Utah.

Blaney, H. F. MONTHLY CONSUMPTIVE USE REQUIREMENTS FOR IRRIGATED CROPS. J. Irrig. and Drain. Div., ASCE 85(IR 1): 1-12. March 1959.

Monthly consumptive use (evapotranspiration) data are useful in determining the disposition of precipitation and its contribution to the ground-water supply, safe yields of ground-water basins, water yields from mountain watersheds, and irrigation requirements of crops. Results of monthly determinations of evapotranspiration and transpiration for irrigated crops may be employed to plan irrigation schedules and for estimating water requirements for each crop for maximum production.

Recently, considerable resurgence of research on evaporation and consumptive use of water has taken place. However, there is a need for additional studies. The importance of a knowledge of water lost through evaporation and consumptive use to the efficient design and later operation of the works involved in a water-supply project has long been recognized by engineers.

This paper presents data on measured monthly rates of consumptive use of water for different irrigated crops growing in Western United States and describes a procedure for determining monthly consumptive use requirements for irrigated crops from climatological data for areas where monthly measurements of water use are not available.

SWCRD, ARS, USDA, Los Angeles, Calif.

Snyder, D. WATER MANAGEMENT BOOSTS YIELDS 400%. West. Crops and Farm Mangt. 8(10): 32-33. 1959.

Wheat yields are being quadrupled as a result of flood irrigation on Wiley McAfee's farm in the dryland area of Sagebrush Flats northwest of Ephrata, Wash. In 1947,

McAfee and his father installed diversion structures and approximately 7 miles of dikes on 180 acres of their cropland.

The diversion structures, made of concrete, had gates to regulate not only the level of water behind them but also the flow into terraces.

Fields receiving flood waters have a series of dikes across them laid out on contour and designed to hold water 18 inches deep in each terrace. From one terrace to another, concrete drop structures have been installed to prevent erosion as water enters the next terrace. McAfee did most of the work with his own equipment.

During the spring runoff each year, water that normally would be lost downstream and cause erosion and sedimentation is diverted into McAfee's fields and used for irrigation. An average of 30 to 36 inches of water is applied to the land in this manner.

As a result of diking and annual flooding, management of the diked fields differs markedly from that of the neighbors. He has been able to adopt annual cropping of wheat in contrast to a wheat-summer fallow system previously followed.

On land seeded to wheat, 40 lb. of actual nitrogen is supplied in the form of anhydrous ammonia after flooding in the spring.

With the additional moisture, alfalfa can now be grown in a rotation with wheat.

No address given.

von Progell, H., and Kidder, E. H. THE EFFECTIVENESS OF WATER USE IN SPRINKLER IRRIGATION FOR FROST PROTECTION. Mich. Q. B. 42(2): 323-330. 1959.

Laboratory tests were conducted under simulated radiation frost conditions. The main objective was to determine the effectiveness of the water used for frost protection by sprinkling. Effectiveness was defined as the temperature rise in degrees F. per unit of water applied in inches per hour. Plant and air-temperatures were measured and a test procedure developed which reduced the disadvantages of excess water and increasing ice thickness. The effectiveness of the freezing water is influenced by the precipitation rate and the frequency of application. An increase in protection was obtained with higher precipitation rates holding the application intervals constant and an increase in protection was obtained with increased frequency of spraying holding the precipitation rate constant. The results are discussed in regard to practical use of sprinkler irrigation for frost protection.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Bloodworth, M. E. SOME PRINCIPLES AND PRACTICES IN THE IRRIGATION OF TEXAS SOILS. Tex. Agr. Expt. Sta. B. 937, 55 pp. 1959.

This guide is designed to present some basic principles and practices of irrigation.

When a farmer changes from dryland to irrigation farming, he often overlooks the importance of the relationships which exist among soil, water and plants. Good irrigation practices must take into account such important factors as soil fertility, amount and quality of water, adapted crops and varieties, land preparation for irrigation, water distribution over the land, irrigation timing to suit crop needs, rate of water application for a particular soil type, capacity of soils to store and release water, rates of seeding and root development, and distribution within the soil storage reservoir for obtaining both water and plant nutrients. The development and maintenance of a good soil and water management program require that these factors be understood by the individual irrigation farmer so that maximum efficiency can be obtained from the use of irrigation.

The great demand for irrigation water makes soil and water management increasingly important in crop production. Much more efficient use of the water and soil resources for crop production will be required if the dwindling water supplies are to be conserved and used most effectively.

Since soil and climatic conditions vary greatly over Texas, it is impossible to give a set of rules for irrigation which can be applied to every problem area. However, by studying and considering all aspects of the interrelated soil-plant-water system, the irrigation farmer should be in a much better position to work out a suitable soil and

water management program for his farm. It is of major importance that the irrigator be more concerned about what is taking place below the soil surface than he is about the conditions above it.

Tex. Agr. Expt. Sta., College Station, Tex.

Gray, A. S. THE VERY SLOW SPRINKLER APPLICATION RATE. Irrig. Engin. and Maintenance 9(8): 7, 17. 1959.

Many valuable results have been attained through the use of very slow application rates of water by sprinkling on heavy adobe soils.

The very slow rates, as low as .04 inch per hour, have shown an actual change in soil structure. The soil has become more friable, and in fact, sponge-like in texture. These results are attributed to the fact that the very slow rate of application allows water to enter the soil so slowly that no silt particles are disturbed, and air is not entirely expelled, or excluded from the soil. Actually air is taken into the soil during irrigation. There seems to be a continual presence of air and oxygen in the soil at all times to permit a continual activity of soil bacteria, microorganisms, etc.

Along with the slow application there must, of course, be a longer period of set. The longer sets give a higher uniformity of water distribution, and the irrigator is able to take advantage of varying wind velocities and wind directions over a long period of time. The longer sets provide a longer period of cooling of both the soil surface and the plant itself.

It is recommended that the intake rate of the soil in question be determined, and then water applied at half this rate, or less. The rates on all these soils should be based on 24-hour sets, or longer.

These slow application rates will naturally require special nozzles and more laterals per given area, generally twice as many as used on what we have been terming a normal system. A 24-hour set, however, means that the laterals will be moved only once a day which would ease the labor problem of moving morning and night. The slow applications, longer sets, and more frequent irrigations should more than pay for the original extra cost in improved top quality yields, plus the all-important factor of improved soil structure.

Engin., Nat'l Rain Bird Sales and Engin. Corp.

Longenecker, D. E., and Lyerly, P. J. SOME RELATIONS AMONG IRRIGATION WATER QUALITY, SOIL CHARACTERISTICS AND MANAGEMENT PRACTICES IN THE TRANS-PECOS AREA. Tex. Agr. Expt. Sta. MP-373, 17 pp. 1959.

An intensive soil and water sampling study was conducted in four irrigated areas of the Trans-Pecos land resource area. The main purpose of the study was to investigate the cumulative effect of poor quality irrigation waters on soil chemical properties, particularly on salt and sodium accumulation.

The data indicate strongly that knowledge of the nature and quantity of salts in the water is not sufficient to properly evaluate water for irrigation purposes. Other important factors that should be considered are the texture and permeability characteristics of the soil and the management practices to be followed.

Productivity of the fine-textured Verhalen soils of the Lobo Flats area is lowered because of the accumulation of soluble and adsorbed sodium in the subsoils and inadequate root aeration, although the quality of the water is classified as good.

The Anthony, Reeves, and Reagan soils of the Wild Horse and Dell City areas show no harmful accumulations of salt or sodium despite appreciable amounts of salt in the waters. Use of these waters is facilitated by excellent soil permeability characteristics, which permit adequate leaching of salts.

Reeves and Reagan soils of the Pecos pump area also have good permeability characteristics. Chemical analyses show that, under proper management, these soils can remain productive although irrigated with waters of extremely poor quality because of their high content of salt.

X-ray and D. T. A. Analyses and laboratory permeability studies indicate that soils of the Lobo Flats, Wild Horse, Dell City and Pecos pump areas are similar mineralogically--the clay content is illite or degraded mica. Chief differences are in texture and profile characteristics.

The low-swelling characteristics of these soils is contrasted sharply with the high-swelling montmorillonitic soils of the El Paso Valley. Poor quality waters which are usable in these four areas cannot be applied continuously to soils of the Upper Rio Grande Valley without disastrous results--reduction in permeability, and salt and sodium accumulation.

The importance of proper management practices for salinity control in each area is emphasized.

Tex. Agr. Expt. Sta., College Station, Tex.

Bernstein, L. THE SALT TOLERANCE OF PLANTS. Conf. On Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 201-202. Jan. 1958.

Soil, climatic factors, and management practices exert strong modifying influences on the relationship of plant growth to irrigation water quality. Thus, while plant response may be adequately described in terms of soil salinity, exchangeable-sodium-percentage, and related soil variables, a statement of the relationship of plant growth to irrigation-water quality must be flexible enough to allow for the modifying influences of soil, climate, and management.

For most crops of low or moderate salt tolerance the inhibitory effects of salinity become progressively greater as salinity increases. In addition to stunting, other characteristics of salt-retarded plants include a blue-green color of the foliage and smaller leaves. Leaf burn, or necrosis, does not generally occur, although extremely hot, windy weather may increase the incidence of such injury. Wilting rarely develops unless the plants are subjected to an abrupt increase in soil salinity.

The range of salt tolerance varies from injury or partial growth inhibition, at as low a level as 2 to 3 millimhos for the most sensitive crops (beans, clovers, many fruit trees), to an ability to tolerate salinities of 10 to 15 millimhos or more, in such crops as sugar beets, barley, and cotton.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Stromberg, L. K. WATER QUALITY AND FARM MANAGEMENT. Conf. On Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 89-94. Jan. 1958.

Water Quality to a farmer means simply survival. Many growers do not fully appreciate the value of good water quality and the dangers of poor quality. They are more interested in the amount of water available.

The use of water of marginal quality in sprinklers should be investigated more thoroughly. The problem is an added concentration of salts in the water from evaporation between the sprinkler head and the soil surface.

One of the obvious problems of poor-quality water is the selection of crops.

An irrigator can do very little to combat boron in water. He must live with it by carefully choosing only tolerant crops, and so irrigate that borates, which are quite soluble in water, will not accumulate in the soil. Growers have many problems with water quality. However, they are learning to live with them. By using available information and their own ingenuity, growers hope to be able to get by until water of better quality can be had. Aside from the phytotoxicity of high-sodium waters, their continued use greatly reduces the rate of water penetration.

Another practice is to plant crops in strip checks rather than on beds. Milo and corn lend themselves very well to this type of irrigation. Flooding crops eliminates the accumulation of salts at the top of planting beds. Moreover, if adequate drainage is provided, there may be a net decrease of total salts in the root zone.

Agr. Ext. Serv., Fresno, Calif.

Gorlinski, J. S. SURFACE-WATER QUALITY AND POLLUTION. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 107-108. Jan. 1958.

Water quality is not a static condition. It tends, in the natural state, to deteriorate progressively downstream, as the water circulates on its great cycle from the land back to the sea. This inherent water-quality deterioration may be considered as "natural pollution." This "natural pollution" is a beneficial process. It imparts to water qualities that enable it to: (1) Sustain life in all its forms; (2) build soil, (3) rearrange the rocks; and (4) create the beauty of the landscape.

The advent of man and his development as the dominant social species has added the debris of his civilizations to the natural water-quality degradation processes. As succeeding civilizations increase in complexity and populations expand, the point is being reached where the disposal of man's wastes to our surface water is capable of producing a threat to his way of existence. This, together with man's ability to create materials not found in nature, his ability to control the regimen of surface streams, and his ever increasing demands for water, has focused more attention on water-quality problems.

In dealing with water-quality degradation we must keep in mind the essential differences between pollution caused by inorganic and organic materials. Inorganic pollution may be derived from the end products retained from the decomposition of organic matter in the streams. Or, it may be acquired as the result of the disposal of manmade wastes containing inorganic salts, minerals, or other chemicals. Dissolved inorganic materials become an integral part of the water itself, imparting definite chemical characteristics to it--alkalinity, hardness, and salinity for example. Suspended inorganic matter, though not an integral part of the water itself, imparts certain physical characteristics to water, such as turbidity and color. Inorganic materials in water remain unchanged except for concentration.

Organic matter, on the other hand--be it leaf mold or sewage--undergoes decomposition in water much as it does in the soil. The main operations are carried out by bacteria and aquatic life forms.

Man can do little about natural pollution. It is, in most cases, a beneficial process. But trouble starts when man upsets the natural conditions by dumping more wastes into the stream than it has capacity to absorb. The effects are objectionable, whether the wastes are inorganic or organic in nature.

Water Pollut. Control Board, Reg. 5, Calif.

McGaughey, P. H., and Orlob, G. T. SURFACE AND GROUND-WATER CHANGES RESULTING FROM WASTE-DISPOSAL PRACTICES. Conf. On Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 119-124. Jan. 1958.

A consideration of the nature of sewage and industrial wastes, and of the treatment required prior to their discharge in the interests of public health and other beneficial uses such as recreation and aquatic wildlife culture, leads to the general conclusion that domestic and waste disposal practices that conform to the requirements of other beneficial uses do not lead to serious water-quality problems for the user of irrigation water. This assumes, of course, that dilution with other surface for ground water occurs prior to irrigation use of water. The principal exceptions to this conclusion occur when sewage or industrial waste waters, either singly or in combination, are applied directly to agricultural land. In this case, clogging of the soil, bacterial pollution of edible plants, excess sodium, toxic cations, or anaerobic soil conditions might result. These could impose limiting conditions on the type of crop and in certain situations, such as when herbicide wastes are present, could be catastrophic to plant life.

Sanit. Engin., U. Calif., Berkeley, Calif.

Klein, G. WATER-QUALITY-CONTROL PROBLEMS ASSOCIATED WITH RADIOACTIVITY. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 125-132. Jan. 1958.

We need to keep in mind the various actual or potential sources of radioactive water contamination if we would safeguard against them. These sources may logically be divided into classes: (1) Naturally occurring radioisotopes whose release is controlled; (2) accidental release of such radioisotopes; (3) fallout from nuclear weapons tests, and (4) wartime nuclear explosions.

The greatest acute peace-time danger of radioactive water pollution stems from accidents. Controlled release of low-level radioactive wastes and world-wide fallout are steadily increasing chronic problems, and atomic war is a catastrophe in which much may be done by judicious application of the measures and techniques applied in time of peace.

The time in which half of the original amount of a radioisotope decays is called its half-life. If the half-life is very short, most of the isotope is not in existence long enough to do damage in the body. On the other hand, if it is very long, the damage done during a man's normal lifespan will be small. Thus, it is the isotopes of intermediate half-lives that are of greatest concern. The half-lives of some of the most dangerous fission products are listed below.

HALF-LIVES OF SOME OF THE MOST HAZARDOUS FISSION PRODUCTS

| Isotope | Half-Life | Unit |
|---|---|---|
| Strontium 90 | 19.9 | Years |
| Strontium 89 | 53 | Days |
| Iodine 131 | 8.0 | Days |
| Barium 140 | 12.0 | Days |
| Cerium 144 | 285 | Days |

Sanit. Engin., U. Calif., Berkeley, Calif.

Wilcox, L. V. WATER QUALITY FROM THE STANDPOINT OF IRRIGATION. J. Amer. Water Works Assoc. 50: 650-654. 1958.

In most localities in the West, the city water supply serves the homeowner not only with household water but also with water for the irrigation of his lawns and plantings. An excellent water may be of inferior quality for irrigation use; in fact, water quality criteria, from the viewpoint of soil and plant relationships, differ in most respects from the criteria for domestic or industrial water. For example, irrigation water should contain a relatively high proportion of calcium plus magnesium, whereas soft water is preferred for domestic use. The concentration of boron in irrigation water should not exceed 1-2 p.p.m., although these concentrations are not important in domestic waters. Silica and fluoride are undesirable constituents in household water but present no particular hazard in irrigation water. One quality preferred in all waters is a low total salt content. These characteristics and the soil-plant relationships are discussed here and also the problems commonly encountered in the use of domestic supplies for irrigation.

Crops should be selected on the basis of their salt tolerance and the salt content of the irrigation water and the soil. The relative salt tolerance of the more important crops follows:

1. Salt Sensitive: avocado; citrus; strawberry; peach; apricot; almond; plum; prune; apple; pear; beans; celery; radish; and clover (most species).
2. Medium Tolerance: grape; cantaloupe; cucumber; squash; peas; onion; carrots; bell pepper; potato; sweet corn; lettuce; olive; fig; pomegrante; cauliflower; cabbage; broccoli; tomato; oats; wheat; rye; and alfalfa.
3. High Tolerance: asparagus; garden beets; cotton; barley; and sugar beets.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Hansen, C. J. EFFECTS ON FRUIT TREES OF BORON IN IRRIGATION WATERS. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14, pp. 186-188. Jan. 1958.

The chemical element boron is never found uncombined in nature; it is always combined with other elements, such as sodium, oxygen, and hydrogen, to form such compounds as borax ($Na_2B_4O_710H_2O$) and boric acid ($H_3BO_3$).

Most, if not all, plants require boron for normal growth, but injury will result from concentrations much above the minimum small quantities that are necessary. In the majority of cases, injury to fruit trees from boron has resulted from excesses in irrigation water. In some cases, the excess boron has been brought in by flood waters or comes from boron minerals in the soil.

Some fruit trees, such as the lemon, are very sensitive to an excess of boron, whereas the olive is considered semi-tolerant. Deciduous fruit trees, such as peach, apricot, plum, prune, cherry, fig, walnut, apple, pear, and almond, vary in tolerance to excess boron. However, all are considered sensitive. They are listed here in approximate order from least to most resistant. Even the rootstock on which a fruit tree is growing may have an influence on the amount of injury. For example, almond and prune trees on peach root usually show more boron injury than similar trees on almond root.

The concentration of boron in irrigation water that results in injury will, of course, vary with the fruit species involved. In addition, the amount of rainfall will have an important effect on the severity of injury. In areas of moderate rainfall in northern California, most deciduous fruit trees may in time be injured by irrigation waters containing in excess of about 1.5 p.p.m. of boron. A marginal leaf scorch is one of the most common results of too much boron; the exact pattern, however, depends on the kind of plant involved. Citrus fruits, walnuts, pecans, fig, and persimmons show this type of injury. These leaf symptoms are usually characteristic enough to identify the trouble, but high concentrations of other salts such as sodium sometimes cause similar injury.

High concentrations of boron finally weaken most fruit trees so much that little or no fruit is produced. Unfortunately, there is no cure for excess boron except the adequate use of a satisfactory irrigation water . Accumulations in the soil may be leached out if the soil is sufficiently porous and if there is no high water table to impede drainage. The time required will depend on how much boron is present.

U. Calif., Davis, Calif.

Fireman, M. SALT ABSORPTION BY PLANTS FROM SPRINKLER IRRIGATION. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 182-185. Jan. 1958.

Field and laboratory information obtained thus far indicates that citrus leaves wetted by intermittent sprinklers can absorb sufficient Na and Cl during a single irrigation season to cause serious leaf burn and defoliation. This same evidence does not indicate that Ca, Mg, or $SO_4$ are absorbed. In several orchards where citrus leaf burn was noted, the same irrigation waters have been applied in furrows for twenty years or more without excessive salt accumulations in the soil or excessive Na or Cl accumulation in the leaves.

In orchards where leaf damage occurred from sprinkling, the total soluble salts in the irrigation water ranged from 491 to 903 p.p.m. The Na content of these irrigation waters ranged from 69 to 190 p.p.m., and the Cl content ranged from 36 to 131 p.p.m.

In many places it was observed that $CaCO_3$ and $CaSO_4$ were deposited on the leaves of citrus. It is theorized that, with moderate-to-high temperatures and low humidity, there is rapid evaporation from intermittently sprinkled leaves, so that $CaCO_3$ and $CaSO_4$ quickly precipitate out of solution, with Na and Cl ions remaining in solution on the leaves until almost all the water has evaporated. In this way it is possible that high concentrations of these two ions build up on leaf surfaces sprinkled with only moderately saline irrigation water. Since it has long been established that Cu, Zn, $NO_3$, and other ions are absorbed from sprays by citrus leaves, it is not surprising to find that Na and Cl also can be absorbed.

It is clear that water quality, as well as climatic conditions, are important factors in this problem. The importance of quality has not been evaluated, except to note that no damage has been observed in orchards sprinkled with waters containing less than 40 p. p. m. of either Na or Cl.

Leaf burn from sprinkling citrus has been found only in the interior, warmer districts, where humidities are relatively low and evaporation rates high. Also, in a given orchard, trees directly exposed to prevailing winds are more severely damaged than interior trees, and the windward side of trees shows greater damage than the lee sides. Any factor that increases the rate of evaporation, and thus the concentration of soluble salts on leaves, is likely to be important in salt absorption during sprinkling. This suggests that sprinkling during cool, overcast days or during cooler evening and night hours might be less harmful than sprinkling during warmer, daylight hours.

Agr. Ext. Serv., U. Calif., Riverside, Calif.

Willets, D. B. WATER QUALITY CONSIDERATIONS IN SOUTHERN CALIFORNIA. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 68-75. Jan. 1958.

Despite the large quantities of surface water diverted to southern California as supplemental water supply, this area of the State still depends on ground water for more than 60 percent of its supply.

The most acute and highly important water-quality problems center on the protection of valuable ground water from pollution and degradation that arise from man's use of water and occupancy of land. When discharged to the land, the following are some of the more significant sources of pollution and degradation: (1) Industrial wastes, including brines, pickling acids, refinery wastes, packing plant wastes, etc; (2) water-softener regeneration wastes; (3) refuse and rubbish in dumps; (4) leachate from cesspools; and (5) irrigation return water.

Salt balance in ground-water basins is another water-quality problem that is aggravated by man's use and re-use of water. The evaporation and transpiration processes use water, but hardly any salts. Accordingly, when consumptive use of water increases in a valley or basin, salt concentrations tend to increase. If outflow of water from a ground-water basin is reduced, the outflow of salts will also be generally reduced, furthering the tendency toward an adverse salt balance. In the event that supplemental water supplies are imported, they will contain salts that will further increase the tendency of salts to concentrate in the ground-water body unless outflow of water and salts is correspondingly increased.

Dept. of Water Resources, Los Angeles, Calif.

Wilcox, L. V. WATER-QUALITY CRITERIA. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 40-45. Jan. 1958.

CRITERIA OF IRRIGATION WATER QUALITY

The characteristics of an irrigation water that determine its quality are: total concentration of dissolved constituents; sodium concentration; concentration of boron or other toxic substances; and bicarbonate content.

Total Concentration. Total concentration is the most important single criterion. This is because there is a satisfactory relationship between total concentration and crop growth, provided, of course, that drainage is adequate and soil management practices are suitable.

Sodium. Sodium is unique among the cations in its effect on soil. As exchangeable sodium builds up in the soil, adverse physical conditions develop. The soil, when wet, is plastic, and only slowly permeable to air and water. As it dries, it shrinks and cracks and forms hard clods, which are difficult to work into a seed bed.

The sodium hazard can best be evaluated in terms of the sodium-adsorption-ratio (SAR) an expression developed by Dr. C. A. Bower, of the Salinity Laboratory, and defined as:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

where the concentrations of the ions are in milliequivalents per liter. SAR was developed statistically, but has since been shown to have a sound theoretical basis. The SAR of an irrigation water indicates the exchangeable-sodium percentage (ESP) that the soil will attain when the water and soil reach equilibrium. Thus, knowing the SAR, it is possible to estimate the ESP of the soil and the corresponding sodium hazard. SAR, because of this relationship to ESP, is an important criterion of water quality, second only to total concentration.

Boron. Boron is the characteristic element of such familiar substances as borax and boric acid. It is essential to normal plant growth, but concentrations only slightly above optimum are toxic to many plants. Boron is present in all irrigation waters in the West. As little as one part per million of boron in irrigation water is about the upper limit for use on sensitive plants, and four parts per million are about the maximum that can be used for any of the ordinary crop plants.

Bicarbonate. Calcium and bicarbonate ions in a water can, under certain circumstances, combine and precipitate as normal calcium carbonate, $CaCO_3$. As calcium precipitates, sodium is left in solution and the ratio of sodium to calcium increases, or, more specifically, the SAR increases.

A satisfactory appraisal of the quality of a water for irrigation use can be made if these four criteria are known and properly interpreted. The success in the use of the water, however, will depend on such factors as drainage, leaching, rainfall, salt tolerance of crops, and management practices. Of these, drainage is by far the most important.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Doneen, L. D. STUDIES ON WATER QUALITY CRITERIA. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 46-56. Jan. 1958.

The utilization of various irrigation waters indicates that the standards, or classifications, suggested for judging a water quality fail to meet all conditions encountered in the field. This appears to be particularly significant for waters containing the bicarbonate ion. Chimonides (1958) working with bicarbonate waters, showed that the SAR is not a good value for estimating exchangeable sodium and its influence on infiltration. This is also indicated by the experiments reported in this paper. He also indicated that "effective salinity" should be extended to include all the bicarbonate ions. The sodium exchanges with calcium of the clay, which in turn precipitates as the insoluble calcium carbonate. Thus, as the soil solution concentrates it loses sodium to the exchange complex, and calcium by precipitation, which prevents salines from forming in the soil in proportion to the amount occurring in the irrigation water. The increase of exchangeable sodium, even though small, from the precipitation of calcium can have a marked influence on infiltration.

U. Calif., Davis, Calif.

Lewis, G. C. WATER QUALITY STUDY IN THE BOISE VALLEY. Idaho Agr. Expt. Sta. B. 316, 27 pp. 1959.

Approximately one-half of the water sources sampled were of good quality for irrigation usage without dilution. This included the surface water supplies with the exception of Sproat Springs. The remainder of the water sources can be used for irrigation if they

are mixed with good quality water, and many of them can be used on some soils without dilution. Most of these sources were of poorer quality because of high salt content or high residual sodium carbonate.

In the case of poor quality well water, if the quality of the available surface supply is known, it is possible to determine a satisfactory mixture of these two sources. A recommended dilution ratio would be satisfactory only if the quality of the sources remained reasonably constant.

A very complex system of stratification and dissection of the area by Snake River basalt flows makes it difficult to predict areas of a certain water quality. There is no well defined pattern of distribution of water quality by areas. Moreover, the depth to the aquifier has no consistent relationship to the quality of water found.

Many water sources showed a change in quality during the irrigation season. This suggests that periodic checks should be made on the quality of the well water during the irrigation season so that changes in dilution requirements can be made when required.

If the drainage problem of the Boise Valley can be alleviated by drainage wells, it appears feasible to reuse much of this water for irrigation purposes. This may lower the water table to a desirable depth and at the same time release water for other uses.

It should be emphasized, however, that a change in ground water salinity can be anticipated as a result of increased domestic, industrial and agricultural ground water use.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

Umback, C. R., Fine, L. O., and Wiersma, F. THE EFFECTS OF IRRIGATING SOILS OF THE PROPOSED SHADEHILL PROJECT WITH WATERS HIGH IN SODIUM AND BICARBONATE IONS. Proc. South Dakota Acad. Sci. 38: 88-95. 1959.

The effect of the application of low-quality water from Shadehill Reservoir upon the accumulation of salts and alkali in soils typical of the proposed Shadehill Irrigation Unit in South Dakota was studied. It appears that exchangeable sodium percentages are in equilibrium with the water being applied (at least in the upper portions of the soil profile) and that these equilibria are reached at levels somewhat lower than those predicted by the SAR-ESP nomograph. Under the conditions of annual rainfall found at this location (about 15 inches per year), the "residual $Na_2CO_3$" content of the water has not, under field conditions, induced further increases in exchangeable Na beyond those levels otherwise anticipated.

The effects of leaching were not studied in the field because this did not become necessary. Gypsum was applied with the irrigation water in amounts chemically equivalent to the "residual $Na_2CO_3$" and appeared to induce equilibrium between ESP and sodium in the water at levels somewhat lower than were otherwise found. Infiltration rates were equal or possibly slightly superior under the gypsum treatment.

Alfalfa production under irrigation was found to be comparable to that in other areas of the state under irrigation. This was equal to about a five-fold increase over dry-land production on these same soils.

SWCRD, ARS, USDA and S. Dak. Agr. Expt. Sta., Brookings, S. Dak.

Herpich, R. L., and Manges, H. L. IRRIGATION WATER CONTROL STRUCTURES. Kans. State U. Engin. Ext. Dept. Land Reclam. 7, 12 pp. 1959.

New irrigation methods and devices are a result of demand from irrigators for better ways of controlling water and an increasing desire to save labor. With the development and application of new techniques of land grading there came a demand for water-control structures that could be installed permanently. These included: pump division boxes, diversion boxes, drops, and checks.

Some of the requirements for water-control structures are: (1) Their use must reduce the labor requirements for applying the irrigation water; (2) they must present minimum interference to normal farming operations; (3) their use must not allow excessive erosion; (4) they must be simple to install and operate; and (5) their cost must not be excessive.

The figures in this illustrated article may serve as a guide for the construction and installation of better water-control structures. The plans shown are for concrete block and monolithic reinforced concrete construction. However, structures of similar dimensions can be built of other materials.

Agr. Ext. Serv., Kans. State U., Manhattan, Kans.

van't Woudt, B. D. CONCRETE PIPE FOR IRRIGATION IN HAWAII. Hawaii Agr. Expt. Sta. C. 57, 62 pp. 1959.

Essentially, there are two systems of water conveyance: (1) Open systems (rivers, canals, ditches, flumes, and furrows); and (2) closed systems (steel, aluminum, asbestos-cement, and concrete pipe). In modern irrigation, open systems are most commonly used for conveying large quantities of water from a source to an irrigated area, and for transient conveyance systems, such as temporary ditches. For permanent systems of a moderate and small capacity there has been an increasing tendency during the last 50 years to change over from open systems to closed ones.

Concrete pipe has been widely used in many irrigated areas, largely on flat grades, but it has become increasingly attractive for use on steeper land due to improvements in pressure-control mechanisms.

Concrete pipe systems are conveniently used with border-, basin-, and check-irrigation and they can be adapted to sprinkler irrigation. With additional surface pipe, efficient furrow irrigation is possible.

To date, concrete pipe has found little use in irrigation in Hawaii. Much development work in Hawaii has been concentrated on improvements in open systems, notably flumes. It is believed that there are areas in Hawaii where an increased use of concrete pipe may be profitable.

Technical details of the design and installation of concrete pipe systems are dealt with.

U. Hawaii, Hawaii Agr. Expt. Sta., Honolula, Hawaii.

Griffith, E. J. WELL CORROSION. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 95-99. Jan. 1958.

Corrosion is one of several major problems in wells. It has not received the attention it deserves. The results are cumulative, building up over a period of, perhaps, years.

Corrosion damage has been much more evident in pumps than in wells. A pump can be inspected every time it is removed from the well. Effects that would not impair a well's operation will make a pump inoperative. A hole in a pump reduces its ability to perform efficiently.

Corrosion in both wells and pumps is a serious problem. The effects can often be minimized if there is an understanding of the factors involved. The quality of water produced is a major factor; it should always be given consideration in the design, construction, maintenance, and operation of the unit.

Pacific Gas and Electric Co., Fresno, Calif.

Tovey, R., and Myers, V. I. EVALUATION OF SOME IRRIGATION WATER CONTROL DEVICES. Idaho Agr. Expt. Sta. B. 319, 32 pp. 1959.

Discharge tests were conducted in the laboratory under carefully controlled conditions using equipment constructed especially for this purpose. The results of these tests are presented in this bulletin in the form of curves which show the amount of discharge to be expected from siphons, gated spiles, and gated pipe. These curves can be used to advantage in the design of surface irrigation systems.

The discharge coefficient of the various siphon tubes became larger as the inside diameter of the tubes decreased and as the length of the tubes increased.

The larger gated spiles did not flow entirely full when set at their widest opening and when operating under low heads, the discharge coefficient decreased at the smaller gate openings as indicated by the slope of the discharge curves, the head loss of the discharge curves represent the head loss per gate for one type of gated pipe at various rates of discharge.

The operation of the devices tested in the laboratory, and others, were observed while being used for irrigation purposes. It was found that the water passing through the various devices must be free of trash and a constant head maintained to insure efficient operation.

The siphon setting device can be used to advantage when a siphon tube is used for irrigation. This device provides an easy and practical means of measuring the head under which a siphon tube operates in the field.

The initial cost of an irrigation system may be high when these water-control devices are used, but the efficiency of operation and savings of time and labor soon overcome this initial disadvantage.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

Herpich, R. L., and Reece, F. N. IRRIGATION MACHINERY. Kans. State U. Engin. Ext. Dept. Farm Mach. 9, 8 pp. 1958.

Farmers planning to irrigate need to consider the machinery they have on hand for dryland farming to see whether it is adaptable for irrigation. Additional machinery may be needed and some dryland machinery cannot be used.

After considering all the points, the equipment for tractor-mounted tool bars comes nearest to meeting the requirements for irrigated agriculture.

Most of this equipment is convenient to mount and operate, is easily adjustable to different row spacings, will put furrows and rows close to the end of the field and ditches, and is comparatively inexpensive.

Agr. Ext. Serv., Kans. State U., Manhattan, Kans.

## Drainage

Harrison, R. W. LAND FORMING IS RESHAPING DELTA FARMS--AND IT PAYS OFF BIG. Land Impr. 6(5): 18-20. 1959.

A brief history of land forming in the Mississippi Delta and how it is used on: (1) Sugar cane land; (2) pasture land; and (3) general crop land are given. Land Impr. 6(6): 10-12. 1959.

Part II explains: (1) How land forming is carried out; (2) what it costs; (3) who does it; and (4) what equipment is used.

FERD, ARS, USDA, Washington 25, D. C.

Fasken, G. B. LAND DRAINAGE IN ILLINOIS. Land Impr. 5(7): 12-15. 1958.

A short history of drainage in Illinois is given along with what is happening now with the new techniques especially in land smoothing and pump drainage.

Under the 1850 Swamp Act, the Federal Government deeded to Illinois areas of land needing drainage and reclamation. By 1851, the State of Illinois had laid claim to 1,833,413 acres and, in so doing, accepted the problem of reclamation and disposition of these lands.

Drain. Engin. SCS, USDA, Milwaukee, Wisc.

Berry, W. L., and Stetson, E. D. DRAINAGE PROBLEMS OF THE SAN JOAQUIN VALLEY. J. Irrig. and Drain. Div., ASCE 85(IR 3): 97-106. Sept. 1959.

This paper outlines: (1) The geography and geology of the San Joaquin Valley of California, with special emphasis on the factors affecting drainage; (2) the drainage

problems as they exist today are unfolded through a description of the cultural changes that have brought them into sharp focus; and (3) the objectives and scope of the drainage investigation currently in progress are described.

In planning for future irrigation projects, one must consider the necessary attendant drainage facilities. In many cases the costs of the drainage facilities should be included in the determination of economic justification and financial feasibility of the project as a whole. Irrigated lands that today are highly productive and capable of supporting a substantial outlay to maintain their productivity can in a few years be reduced to an alkaline waste if proper drainage facilities are not provided.

Calif. State Dept. Water Resources, Sacramento, Calif.

Walker, C. W. DRAINAGE PROBLEMS IN THE YAKIMA VALLEY. Irrig. Engin. and Maintenance 9(10): 12-13. 1959.

Water, the miracle worker that has transformed the semi-arid Yakima Valley into the fifth ranking agricultural producer in the nation, is now a major threat to this gigantic food empire it helped create. Many expensive irrigation structures and systems have been installed to bring water onto the land. Now there is too much water, so the problem is one of adequate drainage. Because of the expanding irrigation projects, seepage conditions in the valley have become progressively worse. Approximately 40 percent of the total 620,000 acres now irrigated in the Yakima Valley have reduced production because of too much water.

Drainage in the valley is an expensive, complex problem. The average cost of drainage is approximately $125 an acre.

Even though expensive drains may relieve most wet conditions, prevention is better than a cure. Proper irrigation methods should first be checked and any drainage needed should be incorporated into an irrigation plan. Applying the correct amount of water for consumptive use of plants is the best guide.

The best designed and operating irrigation systems seldom show an efficiency above 70 percent. Therefore, the excess water must accumulate or follow the path of least resistance.

Because of heterogeneous soil in the valley it was desirable to work up an Irrigation guide that would acquaint engineers and conservationists with soil conditions, and reduce the investigation time required for designing drainage systems.

This guide deals only with soils having the largest acreage of major seepage conditions (approximately 22 different soils series). It gives a brief description of each soil including location in the valley, topography, geological formation, sub-stratas from 10 to 20 feet, permeability, texture and structure.

The guide has a profile sketch of each soil showing location and depth of successful drains. Also, there are several actual photographs of soil profiles which will help engineers and soil conservationists familiarize themselves with the different soil characteristics.

The guide also describes the recommended type of drains for each soil type. This includes the size of tile for expected water yields, grades, kind and strength of tile. Hydraulic charts and tables, included in the guide, have been transposed from other engineering handbooks.

SCS, USDA, Yakima, Wash.

Diseker, E. G., and van Schilfgaarde, J. FIELD EXPERIMENTS WITH TILE AND DITCH DRAINAGE. N. C. Agr. Expt. Sta. Tech. B. 133, 25 pp. 1959.

Two extensive field drainage experiments are described, one located near Plymouth, N. C., and the other near Bethel, N. C. Both consisted of tile and open drains at various depths and spacings constructed in a number of ways.

Records were kept of the depth below the surface of the water table following rains for all treatments. The period of record varied from 5 to 9 years. At each location, a recording rain gauge measured the precipitation. Crop yields were not systematically determined and only a very limited number of measurements of hydraulic conductivity were made.

The data showed that drains less than 2 feet deep were inadequate to prevent serious crop damage; drains at 2, 3 and 4 feet seemed equally effective. Also, spacings of 200 feet or less all seemed equally effective. The presence or absence of spoil banks did not appear to have a significant effect upon drainage.

Corn yields measured on the cultural management experiment verified the conclusion that depth of drains greater than 2 feet did not materially affect the adequacy of drainage and showed also that a spacing of 160 feet was quite satisfactory for this soil.

Agr. Expt. Sta., N. C. State Col., Raleigh, N. C.

Busch, C. D. LOW COST SUBSURFACE DRAINAGE. Agr. Engin. 39: 92-93, 97, 103. 1958.

An experimental machine that positions slitted-plastic strips to form an arch lining for mole-type drains is described and illustrated.

This machine made its initial runs in the summer and fall of 1956. Cost calculations indicate that a price of 7 cents per foot, 4 1/2 cents of which is for plastic material, should cover the operation. An operating speed of 1 1/2 mph was successfully used, and a replicated experiment was installed to evaluate the drain's performance. Preliminary testing, after nine months, indicates the lined mole drain to be in better condition than the unlined moles of the experiment.

The immediate application potential of the drain in its present form is for short laterals to outlet ditches and supplementary laterals to existing tile lines. By virtue of the reduced costs and simplicity of installation, drainage may also be possible on lands that can not justify the cost of conventional subsurface drainage.

SWCRD, ARS, USDA, Beltsville, Md.

Busch, C. D., and Edminster, T. W. LOW COST SUBSURFACE DRAINAGE INSTALLATION. Building Res. Inst. 7th Annual Meeting, April 21-23. 1958, Washington, D. C. pp 1-5. 1958.

Under a cooperative project between Cornell University and the Soil and Water Conservation Research Division of the U. S. Department of Agriculture, studies were instituted in 1955 to develop and test techniques for lining mole channels with new, easily handled materials. Various mole plows and the earth channels they created were examined. Attention was then given to the possible use of semi-rigid plastic sheeting that could be slit into ribbons of various widths, and placed on rolls like paper toweling. Various types, thicknesses, and formulations were studied until one was found that would withstand the twisting, bending, and tensile pulls necessary to take the material from the supply roll and form it into a suitable liner within the mole channel. This 15 mil material was partially slit every two inches at right angles to its direction of travel to eliminate undue transverse stresses as it passed through the $90^{o}$ turn at the bottom of the mole liners.

The advantages of this simplified method of drain construction are in both the cost and speed. Calculations place the entire cost of installation at 7 to 8 cents per foot, with approximately 4 1/2 cents of that amount going for the plastic material. Such an installation cost is roughly one-third that of a conventional system. The installation rate used for the test work is approximately one and one-half miles per hour, again a marked advance over conventional practice. Moreover, the wide trench, the spoil pile, and the long-term backfill settling, with consequent delay of field operations, have been eliminated.

An illustration of the mole liner is presented.

SWCRD, ARS, USDA, Beltsville, Md.

Boddy, H. Land Leveling: THE SECRET IS IN PLANNING. Farm Mangt. 7(12): 26-27. 1958.

Today farmers and ranchers don't have to put up with spotty irrigation. A good land leveling job will work wonders for them. The hard cash land owners are spending on

land leveling is paying off. There's more irrigation water to go around; whole fields are watered better and more evenly. Irrigators are using nearly all of their water and very little is wasted. And, actually, irrigating leveled fields is less work because you don't fight "run-away" water and spotty irrigation. It all adds up to higher yields from crops and pastures.

Planing down uneven land isn't something you do by dead reckoning or rule of thumb dirt-moving. Fields must be carefully engineered down to a gnat's eyebrow, precision leveled with the right kind of heavy earth moving equipment.

When western farmer-irrigators started "planing down" the high spots on their lands a few years ago, they laid the ground work for steadily increasing crop yields and water savings. In California alone, around 400,000 rough, uneven acres have been turned into production.

Farmer-conservationists in one county, Sacramento, spent nearly $1 million in leveling and improving around 100,000 acres of irrigated land. The overall leveling figure also includes 110,000 acres in desert south and east of the Tehachapi Mountains and upwards of 50,000 acres in small coastal valleys.

SCS, USDA, Berkeley, Calif.

McKeag, J. A. THE ONE-DITCH SYSTEM. Irrig. Engin. and Maintenance 8(11): 8-9. 1959.

The one-ditch irrigation drainage system was constructed originally for drainage only. Its purpose was to control high water tables in swamp and overflow land bordering the Sacramento River and in the Sacramento-San Joaquin Delta. The system is just what its name implies--one ditch serves both as an irrigation distribution system and as a drainage collection system. Commonly a central drain seven to nine feet deep is constructed down the slope of the land, and collectors six to seven feet deep are dug at right angles to the main on a flat grade. The size of the ditches is determined by winter flood runoff requirements, as flood runoff is larger than summer irrigation demand.

During the irrigation season water is introduced into the mains at the upper end of the system. In the Sacramento-San Joaquin Delta area, where the river water level is higher than the ground surface, water is siphoned into the system from the adjacent river or delta tidal channels. The irrigation supply within the system is controlled by a series of gates and checks which serve to back the water into the secondary drains or ditches. The controls, installed primarily at road and field crossings, serve to keep the irrigation supply from piling up in the lower end of the system. Normally the summer irrigation supply occupies the bottom three to four feet of the combined use ditches. The individual farmer then lifts the water from the ditch onto his land through portable pumps. Water is applied through either sprinkler systems or conventional gravity methods.

The one-ditch system is most advantageous in areas where a drainage system is required. Lands having two to 10 feet of fall to the mile, lying predominantly in one plane such as valley troughs and lake bed areas, are best suited for a one-ditch system.

U. S. Bur. Reclam., Sacramento, Calif.

Tabor, C. C. DRAINAGE AND SALT BALANCE IN RELATION TO IMPERIAL IRRIGATION DISTRICT. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 76-84. Jan. 1958.

The purpose of a drainage system is to maintain the level of groundwater at a proper depth below the land surface and to remove salts from, and prevent their concentration in, the root zone of the crop being grown. Over the years, the Imperial Irrigation District has constructed an extensive drainage system to provide acres of land.

The District's system in itself does not provide drainage for the land. There is very little lateral movement of groundwater to the District drains. The drains provide only an arterial system into which the individual landowner can dump his drainage. As a rule, this is accomplished by installation of an underground system of tile drain lines.

In an irrigation project using a salt-content water, the outgo must at least equal the income. From the root-zone area of the soil, in the form of drainage, must go in quantity of salts equal to, or greater than, that which enters the soil with the irrigation water. That's what we know as salt balance.

Salt balance must eventually take place, or irrigated agriculture will cease. This is true of a farm, an irrigation district, or a river basin.

Imperial Irrig. Dist., Imperial, Calif.

Donnan, W. W. DRAINAGE OF AGRICULTURAL LANDS USING INTERCEPTOR LINES. J. Irrig. and Drain. Div., ASCE 85(IR 1): 13-23. Mar. 1959.

The basic concepts to be considered when designing an interceptor drain may be summarized briefly as follows: (1) The drain device should be placed as deep as it is practical to install, except that tile drains should not be installed below the surface of any major underlying impervious boundary layer; (2) the drawdown upslope will not be very significant and will be dependent on the initial slope of the water table; (3) the drawdown downslope will be very significant and will be primarily dependent on the water level in the drain device; (4) the quantity of water intercepted will vary directly with depth of flow intercepted; and (5) the open drain and the tile line are equally efficient in the removal of water except on excessively steep slopes where the open drain becomes more efficient.

These concepts will be modified by the extenuating circumstances which are inherent and perhaps unique in each individual problem. The designer should keep in the forefront of his thinking the idea that in the interceptor problem he is dealing with the diversion of an underground stream, a phenomenon at considerable variance with the ordinary drainage of irrigation or rainfall patterns.

SWCRD, ARS, USDA, Pomona, Calif.

Scott, V. H., and Luthin, J. N. INVESTIGATION OF AN ARTESIAN WELL ADJACENT TO A RIVER. J. Irrig. and Drain. Div., ASCE 85(IR 1): 45-62. Mar. 1959.

A pump test of an artesian well in a problem drainage area located adjacent to a river is described. Water moved from the river through a semi-confined aquifer and then vertically upward into the problem area. Pressure conditions within the aquifer vary with changes in river stage resulting from tidal and runoff fluctuation. Calculations of aquifer transmissibilities using established well discharge relationships are made based on analysis of water level recoveries within a tidal cycle. Results indicate that pumping for drainage is not justifiable under these conditions.

Irrig. Dept. U. Calif., Davis, Calif.

Keller, J., and Robinson, A. R. LABORATORY RESEARCH ON INTERCEPTOR DRAINS. J. Irrig. and Drain. Div., ASCE 85(IR 3): 25-40. Sept. 1959.

The purpose of this study was to investigate a type of interceptor drain where there was a source of seepage at some finite distance from the projected location of the drain. An impermeable boundary with constant slope existed at a measurable distance below the ground surface. The source of seepage was such that the water depth at the source point would remain unchanged after drainage. The factors investigated were the flow into the drain installation, and the resulting drawdown curve.

The experiment was designed to establish the relationship between the pertinent variables and to obtain data for comparison with the results from other investigators. A check on the accuracy of theoretically derived relationships was one of the objectives. Dimensional analysis was used to relate the variables for a more systematic study.

A method has been proposed for determining both the resulting flow and shape of the drawdown curve of an interceptor drain using dimensionless plots. These plots were obtained from experimental data and previously determined theoretical relationships. This method is applicable for cases where a barrier layer is confining the flow through a relatively shallow strata and the source is either known or from engineering judgment an equivalent source is determined.

In many cases where a drain is constructed near the seepage source, such as a canal, the quantity of seepage may be increased to a large extent by the proximity of the drain.

Jr. Author, SWCRD, ARS, USDA, Fort Collins, Colo.

## Evaluation of Flood Water Damage

Perrey, J. I. SUGGESTED LEGISLATION ON FLOOD PLAIN REGULATION. J. Hydraul. Div., ASCE 85(HY 12): 43-51. Dec. 1959.

Perhaps the greatest hindrance to accomplishing more widespread flood plain regulation is the lack of adequate authority for planning and zoning at city, county and regional levels in many states. The acceptance of planning and zoning methods for flood plain regulation is still in its infancy and a greater educational effort is needed to bring about greater use of these tools for reducing the flood damage potential.

State laws to provide adequate planning and zoning authority should be enacted promptly where necessary. Such laws should be made adequate for the city, county and regional levels.

Although all states have provisions for administering water resources activities in some state agency to some degree, many of the agencies lack adequate powers to deal with flood problems, to collect basic data or to administer regulations. Many are inadequately financed and staffed. The states' effort should: (1) Support local flood plain regulations; (2) collect basic flood data and prepare flood evaluation reports; (3) provide advice and technical service to local planning agencies in flood plain matters; (4) administer state floodway-encroachment and dam-safety provisions; (5) provide levee inspection and require adequate levee maintenance for urban areas; and (6) cooperate with federal agencies.

The federal government should: (1) Adopt a policy that will require local regulation of flood plains where indicated in federal flood control projects; (2) enlarge the program for the collection of basic flood data; (3) prepare flood-evaluation reports particularly in regions that cross state boundaries; and (4) establish criteria for determining the extent to which loans on private construction in flood plain areas would be guaranteed by federal agencies.

Ind. Flood Control and Water Resources Comm., Indianapolis, Ind.

Moore, C. M. PERFORMANCE OF FLOOD PREVENTION WORKS DURING THE 1957 FLOODS. J. Hydraul. Div., ASCE 85(HY 10): 37-51. Oct. 1959.

The spring storms of 1957 fully tested a great number of upstream floodwater retarding structures and provided a large scale field test by which the hydrologic, design and construction criteria could be evaluated. The evaluation confirmed the fact that vegetated earth spillways for flood prevention structures can be safely used in connection with detention dam operation, involving a controlled outlet and temporary storage to reduce frequency of operation of emergency spillways. This principle of design resulted in significant reductions in the cost of the structures and at a very low relative cost for maintenance following spillway operation.

The effectiveness of watershed protection and flood prevention work in preventing flood damages has been demonstrated, and the effects of similar work in all creek watersheds in the 3-state area in which it appears to be feasible has been pointed out. Through the process of filling, releasing and refilling during the storm period the structures detained and released in an orderly manner almost twice the volume of floodwater as the combined flood detention capacity for which the structures were designed. If all feasible tributary watershed work for flood prevention had been completed, it is estimated that 33 million acre-feet of detention storage would have been available to control 62 million acre-feet of floodwater.

Engin. and Watershed Planning Unit, SCS, Fort Worth, Tex.

Eden, E. W. Jr. FLOODS OF THE FLORIDA EVERGLADES. J. Hydraul. Div., ASCE 85(HY 6): 43-65. June 1959.

Large areas in central and southern Florida are subject to seasonal flooding, since the natural streams are inadequate to remove excess rainfall during wet seasons. Major floods of record in the Everglades and man's efforts to bring that area into productive use through flood and water control are discussed.

U. S. Army Engin. Dist., Jacksonville Corps. Engin., Jacksonville, Fla.

Miller, A. E. THIS DAM HAS PAID FOR ITSELF--AND THEN SOME. Land Impr. 6(8): 18. 1959.

Black River Dam in the Green River Watershed, was completed in December 1956. Since then, the 245 farmers and rural residents living on 3,000 acres of truck crop land along the river have enjoyed three flood-free years; although floods have risen to a height of from 21 to 26 feet on the Green River five times.

Commonly quoted damage figures were $20- to $30,000 a year before the dam was built.

It is hard to understand why people would continue to allow this much damage and inconvenience to occur year after year. The cost of the dam, $38,498, could have been covered by the losses of any two floods.

In addition to 3,000 acres directly benefited, another 8,000 acres in Drainage District No. 1 are helped by improved drainage during flood periods.

SCS, USDA, Renton, Wash.

## Storage and Conveyance

McCracken, W. PONDS AND DAMS. Farm Mangt. 7(9): 36-39. 1958.

This article explains the following: (1) How to control seepage in a dam; (2) how to prevent wave action; (3) prevention of tree damage on dams; (4) how to stop gullies in a spillway; (5) how to prevent and stop leaks in dams; (6) how to control cat tails, tubes, willows and other vegetations; (7) how to build a dam; (8) where to build a dam; (9) how to avoid spillway troubles; and (10) how to prevent siltation in the dam.

Staff writer for Farm Mangt.

Burman, R. D., McNamee, A. M., and Lang, R. L. RESERVOIRS FOR RANGE STOCKWATER DEVELOPMENT. Wyo. Agr. Expt. Sta. C. 67, 6 pp. 1958.

Lack of adequate stockwater on Wyoming ranges creates a widespread problem. Without adequate water, excellent range is often nearly valueless. This circular seeks to present new ideas for solving this problem, and various types of reservoirs are described.

Having enough watering places properly spaced throughout the range, will contribute to uniform distribution of livestock and, consequently, to proper utilization of the range.

The drainage areas required to maintain water in a small reservoir may vary from 30 acres to more than 640 acres depending on rainfall, soil, vegetation, slope, and exposure.

Reservoirs for range stockwater may take several forms: the conventional, small stockwater dam, pit reservoirs of various types such as the pit dam and charco, or the "guzzler", originally developed for game in the Southwest.

Agr. Expt. Sta., U. Wyo., Laramie, Wyo.

Broadfoot, W. M. REACTION OF HARDWOOD TIMBER TO SHALLOW-WATER IMPOUNDMENTS. Miss. Agr. Expt. Sta. Inform. Sheet 595, 2 pp. 1958.

In recent years farmers and sportsmen have built many temporary shallow-water impoundments in southern hardwood forests. While the main purpose has been to attract waterfowl, a recent study shows that these forest lakes, if properly managed, can also benefit the timber.

The impoundments are generally created by constructing low dikes and dams in flats and sloughs. They are built in time to catch the rains of fall and early winter, as most of the low lands are dry by late autumn. When rains are light or delayed water is sometimes pumped into the diked areas from wells, streams, or canals. Impoundments in oak woodlands are especially attractive to mallard ducks, which feed on the mast.

Some forest owners are concerned that the water might damage the trees. The Southern Forest Experiment Station studied 16 impoundments in Mississippi and Arkansas, representing a variety of flooding conditions. Briefly, the study showed that impoundments increase the amount of water that goes into soil storage; this extra moisture is especially beneficial to trees during dry summers. But it showed also that the impoundments should be drained promptly each spring. Letting the water stand all year reduced growth for most tree species, and killed others.

Miss. State Col., Agr. Expt. Sta., State College, Miss.

Quackenbush, T. H. STORAGE FOR IRRIGATION WATER IN HUMID AREAS. J. Irrig. and Drain. Div., ASCE 85(IR 3): 41-47. Sept. 1959.

The factors that affect the development of irrigation storage facilities in humid climates are discussed. Also included are the modifications in design and planning criteria that are necessary in order to properly utilize the engineering knowledge gained on Western irrigation projects.

Future years will undoubtedly see some large irrigation developments installed in the Eastern States. The following factors which differ from conditions in the Western States should be considered in future developments:

1. The economic feasibility of irrigating some farm crops has not yet been fully established. In diversified farming areas such crops will normally be included and must be considered when computing benefits.
2. The increased profits over nonirrigated farming are much less than in the arid climates. This narrow profit margin further restricts the construction costs that can safely be charged against the land.
3. The rainfall and drought occurrence pattern will often dictate the time of irrigation. This will usually require that all farmers in the area be supplied with the maximum amount of irrigation water at the same time. This will tend to increase costs of the distribution system by requiring greater capacities per acre served.
4. Maintenance costs on canals and ditches will be increased due to the extended periods of non-use, and the more vigorous growth of weedy vegetation due to the higher rainfall. This could be offset with pipelines and lined canals, but again the installation costs would increase.
5. The smaller benefits from irrigation will require that a very high percentage of the land under the distribution system be included as a part of the project in order to provide a favorable cost-benefit ratio. Many farmers are not yet ready for irrigation, which makes the formation of an operating organization such as an irrigation district or water users' association more difficult.
6. State laws must be modified to facilitate the formation of irrigation enterprise organizations, and to establish their legal rights to the water. The riparian doctrine which is now in effect in the Eastern States must be modified in order to protect the large investments that are being made in irrigation works.

The steady growth of irrigation in the Eastern States emphasizes the need for careful planning and good engineering in designing irrigation storage reservoirs. Additional research and investigations on various irrigation problems should be encouraged to insure that our limited water supplies are fully and efficiently utilized.

Irrig. Engin., SCS, USDA, Washington 25, D. C.

Hodges, T. O., and Shanklin, M. D. SOME QUALITY FACTORS OF POND WATER IN SELECTED AREAS OF MISSOURI. Mo. Agr. Expt. Sta. Res. B. 675, 12 pp. 1958.

In many rural areas of Missouri and other states, pond water is used for domestic purposes. Surface waters require treatment, usually filtration and chlorination, to meet health standards for human consumption. The quality of a water before treatment determines how effectively the water can be treated on the farm.

A study was carried out to determine certain pond water quality factors and their variability during the season and between selected areas in the state. Samples of water were collected and analyzed monthly from 47 ponds during the period from August 1956, to May 1958.

The results can be summarized as follows: (1) Twenty-nine of the 47 ponds tested had average turbidites higher than 25 turbidity units and would require some kind of treatment, such as flocculation, before filtration for domestic use. (2) It is frequently considered desirable and economical to soften water for domestic use when the hardness is about 70 or greater ppm. Using 70 ppm as a breaking point, 19 of the 47 ponds had water that would need softening. (3) Sulfates, alkalinity, chlorides, and pH were well within desirable limits for all ponds tested. (4) Large seasonal variations in pond water turbidity occurred. Special care should be exercised in filtering pond water, particularly during the heavy spring rains. (5) Average turbidity decreased as pond size increased. Turbidities of ponds with surface areas greater than 5 acres were significantly lower than those with less than 1/2 acre. (6) Pond water in the Northeast was significantly more turbid than that in Central Missouri while values of pH in Central Missouri were significantly higher than in the Northeast area, perhaps due to soil type or to regional climatic differences. (7) The turbidity of pond water is generally less for water with high hardness. Most of the hardness is due to calcium and magnesium, which flocculate suspended material in the water. And (8) in general, turbidities were lower for waters with higher conductivities.

U. Mo., Col. Agr., Agr. Expt. Sta., Columbia, Mo.

Tolman, N. SOIL STERILENT CONTROL OF WEEDS. Irrig. Engin. and Maintenance 8(12): 9, 26-27. 1958.

Men who operate irrigation systems in the higher rainfall belts of the more humid states generally agree that grass-type weeds are one of their more troublesome operation problems.

For the last three and a half years, a soil sterilent (CMU) has been tested at Nebraska for control of grass weeds. Spring application has proven to be the most satisfactory in this area. Sterilent should be applied to a freshly cleaned or burned lateral as soon as the frost is out of the ground in the spring. The results are poor if sterilent is applied to frozen ground or laterals filled with trash and debris. Fall application seems to require about one-third more chemical to get the same results.

Ten (clay soils) to 15 pounds (sandy soils) of the sterilent per acre, gave good control of grass weeds. The sterilent should be applied with a rather low quantity of water; one pound to four or five gallons of water makes a satisfactory mix.

The ordinary truck or jeep-mounted sprayer handles the sterilent mixture satisfactorily, provided the sprayer has a good agitator. Soil sterilent does not dissolve in water, therefore it must be kept in suspension by continuous operation of the agitator. To get a uniform distribution the screens and nozzles should be cleaned about every hour or hour and a half of use. Sterilents should be applied with a hand boom and should not be allowed to spread out over areas where a good cover of grass is needed. After the sterilent has been applied to the clean lateral, water should be put into the ditch and allowed to soak the sterilent into the soil, rather than wash it through the lateral.

To treat 100 or more miles per year, the cost is $45 to $50 per mile. In large quantity orders, the chemical costs $3 a pound. The soil sterilent method of controlling grass weeds is about in line with the cost of 2, 4-D on broad leaf weeds or is comparative to cleaning a ditch with machinery, but the results obtained through sterilent are more lasting than with burning or the usual cleaning methods. After sterilent has been applied, the laterals do not "choke up" with grass after each shower. In the reported trial there

were no claims for crop damage by the sterilent washing out on farm lands, nor were there any personal injuries. The sterilent has effectively controlled some of the most aggravating grass weeds such as foxtail, fireweed and barnyard grass.

U. S. Bur. Reclam., McCook, Nebr.

Allan, P. F. MUSKRATS IN FARM PONDS. Va. Wildlife 20(7): 16-17. 1959.

When building a new pond, be sure it is constructed properly for muskrat control. The construction features that help prevent muskrat damage are: (1) Good compaction of the soil by rolling with a sheepsfoot roller when the dam is being built; (2) plenty of freeboard--that is, dam height above normal water level; (3) low slopes--at least 3 feet horizontal to 1 foot vertical on the upstream face of the dam; and (4) ample top width--10 feet or more is preferable.

Studies on the prevention of muskrat damage showed that little damage occurred when dams were built with a berm on the upstream side. A berm is a shelf of soil that extends out from the dam at or a little above normal water level. Berms are most easily installed on dug-out types of ponds where the soil can be stacked away from the excavation. The width of a berm should be at least 6 feet, but it will vary somewhat depending on the size of the dam.

Alterations in construction of ponds cost money. Berms, low slopes, increased heights, and wide tops are expensive because all of them require additional soil at the base of the dam.

Damage could be prevented by installing vertically, sheets of asbestos-cement in the dam. These sheets come in various sizes, but 4 feet by 8 feet appears to be most suitable. The bottom of the barrier should be 2 feet below normal water level and the top about 6 inches below the ground level. On dams that already were damaged by muskrats, a mechanical ditcher is used to dig a 4 1/2 foot trench in which asbestos-cement sheets are installed. Ordinary ranges of acidity and alkalinity do not affect such sheets, and they may even become more rigid when wet.

Metal sheeting has been used to prevent or correct muskrat damage. This is quite expensive. Wire netting also is installed, either in the dam or flat on its face.

Netting is not a very satisfactory solution to muskrat problems. Rust eats out ordinary wire. In acid, organic soils aluminum netting breaks down quickly. Muskrats also can bite through wire of chicken netting size.

Muskrats do not like to burrow in materials that cave behind them. Where suitable materials are available at low cost, a facing 6 inches deep can be put on dams where muskrats are likely to burrow--that is, 2 feet below normal water level to 2 feet above. This would require about a 12 foot width on a 3:1 dam slope. Sand, rock chips, clinkers, and similar loose materials may do. The major limitations using these materials are holding them in place where there is wave action, and preventing them from gradually settling to the foot of the dam.

The actual control of muskrats is a tedious and temporary job.

SCS, USDA, Ithaca, N. Y.

Turnbull, W. J., and Mansur, C. I. DESIGN OF UNDERSEEPAGE CONTROL MEASURES FOR DAMS. J. Soil Mech. and Found. Div., ASCE 85(SM 5): 129-159. Oct. 1959.

Methods of controlling seepage and excessive hydrostatic pressures beneath dams and levees founded on deep strata of pervious sands are presented. The principles involved in the different methods of underseepage control are also considered. Although the design of seepage control measures is not an exact science, formulas and criteria for preparing a rational design of such are given. These are based on known seepage laws, laboratory tests, and field observations.

U. S. Army Engin. Waterways Expt. Sta., Vicksburg, Miss.

Lobanov, I. GUNITE LINING THIS DITCH IN THE HILLS STOPS WATER LOSS. Land Impr. 6(8): 14-15. 1959.

Adding a gunite lining to 1,042 feet of a 2 mile community ditch stopped 30% of the seepage loss and eased the cleaning and upkeep problem of the ditch. It now takes 8 minutes for water to travel the gunite section, where it used to take 1 1/2 hours. The lining starts where the water comes out of a 100 foot flume on the hillside.

The finished ditch is 24 inches at the bottom, 54 inches across the top and 15 inches deep. The total cost was $2,131.93 or 15 cents per square foot of ditch surface.

No address given.

Corry, J. A., and Scott, V. H. POLYETHYLENE FILM FOR DITCH LININGS. Irrig. Engin. and Maintenance 8(10): 12-13. 1958.

Recent estimates and measurements indicate that from one-fourth to as high as one-half of the water conveyed in canals and ditches for irrigation is lost by seepage.

Black polyethylene film, 1 1/2, 4, and 8 mils in thickness has been tested in several field installations for evaluation of seepage and vegetation control, water control, installation and handling methods, and mechanical and animal damage.

Standard farm ditching equipment can be used to prepare a ditch for plastic lining. Before lining it is necessary to remove sharp protuberances of all kinds to prevent film damage.

The first step for installation is to dig a trench across the ditch at the upper end, where the end of the film is buried and secured. The trench should be about eight inches wide and 12 inches deep. When the upper end of the film is secured in the trench, the film should be rolled out in the ditch with the edges placed over the ditch tops. About six inches of film are needed on the outside of the banks to secure the edges properly. Sufficient slack must be provided in the film to conform to irregularities of the ditch bottom and banks when water fills the ditch. At the lower end of the lined section, the film should be buried in a cross trench similar to the one at the upper end. Soil on top of the film will hold the lighter films down if the wind is blowing.

All thicknesses of film have been successful in controlling Johnson, Bermuda, water grass, and most other persistent weeds and grasses. Nutgrass has proven a problem. It has penetrated 1.5 and 4-mil film. It would be best to use 8-mil film if nutgrass is present.

A serious and difficult problem to handle on some irrigated farms is ditch bank washouts. This problem is common in sandy soils and sometimes in heavier soils. Film of 1.5 and 4 and 8-mil thicknesses have effectively prevented washouts, eliminating costly and oftentimes inadequate stop gap measures. Another important advantage of polyethylene film linings is reduced bank sloughing and erosion.

Direct damage to linings may result from several sources. The damage, varying in degrees of severity, may result from activity of rodents, birds, dogs, game animals and the irrigators. The best prevention would be heavier film or fencing.

Siphon and shovel cuts, small punctures and rips, and damage from animals on 4 and 8-mil film can be repaired by applying a pressure sensitive tape. Properly applied, tape will securely hold for one or two seasons.

Field observations indicate that smoothness of polyethylene film increases the hydraulic efficiency of a ditch so that the rate of flow carried in an unlined ditch can be conveyed in a much smaller cross section of lined ditch. Steeper slopes can be accommodated by plastic linings because higher water velocities can be conveyed without soil erosion or sediment transport.

U. Calif., Davis, Calif.

Ellsperman, L. M., and Hickey, M. E. THE USES OF ASPHALT IN HYDRAULIC CONSTRUCTION BY THE BUREAU OF RECLAMATION, 1946-1959. Paper presented at The Third Annual Kansas Asphalt Paving Conference U. Kans., Lawrence, Kans. Nov. 5-6, 1959 33 pp. map and plates. 1959.

Various types of construction are outlined and the materials and general procedures associated with each type described. New installation procedures have been devised for some of the older types, and for the newer types, up-to-date conclusions regarding materials and methods are given. Much progress has been made during the past several years towards improving old and developing new uses for asphalt. There is every indication that advancements will continue to be made and that asphalt will become increasingly important in hydraulic works as experience and research contribute to the general knowledge of its use. It should be pointed out that many of the types of construction described in this paper involve the element of minimum cost. In asphaltic construction, rigid inspection of construction procedures and care in proper design and control of materials are necessary if high efficiency and truly minimum costs are to be obtained. Some of the types of construction discussed herein have demonstrated their effectiveness and efficiency for the purpose intended. However, some factors such as normal life expectancy can be determined only by the test of time.

Div. Engin. Lab., Bur. Reclam., Denver, Colo.

Grindrod, J. THE AUSTRALIAN BATTLE WITH EVAPORATION. Irrig. Engin. and Maintenance 9(3): 12, 23. 1959.

The reduction of evaporation losses from water surfaces through the use of specially prepared cetyl alcohol monolayers is being carried on in Australia and East Africa with a considerable degree of success. This method has been particularly successful with small sheets of water, though larger areas have also been successfully treated.

In arid, tropical regions, evaporation from water surfaces may amount to as much as 150 inches a year. In the case of large reservoirs, the total annual losses vary from 10 to 20 percent of the full total capacity, and in small reservoirs of the large farm type, losses are rarely less than 40 percent and may exceed 60 percent. In Australia the normal loss by evaporation is four times the consumption.

Two methods of reducing evaporation losses have been developed, both being based on the fact that a saturated long chain fatty alcohol, cetyl alcohol, spreads a liquid monomolecular layer over the surface of the water. The film is non-toxic and retards evaporation while allowing free passage of oxygen and sunlight.

The film is effective for wind velocities of up to 50 miles an hour, but it can be damaged by carbonaceous dust and large waves. If ruptured, it will heal itself so long as a reservoir of cetyl alcohol remains in the water. It spreads to an equilibrium pressure of 40 dynes per centimetre, at which point it is most efficient. The relationship between surface pressure and percentage retardation of evaporation is roughly linear. At a pressure of 40 dynes, reductions of 70 percent have been obtained, compared with reduction of one to two percent at 10 dynes.

For small areas of water up to two acres, the Commonwealth Scientific and Industrial Research Organization in Australia has developed the Mansfield process, which depends on the use of a specific grade of cetyl alcohol made in uniform sized beads, which must conform to the organization's specifications.

In use, the beads are confined in bronze or aluminum baskets, 14 to 16 mesh to the inch, floating in rafts. The initial charge is 2 to 2.5 pounds of hexadecanol, which must cover the 9 square feet of water enclosed by the basket. The top of the basket should clear the water by three inches and the bottom of the basket should be two inches below the surface to prevent wasting the beads through abrasion. An additional one-half- to one-pound of hexadecanol is added approximately once a month, one raft per acre of water being used. Properly operated, the process reduces evaporation losses by at least 25 percent. Savings of 50 percent and in some cases 70 percent have been achieved.

Approximately 1,000 rafts for use in water conservation have already been built, and the process is being increasingly used in Australia.

No address given.

## Soil Structure

Ramacharlu, P. T. PERMEABILITY IN RELATION TO WATER STABILITY OF SOIL AGGREGATES. J. Indian Soc. Soil Sci. 6: 177-185. 1958.

The dry and wet sieve analyses and measurement of permeability for water have been carried out with the following soils--red, laterite, black, alluvial, forest, desert, saline, alkaline, and peaty.

In contact with water, the soil aggregates disintegrate. Different soils disintegrate to different extents. Sand suffers the least, whereas the disintegration suffered by saline and alkaline soils is high. The differences in the water stabilities of the aggregates in different soils are indicated by the instability factors. The permeabilities of the different soils bear a better relation to particle size distribution in the wet state than in the dry state. The relation however is approximate.

Defence Sci. Lab., Ministry Defence, New Delhi, India.

Reeve, R. C. THE RELATION OF QUALITY OF WATER TO SOIL STRUCTURE. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 158-162, Jan. 1958.

It is well known that soil structure is affected by both the kind and amount of salts contained in irrigation waters. Not so well known are the mechanisms by which the interactions between soils and waters take place. This paper discusses some of the major factors affecting soil structure, and presents some of the recent findings of the U. S. Salinity Laboratory on this subject.

Changes in soil structure due to the quality of the irrigation water are observed chiefly in changes in the rate of entry of water into the soil and in changes in soil tilth and ease of cultivation, and preparing the seed bed.

The major factors affecting the rate of water movement in soils are: (1) Total salt content of the irrigation water; (2) proportion of sodium salts in relation to the other salts in the water; and (3) exchangeable cation status of the soil.

It has been observed by many investigators that the permeability of a given soil is different for waters of different salt contents.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

## Soil-Water Relationships

Stanberry, C. O. CROPPING PRACTICES FOR MAXIMIZING MOISTURE UTILIZATION EFFICIENCY. Can Man Develop a Permanent Agriculture? 1st Inter. Soc. Conf. Irrig. and Drain. Proc., San Francisco, Calif., 1957, pp. 59-67. 1959.

Moisture utilization efficiency (MUE) is defined as units of marketable crop produced per unit depth of water utilized in evapotranspiration.

Since MUE is expressed as water used in evapotranspiration per unit of crop produced it can be increased either by decreasing transpiration without sacrificing yields, (direct), or by increasing yields without a corresponding increase in transpiration, (indirect).

MUE is affected by climatic, plant, soil, and water factors, the first being most difficult to control for maximizing MUE. Since some of the direct factors are uncontrollable, MUE improvement must occur predominately through evaporation suppression and indirect factors. Suggested possibilities for minimizing evapotranspiration per unit of crop produced, and maximizing MUE follow:

1. Evaporation may be minimized by: (1) Irrigation to fill the soil reservoir so as to minimize irrigation frequency; (2) surface roughness to decrease wind velocity at the soil surface; (3) provide windbreaks by strip cropping or other method; and (4) surface cover, stubble mulch, or other mulches to increase infiltration, decrease evaporation, minimize erosion, and control blowing hazards.

2. Decrease Transpiration by: (1) Minimize length of growing period if possible by producing crop at season of year when evapotranspiration rate will prevent maximum yields; (2) choose a given species or variety to shorten growing period; and (3) minimize irrigation frequency by associating water needs with physiological growth stages of crop.
3. Increase Yields by: (1) Obtain a plant population to utilize effectively soil and solar energy available; (2) utilize crop sequence and green manure crops for residual fertility and productivity; (3) maintain cultural treatments to sustain thrifty growing conditions; (4) fertilize to provide chemical and physical availability of nutrients (rate, frequency, source, particle size, placement); (5) tillage to maintain adequate temperature for organic matter decomposition, nitrification, and plant growth; (6) tillage practices to increase water intake and storage in the soil; (7) use soil management practices to maintain adequate drainage; (8) maintain water quality including low boron, $HCO_2$, and Na--Ca ratio; (9) irrigation practices to avoid nutrient leaching or soil flooding; and (10) irrigate to maintain turgor of plant tissue since growth rate decreases with moisture stress.
4. Decrease Transpiration and Increase Yields by: (1) Choose an appropriate soil exposure to make possible a suitable growing season; (2) use windbreaks to decrease evapotranspiration and increase yields; (3) select general, species and varieties well adapted to climate, soil and water supply available; (4) clip and graze infrequently enough to maintain plant vigor and welfare; (5) avoid plant-tissue damage affecting the anatomy of plant absorbing, conducting and transpiring tissues, or yield reductions by diseases, insects, nematodes, rodents, weeds, nutrient deficiencies, phytotoxic conditions, and mechanical injuries; (6) tillage and management to insure adequate aeration and temperature control; (7) till and irrigate to keep available large reservoir for moisture and nutrients; (8) correct pH conditions affecting membrane permeability; (9) maintain soil physical conditions, soil aggregation and soil structure by tillage, addition of organic matter and use of practices for oxidation and nitrification processes; plant growth; prevention or elimination adequate soil drainage; (10) decrease salinity and toxic accumulations which decrease evapotranspiration, plant growth and yields; (11) irrigate frequently enough so soil moisture stress doesn't limit moisture uptake and growth; and (12) do not irrigate so frequently that root development is superficial due to an oversupply of water.

SWCRD, ARS, USDA, Yuma, Ariz.

Haise, H. R., and Viets, F. G. Jr. WATER REQUIREMENTS AS INFLUENCED BY FERTILIZER USE. International Comm. on Irrig. and Drain. Proc. Third Cong. 8: 498-508. 1957.

Water requirement has been expressed as the ratio of water used to dry matter produced. A more useful concept is water use efficiency defined as units of marketable crop produced per unit depth of water used in evapotranspiration. The effects of fertilizers on evapotranspiration are comparatively small where vegetative cover is reasonably continuous. On nutrient deficient soils, fertilizers may increase greatly the amount of growth and efficiency of $CO_2$ assimilation. Therefore, where fertilizers affect the amount of crop produced, water use efficiently is substantially increased by the use of fertilizers.

Nitrogen fertilization hastens the development of some crops like corn and grain sorghums in contrast to the effects of delayed maturity that can occur with wheat.

Expression of water use efficiency in terms of marketable product per inch or foot of water used has a very practical advantage where water is scarce and costly. Comparisons on alternative users of water can easily be made. Comparisons of water use efficiency of a given crop in different climates are facilitated.

The irrigation requirement of a crop includes those losses of water incident to applying the desired amount of water to the soil. In the West irrigation efficiency is often as low as 50 percent. Improved irrigation efficiency through redesign of application systems would also save much water now being lost.

SWCRD, ARS, USDA, Fort Collins, Colo.

Gerard, C. J., Bloodworth, M. E., and Cowley, W. R. EFFECT OF TILLAGE, STRAW MULCHES AND GRASS UPON SOIL-MOISTURE LOSSES AND SOIL TEMPERATURES IN THE LOWER RIO GRANDE VALLEY. Tex. Agr. Expt. Sta. MP-382, 15 pp. 1959.

Tests were conducted at the Substation at Weslaco, Texas for 4 years on evaporation from soil and straw-mulch surfaces and evapotranspiration from grass-covered surfaces.

Evaporation from straw and soil-mulched surfaces was not significantly different. Grass covers required 30 to 35 percent more moisture than soil and straw-mulched surfaces.

Fertilization of grass caused a 7 to 8 percent increase in moisture requirement.

Data indicate that the temperatures under soil-mulch covers generally were higher in spring, summer, and fall than straw mulch and grass covers. However, soil under grass cover had higher average temperature during the winter. Straw-mulch surfaces were intermediate in effect on soil temperatures at the 3-inch depth but showed the lowest soil temperatures at the 9-inch depth.

Correlative analyses indicated that evapotranspiration from grass was influenced significantly by air and soil temperatures. Air and soil temperatures did not seem to influence evaporation from soil-mulched surfaces, but air temperatures appeared to have some influence on evaporation from straw-mulched surfaces. The factors which influence evaporation and evapotranspiration under various covers were investigated and the possible mechanisms in the moisture-loss processes are discussed in this report.

Tex. Agr. Expt. Sta., College Station, Tex.

Shaw, R. H., Runkles, J. R., and Barger, G. L. SEASONAL CHANGES IN SOIL MOISTURE AS RELATED TO RAINFALL, SOIL TYPE AND CROP GROWTH. Agr. and Home Econ. Expt. Sta. Res. B. 457: 223-239. 1959.

A series of soil moisture samples from 0 to 5 feet were collected at some 20 different locations in Iowa over a period of 3 years.

Average daily water use for 1954, 1955 and 1956 from corn land for the period mid-April to mid-June was 0.10, 0.09 and 0.08 inch; for mid-June to mid-August, 0.18, 0.18 and 0.15 inch; and for mid-August to November, 0.09, 0.07 and 0.08 inch, respectively. Daily water use consisted of runoff, evapotranspiration and percolation.

At Ames in 1954 for a 19-day period in July, an average evapo-transpiration rate of 0.16 to 0.17 inch was measured. Soil moisture was probably limiting the rate of water use.

Soil moisture change was measured for different times of the year. With normal precipitation, some increase in soil moisture occurred under corn plots, except during the summer period when, even with normal rainfall, soil moisture was reduced. In all periods, except the summer, soil moisture gains averaged less under meadow than corn, or actual losses occurred.

Yield of corn increased with increased water use. The highest correlation between yield and water use was found for the period mid-June to early August.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

Carlson, C. W., Alessi, J., and Mickelson, R. H. EVAPOTRANSPIRATION AND YIELD OF CORN AS INFLUENCED BY MOISTURE LEVEL, NITROGEN FERTILIZATION, AND PLANT DENSITY. Soil Sci. Soc. Amer. Proc. 23: 242-245. 1959.

Yields and evapotranspiration rates by corn grown in Gardena l at two levels of soil moisture, two plant densities, and several rates of N fertilization were studied for two growing seasons.

Neither N fertilizer or plant density influenced yields in the nonirrigated treatment, but in the irrigated treatment corn yields in both plant densities increased when N fertilizer was applied. Measurements made on the number of kernels per square foot, and individual kernel weights showed that grain yields were most influenced by the number of kernels produced per unit acre. Neither N fertilizer nor plant density appreciably affected the evapotranspiration rate. Evapotranspiration was considerably greater for

the irrigation plots than for the nonirrigation plots. Rates of evapotranspiration were higher in 1957 than in 1956. The pounds of dry matter produced per inch of water used in evapotranspiration (water-use efficiency) was appreciably increased by using a high plant density and N fertilizer. This effect was much less marked in the nonirrigated treatments than in the irrigated. The amount of dry matter produced per inch of water used was greater on the nonirrigated treatment than on the irrigated treatment, except at the high N rate in the high plant density. It is apparent that if maximum efficiency of moisture use is to be realized, adequate fertilizer and plant densities are required.

SWCRD, ARS, USDA, Mandan and Grand Forks, N. Dak.

Rosenqvist, I. T. PHYSICO-CHEMICAL PROPERTIES OF SOILS: SOIL-WATER SYSTEMS. J. Soil Mech. and Found. Div., ASCE 85(SM 2): 31-53. Apr. 1959.

The heat of wetting, the diffusibility of hydrogen and isotopic prothiumdeutrium exchange, indicate that a part of the water in a clay-water system should be considered as belonging to the mineral phase. The minerals thus consist of a central silicate skeleton with an outer part of aqueous composition. The presence of this outer part is the essential characteristic of the mineral phase in a clay-water system. Typical clay properties, such as cohesion and plasticity, are discussed in terms of this concept. The Bowden friction theory is assumed to be valid in clay-water systems.

Norwegian Geotechnical Inst., Oslo, Norway.

Gard, L. E. MOISTURE USED BY CORN ON A SILT PAN SOIL IN SOUTHERN ILLINOIS. Ill. Res. 1(4): 5. 1959.

Even short drouths have often drastically reduced corn yields on the silt pan soils of southern Illinois. This is true despite the fact that, in most growing seasons, the available moisture is mathematically enough for a 125-bushel crop. Under average summer temperatures in southern Illinois, 18 to 21 inches of water are used to produce a 125-bushel corn crop.

Average rainfall during the corn growing season (May 15 through September 12) for the 21-year period 1938-1958 has been 14 inches. In addition 16 inches of available moisture from winter and spring rains can be stored in the top 60 inches of soil, making a total of 30 inches potentially available for the corn crop. Unfortunately, however, the soil is seldom filled to more than three-fourths capacity at corn planting time. Furthermore, on silt loam soils in southern Illinois, the corn plant can utilize very little of the moisture below 24 inches.

Studies were conducted on Grantsburg sil, a fragipan soil. Corn was grown both without irrigation and with medium and high amounts of supplemental water. The medium irrigation consisted of two 2-inch applications, one when the corn was in the early tassel stage and another 10 to 14 days later. The high level consisted of enough water to bring the total supply, including rainfall, up to 2 inches a week for the seventh through twelfth week after planting.

Of the total water utilized by unirrigated corn, the amount supplied from below the 24-inch level averaged only about 6 percent for the 4-year period; and in none of the measurements did it exceed 12 percent. Whenever the water supplied from below 24 inches did approach 12 percent of the total, yields were materially reduced. In 1955 less than 3 percent of the water came from below 24 inches.

Irrigation decreased the amount of water that was supplied from below 24 inches. The 3-year (1955-1957) average was less than 4 percent on plots receiving medium irrigation. On heavily irrigated plots, only 2 percent of the water used in producing the crop came from below 24 inches.

Average acre yields for 1955, 1956, and 1957 were increased 27 bushels by two 2-inch applications of irrigation water, put on at tasseling and shooting stages. Plots receiving heavy irrigation yielded 32 bushels an acre more than the unirrigated plots.

On the basis of these results, plus a study of rainfall amounts and patterns over a 21-year period, irrigation seems to be an economical, sound practice in 3 out of 4 years. Usually irrigation is not necessary for the first 6 or 7 weeks after the corn is planted. Conditions are most likely to be critical from the eighth week after planting throughout

the twelfth week. Under average temperature conditions, moisture was used at the rate of 1/3 inch a day during the tenth and eleventh weeks. When temperatures and winds are high, this rate may increase to 1/2 inch a day.

The use of other good agronomic practices, especially an adequate fertility program, should accompany an irrigation system.

U. Ill. Col. Agr., Agr. Expt. Sta., Urbana, Ill.

Shaw, R. H., Nielsen, D. R., and Runkles, J. R. EVALUATION OF SOME SOIL MOISTURE CHARACTERISTICS OF IOWA SOILS. Agr. and Home Econ. Expt. Sta. Res. B. 465: 411-420. 1959.

Sampling of a Webster till soil for soil moisture showed significant variability from corn hill to corn hill, with small variability between samples taken 1 foot apart. Variation between hills increased with depth down to 5 feet. Variation between replications was greatest in the surface foot. Spacing was significant at 2- to 3-feet.

The standard error of the mean of six samples taken with a Veihmeyer tube in a 40 x 40 foot area was estimated to be 0.18, 0.22, 0.31, 0.47 and 0.48 inches for the 0 to 1, 1 to 2, 2 to 3, 3 to 4, and 4 to 5 foot depths.

The 15-atmosphere percentage for samples taken a few feet apart was found to be variable, showing ranges up to 10 percent for a given depth in a Webster soil and 11 percent in an Edina soil. The Ida, Monona, and Carrington soils sampled were much less variable. To obtain an accurate wilting point, it must be determined for each plot.

Field capacities determined in the field showed that slowly permeable layers, which cannot be determined visually, have considerable effect on the field capacity.

A bulk density on loess soils of 1.3 can be used with little error for all depths, but on till soils the bulk density changes with depth. The data available averaged 1.21 in the surface 6 inches up to 1.8 from 54 to 60 inches.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

Axley, J. H., and Lull, H. W. FOREST SOIL-MOISTURE RELATIONS IN THE COASTAL PLAIN SANDS OF SOUTHERN NEW JERSEY. Forest Sci. 4: 2-19. 1958.

In a study of forest soil moisture relations in the coastal plains (upland sites) sands of southern New Jersey the following conclusions were reached:

1. Soil-moisture measurements during the growing season on upland sites in the New Jersey Pine Barrens indicated that stands of shortleaf pine and oak scrub used about the same amount of water at about the same rate from the upper 5 feet of soil. Both removed moisture to a depth of at least 12 feet, the lowest depth sampled.
2. Evapo-Transpiration from 7-year-old pine seedling-oak sprout stands was governed largely by the sprouts, which removed moisture as rapidly and from the same depth as older oak stands.
3. A 15-year-old stand of shortleaf pine saplings utilized moisture to a depth of 8 feet; this was about 4 feet less than depths utilized by the pine-pole and oak stands, indicating withdrawal of a smaller amount of moisture.
4. Soil-moisture was evaporated from the bare area to a depth of 6 feet, the smallest depletion of soil moisture.
5. Total evapo-transpiration from the 0- to 5-foot depth for the period of record ranged from 17.24 inches for the bare plot to an average of 22.15 inches for the four forested conditions. Differences were not statistically significant.
6. Based on the soil-moisture record for the 0- to 10-foot depth, evapotranspiration from a pine-pole plot amounted to 26.21 inches for the 7-month period; 20.84 inches came from the 0- to 5-foot depth.
7. Within the 0- to 5-foot depth, soil-moisture depletion proceeded simultaneously within each foot-depth and tended toward the same rate. During the period of record, 30 percent of moisture removed came from the upper foot, 22 percent from the second foot, and 16 percent from each of the next 3 feet.

8. Generally, standard deviations at any one sampling, of 1-foot samples to a depth of 5 feet, were about one-third of the mean moisture contents and one-fifth to one-fourth when depth variance was substracted. Variation of 1-foot samples was similar within 12 x 12- and 42 x 42-foot plots, and between 42 x 42-foot plots within a square-mile area.

Northeastern Forest Expt. Sta., FS, USDA, Upper Darby, Pa.

## Soil Chemistry

Taylor, A. W. PHYSICO-CHEMICAL PROPERTIES OF SOILS: ION EXCHANGE PHENOMENA. J. Soil Mech. and Found. Div., ASCE 85(SM 2): 19-30. Apr. 1959.

The origin of the various types of electrical charges carried by soil celloids is described and the influence of different species of exchangeable cations on the forces arising from the electrical fields due to these charges is discussed in terms of the theory of the diffuse double layer. The principles of the application of this theory to the study of flocculation and swelling phenomena are described. Examples are given to illustrate the way in which it may be used to predict the effects of different types of exchangeable cation and salt concentration on the mechanical properties of soils.

Pa. State U., University Park, Pa.

Basu, A. N. EXCHANGE BEHAVIOUR OF Cu, Mn AND Zn IONS IN CLAYS. J. Indian Soil Sci. 6: 71-76. 1958.

Exchange behavior of $Cu^{++}$, $Mn^{++}$ and $Zn^{++}$ ions was studied using aqueous suspensions of H-clay prepared from a sample of Akli bentonite and the clay-salts prepared from it. In order to prevent hydrolysis, electrolyte solutions used for the preparation of Cu-, Mn-, and Zn-clays were maintained at about pH4.

Not the whole quantity of adsorbed metal ions could be released by dilute acid leaching, thereby suggesting a portion being rendered non-exchangeable or fixed by the clay.

The metal ions exchange H ions generally in the sequence of $Cu^{++} > Mn^{++} > Zn^{++}$ and are themselves released from the clay-salts by other metal ions in the reverse order. $Cu^{++}$ and $Mn^{++}$ show reverse order of exchange at higher concentrations. A lyotrope series is more or less followed in respect of $Na^{+}$, $K^{+}$, $NH_4^{+}$, $Ba^{++}$ and $Mg^{++}$ ions exchanging against Cu-, Mn- and Zn-clays.

The presence of two categories of exchangeable ions is shown by the breaks in the logarithmic plots of the exchange data for $Cu^{++}$ and $Mn^{++}$ against H-clay and the isotherms of Zn-clay + added cations.

U. Col. Sci. & Tech., Calcutta, India.

Carroll, D. ION EXCHANGE IN CLAYS AND OTHER MINERALS. Geol. Soc. Amer. B. 70: 749-779. 1959.

Ion exchange in clays and other minerals is dependent on the crystalline structure of the mineral and on the chemical composition of any solution in contact with the mineral. The structures of clay minerals and zeolites are briefly described to provide a background for the discussion of their ion-exchange reactions. Ion exchange in these minerals is a reversible chemical reaction that takes place between ions held near a mineral surface by unbalanced electrical charges within the mineral framework and ions in a solution in contact with the mineral.

Ion-exchange capacity is discussed and the order of replaceability of the common cations are given. Other exchange phenomena discussed are anion exchange, fixation of cations and anions by clay minerals, effect of environment on cation exchange, and the exchange capacity of zeolites, of rocks, of other minerals, of organic matter and organic complexes, and of amorphous mineral material.

Bibliography of 243 articles.

U. S. Geol. Survey, Washington, D. C.

Blackmon, P. D. NEUTRALIZATION CURVES AND THE FORMULATION OF MONOVALENT CATION EXCHANGE PROPERTIES OF CLAY MINERALS. Amer. J. Sci. 256: 733-743. 1958.

Exchange constants derived from observed titration curves for three clay minerals (beidellite, "illite", and bentonite) were used to calculate new titration curves against potassium, ammonium, and sodium hydroxides. Assuming two exchange sites, $\overline{C}$ and $\overline{E}$, in each clay, the observed titration curves indicate that hydrogen is more firmly bound to the $\overline{E}$ sites than to the $\overline{C}$ sites in the order bentonite > beidellite > "illite". The $\overline{E}$ site, or substrate, in the titration of an H+ substituted clay, is the weaker acid, that is, it is occupied only after all $\overline{C}$ sites are occupied by other cations. Differences in bonding strength of the $\overline{C}$ sites for the several clays are very small.

The exchange constants indicate that potassium and ammonium react in a similar manner and replace hydrogen more easily than sodium replaces hydrogen. In addition potassium, ammonium, or sodium will replace one another more readily than they will replace hydrogen in the clays.

U. S. Geol. Survey, Denver, Colo.

Grim, R. E. PHYSICO-CHEMICAL PROPERTIES OF SOILS: CLAY MINERALS. J. Soil Mech. and Found. Div., ASCE 85(SM 2): 1-17. Apr. 1959.

Modern concepts of the structure, composition, and origin of clay minerals and current procedures for their identification are reviewed.

Dept. Geol., U. Ill., Urbana, Ill.

Blomberg, N., and Holmes, W. E. THE CARBON-NITROGEN RATIOS IN SOME HAWAIIAN SOILS. Hawaii Agr. Expt. Sta. Tech. Prog. Rpt. 122, 7 pp. 1959.

Both carbon and nitrogen increase with increasing rainfall. The cultivated soils in regions of rainfall below 30 inches have more carbon and nitrogen than the virgin soils. In regions of rainfall above 60 inches the cultivated soils have less carbon and nitrogen than corresponding virgin soils. This phenomenon is associated with the amounts of plant residues returned to the soil by crops or native vegetation.

The carbon-nitrogen ratio increases logarithmically with increasing rainfall. There is no difference in the carbon-nitrogen ratio of cultivated and virgin soils of similar rainfall areas. The large number of leguminous plants is probably the main reason why the native plant growth is not hindered by the high carbon-nitrogen ratio and subsequent nitrogen availability.

The high amounts of organic matter in the soils of the high rainfall areas aid in the maintenance of the soil structure which allows large amounts of water to enter the soil. This large quantity of water produces a semianaerobic condition that hinders decomposition and maintains the organic matter and the carbon-nitrogen ratio at high levels.

There were no significant correlations between the elevation and carbon content, nitrogen content, and carbon-nitrogen ratio.

U. Hawaii, Hawaii Agr. Expt. Sta., Honolulu, Hawaii.

Katalymov, M. V., and Ryabova, S. I. CONTENT AND METHODS OF DETERMINATION OF SOLUBLE BORON IN SOILS. Soviet Soil Sci. 8: 863-866. Aug. 1958.

The amount of boron extracted from a clay loam wooded podzol with cold water depends on the reaction time of water with the soil. Increasing the reaction time from 1 to 24 hours increases the amount of soluble boron by one-half.

Hot water extracts several times more boron from soils than cold water. Upon boiling the soil with water the extraction of boron proceeds in the first 5 to 10 minutes. Increasing the reaction time of hot water with soil gives almost no increase in the amount of boron in the extracts. Upon repeated treatment of the soil with hot water, the amount of boron going into the extract is sharply reduced (4 to 5 times).

Hydrochloric acid in low concentrations as a rule extracts more boron from soils than does water. At the same time, the increase in solubility of soil boron using hot acid as compared with hot water is relatively small.

Comparisons of the solubility of soil boron in cold and hot water and weak hydrochloric acid solutions show that with the amount of boron taken up from the same soil by plants, the most satisfactory indication of the available boron content in soils is given by a hot water extract.

On the basis of the data obtained, a short description of a recommended method for determining the soluble boron content in soils is presented.

Amer. Inst. Biol. Sci., 2000 P St. N. W., Washington 6, D. C.

Higdon, W. T., and Marshall, C. E. THE UPTAKE OF Ca AND K BY YOUNG SOYBEAN PLANTS. Mo. Agr. Expt. Sta. Res. B. 716, 28 pp. 1959.

Soybeans were grown for 20 days on 24 liquid nutrient media comprising chloride and bicarbonate solutions, colloidal Putnam clay, colloidal Wyoming bentonite, and a suspension of a carboxylic cation exchange resin. (Amberlite XE64.) The variables under study were: absolute activity levels of K+ and Ca++ ions, the ratio $K/\sqrt{Ca}$, and the free energy change in the exchange reaction between plant root and cationic medium.

At the beginning of the treatments all seedlings were strongly calcium-deficient. Hence the study involves chiefly the conditions for recovery from marked calcium deficiency. The cation exchange properties of the roots, composition of roots and tops as regards K and Ca, and final yields were used as criteria.

The evidence from cation exchange experiments on plant roots indicated clearly that simple Donnan equilibrium relationships did not adequately account for the results. Consideration of plant composition and uptake in relation to $K/\sqrt{Ca}$ ratios for the substrates also brought out this point. In recovery from calcium deficiency calcium was found necessary for the efficient utilization of potassium. The absolute level of the calcium activity was found to be of dominant importance. The influence of the free energy change in the exchange reaction between, plant roots and substrate was clearly apparent in the chloride-bicarbonate comparisons. In the colloidal systems superiority of uptake of Ca and K over true solutions could not be decisively linked to any of the above factors.

U. Mo., Agr. Expt. Sta., Columbia, Mo.

## Soil Physics

Brooks, R. H., and Reeve, R. C. MEASUREMENT OF AIR AND WATER PERMEABILITY OF SOILS. Amer. Soc. Agr. Engin. Trans. 2(1): 125-126, 128. 1959.

Procedures for measuring air and water permeability of soils in the laboratory and the use of the air-water permeability ratio, $k'_a/k'_w$, in evaluating stability of soil structure are reviewed. The scale of air-water permeability ratio may range from 1 to infinity with a value of 1 indicating no change in structure as a result of wetting the soil with water. The greater the ratio value the greater the instability of the soil.

Data are presented which show that exchangeable sodium has a marked effect on the stability of soil structure and that this effect is more pronounced as the cation-exchange-capacity of the soil increases.

The effect of moisture content on air permeability of soil cores was investigated. Results are reported for two soils (Pachappa and Chino) of widely different textures. The change in air permeability over the available moisture range, which in this case is taken as the range from the 0.15- to the 15-bar percentage, was considerably greater for the fine than for the coarse textured soil. However, when expressed as a fraction or as a percentage, the change was approximately 50 percent for both soils.

SWCRD, ARS, USDA, Fort Collins, Colo.

Lambe, T. W. PHYSICO-CHEMICAL PROPERTIES OF SOILS: ROLE OF SOIL TECHNOLOGY. J. Soil Mech. and Found. Div., ASCE 85(SM 2): 55-70. Apr. 1959.

The components of soil technology are listed and the type of contribution of each component is described. Soil technology is an applied science which covers the physico-chemical properties of a soil plus the geological history of the soil.

The two major contributions soil technology makes to the soil engineer are: (1) Help in the estimation of the soil property to be used in any given engineering problem, and (2) help in explaining the fundamentals of soil behavior. These are very important contributions and, in the opinion of the Author, they will become of increasing significance to both the research and practicing soil engineer. The day may not be too far off when, on major engineering projects involving clay, the soil engineer will make compositional and structure analyses (including some estimate of the contact area between soil particles) prior to the instigation of an experimental program involving the conventional engineering tests.

Mass. Inst. Tech., Cambridge, Mass.

Gardner, W. R. MATHEMATICS OF ISOTHERMAL WATER CONDUCTION IN UNSATURATED SOIL. Highway Res. Board, Natl. Res. Council, Washington, D. C. Spec. Rpt. 40: 78-87. 1959.

In addition to helping understand unsaturated flow problems of practical importance, the flow equation and its solutions can be helpful in studying the role of various soil and water properties in their influence on water movement. The equation provides means to evaluate the diffusivity and the conductivity. Departures of real systems from theoretical solutions of the equation indicate the importance of temperature gradients, vapor movement, inhomogeneities, concentration gradients, and other effects which are usually otherwise difficult to study. Studies of the diffusivity and the conductivity as functions of water content, temperature, specific surface, particle size and arrangement, etc., should facilitate an understanding of the mechanisms involved in water movement. Although in practice it may seldom be feasible to attempt complete solutions of the flow equation, solutions for certain ideal cases can provide upper and lower limits to the rate of movement and a greater insight into flow processes.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

## Soil Biology

Cooke, W. B., and Lawrence, D. B. SOIL MOULD FUNGI ISOLATED FROM RECENTLY GLACIATED SOILS IN SOUTH-EASTERN ALASKA. J. Ecol. 47: 529-549. 1958.

The process of natural development of communities on terrain which has never before been populated has long interested biologists and soil scientists.

Rapid recession of glaciers during the past two centuries in south-eastern Alaska has made that region especially favorable for studies of vegetation development.

In the hope of learning something about development of the soil mould fungus populations in the recent glacier deposits of known age, the writers in the spring of 1955 planned a joint effort. Lawrence collected fresh soil material from developing communities of differing ages ranging from zero at the ice edge to spruce (Picea sitchensis) forests 150 years old, and to much older hemlock (Tsuga heterophylla and T. mertensiana) forests, and Sphagnum moss and Carex muskegs on peat that had been accumulating for several thousand years, and Cooke carried out the culturing and identification of the samples.

As the natural vascular plant communities mature and as the nitrogen content of the soil increases the populations of mould fungi increase in numbers of species and individuals. As the litter materials increase, the nitrogen fraction is used by a larger number of organisms in the presence of greater carbon supplies in the litter. As more coniferous litter becomes available, materials which decompose slowly or poorly, if at all, are

added to the forest floor, and organisms such as the mushroom-type fungi, which may be able to use these newer chemicals, such as humic acids and numerous types of lignin-containing compounds, become competitive. Under these conditions, the numbers of colonies of soil mould fungi decrease and some species may drop out while others may be added to the populations.

As the vascular-plant vegetation matures, more and more soil mould fungi are found in deeper layers of mineral soil.

The fermentation (F) and humus (H) layers of the forest floor, and the upper layers of mineral soil (A, B) appear to be most densely populated with fungus colonies. The large number of species in the litter layer is related to the primary decomposition processes in the litter.

The soil mould populations in the two areas studied are fairly homogeneous. With the techniques used, no special trend is shown for dominance of a particular horizon by a special fungus.

PHS, U. S. Dept. Health, Ed. and Welfare, Cincinnati, Ohio.

Sinha, S. B. CONTRIBUTION OF AZOTOBACTER IN NITROGEN FIXATION UNDER NATURAL CONDITIONS. J. Indian Soc. Soil Sci. 6: 153-159. 1958.

The efficiency of Azotobacter as nitrogen fixer, has been studied under different conditions and it has been established that the efficiency of Azotobacter dies out with time, also that the bacteria are killed when exposed to sunlight. Fixation of nitrogen even then continues in flasks exposed to sunlight.

It has been clearly demonstrated that under tropical conditions, where sunlight is abundant the Azotobacter does not play a big role in increasing the nitrogen status of soils.

M. B. Col. Agr., Gwalior, India.

## EROSION CONTROL

### General

Held, R. B., and Timmons, J. F. SOIL EROSION CONTROL IN PROCESS IN WESTERN IOWA. Agr. and Home Econ. Expt. Sta. Res. B. 460: 296-315. 1958.

A previous study (4 years earlier) of the problems of controlling soil erosion losses on a sample of 144 farms in western Iowa indicated that several factors, largely economic in nature, were usually responsible for the failure of farm operators to use the practices necessary to reduce soil losses. This second study examines further each farm situation and determines whether changes in these obstacle factors were responsible for corresponding changes in the rate of soil loss.

Progress among farmers in reducing soil erosion losses in western Iowa has been slow. This analysis of practices in the 144 sample farms showed an average decline of only 1.5 tons per acre in the annual rate of soil loss from 1949 through 1952. This average decline is misleading, however, because on 69 farms erosion losses increased by about 7 tons per acre per year, while on 70 farms erosion losses decreased by about 9 tons per acre per year. Individual farms varied widely. The average rate of loss on all farms was still nearly 20 tons per acre annually. As a group, the operators had not succeeded in reaching their own goals of erosion control (16 tons per acre annually) which they had suggested 4 years earlier. If those goals had been reached, the average annual soil loss would have been reduced by 4 tons per acre, which is still about four times the conservation technicians' goal of 5 tons per acre of permissible soil losses.

Erosion-control practices of contouring, use of commercial fertilizers, terracing and grassed waterways, showed a gain in use. The use of contour listing and high-forage rotations, however, declined. Habit, custom, and lack of knowledge concerning the benefits that might be obtained from erosion-control practices continued to be responsible for heavy soil losses. In those instances in which farm owners and farm operators became more fully aware of the extent and effects of erosion losses on their farms, they took steps to reduce these losses.

Farm owners and farm operators had little incentive to sacrifice immediate incomes or to make erosion-control investments if they had insufficient assurance that they would receive compensating benefits.

Efforts to overcome the obstacles to soil erosion control must vary with the situations encountered. Problems not only differ from farm to farm; they also differ on the same farm from time to time. What was acceptable to an operator under a particular tenure situation, with given price and cost ratios, with a given financial situation and given objectives and with a given attitude toward the problem of soil erosion, may be unworkable with changes in any or all of these factors.

The major causes for failure to reduce soil losses during the period studied apparently were uncertainty of tenure, lack of adequate finances, greater reluctance to assume risk, and lack of confidence in recommended practices. The major causes of success in reducing soil losses appear to be: (1) Increased appreciation of the seriousness of soil losses; (2) increased security of tenure; (3) increased appreciation that a shift to more grass on the steeper slopes; and (4) an increase in livestock inventories that was conducive to erosion control and profitability of farming over the long pull.

The control of erosion is a continuing problem rather than one that is amenable to a permanent "once and for all" solution. Even so, it can be less of a problem in the future than it is now if the socio-economic factors that make it a problem are more fully understood and the techniques used to cope with the problem are kept flexible to meet changing situations.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

## Terraces

Anonymous. FARMING FASTER, EASIER WITH PARALLEL TERRACES. Land Impr. 6(1): 10-11. 1959.

Farmers in Iowa have found they can save time cultivating fields laid out with parallel terraces which permit use of 4-, 6-, or even 8-row equipment and with less damage to crops; the method also saves wear on machinery by eliminating sharp turns in the field.

The major advantages of parallel terraces are: (1) They speed up planting, cultivating and harvesting; (2) less damage to crops from turning machinery around in the field; and (3) they save wear on equipment by eliminating sharp turns in field work.

The main idea in laying out a system is to keep the terraces in a fairly straight line with as much even spacing between them as possible. The distance between the terraces depends on the ground's slope. In Polk County most of the spacing on slopes of 3 to 6 percent is about 107 feet from the crest of one terrace to the next. This is the width needed for 8 round trips along the terrace with 4-row equipment set for 40-inch rows.

Larger parallel terraces have a channel width of 8 to 10 feet and a 12-foot width on each of the uphill and downhill slopes. This provides a more gentle slope to cultivate. The total width of 32 to 34 feet compares with about 24 feet for the conventional terrace.

Parallel terrace systems cost about 10 percent more to build, are a little harder to plan and usually have a little more of the land devoted to grassed waterways.

In laying out parallel terraces, a different technic is used. The technician finds the steepest part of the slope, then places his first terrace there. This key terrace is used as a guide for proper spacing of the other terraces, both above and below this line.

Special problems are involved for the contractor building the parallel system. Slopes vary gently and in order to keep the terraces at proper grade and yet parallel, considerable planning by the technicians and earth moving work by the contractor are necessary.

The proper equipment and a skilled operator to run it are necessary in order to cut the soil off the high spots and fill in the lower ones to straighten out the terraces. The soil is moved parallel from the deep cuts to the lower spots on either side usually with a bulldozer and a carryall. It is difficult to use road grading equipment in this type of construction.

A short waterway can be used to break the terrace where a depression occurs which would be impractical to fill to grade. This helps keep the terraces properly spaced. Where major changes in grade make it impossible to keep continuous terraces on grade and parallel, corrective stub terraces may be worked in.

Albert Horlings, Editor, Land Impr., 4710 No. 16 St., Phoenix, Ariz.

Selby, W. E. TERRACE SYSTEM MAINTENANCE. Kans. State U. Engin. Ext. Dept. Land Reclam. 6, 6 pp. 1959.

Terrace systems, like other farm structures and equipment, need regular care and maintenance to remain effective.

Maintenance starts between the terraces. Plowing, planting, and cultivating up and down the slope across the terraces, may damage the terraces to such an extent as to require rebuilding every other year. Terraced land that is plowed, planted, and cultivated parallel to the terrace requires no maintenance except a small amount of repair work on some of the terrace fills across gullies.

An illustrated guide is presented to show how to maintain terraces.

Agr. Ext. Serv., Kans. State U., Manhattan, Kans.

Coyle, J. J. A DICTIONARY OF TERRACES. Land Impr. 6(10): 6-7. 1959.

Standard terraces, conventional terraces, parallel terraces, ridge terraces, channel terraces, level terraces, graded terraces, broadbase terraces, Nichols terraces, Mangum terraces, basin terraces, diversion terraces!

All these terms are terms you hear and read about. Small wonder that contractors and WUCs sometimes wonder what the other is talking about.

Each of these names describes some feature of a type of terrace designed to meet a problem common in some part of the country. Often different terms spring up in different localities for the same feature of terrace design. For example, the same type of terrace may be called a channel terrace in the Southwest and a Nichols terrace in the Southeast.

To help reduce the confusion, this paper relates these names to a few basic terms that describe important features of terraces. Alternate or local names are given for each type.

The differences in terraces which give rise to certain names relate mainly to the following three features: (1) Grade or fall along the length of the terrace; (2) shape of the cross section of the terrace; and (3) alignment or positioning of the several terraces in a system. In addition, some terraces derive their names from the special purpose or function they perform.

SCS, USDA, Washington 25, D. C.

Owen, W. H. THE NEW LOOK IN TERRACING. Land Impr. 6(4): 12-15. 1959.

Terracing on farms is changing from the faulty old-fashioned contour method to new efficient systems called parallel terracing, conservation benching, and contour bench leveling.

PARALLEL TERRACING

The purpose of parallel terraces is to obtain terrace and row alignment by having the terraces spaced an equal distance apart. This spacing between terraces should be in multiples of 4 rows and preferably in series of 8 rows, so the farmer will have an equal number of rounds with four-row equipment. To accomplish this, the following principles should be observed: (1) The land should be fairly smooth and the slopes uniform. (2) The natural drainage depressions in the field should be used for grassed waterways. (3) Outlets must be of sufficient width to include all of the steeply sloping land in the depressions. (4) Graded terraces must drain from the ridge to the natural waterway. (5) Where there are abrupt slope changes, a land use change from row crops to sod crops should

be made. (6) The interval between any two terraces must be based on land slope and to fit the farmers' implements. (7) It must be recognized that all terraces in a given field will probably not be parallel. Some intervals will have to be irregular to keep the terrace grades within the allowable limits. And (8) these irregular terrace intervals can be handled to suit the farmer by planting the interval to a close-growing crop, using as many continuous rows as will fit and plant the area left to a close-growing crop, or by using point rows as on a conventional terrace layout.

Land smoothing operations should be the first step after the terraces have been staked. Old terraces, if present, should be torn down and the soil used to fill in the old terrace channel and low places within the terrace interval. Some of the advantages of land smoothing are: (1) Eliminates high and low areas; thus all implements operate more efficiently, especially multiple row planters and cultivators; (2) provides for better distribution of water; (3) facilitates the use of farm machinery by eliminating gullies, old terraces, fence rows, etc; and (4) provides continuous row drainage from ridge to outlet.

CONSERVATION BENCHING

Another new terracing practice that is in the development and research stage has been designated as conservation benching. It is a new concept for the management of runoff water from cultivated lands to control erosion and improve crop yields in semi-arid regions.

This practice is defined as a terrace system employing level contour benches and ridges to provide erosion control and to retain, spread, and infiltrate surface runoff for the improvement of soil moisture and related crop production. The benches serve as catchment areas for surface runoff from the original land slope from both the bench and contributing area.

The contributing area is the upper two-thirds of the interval. Terrace ridges serve as controls for impounding and spreading runoff water. Dimensions of the system are variable and subject to the design warranted by slope, soils, land use and anticipated runoff.

CONTOUR BENCH LEVELING

The latest trend in terracing is contour bench leveling on dryland farms. This system has been used in irrigated areas to secure more even application and efficient use of irrigation water.

The purpose of contour bench leveling is to alter the topography of non-irrigated lands to facilitate equal distribution and maximum utilization of rainfall, and to hold erosion damage to a minimum.

The benches must be parallel with point rows taken up in point levels. The fall from the upper side of the bench to the lower side must not be more than 0.1 foot. The grade in the direction of rows on tillage should not be more than 0.05 foot per 100 feet. Earth should be moved by scrapers, bulldozers, land levelers or motor graders. The land should be plowed or disked and the entire area finished-graded by a land leveler or grader.

Maximum depth of cut should not exceed one-half the depth of topsoil unless the cut area is reconditioned following leveling by use of green manure crops or heavy applications of organic matter.

Caterpillar Tractor Co.

## Critical Areas

Purnell, W. F., and Jones, B. A. Jr. SAVE SOIL WITH GRASS WATERWAYS. U. Ill., Col. Agr. C. 810, 16 pp. 1959.

An illustrated circular on the culture and care of grass waterways in Illinois.

U. Ill., Col. Agr. Ext. Serv. Agr. and Home Econ., Urbana, Ill.

Trepetsov, Y. V. DEVELOPMENT OF GULLIES IN THE OB' REGION. Soviet Soil Sci. 5: 505-513. May 1958.

A study of the gullies on the Ob' steppe was made to predict the rate of gully development and to work out control measures.

The following types of gully development were found in the area: (1) Sheet erosion on bare gully banks and plowed-slopes of small valleys; (2) rill erosion by snowmelt flowing down from the steppe plateau; (3) rill erosion of the heads and branches of gullies by snowmelt from snowdrifts on the slopes and development of branch gullies by suffosion; (4) talus formation from the sides of gullies as a result of undercutting at their bases by transient flow of water through the gullies; (5) solifluction and snow erosion developing along bare gully banks at the edges of snowdrifts lying on them; (6) fracture and creep of soil and plant cover along steep gully banks and slopes of small valleys at thawing; (7) crumbling at the rims of gully banks caused by snowdrifts; (8) talus formation from gully banks caused by changes in air temperature and soil moisture; (9) slides of gully banks caused by suffosion at their bases; (10) earth creep of gully banks; (11) mudflow on gully banks at the points of emergence of subsurface water; (12) fracture in the continuity of the soil of gully banks with freezing and the accumulation of snow in gullies and small valleys; and (13) blowing away of bare gully banks (deflation).

It appears that for control of gully erosion, attention should not be confined to the eroding action of transient, linear streams of water. Consideration must also be given to other gully development caused by the action of subsurface water, air temperatures, snow erosion, the way the snow and rain fall, the direction of the wind, the microrelief, and other factors, and also by the activities of man. In each case attention should be devoted primarily to the leading forms of gully development, which may differ in areas with differing natural conditions.

Amer. Inst. Biol. Sci., 2000 P. St. N. W., Washington 6, D. C.

Grandt, A. F., and Lang, A. L. RECLAIMING ILLINOIS STRIP COAL LAND WITH LEGUMES AND GRASSES. Ill. Agr. Expt. Sta. B. 628, 64 pp. 1958.

Formal research on the reclamation of strip-mined lands in Illinois was begun in 1946. Characteristics of the soil material, species adaptation, and the utilization of strip-mined lands have been investigated.

Mined lands have been classified on the basis of acidity and texture of the soil material. Both the material in the overburden and the method of mining affect the land classification. Of more than 2,000 soil samples tested, 73 percent had a pH above 7.0 and 90 percent a pH above 5.5. The soil material was found to be very high in available phosphorus and high in available potassium. The texture is predominantly sicl, sic, or cl. Permeability was found to be rapid on the ridges and moderate on the graded areas.

Grasses and legumes can be successfully established on most of the strip-mined lands in Illinois. Alfalfa, birdsfoot trefoil, sweet clover, lespedeza, bromegrass, orchard grass, Kentucky bluegrass, and tall fescues are the most desirable species that can be established. The forage produced is high in nitrogen, phosphorus, calcium, and potassium.

The three-year average daily gain of steers on strip-mined pastures in western Illinois was 1.24 pounds, compared to 1.10 pounds for the control steers that grazed on unmined lands. In southern Illinois steers grazing strip-mined areas made a two-year average daily gain of .95 pound, while steers on improved grass-legume pasture on unstripped land gained 1.17 pounds. During the 1951 season, 29 lambs made an average daily gain of 0.29 pound on strip-mine pasture.

Various methods of sowing and of preparing the mined land are possible. Seedings have been made by hand, with power seeders, and from the air. These methods have been used on undisturbed ridges, topped ridges, and more completely graded areas.

The most concentrated and continued use of mined land can be made by incorporating it with surrounding farmland into a well-organized livestock farm unit. Such use has proved profitable even in a period of lowering prices.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

van't Woudt, B. D. SOIL EROSION PREVENTION ON BAUXITE STRIPMINED SOILS IN HAWAII. Hawaii Agr. Expt. Sta. Tech. Prog. Rpt. 123, 8 pp. 1959.

The discovery of extensive bauxite deposits within the boundaries of the United States (Sherman, 1957) has raised considerable interest, and their possible exploitation is now under study. One of the phases of an exploitation study has been made the responsibility of the Hawaii Agricultural Experiment Station, that of determining whether stripmining would harm watersheds and the agricultural value of the land.

A study of this possibility was initiated about 1 1/2 years ago to determine the extent of soil erosion which might occur after stripmining the land and what measures could be taken to prevent such erosion and its effect on local watershed hydrology. In addition, a range of fertilizer treatments has been applied to a number of selected crops in plots to determine the agricultural value of the subsoil exposed after stripmining.

Bauxite is an aluminum-rich end product of soil weathering under favorable drainage conditions in tropical regions. Consequently, the ore is concentrated near the surface and its mining requires stripping the surface soil for processing. The depth of surface soil removed will depend on the concentration of aluminum which declines with increasing depth below the surface. The depth of mining is thus determined by economics.

Owing to apparent erosion-resistant properties of the soil and a favorable rainfall pattern, erosion in the stripmined area has been of small significance during seven months of observation. Relatively small soil losses from bare subsoil can be largely prevented by rapid revegetation, or by bagasse cover. Soil losses from bare soil were found to be reduced to 1/10th by surface protection. These conclusions may be modified in the future, as the effect of infrequent, very heavy storms has not yet been assessed.

U. Hawaii, Hawaii Agr. Expt. Sta., Honolulu, Hawaii.

Land Improvement. THE GREAT PLAINS: A SPECIAL LAND IMPROVEMENT REPORT. Land Impr. 6(6): 31 pp. 1959.

This special issue of Land Improvement covers the following articles:

Williams, D. A. THE GREAT PLAINS CONSERVATION PROGRAM, WHAT IT IS--HOW IT OPERATES.

Luker, C. THE GREAT PLAINS CONSERVATION PROGRAM: A PROGRESS REPORT.

Richter, J. WATERSHED CONGRESS POINTS UP PROGRESS AND PROBLEMS.

Tedford, L. D. THE GPCP WORKS FOR THIS RANCHER.

THE GREAT PLAINS CONSERVATION PROGRAM STATE BY STATE:
Bobst, H. G. - Nebraska; Walker, R. - Oklahoma; Lloyd, L. G. - North Dakota; Smith, H. N. - Texas; Young, R. A. - New Mexico; Hurd, H. D. - Montana; Chalmers, K. W. - Colorado; Sykes, F. J. - Kansas; Hopkins, B. H. - Wyoming; and Davies, R. D. - South Dakota.

Anonymous, HERE'S HELP IN SELLING THE GPCP--COLOR FILMS, BOOKLETS ON TAP.

Jones, H. WATERSHED CONSTRUCTION ON THE PLAINS.

Anonymous, WATERSHED REPORT.

Singleton, S. THE DISTRICTS AND THE PLAINS.

Anonymous, THE LAST WORD: THE GREAT PLAINS; LAND IMPROVEMENT COUNTIES.

Albert Horlings, Editor, Land Improvement, 4710 N. 16 St., Phoenix, Ariz.

## Cropping Practices

Harper, H. J. SIXTY-FIVE YEARS OF CONTINUOUS WHEAT ON REDDISH PRAIRIE SOIL IN CENTRAL OKLAHOMA. Okla. Agr. Expt. Sta. B. B-531, 38 pp. 1959.

Wheat has been grown every year on a phosphorus-deficient reddish prairie soil near Stillwater, Oklahoma, for 65 years. Throughout this period, one portion of the experimental areas has never been fertilized. Another has been fertilized only with barnyard manure since 1898 while other plots have been given varying fertilizer treatment for varying periods.

The organic matter and nitrogen in the top soil has gradually decreased as a result of tillage. However, the average yield of wheat has not declined appreciably even where no fertilizer has been applied. The average yield on the unfertilized plot has been about 12.6 bushels per acre.

Barnyard manure applied at varying intervals during the past 59 years has produced an average yield of 20.5 bushels of wheat per acre. Only seven crops of wheat on the manured land were too low to pay the cost of production during the 59 years. Whereas, 20 crops of wheat on the unmanured soil were too low to pay the cost of production during this same period. (Cost of production was estimated to be 10 bushels per acre on manured land and 9 bushels per acre on unmanured soil.)

Superphosphate containing 20 percent of $P_2O_5$ and applied at the rate of 150 pounds per acre when the wheat was planted increased the average wheat production from 12.9 to 18.55 bushels per acre from 1930 to 1957. This was only one bushel less than the average yield obtained from a plot fertilized with barnyard manure at the rate of 12 tons per acre every four years.

Superphosphate or rock phosphate added to plots fertilized with barnyard manure produced very little increase in wheat yield over that obtained from barnyard manure alone.

Neither nitrate of soda at the rate of 100 pounds per acre, applied annually from 1930 to 1945, nor a similar quantity of ammonium nitrate applied from 1946 to 1957, produced enough increase in grain production to pay the cost of the fertilizer, Neither muriate of potash nor lime had much effect on grain production when applied to plots receiving superphosphate and either nitrate of soda or ammonium nitrate.

Straw yields were increased when superphosphate or barnyard manure was applied to this soil. The other fertilizer combinations did not produce much increase in the yield of straw.

Winter growth of wheat was much greater on plots fertilized with superphosphate or manure than on unfertilized soil.

The average profit from superphosphate applied in this experiment was $4.91 per acre over a 28-year period. The average profit from continuous wheat for this same period was $5.47 per acre. Superphosphate fertilization increased net income about 90 percent above the income obtained from wheat on unfertilized soil.

Nine of the wheat crops produced on unfertilized soil were unprofitable during the 28-year period 1930 to 1957. Only five crops produced on a plot where superphosphate was applied were unprofitable. However, during seven years superphosphate fertilization did not produce a sufficient increase in wheat yield to pay the fertilizer cost and cost of application.

About 50 percent of the organic matter and nitrogen in the topsoil on the unfertilized land disappeared as a result of the continued production of wheat over a 62-year period from 1893 to 1954. A more rapid loss occurred during the first 34 years than was observed during a second interval of 28 years.

The easily soluble phosphorus in this soil was increased by phosphate fertilization and the application of manure.

Soil acidity has increased as a result of cultivation. In 1926, the unfertilized topsoil was strongly acid, and the manured soil moderately acid, as compared with slight acidity in an adjacent virgin soil.

Soil samples collected from these plots in 1938 revealed that the topsoil from 0 to 6 inches deep on the unfertilized plot contained less nitrogen and organic matter than was

present at a depth of 6 to 12 inches. The total phosphorus and easily soluble phosphorus decreased with depth. Manured soil contained more exchangeable calcium, magnesium and potassium than unfertilized soil. Exchangeable calcium was high, and increased with depth. Exchangeable potassium was lower than exchangeable magnesium but was high enough to produce an optimum yield of wheat during an average season without potash fertilization. Easily soluble manganese was adequate for optimum wheat production.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

Vlasin, R. D., and Epp, A. W. ALTERNATIVE CROPPING SYSTEMS FOR SOUTHWESTERN NEBRASKA. Nebr. Agr. Expt. Sta. S. B. 443, 35 pp. 1958.

Acreage restrictions plus low yields of wheat in parts of southwestern Nebraska have induced farm operators to seek alternative enterprises to use available farm resources and increase farm income.

The alternative crops used in the study were grain sorghum, proso, barley, safflower and oats. Budgets were calculated for a representative 1,440 acre farm to determine the net returns from cropping systems that included these crops.

The cropping systems were wheat-fallow, wheat on fallow plus an alternative crop grown on stubble, and wheat and an alternative crop grown on fallow. The returns were determined for grain sorghum, barley, proso, safflower and oats following wheat, and for grain sorghum and safflower grown on fallow.

The following results were obtained: (1) Net returns per acre from wheat are higher than from any other crop studied. Under the assumed prices, costs and yields, the return to the operator for his labor and management from the wheat-fallow system was superior to all other cropping systems tested. (2) Grain sorghum showed the highest net return of the alternative crops. Both grain sorghum on fallow and grain sorghum on stubble showed higher net returns than cropping systems that included barley, proso, safflower, and oats. And (3) ranking in order below grain sorghum were barley on stubble, proso on stubble, safflower on stubble, safflower on fallow, and oats on stubble.

The relative advantages of the various alternative crops as substitutes for wheat are based on one set of prices and yields. Relative prices and yields may differ in the future from those used in the study.

Under conditions of changing price and yield relationships, the ability of alternative crops to compete with wheat is also subject to change. Farmers need to consider which crops will give the highest returns under these changing conditions.

A technique was developed for determining the best cropping system on a particular farm.

The information will be useful in determining whether the production of alternative crops is as profitable as the production of wheat under the conditions assumed, even though yields and prices changed from those used in the study.

Although the results of the study apply directly to southern Kimball County conditions, they have general applicability over a wider area in the Great Plains.

U. Nebr., Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

Leggett, G. E., and Nelson, W. L. WHEAT PRODUCTION AS INFLUENCED BY CROPPING SEQUENCE AND NITROGEN FERTILIZATION IN THE 10 TO 15 INCH RAINFALL AREA OF EASTERN WASHINGTON. Wash. Agr. Expt. Sta. B. 608, 16 pp. 1960.

The average wheat yields resulting from annual cropping with optimum nitrogen fertilization were 13 bushels per acre at Ritzville, 23 at Harrington and 29 at Dusty. The yields obtained at Ritzville were too low for this practice to compete economically with the summer-fallow system of farming. The average yields were high enough at Harrington and Dusty for this cropping system to be seriously considered. At Dusty, on a yearly basis, annual cropping resulted in a yearly average yield of 6 bushels per acre more than was obtained on fallowed ground.

The yield of wheat following Austrian winter peas as a green manure crop at Dusty was greater than that obtained after alfalfa or sweetclover.

Soil analysis revealed that nitrogen fertilization resulted in a carryover of nitrate-nitrogen for subsequent crops. This was especially notable under annual cropping and with high rates of application on summer fallow.

The protein content of the wheat was increased markedly by nitrogen fertilization.

Wash. Agr. Expt. Sta., Inst. Agr. Sci., Wash. State U., Pullman, Wash.

Young, R. A. CAN NITROGEN FERTILIZER AND MODERN WEED CONTROL METHODS ELIMINATE SUMMERFALLOW? N. Dak. Agr. Col. Bimonthly B. 20 (3): 3-9. 1958.

From the results of trials in North Dakota the results were summarized as follows: (1) With modern technique of weed control and use of adequate amounts of nitrogen fertilizer, summerfallow can almost be eliminated from the cropping systems of Eastern North Dakota and the favored moisture sites in the rest of the state; (2) in the drier portions of the state and where row crops are not profitable, there is less chance of eliminating it, but its acreage can be reduced; (3) in seasons when soil is moist to a depth of 2 feet or more at seeding time and weeds are under control, there is little or no justification for following in any part of North Dakota; (4) an occasional fallow may be required to control some weeds, such as quackgrass; and (5) by reducing or eliminating fallow, current income should be increased, and better long-term maintenance of soil will be accomplished.

N. Dak. Agr. Col., Agr. Expt. Sta., Fargo, N. Dak.

Dunham, R. S., Robinson, R. G., and Andersen, R. N. CROP ROTATION AND ASSOCIATED TILLAGE PRACTICES FOR CONTROLLING ANNUAL WEEDS IN FLAX AND REDUCING THE WEED SEED POPULATION OF THE SOIL. Minn. Agr. Expt. Sta. Tech. B. 230, 20 pp. 1959.

This study, begun in 1946 and carried through 1955, comprised two rotations, also certain cultural practices made to corn that preceded flax in one rotation and to oats that preceded flax in the other rotation. In the corn-flax sequence, a comparison of normal cultivation was made with similar cultivation plus hoeing to keep escaped weeds from going to seed. In a subdivision of this comparison, the corn stubble was plowed in preparation for flax in one instance and was surface-worked only in the other. In the second rotation, plowing or disking of oat stubble in August was compared with September plowing.

Both rotations included a legume-two years of red clover and timothy in the oats rotation. Data were obtained on the number of weed seeds in the soil each time flax appeared in the rotation and on yields of flax seed, flax straw, and the weeds in the flax.

A crop rotation of corn-flax-alfalfa-alfalfa or oats-flax-clover and timothy-corn continued over a ten-year period did not reduce the annual weed seeds of the soil appreciably, nor did it control annual weeds satisfactorily in the flax crop.

Although some tillage practices on crops preceding flax reduced weed seeds in the soil, reduced weeds in flax, and increased yields of flax when compared to unhoed corn plots of those receiving no August tillage, the expected cumulative effects of these treatments were not apparent. At the close of the experiment about 400 weed seeds per square foot of soil, 7 inches deep, remained on the best treatments. In the germination of 58,944 weed seeds recovered in soil samples, a relatively large proportion of purslane (70.1%) germinated shortly after samples were taken; mustard, oxalis, and wild buckwheat showed the longest dormancy; and foxtail, barnyard grass, lambsquarter, and pigweed were intermediate.

U. Minn., Agr. Expt. Sta., St. Paul, Minn.

Holmgren, A. H. WEEDS OF UTAH. Utah Agr. Expt. Sta. Sp. Rpt. 12, 85 pp. 1958.

More than 150 species of weeds are described and illustrated. Brief mention is made of at least 50 others.

The weeds are placed in 37 families. The family sequence follows that used in larger manuals treating floras of regions or states and also in the filing system used in the Intermountain Herbarium. This sequence has the advantage of keeping family groups intact. Genera and species within a family are, for the most part, in alphabetical order.

An attempt has been made in the descriptions to hold rather closely to a uniform plan of presentation and arrangement of details. A sequence beginning with such general characteristics as duration of the plants, roots, stems, leaves, flowers, fruits, and often seeds follows in this order.

Utah State U., Logan Agr. Expt. Sta., Logan, Utah.

Rea, H. E. SPOT-SPRAYING JOHNSONGRASS. Tex. Agr. Expt. Sta. B. 902, 14 pp. 1958.

Grazing, mowing, tillage, cultivation, rotary weeding, hand hoeing, and various combinations of these practices can be used for mass control of Johnsongrass in fields. Pre-emergence chemical treatments, lateral applications of chemicals, and flaming are used for this purpose in some areas but are not suited to many Texas conditions. Mass methods are effective for reducing Johnsongrass stands but ordinarily do not get rid of this grass. However, the old grass in most Texas row crops can be eradicated in one season by consistent use of cultural methods supplemented by spot-spraying.

Herbicidal oils and water solutions of sodium dalapon, sodium TCA and maleic hydrazide are some of the sprays used for spot-treating Johnsongrass. Oils are commonly applied to the crown. Water solutions are applied as wetting sprays to either the foliage or the soil or both. These and other sprays suitable for spot-treating Johnsongrass must be applied selectively if the crop plants in the treated spots are to be saved.

A half-and-half mixture of naphtha and diesel fuel oil is the oil spray most generally used. Various other oil mixtures may be used for economy, for increased contact toxicity, or for a combination of contact toxicity and residual effectiveness. Oil sprays kill on contact and are most effective when applied to the crown of Johnsongrass sprouts 6 inches or less in height.

Sodium dalapon is used at the concentration of 20 pounds in 100 gallons of water. It is a translocated herbicide but also has a residual effect. Sodium dalapon kills the tops of the grass and many underground buds. Previously, it was primarily for nonselective treatment of large spots of Johnsongrass in sparsely infested cotton fields and for treatment of noncrop sites. A new sprayer developed at College Station now permits selective use of this herbicide in cotton and sorghum.

Sodium TCA at a concentration of 50 pounds in 100 gallons of water is used for controlling Johnsongrass spots in noncrop sites and in fields during noncrop periods. A mixture of 40 pounds of sodium TCA and 20 pounds of sodium dalapon can be used for spot-treating sparsely infested cotton fields.

Maleic hydrazide (MH-30) is a translocated growth inhibitor with no residual. It is used as a wetting spray to the foliage at a concentration of 2 1/2 gallons in 100 gallons of water for preplanting treatment of established Johnsongrass spots before any spring crop when no residual can be tolerated. Subsequent killing of the affected tops eradicates the grass.

A man on foot using a hand sprayer does the best and safest job of spot-spraying Johnsongrass in crops. Three excellent hand sprayers: The Texas Gravity Sprayer; the Texas Jetgun, and the Texas Slidegun have been developed. The first two sprayers are for close work when Johnsongrass infestation are interspersed between crop plants. The Slidegun is for rapid spraying in fields when it is more economical to kill the crop plants in the treated spot than to save them. Texas Blade, a combination weeder and shield, also has been developed for shielding a crop plant while making a close application of spray with a Jetgun.

Tex. Agr. Expt. Sta., Tex. Agr. Ext. Serv., College Station, Tex.

Bingham, S. W., Easley, T., Edwards, F. E., Harris, V. C., Holstun, J. T. Jr., Normand, W. C., and Wooten, O. B. Jr. WEED CONTROL RECOMMENDATIONS. Miss. Agr. Expt. Sta. B. 556, 36 pp. 1958.

Weed control recommendations for various crops in Mississippi based on research studies at the college that are believed to be safe and effective methods of weed control

are given. Certain hazards and precautions are pointed out and an understanding of these common sense rules is necessary to derive full benefit from these recommendations.

CRD, ARS, USDA and Miss. State U. Agr. Expt. Sta. State College, Miss.

Kries, S. K. CHEMICAL AND CULTURAL METHODS OF CONTROLLING WEEDS IN PICKLING CUCUMBERS. Mich. Q. B. 40(3): 503-513. 1958.

Weeds are a big problem to cucumber growers. Cucumbers do not compete well with weeds and must be free of them for best growth and effective harvest.

Most prevalent in the cucumber-growing areas of Michigan are annual broadleafed weeds, annual grasses, and quackgrass (Agropyron repens). In controlling these weeds mechanically, many growers injure the crop because they do not consider the extensive root system developed by the cucumber plant during early growth.

Studies on the use of chemicals and cultivation for control of weeds in pickling cucumbers indicated:

1. Only one new herbicide, CDEC (Vegadex), at a rate of 4 pounds per acre, was as effective in pre-emergence weed control as either form of NPA (Alanap-1 or Alanap-3).
2. Ten pounds of dalapon per acre can be used effectively to control quackgrass before the planting of pickling cucumbers. This material should be applied to quackgrass at least 4 inches.tall 5 weeks before planting cucumbers. If the quackgrass is not growing vigorously before application, 30 to 50 pounds of nitrogen per acre should be applied to stimulate growth.
3. The cucumber plant up to 4 weeks old has a much larger root system than the top growth would indicate; this root system is concentrated in the top 8 inches of soil. Deep cultivation (4 to 6 inches) caused a decrease in yield. Sweeps are probably better than shovels for cultivating cucumbers because they effectively cut off weeds without disturbing the roots.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Linn, M. B., Slife, F. W., and Butler, B. J. PREVENT 2,4-D INJURY TO CROPS AND ORNAMENTAL PLANTS. U. Ill. Col. Agr. C. 808, 16 pp. 1959.

The widely used herbicide 2,4-D when carelessly applied may severely injure or kill a wide variety of broadleaf crop and ornamental plants. They include among others such plants as tomatoes, snap beans, soybeans, melons, grapes, cotton, roses, chrysanthemums, redbud trees, and birch trees. Some of these plants are more susceptible to injury from 2,4-D than the common broadleaf weeds.

Using 2,4-D on lawns and other grassy areas, in corn and grain fields, along fence rows, highways, drainage ditches, railroads, and under power lines has caused widespread damage to fields and gardens. Mist or vapor from 2,4-D has damaged susceptible plants growing a half mile or more from the area actually sprayed. Much of the damage from this valuable agricultural chemical can be avoided if users are aware of the dangers in its application.

The purpose of this circular is: (1) To describe and illustrate the symptoms of 2,4-D injury on some of the more common susceptible crops and ornamental plants; (2) to characterize the commercially available forms of 2,4-D; (3) to discuss kinds of exposure of crops to 2,4-D; (4) to give information concerning the factors that influence the drift of mist; and (5) to suggest ways in which 2,4-D can be used to control weeds with the least chance of injury to crops and ornamental plants in the neighborhood.

U. Ill. Col. Agr., Ext. Serv. Agr. and Home Econ., Urbana, Ill.

McKay, H. C., Ames, G., Hodgson, J. M., and Erickson, L. C. CONTROL CANADA THISTLE FOR GREATER PROFITS. Idaho Agr. Expt. Sta. B. 321, 14 pp. 1959.

Eleven different cropping systems were tested for the control of Canada thistle during a 5-year period 1953 to 1957, in the irrigated area near St. Anthony, Idaho. The effect of several crops, 2,4-D spray, nitrogen fertilizer, and clean cultivation used

alone and in various combinations for the control of Canada thistle were evaluated. The treatments were also evaluated on the basis of net returns.

The data show that when wheat is grown on a low fertility soil, 2,4-D gives more effective Canada thistle control when nitrogen fertilizer also is applied. When the land was previously infested with wild oats, their population increased in the continuous spring wheat plots to such an extent that this combination treatment should not be used more than 2 or 3 years.

The use of close-growing crops such as alfalfa-grass or 2,4-D sprayed pasture grasses, mowed twice each year also proved to be effective, giving 99 percent Canada thistle control at the end of 4 years.

One season of clean cultivation every 21 days eliminated 99 percent of the established Canada thistle plants. However, no single treatment or single year's work will give permanent Canada thistle control, because new seedlings develop from seed in the soil. Only long-term control will eliminate this problem.

Yields of spring wheat were directly influenced by the degree of Canada thistle control and the fertility of the soil. The highest yields were obtained when both nitrogen fertilizer and 2,4-D spray were used.

The most expensive "control-measure" for Canada thistle was doing nothing. Nitrogen and 2,4-D applied to spring wheat gave the highest immediate returns per acre, but the increasing presence of wild oats limited the number of years this practice could be followed.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

Sexsmith, J. J. INFLUENCE OF THE ESTER OF 2,4-D APPLIED AT VARIOUS GROWTH STAGES FOR THE CONTROL OF RUSSIAN THISTLE (SALSOLA PESTIFER NELS.) IN FLAX. Canad. J. Plant Sci. 39: 458-465. 1959.

Linseed flax, growing with naturally occurring infestations of Russian thistle at Lethbridge, was treated with three rates (2, 3, and 6 oz. acid equivalent per acre) of the butyl ester of 2, 4-D at 5-day intervals from the seedling stage to boll formation in each of the 5 years 1952 to 1956, inclusive.

Two peaks of weed control were determined, the first being at the early growth stages between 19 and 35 days after crop seeding when some measure of weed stand reduction was obtained. The second peak occurred from 45 to 60 days after seeding when the Russian thistle plants were 6 to 8 in. tall, the control being characterized by a "curl-down" of weed growth which persisted to harvest time. Mature flax height was relatively unaffected except when the crop was treated at or near the first-bud stage of growth. Height of flax above the weed mass was 9.7 and 13.2 in.in 1954 and 1955, respectively, as a result of the best-timed 6-oz. treatment. Such height differences would make it possible to combine-harvest flax seed containing a minimum of weed material. Maturity delays of only 2 or 3 days resulted from treatments made within 1 month after seeding, whereas delays of up to 33 days resulted from treatments made when the flax was in full bloom. On the average for all three treatment rates, flax yields equal to or better than those from untreated weedy plots were obtained in each of the 5 test years when the 2, 4-D was applied prior to 36 days after seeding. Thus, for adequate control of a Russian thistle infestation and the undelayed harvest of a good yield of flax seed, it would appear that, 25 to 30 days after seeding, the crop should be treated with a 6-oz. rate of the butyl ester of 2, 4-D. Slightly earlier treatment is indicated if cool, wet conditions prevail after seeding.

Canad. Agr. Res. Sta., Lethbridge, Alberta, Canada.

Moomaw, J. C. PROGRESS IN CHEMICAL GORSE CONTROL. Hawaii Agr. Expt. Sta., Tech. Prog. Rept. 119, 7 pp. 1958.

Gorse or Irish furze (Ulex erropaeus) is a grey-green leguminous shrub with showy yellow-orange flowers and long, sharp spine-like reduced leaves. It grows best in well-drained but moist soils in a mild, cool environment at elevations above 3,000 feet and is concentrated in the Olinda-Kula region of Maui, although it also occurs on Hawaii. It fixes nitrogen in the soil and is tolerant of fairly acid conditions and low fertility. Gorse

was introduced to the Islands from Europe during the late 19th century as a fence-row plant for sheep ranching and had become a pest by 1920.

A number of new chemical treatments were used experimentally to determine their effectiveness in gorse control. "Monuron" (3-p-chlorophenyl-1, 1 dimethylurea) and related compounds gave essentially 100 percent kill of gorse. On large plot tests "Urox" proved to be most effective. CMU treatments more than tripled the germination of gorse seed.

U. Hawaii, Hawaii Agr. Expt. Sta., Honolulu, Hawaii.

Keith, J. O., Hansen, R. M., and Ward, A. L. EFFECT OF 2,4-D ON ABUNDANCE AND FOODS OF POCKET GOPHERS. J. Wildlife Mangt. 23: 137-145. 1959.

Aerial spraying of weedy, mountain rangeland in western Colorado with 2,4-D resulted in the following changes 1 year after treatment: (1) Pocket gopher populations were reduced 87 percent; (2) production of perennial forbs was reduced 83 percent and grass production increased 37 percent; and (3) the diet of pocket gophers changed from 82 percent forbs to 50 percent forbs, and from 18 percent grass to 50 percent grass.

Untreated control areas showed no significant change in gopher numbers or herbage production from one year to the next. Gopher food habits did not change on untreated areas. About two-thirds of the gophers' diet during summer months consisted of above-ground plant material. The most common food items identified in pocket gopher stomachs were dandelion, western yarrow, and Rydberg penstemon. Although the reasons for the decline in gopher numbers on sprayed areas are not known, depletion of essential food items and nitrate poisoning are the most likely explanations.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

## Crop Residue Management

Barnes, O. K., and Bohmont, D. W. EFFECT OF CROPPING PRACTICES ON WATER INTAKE RATES IN NORTHERN GREAT PLAINS. U. Wyo. Agr. Expt. Sta. B. 358, 20 pp. 1958.

One opportunity for increased moisture conservation in the Great Plains is by reduction of water loss from runoff during intense storms and from rapid snowmelt. In an effort to evaluate effectiveness of a number of soil and residue-management practices in terms of water-absorption rates, a study was set up at the Sheridan Station to apply simulated rainfall on various soil conditions of cropping and residue-management. A mobile infiltrometer was constructed and a number of soil conditions were evaluated in terms of their capacity to handle the intense type of storm. Limited work was done also on water absorption during the winter when soils were frozen.

Comparisons were made of water intake rates on bare fallow, "trashy" fallow, and perennial sod cover. Land in grass as commonly left after a haying operation absorbed water 25 percent slower than "trashy" fallow. Both conditions absorbed from 30 to 75 percent more water in 1 hour than did bare fallow land.

Raking and baling loose straw from a stubble field reduced water-intake rate by over 30 percent. On a recently combined stubble field with an average of 2,850 lbs. of residue per acre, the removal of 1,720 lbs. of straw by baling and leaving 1,130 lbs. in the form of erect standing stubble reduced the water absorption capacity from 3.51 in. to 2.30 in. per hour. Burning the residue reduced water absorption by nearly 50 percent.

Effect of different types of fall tillage were studied. Various types of ripping and tilling that leaves most of the stubble standing have made the soils more receptive to water. However, when mechanical tillage was used for weed control the next summer, the loosening effect of the fall tillage was lost. Chemically fallowing for weed control retained some of the loosening effects through the summer, and water-intake rates were thereby improved. Fall tillage improved water absorption during snowmelt when soils were frozen. This appears due to the honeycomb condition of the fall-tilled land that goes into the winter in a loosened and well-shattered condition.

Indications were that a system of fallowing with chemicals with no mechanical disturbance at all, created soil conditions after 3 or 4 years that are unfavorable for high

absorption rates. Indications point to the need for some mechanical tillage in connection with chemical fallowing.

Water-intake studies were made on certain crop-rotation plots that were started in 1916 and continued to the present time. One group of rotations comparing the use of manure to no manure shows that the land receiving no manure lost 36 percent of the soil organic matter since it was taken out of sod in 1916. The rotation receiving manure held its own during this period, with no organic-matter loss. A series of water-intake measurements on this land failed to show any important difference in water absorption during a 1-hour intense simulated rainstorm. The test plots on both soil conditions were bare at the time the simulated rainfall was applied. Had the surface been protected with residue, differences in water intake might have developed between these two soil conditions.

With all the different conditions measured, the importance of surface cover was consistently brought out regardless of past or present management.

SWCRD, ARS, USDA and U. Wyo. Agr. Expt. Sta., Laramie, Wyo.

Wiese, A. F., Bond, J. J., and Army, T. J. CHEMICAL FALLOW IN THE SOUTHERN GREAT PLAINS. Weeds 8 (2): 284-290. 1959.

Studies to evaluate herbicides for use in chemical fallow and to determine the effect of chemical fallow on moisture storage, crop yields, and residue conservation have been conducted since 1955. Satisfactory control of broadleaved weeds was obtained with 2,4-D. Grasses were not satisfactorily controlled with chemicals. More moisture was usually stored prior to seeding with sweep tillage than with chemical fallow. Decreased yields on chemically fallowed plots reflected this lower moisture storage. The wind erosion hazard, following wheat harvest, was reduced with chemical fallow.

SWCRD, ARS, USDA and Tex. Agr. Expt. Sta., College Station, Tex.

Krall, J. L., Power, J. F., and Massee, T. W. SUMMER FALLOWING METHODS RELATED TO EROSION AND WHEAT PRODUCTION. Mont. Agr. Expt. Sta. B. 540, 33 pp. 1958.

Comparisons of methods of summer fallowing at three locations in Montana have shown that: (1) The method of fallowing had no appreciable effect upon the yield or marketing quality of the hard red wheats produced upon the fallow; (2) all fallow methods studied were about equally effective in conserving moisture during the fallow period; and (3) soil erosion control was much better on stubble-mulch fallow than on any of the other kinds of fallow investigated.

The use of fall tillage, cultipackers, stubble burning, and rotating tillage methods were also investigated. Results indicated that these practices generally were not influential in increasing grain production and quality, or in conserving soil moisture. Since most such practices were of no value in improving erosion control, no basis was found for their recommendation. However, the effects of fall tillage upon weed control should be more fully investigated.

Comparisons of various types of drills indicated that the lister-type and hoe-type drills were best adapted for winter wheat production. In the spring wheat producing areas, the disk-type drills proved to be satisfactory. In all cases packer wheels on the drills were highly desirable.

The results of these studies on summer fallow methods have shown that the kind of tillage equipment to be used for fallowing should be regulated mainly by two factors: (1) The amount of residues on the soil surface at the beginning of the fallow year; and (2) the amount of residues desired on the surface at the end of the fallow season. By the use of the proper fallow equipment, it is possible to achieve satisfactory soil erosion control at no sacrifice in grain production or quality.

Mont. Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

## Tillage

Bateman, H. P. EFFECTS OF BASIC TILLAGE METHODS AND SOIL COMPACTION ON CORN PRODUCTION. Ill. Agr. Expt. Sta. B. 654, 35 pp. 1959.

Three basic tillage treatments--turning residues under, mixing them throughout the tilled layer, and leaving a mulch on the surface were studied. Two methods of spacing the rows at 2 levels of nitrogen--75 and 150 pounds to the acre--under weather conditions in 4 seasons were also studied.

The till-planter prepared the seedbed and planted the corn successfully in soil where the crop residues were dead, but where growing forage was heavy, it presented problems in both planting and cultivating.

The sweep-rotary machine more completely pulverized compacted soil and sod growth than did the sweeps on the till-planter. Mixing the forage in the soil, however, appeared to cause some reduction in germination. The rotary machine pulverized the soil most thoroughly, but such thorough pulverization did not prove necessary on the soils used in the tests.

When a sod mulch was left at planting time, disk hillers were used successfully to cultivate the corn. Standard cultivator sweeps were used for all other treatments. Leaving the soil rough at planting time reduced the weed problem.

When the corn was planted, various amounts of tillage produced little difference in soil moisture at seed level, and soil moisture changed little during the germination period.

Soil resistance to penetration by a metal probe was least in the seedbed prepared by the plow and greatest in that prepared by the rotary-tiller.

Loss of plant population due to cultivation or barren stalks was not affected by variation in tillage treatments. Tillage treatments also had little influence on the amount of corn lost in machine harvesting. Less corn was lost, however, in the rows spaced 40 and 90 inches apart than in those spaced 40 inches apart, and less was lost in standing corn than was lost in lodged corn.

Corn yields produced by using minimum tillage treatments were equal to or greater than those produced by more intensive tillage. Plowing normally produced higher yields than other methods. Yields on plots prepared by the till-planter more often equalled or approached yields on the plowed plots than did yields on plots prepared by the two types of rotary-tillage machines. Least tillage was used on those plots prepared by the till-planter, which left a mulch on the surface. Using narrower sweeps on the till-planter gave yields equal to those produced with sweeps of normal width. Rotary tillage of all the soil produced more corn than rotary tillage of half the soil.

Yields on the plots where rows were spaced 40 and 90 inches apart were below those on plots where rows were spaced 40 inches apart, but not below them in proportion to the one-third reduction in the area planted to corn. Yields were higher where the rows were not rotated each year to the alfalfa strips than where they were.

Using 150 pounds of nitrogen to the acre rather than 75 had little effect on yield or harvest loss.

Compacting the soil before plowing, using pressures of 75 to 85 pounds per square inch, increased the plow draft 92 percent. The effect of compaction, however, did not carry over to the next season.

When the soil was disked 4 times after it had been compacted, there was less loss of both plant population and yield than there was when the ground was disked only once. The 1956 yield was not influenced by the compaction made in 1955. Disking noncompacted ground 4 times after it was plowed rather than only once did not change either yield or ear population.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

Promersberger, W. J., and Pratt, G. L. POWER REQUIREMENTS OF TILLAGE IMPLEMENTS. N. Dak. Agr. Expt. Sta. Tech. B. 415, 35 pp. 1958.

A summary of the power requirements of tillage machines in common use in North Dakota for seedbed preparation and summerfallow purposes.

N. Dak. Agr. Col., Agr. Expt. Sta., Fargo, N. Dak.

## Fertility Requirements For Conservation Farming

Brown, W. W. Publishing Company COMMERCIAL FERTILIZER AND PLANT FOOD INDUSTRY YEARBOOK FOR USE THROUGH 1960. 208 pp. 1959.

This Yearbook is written particularly for the Fertilizer Industry, but it does have the fertilizer terms and definitions adopted by the Association of American Fertilizer Control officials, and numerous tables on fertilizer consumption and use that are of value for farm planning. The following tables are of particular interest to a farm planner:



75 Third St. N. W., Atlanta, Ga.

Allaway, W. H. NUTRIENT BALANCE AND FERTILIZER PRACTICE. Agr. and Food Chem. 7: 470-473. 1959.

Plants require many different nutrients. In order for a plant to complete its life cycle it must be furnished with each one of these nutrients, some in large amounts and some in very small or trace amounts. Within relatively broad limits there are some fairly general relationships between the amounts of the different nutrients in vigorous plants. For example, as the potassium content of a plant increases, its content of magnesium and calcium decreases. But equally healthy and productive plants of the same species may show variation in their total contents and ratios of many of the essential nutrients.

The absorption of nutrients by plants is a selective process. The ratios of the nutrient elements found in the plant are not necessarily the same as the ratios of these elements in the culture medium, even though the culture medium may be a true solution of the nutrient elements.

Plants do not grow on fertilizers; they grow on fertilized soils. Different soils present the plant with widely different ratios and amounts of the nutrient elements in soluble form, even when heavily fertilized with the same fertilizer. Within the same soil type, the supply of available nutrients may be markedly affected by moisture content or past management history.

An adequate and balanced nutrient supply resulting from the soil, the fertilizer, and the reactions between them is the objective of a proper fertilizer program. In order for it to be reached fertilizer practices need to be designed on the basis of the requirements of the crop, the characteristics of soil on which it is to be grown, including its management history and the growing conditions and cultural practices in the area.

In any given region, the first step toward this objective is an understanding of its soils. A modern soil survey of the region is a necessary part of the development of the information needed for this first step.

The second step consists of research to develop and test alternative fertilizer-use programs on specific soils and crops in the region.

The third step toward achieving an adequate and balanced nutrient supply for the crops in a region is the development of educational and advisory services.

Advisory services, staffed by people familiar with soils, crops, and research results of the area, and utilizing soil and plant tissue tests where necessary, should be established.

A final necessary step is for the fertilizer industry to make available to farmers the materials and mixtures suggested by the research and advisory programs.

SWCRD, ARS, USDA, Beltsville, Md.

Painter, C. G., and Baker, G. O. FERTILIZER MATERIALS FOR IDAHO FARMERS. Idaho Agr. Ext. Serv. B. 283, 16 pp. 1958.

A description of chemical analysis and uses for the various kinds of fertilizers sold in Idaho is given in simple terms for the farmer.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

Paden, W. R., and Riley, J. A. COTTON YIELD RESPONSE AND SOME RESIDUAL SOIL EFFECTS FROM CONTINUOUS USE OF VARIOUS SOURCES OF FERTILIZER NUTRIENTS. S. C. Agr. Expt. Sta. B. 464, 53 pp. 1959.

A carefully designed system of field-plot experiments using standard techniques commonly in practice at that time was established at the Sandhill Station in the early 1930's and was located mainly on Lakeland s. These were designed to test many sources of plant nutrients under unlimed and limed soil conditions. The yield results secured and the residual effects that have been obtained very closely agree with theoretical expectations. The data have provided significant information pertaining to many of our fertilizer problems as they exist today. Certain new sources of nutrient materials which are rapidly gaining in importance, such as ammonium nitrate and the various solution forms of nitrogen, are included for study in later established experiments.

The data presented with summaries should serve as a valuable guide.

S. C. Agr. Expt. Sta., Clemson Agr. Col., Clemson, S. C.

Reichman, G. A., Grunes, D. L., Carlson, C. W., and Alessi, J. YIELD AND QUALITY OF IRRIGATED CORN BOOSTED IN DAKOTA. U.S.D.A. Crops & Soils 11(8): 31-32. 1959.

Corn forage and grain yields under irrigation in North Dakota on the Deep River Development Farm were increased 31 percent by nitrogen fertilizer and 44 percent with phosphorus. The fertilizer also improved the quality of the feed by increasing the nitrogen and phosphorus content of the corn.

Nodak Hybrid 301 corn was grown in a potato-barley-corn rotation from 1953 through 1957, with the corn receiving up to 120 pounds of nitrogen per acre. The year before corn, the barley received up to 60 pounds of nitrogen and 150 pounds of phosphate ($P_2O_5$) per acre. The potatoes got nitrogen at rates up to 180 pounds per acre.

These phosphorus rates were high enough to supply phosphorus for the entire rotation, but most of the added nitrogen was removed by crops each year. Staggered planting gave yields from each crop each year.

Both corn grain and forage yields from phosphated plots were increased with rates of nitrogen up to 80 pounds per acre. With ample nitrogen present, the phosphorus fertilizer was more effective.

The nitrogen content, and thus total protein in both the grain and stover, was increased by nitrogen fertilizer. The phosphorus, too, was increased by fertilizer. This meant large quantities of a higher quality feed.

Tests of the corn leaves made at pollination time showed that differences in nitrogen and phosphorus content due to fertility were as great at this time as at harvest. A tissue test of leaves taken during pollination is useful in checking the soil fertility level. Corn with less than 2.5 percent nitrogen in the leaves at this time is suffering from a shortage of nitrogen.

CRD, ARS, USDA, Mandan, N. Dak.

Parks, W. L., and Chapman, E. J. ALFALFA FERTILIZATION IN THE CENTRAL BASIN. Tenn. Agr. Expt. Sta. B. 305, 11 pp. 1959.

One ton of alfalfa hay removes plant nutrients from the soil equal to the following: 1.8 pounds of borax; 60 pounds of 20 percent superphosphate; 85 pounds of 60 percent muriate of potash; and 40 pounds of agricultural limestone.

Annual potash topdressings gave increased alfalfa yields on the high phosphate Maury soil. Topdressings made in late February or early March gave higher alfalfa yields than those made after the first cutting.

Annual applications of about 200 pounds of $K_2O$ per acre were necessary to maintain the soil potassium level.

Nitrogen applications on alfalfa resulted in only small yield increases.

Minor element applications do not appear necessary under the conditions encountered.

A high soil pH (near 7.2) appears desirable for increasing yield and life of the alfalfa stand.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

Nichols, B. C., Bowman, D. R., and McMurtrey, J. E. Jr. RESPONSE OF BURLEY TOBACCO TO FERTILIZATION IN THE CENTRAL BASIN. Tenn. Agr. Expt. Sta. B. 280, 23 pp. 1959.

A fertilizer test with burley tobacco was conducted over a four-year period at the Middle Tennessee Experiment Station. The soil used for this test was Maury sil which was initially high in phosphorus and relatively high in potassium. Tobacco was transplanted following the turning under of a crop of rye each year. Some effects of nitrogen, phosphorus, potassium, and manure on tobacco yield, quality, value, and chemical constitution were determined.

By using up to 120 pounds nitrogen per acre, significant improvements were obtained in yield, quality, and acre value of tobacco.

Increasing the nitrogen supply to tobacco tended to increase nicotine and calcium and to decrease phosphorus and potassium in the cured leaf.

The application of 60 pounds $P_2O_5$ per acre was not beneficial, rather the use of phosphorus fertilizer on this high-phosphate soil tended to depress both yield and quality evaluations of tobacco.

Favorable responses in yield, quality, and acre value were realized by using 120 pounds $K_2O$ per acre. As fertilizer potassium was increased, analyses showed somewhat corresponding increases in potassium and decreases in calcium in cured tobacco.

Benefits obtained from manure were outstanding. Average results showed that 10 tons manure increased tobacco yields by almost 500 pounds per acre and that manure was worth about $32.00 per ton under the prevailing conditions of the test. Manure increased the potassium content of tobacco which is beneficial, but it also supplied too much chlorine which is considered to be detrimental to tobacco used in cigarettes.

CRD, ARS, USDA and U. Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Nichols. B. C., and McMurtrey, J. E. Jr. FERTILIZING BURLEY TOBACCO PLANT BEDS. Tenn. Agr. Expt. Sta. B. 294, 21 pp. 1959.

Two fertilizer experiments with burley tobacco plant beds were carried on for a 5-year period. Evaluations of tobacco seedling production were made for time and rate of fertilizer application and for responses to nitrogen, phosphorus, and potassium. All experimental areas were treated with methyl bromide gas.

In one experiment, 4-12-8 fertilizer was applied in the spring at rates of 1/2, 1 and 2 pounds per square yard; 0-12-8 fertilizer was applied in the fall, followed by 4-0-0 in the spring.

On the average, similar numbers of usable tobacco plants were obtained with the three fall fertilizer rates and with the three spring fertilizer rates--both at the first pulling and in season totals.

As compared with spring fertilizer applications, fall applications resulted in poorer plant stands and lower plant production. Fall fertilizer applications, however, often resulted in satisfactory plant production.

In the other experiment, responses to nitrogen, phosphorus, and potassium were determined. Early plant production where phosphorus was omitted was not satisfactory in any year. Comparatively large responses in plant production were obtained with both nitrogen and phosphorus. Very little response was obtained from potassium in these tests.

Results obtained suggest that 1/2 pound per square yard of 4-12-8 fertilizer applied in the spring would usually be an adequate fertilization procedure for burley tobacco seedlings in the area concerned.

CRD, ARS, USDA and U. Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Landcaster, J. D. MAGNESIUM STATUS OF BLACKLAND SOILS OF NORTHEAST MISSISSIPPI FOR COTTON PRODUCTION. Miss. Agr. Expt. Sta. B. 560, 8 pp. 1958.

In a series of studies on Blackland soils in Northeastern Mississippi the author reaches the following conclusions: (1) Farmers in the Blackland area should consider the use of magnesium as a fertilizer for cotton. (2) On soils having a pH above 6.0 Sul Po Mag or some other water-soluble source of magnesium applied annually at the rate of 40 to 60 pounds of MgO per acre was found to be adequate in most cases. Sul Po Mag may be more conveniently applied when incorporated in mixed fertilizers to provide both $K_2O$ and MgO. And (3) on soils having a pH of 6.0 or below dolomitic lime should be an effective source of magnesium for cotton. The rate of application should be 1 to 2 tons per acre which can be determined by soil test. Such an application probably will maintain an adequate supply of magnesium for cotton for 10 to 20 years.

Miss. State U., Agr. Expt. Sta., State College, Miss.

Hatcher, J. T., Blair, G. Y., and Bower, C. A. RESPONSE OF BEANS TO DISSOLVED AND ADSORBED BORON. Soil Sci. 88: 98-100. 1959.

To determine whether plants respond to adsorbed boron per se, beans were grown at approximately equivalent solution concentrations in three soils having a wide range of boron adsorptive capacities. Three solution concentrations of boron (0.1, 5, and 10 mg./l.) were employed. It was found that plants respond only to boron in solution and are not directly influenced by adsorbed boron.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Harper, H. J. SULFUR CONTENT OF OKLAHOMA SOILS, RAINFALL AND ATMOSPHERE. Okla. Agr. Expt. Sta. B. B-536, 18 pp. 1959.

Many high analysis fertilizers now being manufactured contain little or no sulfate. Several experiments in different states show that on some soils sulfur must be used with these fertilizers to produce maximum crop yields.

Data are reported on: (1) Sulfur and nitrogen in 170 paired samples of virgin and adjacent cultivated soils; (2) sulfur, nitrogen, and phosphorus in 18 soil profiles; (3) inorganic sulfur in 11 soil profiles to a depth of 7 feet; (4) atmospheric sulfur deposited by rainfall at Stillwater, and other Oklahoma locations; and (5) atmospheric sulfur content at Stillwater and at two locations in Minnesota.

1. Average nitrogen-sulfur ratio was 7.5 to 1 in the virgin soils and 7.6 to 1 in the cultivated soils. Average loss as a result of cultivation was about 30 percent for sulfur and about 37 percent for nitrogen.
2. Average nitrogen-sulfur ratio in the surface layers of 18 profiles was 7.3 to 1. The narrowest was 3.86 to 1 in a San Sabe C sample and the widest 11 to 1 in a Durant fsl sample. The ratios were either relatively constant in the different layers, or decreased in the lower parts of the profiles.

3. Two of the profiles contained much higher concentrations of sulfate sulfur than did the other nine. Downward movement of water was restricted by a subsurface layer of impervious clay in these profiles.
4. Average sulfur content of rainfall at Stillwater was 8.7 pounds per acre per year. At other locations the annual quantity varied from about 6 to 18 pounds per acre.
5. Atmospheric sulfur at Stillwater, Oklahoma was less than 4 percent of that present at St. Paul, Minn. and was comparable to that at Bemidiji, Minn.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

Rost, C. O., Evans, C. A., and Kramer, H. W. SULFUR FERTILIZATION OF OATS IN NORTH CENTRAL MINNESOTA. Minn. Agr. Expt. Sta. Sta. B. 444, 15 pp. 1958.

Previous investigations had shown that sulfur fertilization on many soils in North Central Minnesota increased the yield of legume hays.

In a study of the effects of sulfur fertilization for non legume crops the following conclusions were reached: (1) Sulfur fertilization increased the yield of oats on occasional fields in north central Minnesota; (2) the bushel weight (or quality) of oats was increased by sulfur fertilization on one third of the fields of the same area even though the yield of grain may not have been increased; (3) oats straw yields were not significantly increased by sulfur fertilization unless accompanied by an application of nitrogen fertilizer; (4) when accompanied by an application of nitrogen fertilizer sulfur significantly increased the yield of grain on five and straw on seven of the fifteen fields above those obtained with nitrogen alone; (5) nitrogen fertilizer alone greatly increased the yields of oat grain and straw but reduced the bushel weight of the grain; (6) some fields in north Minnesota require applications of both sulfur and nitrogen for maximum yields of oats; (7) treatment of the soil with gypsum did not appreciably affect protein or phosphorus content of the grain, but it tended to lower the sulfur content of the grain; and (8) sulfur fertilization tended to lower the phosphorus content of the straw but increased the amount of sulfur.

U. Minn., Agr. Expt. Sta., St. Paul, Minn.

McLean, E. O., and Simon, R. H. POTASSIUM RELEASE AND FIXATION IN OHIO SOILS AS MEASURED BY CROPPING AND CHEMICAL EXTRACTION. Ohio Agr. Expt. Sta. Res. B. 824, 30 pp. 1958.

Thirteen Ohio soils, varying from 49 to 496 pounds of exchangeable K per acre and from 190 to 1968 pounds of K released per acre with boiling $HNO_3$, were studied in the greenhouse and laboratory.

Results were briefly summarized as follows:

1. Addition of K to moist soils and analysis after equilibration revealed a certain fraction was exchangeable and another was fixed in non-exchangeable form. Drying in the oven at 105° C. for at least 24 hours fixed still more of that previously exchangeable. The moist fixed K was not to any great extent extractable with boiling 1N $HNO_3$, while the dry fixed K was largely extractable with the $HNO_3$.
2. A highly significant correlation was found between the exchangeable K and the response of alfalfa to applied K.
3. The relative yields of alfalfa at various rates of K applied indicated the added K was available.
4. Crops on only those soils with K release values above a range of about 700 to 800 lbs per acre failed to respond with increased yields as K was applied at increasing rates in greenhouse studies. Except for the fine textured, lakebed soils, most Ohio soils have K release values below this range.
5. More K was taken up by nine cuttings of alfalfa than was initially exchangeable; yet there was still exchangeable K after cropping. Non-exchangeable K necessarily was released to make up this difference, and the amounts released were roughly proportional to K released with boiling $HNO_3$. When sufficient K was added, K was fixed instead of released.

6. Average yield and K contents of alfalfa were remarkably similar whether K was applied after each cutting or three times as much after every third cutting.
7. Removal of the exchangeable K by repeated leaching with ammonium acetate as well as by cropping resulted in additional K becoming exchangeable.
8. It appeared from yields and K contents of alfalfa that the total K offered to the plant in a treatment of K-soil, including both exchangeable and fixed K, was similar to KCl in amount of K available to the plant.
9. Extra N over a minimal level generally increased yields, decreased percentage of K, but increased the total uptake of K by sudan grass on four soils having wide variation in K released with $HNO_3$. Crop response to increased rate of K generally occurred only with additional rate of N.
10. Lack of yield response to increasing amounts of applied K in the field on a soil where it might have been expected, suggests that some complicating factor such as subsoil feeding might have been supplementing the supply of needed K for the alfalfa.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Peele, T. C. EVALUATION OF CRUSHED GRANITE AS A SOURCE OF POTASSIUM FOR PLANTS. S. C. Agr. Expt. Sta. C. 120, 8 pp. 1959.

Granite dust from Rion, South Carolina containing 5.40 percent $K_2O$ was ineffective as a source of potassium for tall fescue and Ladino clover. During the 5-year period 1954 to 1958, the granite dust failed to produce hay yields significantly higher than yields where no potassium was added. The available (exchangeable) potassium in the soil at the end of the experiment was no greater where granite dust was added than where no potassium was applied, and both of these treatments were much lower than where muriate of potash was applied at the rate of 100 pounds $K_2O$ per acre annually. The results of this study indicate that the granite dust tested has no economic value as a source of potassium for plants.

S. C. Agr. Expt. Sta., Clemson Agr. Col., Clemson, S. C.

Ward, G. M. POTASSIUM IN PLANT METABOLISM. II. EFFECT OF POTASSIUM UPON THE CARBOHYDRATE AND MINERAL COMPOSITION OF POTATO PLANTS. Canad. J. Plant Sci. 39: 246-252. 1959.

Potato plants grown in sand culture and fed varying quantities of potassium responded with more vegetative growth and produced more and larger tubers as potassium application increased. Seven treatments ranging from complete deficiency to luxury consumption levels resulted in increasing amounts of potassium in all plant tissues and in decreasing amounts of sodium, calcium, magnesium, iron, and copper in certain tissues. The amount of starch in the leaves was a direct function of the amount of potassium applied, but the starch content of the tubers was not.

Chem. Div., Sci. Serv., Canad. Dept. Agr., Ottawa, Ontario, Canada.

Byrnside, D. S. Jr., and Sturgis, M. B. SOIL PHOSPHORUS AND ITS FRACTIONS AS RELATED TO RESPONSE OF SUGAR CANE TO FERTILIZER PHOSPHORUS. La. Agr. Expt. Sta. B. 513, 30 pp. 1958.

Total, organic, and "adsorbed" phosphorus were determined in soils of the sugar cane area of Louisiana. Easily-soluble or dilute acid-soluble phosphorus was determined by various methods and the results evaluated in relation to the growth of sugar cane.

A relatively higher percentage of the phosphorus is in organic forms in soils low in total phosphorus, but the organic fraction apparently supplies relatively little available phosphorus.

In soils of the Richland, Olivier, Patoutville, and Baldwin series, developed on Pleistocene terraces, the "adsorbed" phosphorus should be taken into account in assessing the level of "available" phosphorus and in determining the probability of response of the soil to fertilizer phosphorus. "Adsorbed" phosphorus is of less importance in estimating "available" phosphorus in the recent alluvial soils.

A chemical method for determining easily-soluble and "adsorbed" phosphorus was modified and further developed. The dilute acid-soluble and "adsorbed" phosphorus by this method has been termed "available," and it was more closely correlated with the absorption of phosphorus by the crop than was phosphorus extracted by the simpler dilute acid-soluble methods.

Responses to the application of fertilizer phosphorus to sugar cane can be expected if the "available" phosphorus values are less than 100 ppm. of P by the Bray combined "adsorbed" and acid-soluble method, less than 50 ppm. of P by the Truog method, less than 100 ppm. of P by the 0.1 N hydrochloric acid method or less than 75 ppm. of P by the proposed modified method. Laboratory methods can be expected to give no more than relative indications of the phosphorus status of soils. Not over 20 percent of the "available" phosphorus as shown by the newly proposed method can be absorbed by a sugar cane crop.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Barber, S. A., and Stivers, R. K. PHOSPHORUS FERTILIZATION OF FIELD CROPS IN INDIANA--RESEARCH PRIOR TO 1959. Purdue U. Agr. Expt. Sta. Res. B. 687, 28 pp. 1959.

Research on phosphorus fertilization on field crops in Indiana show that:

1. Most Indiana soils need additional phosphorus for high crop yields.
2. The relative benefits of placing phosphorus in the row rather than broadcasting, depend on the crop, the soil, and the amount of phosphorus used. For example, all the phosphorus may be broadcast for corn when large amounts are used. Wheat, on the other hand, is more responsive to row applications.
3. Phosphorus applications affect subsequent crops, too. The magnitude of this residual effect is proportional to the amount to which the phosphorus application increases the soil test level.
4. Applying phosphorus to corn or the crop preceding corn was found to be the most profitable placement in a rotation.
5. Nitrogen added to row phosphorus increased phosphorus uptake but did not increase yields any more than the same amount of nitrogen plowed under.
6. Phosphorus efficiency was increased by liming the soil.
7. In 96 experiments comparing rock phosphate with superphosphate, there was no advantage in using rock phosphate rather than superphosphate; in almost all of the experiments, rock phosphate was an uneconomical source of phosphorus compared to superphosphate.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Mannering, J. V., Baker, G. O., and LeBaron, M. RESIDUAL INFLUENCE OF PHOSPHATE FERTILIZER APPLIED TO A CALCAREOUS SOIL OVER A SIX-YEAR PERIOD. Idaho Agr. Expt. Sta. Res. B. 41, 11 pp. 1959.

A study was initiated at the Twin Falls Branch Experiment Station in 1951 to study the residual influence of various rates of phosphate fertilizer applied prior to planting alfalfa on the crops grown in a 6-year rotation. The fertilizer applied in 1951 on soils testing low in available phosphate was responsible for yield increases of barley straw, and alfalfa in 1951, of field beans in 1955, and of sugar beets in 1956. Alfalfa, the crop in the rotation from 1952 through 1954 showed no yield response to the phosphate fertilizer; however, phosphorus content of the plant was increased by the applications.

From these results it is concluded that soils having properties similar to the Portneuf sil evidently do not permanently fix appreciable amounts of phosphate. Increased yields substantiated by soil tests indicate that at high rates of application (120 pounds per acre and higher) sufficient phosphate to fulfill a large part of the crop requirements is available for plant use 6 years after application. This residual effect supports the recommendation of applying high initial rates to the legume in the rotation, and supplementing with lighter applications as needed.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

Lugo-Lopez, M. A., Hernandez-Medina, E., and Acevedo, G. RESPONSE OF SOME TROPICAL SOILS AND CROPS OF PUERTO RICO TO APPLICATIONS OF LIME. Puerto Rico Agr. Expt. Sta. Tech. Paper 28, 19 pp. 1959.

Published and current experimental work concerning the use of agricultural lime in Puerto Rico are reviewed. Most of the research with lime has been incidental to studies designed mainly for other purposes. In general, field crops such as cotton and corn, respond well to lime applications. Sugarcane responds only on very acid soils and the response is more marked in ratoon crops. Other crops such as sorghum, coffee, and tobacco, respond only to small doses of lime when soil acidity is rather high. Forage crops, except molasses grass, are generally responsive to increased lime in the soil.

Of the orchard crops, only the West Indian cherries, (acerola) respond in a highly significant way to applications of lime. Pineapples seem to grow better in soils on the acid side. Sweetpotato yields are increased by liming the soil, but other food crops such as plantains, yams, taniers, and peppers are not benefited. Green-manure crops respond readily to lime applications.

U. Puerto Rico, Agr. Expt. Sta., Rio Piedras, Puerto Rico.

Longhouse, A. D., Burger, O. J., and Henderson, H. O. LIQUID MANURE: CONSERVATION AND USE. W. Va. Agr. Expt. Sta. B. 425, 13 pp. 1958.

Approximately one-half of the nitrogen and two-thirds of the potassium excreted by cattle are excreted as urine. Together, these constitute about one-half of the value of manure.

Many European and Asiatic farmers make a regular practice of collecting and distributing the liquid portion of manure. Common practice in America is to absorb all or part of the liquid in bedding. The liquid not absorbed is usually lost in drainage.

The present study was made to find practical ways of collecting, storing, and applying the liquid portion of manure not absorbed by bedding and to determine its effect on forage production.

A calculation of the amount of liquid manure stored in relation to normal urine production during the various periods showed that from 50 to 83 percent of normal urine production was being held in the bedding use.

W. Va. U., Agr. Expt. Sta., Morgantown, W. Va.

Ghosh, A. B. AMMONIA IN IRRIGATION WATER AS A FERTILIZER FOR PADDY AND WHEAT. J. Indian Soil Sci. 7: 37-41. 1959.

Ammonia, applied in irrigation water to standing crops of paddy and wheat was found to be an excellent source of nitrogen as judged from the highly increased crop yields, higher grain/straw ratio and greater nitrogen uptake by the crops as compared to no nitrogen treatment. In comparison to ammonium sulphate on equal nitrogen basis, its manurial value was found to be exactly equal in the case of paddy and for wheat, ammonium sulphate was slightly better than ammonia in irrigation water.

Indian Agr. Res. Inst., New Delhi, India.

Abichandani, C. T., and Patnaik, S. NITROGEN CHANGES AND FERTILIZER LOSSES IN LOWLAND WATER-LOGGED SOILS. J. Indian Soil Sci. 6: 87-93. 1958.

In lowland water-logged soils incubated at 35° C., ammoniacal nitrogen of soil increases progressively and nitrate nitrogen decreases rapidly and after 3 to 5 days of water-logging, only traces of nitrate nitrogen remain in the soil. Large nitrogen losses, particularly from surface applied fertilizer, are observed and are attributed to denitrification occuring in the sub-surface reducing zone of water-logged soil. Nitrogen loss is rapid in the first seven days of water-logging and later decreases considerably.

Nitrogen losses with surface and sub-surface applied ammonium sulphate and ammonium nitrate are compared and sub-surface application is found superior to surface application in all respects. Recovery of ammoniacal nitrogen with sub-surface placed

ammonium sulphate is 88 percent and with surface application, it is only 40 percent, after a water-logging period of 42 days. Ammonium nitrate is found far inferior to ammonium sulphate. Recovery of ammoniacal nitrogen with ammonium nitrate is 44 percent and 24 percent respectively with sub-surface and surface application. It is presumed that with ammonium nitrate, the nitrate part of the fertilizer gets largely denitrified on water-logging and loses its fertility value.

Sub-surface application of ammonium sulphate fertilizer as compared to surface application is also found to assure higher and deeper distribution of fertilizer in the soil profile and avoids possible losses of nitrogen in the surface drained water in submerged soils.

Cent. Rice Res. Inst., Cuttack, India.

Nichols, B. C., Davis, R. L., Bowman, D. R., and McMurtrey, J. E. Jr. SOURCES OF NITROGEN FOR BURLEY TOBACCO. Tenn. Agr. Expt. Sta. B. 302, 23 pp. 1959.

Experiments were carried on for a 5-year period (1954 to 1958, inclusive) to determine the relative efficiency of several commercial sources of nitrogen in the production of burley tobacco. Sources of nitrogen tested were sodium nitrate, ammonium sulfate, urea, a mixture of 1/3 each of the preceding sources, and ammonium nitrate. All materials were applied at the rate of 60 pounds of elemental nitrogen per acre. A check or no-nitrogen treatment also was included.

All sources of nitrogen applied at the specified rate gave significant increases in yield, value per 100 pounds, acre value, and percentages of total nitrogen and nicotine in the leaf lamina of tobacco over that grown without the addition of fertilizer nitrogen.

Results obtained for the various evaluations made relating to yield, quality, value, burning properties, and chemical analyses indicate that the nitrogen sources used were equally satisfactory in producing burley tobacco. Therefore, the selection of the commercial source of nitrogen to apply to this type of tobacco should usually be based on the relative cost per unit of nitrogen.

CRD, ARS, USDA and U. Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Wei-ming, L., Odland, T. E., and Bell, R. S. EFFECT ON SOILS AND CROPS OF LONG CONTINUED USE OF SULFATE OF AMMONIA AND NITRATE OF SODA WITH AND WITHOUT LIME. R. I. Agr. Expt. Sta. B. 344, 31 pp. 1959.

During the past 64 years, four plots were equally fertilized so far as the annual amounts of nitrogen, phosphorus, potassium, and magnesium are concerned. Two of the plots received nitrogen as sulfate of ammonia, and the other two as nitrate of soda. Lime was applied from time to time in order to compare the two nitrogen sources at two pH levels.

A total of 369 different varieties and types of plants have been grown on the plots. Yields and other crop growth measurements were obtained. Many determinations were made on both physical and chemical effects on the soil of the long continued use of these nitrogen sources.

This experiment was terminated at the end of the 1956 season. Results to date, both published and unpublished, have been summarized as follows:

(1) Long continued use of ammonium sulfate increased soil acidity and solubility of toxic aluminum which made the soil incapable of producing satisfactory yields unless adequate lime was used. (2) Long continued use of nitrate of soda maintained soil pH practically constant. (3) Liming increased exchangeable calcium and magnesium and decreased the exchangeable hydrogen. Nitrate of soda tended to increase exchangeable sodium in both top soil and subsoil, but the increases appeared too small to affect crop growth, soil structure, or other physical factors. (4) Accumulations of organic matter were a little greater in the more acid topsoil. (5) No significant difference was found in the soil physical properties from the use of different single nitrogen sources for more than half a century. (6) Liming stimulated the activity of nitrifying bacteria and hastened the nitrification of sulfate of ammonia. (7) The plant species grown showed a wide

variation in their response to liming. And (8) for efficient crop production and for obtaining the most benefit from fertilizer used, lime requirement of the crop must be taken into consideration.

Agr. Expt. Sta., U.R.I., Kingston, R. I.

Mederski, H. J., Wilson, J. H., and Volk, G. W. RESPONSE OF SOYBEANS TO PLOW-DOWN AND SIDE-DRESS APPLICATIONS OF NITROGEN ON IRRIGATED AND NON-IRRIGATED SOILS. Ohio. Agr Expt. Sta. Res. C. 59, 8 pp. 1958.

In these experiments the yield of soybeans was increased by the application of fertilizer nitrogen in three out of four years at Wooster, Ohio and in two out of three years at Hoytville, Ohio. In six of the seven experiments the application of nitrogen to soybeans did not produce yield increases which were profitable at current price levels.

The increase in soybean yield was related to the level of soil moisture, that quantity of nitrogen that was applied and the method of applying the nitrogen.

Side dressing the soybeans with nitrogen when the beans began to flower produced larger yields than when the nitrogen was plowed down prior to planting; the yield differences, however, were small.

Soybean yields increased progressively with increasing rates of nitrogen from 0 to 100 pounds per acre. Application of nitrogen in excess of 100 pounds per acre did not produce an additional yield increase.

The effect of irrigation varied with season and rate of applied nitrogen. In 1948 the single effect of irrigation or the highest rate of nitrogen increased yield approximately 7 bushels per acre while the combined effect of these treatments increased yield 20 bushels per acre. Irrigation increased the 1949 yield approximately 4 bushels per acre at all levels of nitrogen, but did not affect yield in 1950.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Robertson, L. S., and Hansen, C. M. LOSSES OF AMMONIA FROM SURFACE AND SHALLOW APPLICATIONS OF A LOW PRESSURE FERTILIZER NITROGEN SOLUTION. Mich. Q. B. 42(1): 47-51. 1959.

A low pressure nitrogen solution was dribbled on the surface of soil at rates of 25, 50, and 100 pounds of nitrogen per acre at several locations. Losses of nitrogen to the atmosphere varied between 63 and 100 percent of the volatile ammonia nitrogen content of the solution. Losses were greatest immediately after application and decreased with time. Losses were proportional to the rate of application. Losses were not closely related to soil type, soil structure, moisture levels, soil reaction, or soil texture. There was a tendency for lower losses to occur from the soils which had higher organic matter levels. Where the solutions were injected into the soil to a depth of 2 inches, losses were measured in three out of nine trials, but greatest loss amounted to only 1.7 percent of the total nitrogen applied.

Mich. State U., Agr. Expt. Sta., East Lansing. Mich.

Walunjkar, W. G., Bartholomew, W. V., and Woltz, W. G. NITROGEN INTERCHANGE IN SOIL AS AFFECTED BY SOIL TYPE, SOURCE AND RATE OF NITROGEN ADDITION, MOISTURE, AND TIME OF INCUBATION. J. Indian Soil Sci. 7: 65-72. 1959.

Biological interchange of nitrogen between the organic and inorganic forms was evident in the soils studied even without the addition of supplemental organic materials. However, nitrogen interchange was closely related to the organic matter content of the soil, being greater in the soil with higher organic matter than in the soil with the lower organic matter content.

The amount of extractable fertilizer nitrogen in the soil increased with the increased moisture content of the soil.

With the increased rate of fertilizer nitrogen addition, greater quantities of fertilizer nitrogen were immobilized thereby increasing the amount of inorganic soil nitrogen in the soil solution.

The source of nitrogen added did not have any appreciable overall effect upon the process of nitrogen interchange.

Added inorganic nitrogen was immobilized in the soil mostly during the first few days of incubation, and was slowly mineralized in the subsequent periods along with the nitrogen from the soil organic matter.

Wrapper & Hookah Tobacco Res. Sta., Dinhata, West Bengal, India.

Chandnani, J. J., Bokde V., and Sharma, J. C. STUDIES ON LODGING IN WHEAT IN RELATION TO FORM, DOSE AND TIME OF APPLICATION OF NITROGEN. J. Indian Soc. Soil Sci. 6: 161-167. 1958.

Studies on lodging of wheat were made in two experiments viz. optimum time of application of nitrogen in different commercial forms of nitrogen and response curve of nitrogen in wheat. Observations were recorded on the extent and effect of lodging. It has been observed that: (1) Application of nitrogen in any form of commercial nitrogenous fertilizer induces lodging, the extent of which increases with increase in dose of nitrogen. (2) Early application of nitrogen causes more lodging than the late application. Time of application is more important when the dose of nitrogen exceeds 20 lb. per acre. (3) Application of $P_2 O_5$ in presence of nitrogen induces lodging. (4) Lodging in wheat reduces ear length, number and weight of grain per earhead, grain yield and widens the ratio between total dry matter and grain. The loss in grain yield varies according to the extent and degree of lodging and lies between 25 and 50 percent. And (5) nitrogen in wheat grain is increased as a result of lodging.

Indian Agr. Res. Inst., New Delhi, India.

## Salinity and Alkali Problems

Maksimyuk, G. P. AN EXPERIMENTAL STUDY OF THE LEACHING PROCESS OF SOLONCHAK-LIKE SOLONETZES. Soviet Soil Sci. 8: 836-843. Aug. 1958.

Experiments were made with the aim of studying the processes of desalinization and desolonetzization of solonchak-like solonetzes by means of deep plowing and additional watering.

Solonchak-like solonetzes, even virgin, are characterized by a relatively high intake rate. During leaching, uneven wetting of the soil profile, owing to cracks, is observed at the beginning.

Deep plowing, which brings gypsum up into the cultivated layer, increases the water intake rate approximately 4 times. During leaching the intake rate decreases; this is explained by soil swelling, by closing of the cracks and by the compaction of the sub-solonetz horizon when easily soluble salts are leached from it. Even at the end of leaching, however, the intake rate remained higher in plowed solonetzes.

The leaching waters percolating through the soil replace part of the soil solution. Saturation of the soil with moisture up to the minimum water-holding capacity favors the dissolving of salts which occur in the solid state. Each successive leaching replaces a new part of soil solution. The qualitative composition of salts changes during leaching in the direction of an increase in the calcium content.

The first leachings of 100-and 250-mm. (3.94-and 9.84-in.) produced only a redistribution of salts within the 1 m. and 2 m. (39.37 and 78.74 in.) layers respectively. Two successive leachings by the same amount of water produce a complete leaching of chlorides from these layers. Sulfates are leached more slowly than chlorides.

Bringing gypsum up into the cultivated layer and the irrigation rate of 1250 mm. (49.21 in.) produce desalinization and desolonetzization of the upper 1 m. (39.37 in.) layer. The exchangeable sodium content decreased to 4 to 5 percent of exchange capacity in the case of an initial content of 40 to 60 percent. An increase of alkalinity of plowed solonetzes during leaching is observed at the beginning of leachings, and is replaced subsequently by a decrease.

The composition of soil solutions of solonchak-like solonetzes changes along the profile. Leachings result in a considerable decrease in concentrations of all ions excluding the calcium ion, the concentration of which remains constant for a long time as a

result of the presence of gypsum. Towards the end of leaching, the concentration of soil solutions at the irrigation rate of 500 mm. (19.69 in.) in the 1 m. (39.37 in.) layer, under conditions of the absence of evaporation, decreases by 10 times. In the presence of evaporation at the irrigation rate of 630 mm. (24.79 in.) it decreases by two times in the same layer.

Loosening the surface of solonchak-like solonetzes, particularly at the moment of highest moisture, decreases the moisture loss by evaporation, but by only 4 to 12 mm. (.16 to .47 in.), with a total consumption of 36 to 78 mm. (19.69-to 31.5. in.) With evaporation the reverse, ascending movement of leached $Cl^-$, $SO_4^{--}$ and $Na^+$ is observed. It is expressed most strongly when salts occur at a depth of 50-to 80-cm. from the surface. Transpiration produces an ascent of salts from the second 1 m. (39.37 in.) layer. On fallowed plots at this depth of leaching the ascent of salts is not observed.

Evaporation and transpiration retard the leaching of salts.

Amer. Inst. Biol. Sci., 2000 P St. N.W., Washington 6, D.C.

Bernstein, L., and Hayward, H. E. PHYSIOLOGY OF SALT TOLERANCE. Ann. Rev. Plant Physiol. 9: 25-46. 1958.

A review of the literature on the understanding of the physiology of salt tolerance of plants. The excessive accumulation of soluble salts in the rhizosphere is a potential if not an actual limiting factor for the productivity of irrigation agriculture everywhere. Recently, widespread interest in the beneficial effects of supplemental irrigation during periods of drought has extended the concern with salt problems to the humid eastern sections of the country. Salt-spray damage and salt-water intrusions along the coast, and salinity problems in green house operations represent additional focal points of interest in salinity.

U.S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Eaton, F. M. FACTORS TO CONSIDER IN SALT BALANCE STUDIES. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 100-106. Jan. 1958.

As knowledge is gained of the effect of excess salt on the well-being of agriculture, the problems of the irrigation and drainage engineers become ever more complex. The need, or justification, of drainage is the removal of not only excess water but of extra water purposefully used to remove salts from the root zone. As often as not, there is too little rather than too much leaching of the soil.

Table 1. 20-year salt balance in a lysimeter, Sudan crops removed, vetch turned under.

| | Pound Equivalents | | | |
|---|---|---|---|---|
| | Applied | Removed by crop | Removed by leachate | Retained % |
| Ca | 289 | 57 | 29 | 70 |
| Mg | 94 | 49 | 16 | 31 |
| Na | 170 | 12 | 22 | 80 |
| $HCO_3$ | 357 | -- | 13 | 97 |
| $SO_4$ | 118 | 16 | 42 | 52 |
| Cl | 69 | 54 | 5 | 15 |

Water - 44.2 ac. ft., leachate 3%
pH - Start: 6.8
End: 8.1

Soils and Plant Nutr. U. Calif., Riverside, Calif.

Ehlig, C. F., and Bernstein, L. SALT TOLERANCE OF STRAWBERRIES. Amer. Soc. for Hort. Sci. 72: 198-206. 1958.

Strawberries were extremely sensitive to salinity in sand culture and artificially salinized field plots. The osmotic pressure of the nutrient solution was the predominant factor in determining growth of Lassen and Shasta varieties of strawberries in sand culture. High concentrations of chloride in the substrate caused marginal burn on mature leaves. Sodium also produced some marginal burn, but accumulated much more slowly in the leaves than did chloride. Shasta accumulated more chloride and sodium than Lassen and exhibited more severe burn symptoms.

Yields of marketable fruit were decreased by 50 percent when the conductivity of the saturation extracts from soil beneath the plant rows was 2.3 mmhos for Shasta and 2.6 mmhos for Lassen. Beds 6 inches in height caused greater chloride injury and reductions in yield than did 3-inch beds, because of greater salt accumulation. Salinity decreased berry size but increased sugars and titratable acids within limits. Plants survived higher salt concentrations in the fall than in the following spring. Plants died in the spring when the conductivity of saturation extracts from soil beneath the plant rows exceeded 3.0 mmhos for Shasta and 3.6 mmhos for Lassen.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Lilleland, O. EFFECTS OF MILD SALINITY ON DECIDUOUS FRUIT TREES. Conf. on Quality of Water for Irrig. Proc. Water Resources Cent., U. Calif. Contrib. 14: 189-192. Jan. 1958.

Salt excess in western orchard soils is a product of the same general climatic factors that tend to make this region of the United States unexcelled for fruit production. Our arid and semi-arid climate, together with irrigation, permit fruit trees to produce outstanding yields of excellent quality.

Deciduous fruit trees are in general very sensitive to salts in the soil. Technically it is the salts of the element sodium that are largely responsible for most of the injury. Growers have at times been surprised to find salt injury where excellent cotton land has been planted to fruit trees.

Injury to plant growth generally occurs when soils contain from 1,000 to 2,000 pounds of soluble salts per million pounds of soil. Injury from sodium salts can occur in California orchards when the soluble salt content is as low as 300 ppm.

A soil-water extract contains principally salts of the following elements: calcium, magnesium, potassium, and sodium. Investigations have indicated that injury at the lower salt concentrations occurs when the proportion of sodium salts to other soluble salts is high. Whenever two thirds of the soluble salts are sodium salts, then injury may occur, particularly in sandy orchard soils, even if the total salt content is low.

Young trees are ordinarily not affected, partly because of their shallow rooting and partly because they have not had time to accumulate salts in their root system. Recent studies indicate that fruit trees can tolerate a salt condition for a season, but the same salt condition continued for another year or two results in injury and death.

Sampling orchard soils in one-foot increments to a depth of eight feet has been found desirable in diagnosing salt and alkali injury to fruit trees. In addition to confirming chemically a suspected salt condition, an examination of this type also reveals some of the problems of correction. A study of the physical characteristics of the soil profile is important in any future reclamation. Heavy subsoils, hardpan, and high water tables make correction of a salt area most difficult for orchard trees. On the other hand, sandy subsoils and good subsoil drainage favor leaching of the sodium salts, and a possible correction. The deeper rooting and the marked sensitivity of fruit trees to salts in the subsoil makes a detailed soil study highly desirable.

Studies in California orchards have indicated that no salt correction is possible when there is a high water table. Free water at depths of 5 to 10 feet is an undesirable orchard situation, tending to develop a saline condition.

Where water penetration and drainage are possible, the application of sulfur, gypsum, or lime may be helpful. Generally speaking, the sandier the soils the greater the chances are for correction. Fifty pounds of soil sulfur per tree has had no injurious effects when broadcasted and disked under the trees.

Flood irrigation by contour or square checks should also be tried to wash the salts out of the root zone. Complete correction may take several years. Salts are not easily removed from the deeper soil explored by the roots of fruit trees.

Since fruit trees are especially sensitive to sodium, caution in the use of fertilizer materials containing this element is advisable, particularly in areas of light rainfall. A careful appraisal of the quality of irrigation water is also indicated, especially the sodium content of irrigation waters.

U. Calif., Davis, Calif.

## Cover Crops

Kamprath, E. J., Chandler, W. V., and Krantz, B. A. WINTER COVER CROPS: THEIR EFFECTS ON CORN YIELDS AND SOIL PROPERTIES. N. C. Agr. Expt. Sta. Tech. B. 129, 47 pp. 1958.

Four experiments were conducted over a 10 to 14 year period to measure the effect of cover crops and rate of nitrogen applications on corn yields and the subsequent effect of the treatments on the chemical properties of the soil and the yields of succeeding crops. The results are summarized as follows:

1. Yields of the legume winter cover crops were not increased by the application of nitrogen.
2. Hairy vetch gave better growth and added more nitrogen to the soil than either Austrian winter peas or a mixture of oats and hairy vetch.
3. The beneficial effect of winter legume cover crops on the yield of corn was related to the amount of nitrogen which was supplied by the legume crop. The use of winter legumes alone increased the average yield by 33, 43, and 73 bushels per acre on a Norfolk ls, a Norfolk sl and a Norfolk vfsl. This was comparable to the application of 75 to 95 pounds of nitrogen per acre where no legume had been grown.
4. At both high and medium nitrogen levels non-legume cover crops had very little effect on the yield of corn compared to no cover crop.
5. The organic matter and nitrogen content of the soil decreased where no cover crop or nitrogen fertilizer was used.
6. At high rates of nitrogen fertilization the nitrogen contents of the soils were maintained, as were organic matter contents except where the organic matter content was relatively high at the beginning of the experiment.
7. The organic matter and nitrogen contents were increased by the use of vetch cover crops plus high nitrogen fertilization of the corn on those soils which were relatively low in organic matter and maintained the levels on soils with relatively high contents.
8. The greatest residual effect on the yield of succeeding crops was obtained where vetch had been grown previously and the corn had been fertilized with a high rate of nitrogen.
9. The residual effect of previous nitrogen fertilization on the yield of succeeding crops was greatest on the heavier soils.
10. Winter cover crops and nitrogen treatments had no apparent effect on the physical properties of the soil as measured by the yields of succeeding crops.

Agr. Expt. Sta., N. C. State Col., Raleigh, N. C.

Willard, C. J., and Barnes, E. E. EXPERIMENTS ON THE USE OF SWEETCLOVER FOR GREEN MANURE. Ohio Agr. Expt. Sta. Res. B. 839, 32 pp. 1959.

Experiments by the Ohio Agriculture Experiment Station were summarized as follows:

1. Numerous experiments on a variety of soil types in Ohio have shown that when conditions are or can be made favorable for sweetclover the 2-year rotation of corn followed by a small grain seeded to a sweetclover catch crop will maintain the productivity of a productive soil nearly or quite as well as a 3- or 4-year rotation with one year of mixed hay including red clover and alfalfa.

2. On soils which are highly deficient in organic matter, this rotation will increase the productivity of the soil.

3. Sweetclover, in this rotation, will produce as high yields of corn as are obtained by plowing under 6 tons of manure per acre or applying commercial nitrogen up to, at times, as much as 100 pounds per acre.

4. Sweetclover may be plowed under any time from November to the first of May in the latitude of Ohio, the most favorable time depending on the soil type and not the sweetclover.

5. The soil improving value of the rotation is increased when the straw and stover from the grain crops are not removed but are plowed down with the sweetclover.

6. Factors in the successful use of sweetclover in this rotation are: (1) Spring seeding, summer seedings alone or in corn are much less effective and are quite likely to be unprofitable; (2) do not harvest a companion crop with a mowing machine; and (3) do not clip the stubble of the companion crop or cut the sweetclover for hay at any time during the seeding year.

7. Because of its unique life history properly grown sweetclover will accumulate much more nitrogen per acre in the roots in the fall of the seeding year than any other legume. Alfalfa is next in this respect and preferable if the field must be clipped.

Ohio Agr. Expt. Sta., Wooster, Ohio

Smith, R. M., Hervey, R. J., Collier, J. W., and Cook, E. D. SHOULD FARMERS PLANT WINTER LEGUMES FOR GREEN MANURE? Soil & Water (Assoc. Tex. Soil Cons. Dist.) 8(8): 8-9. 1959.

Research studies for many years plus observations and experiences on field areas and farms, show that in Blackland Prairie soils, winter legumes for green manure in one-year cropping systems may be valuable for special purposes but their usefulness is limited. From research results the following conclusions can be made:

1. On sloping land in Central Blackland, winter legumes can be expected to reduce runoff and erosion during the winter and early spring: however, the period of maximum protection does not correspond with the season when losses are most serious that is, April, May, and June.
2. On eroded or depleted soils where yields are low because nitrogen is a primary limiting factor, winter legumes or mineral nitrogen fertilizer can be expected to increase yields of cotton or other warm season row crops. In most cases, improved conservation cropping systems are needed for permanent use of such land.
3. Water use by winter legumes is likely to cause moisture deficits of at least 1 inch of moisture compared to winter fallow. During spring seasons of low rainfall this may result in dry seedbeds at planting time as well as somewhat less stored moisture for plant growth and yield as the season progresses.
4. During wet springs it is sometimes difficult to destroy winter legumes and provide proper seedbeds. Compaction and puddling of Blackland clay soils by working the land when too wet, may damage soil structure and reduce yields, Insect and stand establishment problems, also, have been serious with winter legumes during wet springs.

SWCRD, ARS, USDA, Blackland Expt. Sta., Temple, Tex.

## Climatic Influences

Hendricks, S. B., Toole, E. H., Toole, V. K., and Borthwick, H. A. PHOTOCONTROL OF PLANT DEVELOPMENT BY THE SIMULTANEOUS EXCITATIONS OF TWO INTERCONVERTIBLE PIGMENTS: III. CONTROL OF SEED GERMINATION AND AXIS ELONGATION. Bot. Gaz. 121(1): 1-8. 1959.

Germination of seeds of many plants is controlled by a brief irradiation of low energy (0.01J), which is effective through the reversible photomorphogenic reaction. The germination of many other seeds is known to be influenced by light, but much longer exposures, often distributed over several days, are required. The germination of some of these latter kinds of seeds depends upon the low-energy photomorphogenic reaction in

involved ways; examples are seeds of Paulownia tomentosa and of Pinus taeda. Evidence is presented here that other kinds of seeds, for which an analysis of germination response was previously lacking, really have a high-energy photo-requirement (O. 1J). The inhibition of germination of these seeds is found to be controlled not only by the reversible change of the pigment forms but also by their continued excitation.

CRD, ARS, USDA, Beltsville, Md.

Ward, G. M. POTASSIUM IN PLANT METABOLISM: I. EFFECTS OF LIGHT ON THE MINERAL COMPOSITION OF NORMAL AND POTASSIUM-DEFICIENT WHEAT SEEDLINGS. Canad. J. Plant Sci. 38: 292-299. 1958.

Normal and potassium-deficient wheat seedlings were grown in sand culture under controlled environmental conditions in a growth chamber. Successive crops were subjected to varying photoperiods and light intensities. Chemical analysis of tissues of the 14-day seedlings indicated that any restriction of light intensity or duration resulted in higher levels of potassium in the plant, when potassium was available. Phosphorus decreased with increasing photoperiod. Levels of calcium, magnesium, iron, copper, and manganese were not directly related to illumination. Chlorosis due to potassium deficiency showed a correlation with high phosphorus/iron ratios.

Canada Dept. Agr., Ottawa, Ontario, Canada.

Vaartaja, O. EVIDENCE OF PHOTOPERIODIC ECOTYPES IN TREES. Ecol. Monog. 29: 91-111. 1959.

The hypothesis of photoperiodic ecotypes was tested with 38 tree species of 19 general and 81 seed sources from various latitudes in the Northern Hemisphere. The 4 greenhouse test conditions differed photoperiodically but received the same amount of light from sun and fluorescent tubes. In general, the farther north the seed source, the greater was the response to test conditions, and the longer was the maximum ("critical") daylength that strongly inhibited the seedlings. The interaction of seed source and photoperiod was analyzed in comparisons of latitudinally distant seed source pairs within 17 species belonging to 9 genera. In most cases interactions were recorded in the following responses: (1) Duration of elongation. Under certain daylengths elongation of northern seedlings soon ceased while it continued in southern seedlings. No difference or loss was found under other daylengths. The endogenous seasonal elongation pattern was entirely overruled by the effects of photoperiods in many species Picea spp. or only modified in others Pinus spp. (2) Amount of growth. Height and top weight of northern as compared to southern seedlings were very small under certain daylengths but not under others. The growth responses followed a certain pattern in accordance with the hypothesis. (3) Lateral development. Number of side branches and buds was restricted in northern seedlings under short days. Individual variation was usually greatest at the critical daylength, as would be expected if the populations were somewhat mixed in their inherited responses to photoperiods.

It is suggested that the photoperiodic ecotypes have evolved as an indirect mechanism in the adaptation of trees to various seasonally changing climatic factors. Therefore, they are only approximately similar at different sites in each latitude.

Forest Biol. Div., Sci. Serv., Dept. Agr., Ottawa, Ontario, Canada.

Lucas, H. L., and others. INFLUENCE OF ENVIRONMENT ON THE CHEMICAL COMPOSITION OF PLANTS. III. RELATIONS OF THE COMPOSITION OF TURNIP GREENS TO SOIL AND WEATHER FACTORS. Southern Coop. Ser. B. 52, 92 pp. 1959.

Crops of turnip-greens were grown in two or more seasons of the year in one or more years at each of nine locations in the Southeastern Region of the United States and at one location in Puerto Rico. Crops were grown under natural field conditions and simultaneously in sand cultures subjected to the field weather. Four to a dozen successive harvests were made on each crop. Fourteen plant constituents of interest to nutritionists were measured in the leaf blade tissue. The constituents were: dry matter, crude

fiber, ascorbic acid, nitrogen, riboflavin, thiamine, carotene, ether extract, phosphorus, calcium, potassium, magnesium, iron and sodium. Some observations were also made on plant weight (aerial portion) and number of leaves. Concomitant observations on weather factors (including soil temperature and soil moisture) were made for all crops. Many soil properties of the field plots were evaluated, but, at most, only once for each crop.

N. C. Agr. Expt. Sta., Raleigh, N. C.

Ludwig, J. W., and Harper, J. L. THE INFLUENCE OF SOIL COLOUR. THE INFLUENCE OF THE ENVIRONMENT ON SEED AND SEEDLING MORTALITY. J. Ecology 46: 381-389. 1958.

White corn was sown on three sowing dates in the spring of 1955 and 1956 on soils which had been slightly coated with coloring materials to give surface colors ranging from white to black through yellow, brown, and grey. The soil temperature was markedly changed by such treatments, and in the darkened soils this was reflected in both increased ultimate percent emergence of corn and decreased time for 50 percent ultimate emergence. It is emphasized that many factors other than soil color determine soil temperature but that under field conditions in the spring the speed and success of establishment are significantly influenced by soil color.

After emergence of the seedlings the soil color may exert effects on the growth of plants other than through soil temperature--these effects require further study before the full agronomic and ecological significance of soil color can be appraised.

U. Oxford, Oxford, England.

Bark, L. D. WHEN TO EXPECT LATE-SPRING AND EARLY-FALL FREEZES IN KANSAS. Kans. State U. Agr. Expt. Sta. B. 415, 23 pp. 1959.

Late-spring freezes and early-fall freezes occasionally do considerable damage in Kansas. The amount of damage depends on the hardiness, the stage of development, and, to some degree, the exposure of the plant.

Maps showing the average dates of the first occurrence in the fall and the last occurrence in the spring of 32-, 28-, 24-, 20-, and 16-degree freezes are presented. They show a general pattern of early-fall and late-spring freezes in northwestern Kansas.

Tables accompanying the maps enable you to estimate the best time of operation, once you decide on the risk you are willing to take, or you can assess the risk you are taking if you have decided on a date of operation.

Freeze risks in small-scale operations, such as home gardens, can often be reduced by carefully considering air drainage and slope of land in the selection of the planting site.

Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

## Mulching

Carolus, R. L., and Downes, J. D. STUDIES ON MUSKMELON AND TOMATO RESPONSES TO POLYETHYLENE MULCHING. Mich. Q. B. 40(4): 770-785. 1958.

Mulches are expensive; the plastic required to cover two-thirds of the area on an acre at present prices will cost from $125 to $150. For many crops there are other ways of improving yield which, in some cases, may be almost as effective and much less expensive.

Ries (1957), in a recent study with pickling cucumbers, found that black plastic increased the yield of fruit over that produced on plots receiving deep, normal cultivation by 21 percent. However, in the same test, chemical weed control increased the yield by 19 percent, and shallow cultivation, using sweep instead of shovel attachments, increased the yield by 18 percent.

Irrigation with proper nozzles and pressures to produce small drops will help eliminate the damaging effect of falling water on soil structure. Timely applications of water, previous to the appearance of noticeable drouth symptoms, would help serve one of the functions of mulching. If more careful attention had been paid to the timing of irrigation in this study, it is probable that at Sodus, the effectiveness of mulching would have been reduced. However, mulching will minimize the effect of the lack of proper timing of irrigation, and should increase its profitableness under most conditions.

The maintenance of a high state of tilth by maintaining the organic matter through suitable rotation, green manuring, and cover cropping practices would eliminate some

of the advantages to be gained by mulching. However, as in the case with irrigation, under many conditions, mulching may increase the profitableness of these practices.

In crops that must be hand-hoed at considerable labor expense, mulching may reduce the cost of production.

For the commercial grower that wishes to mulch several acres with plastic a tractor-attached applicator is a necessity if a smoothly covered bed of well-anchored film is to be applied economically. Plants set on plastic are more easily injured by low temperatures, and frosts because the soil heat is held by the mulch. Consequently, crops cannot be safely planted as early on plastic as on uncovered soil.

Black plastic mulch of 1.5 mil thickness will not completely prevent the sharp spikes of quack and nut grass from growing through it. The material is resistant to decomposition and should be removed from the field unless it can be preserved in place for use another season.

Mulching will prove most profitable on high value warm season crops; i.e. muskmelon, cucumber, early squash, tomato, pepper, eggplant, and perhaps with sweet potatoes, early beans, and okra, where all other practices necessary for optimum crop production are followed carefully, fertile soils are used, and a premium market for earliness and high quality are available.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Honma, S., McArdle, F., Carew, J., and Dewey, D. H. SOIL AND AIR TEMPERATURE AS AFFECTED BY POLYETHYLENE FILM MULCHES. Mich. Q. B. 41(4): 834-842. 1959.

Muck soils covered with black polyethylene film had average temperatures at a depth of 5 inches which were 2.5 degrees F. warmer than uncovered soil at the same depth. Early morning temperatures (4 to 6 a.m.) of the air 1/4-inch above the black plastic averaged 1/2 to 1 degree higher than air temperatures above bare soil.

Soil and air temperature effects were determined for coverings of black polyethylene, and aluminum colored polyethylene on mineral soils. Night temperatures of the soil beneath the plastic films were higher than the uncovered soil. During the daytime bare soil temperatures were higher than the soil beneath the films. Early morning air temperatures 1/2-inch above the plastics were no higher than comparable air temperatures above bare soil. Air temperatures below the black and the aluminum colored plastics average 10 to 30 degrees higher than outside air temperature during daylight hours. The higher air temperatures beneath the white-surfaced plastic ranged within 5 degrees of the air temperature.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Kirsch, R. K. EFFECTS OF SAWDUST MULCHES: I. SOIL PROPERTIES. Oreg. State Col. Tech. B. 49, 16 pp. 1959.

As one phase of a study designed to show effects of sawdust on soil properties and plant growth an extensive field trial was initiated at the Lewis-Brown Horticultural Farm near Corvallis. Douglas Fir sawdust was applied, with and without fertilizers, both as a surface mulch and as a soil amendment to the surface soil. Marshall strawberries, used as the indicator crop, became infested with red stele disease (Phytophthora fragariae). Incidence of this disease was increased by both sawdust and nitrogen.

Following removal of the strawberries, all plots were rotovated and soil samples obtained. Sweet corn was planted to determine the residual effects of sawdust and fertilizer treatments.

Statistical analysis of data obtained showed: (1) Nitrogen applied as ammonium sulfate reduced soil pH as the cumulative amount of nitrogen applied reached 1,600 lbs. per acre over a 4-year period. Sawdust had no effect on soil pH. (2) Both sawdust and nitrogen increased total nitrogen content of the soil. Applied nitrogen had the greatest effect when sawdust was incorporated. (3) Water-soluble nitrates in the soil were decreased by sawdust treatment and increased by nitrogen treatment. (4) Both nitrifiable nitrogen (nitrates after incubation) and available nitrogen (nitrates before plus nitrates after incubation) in the soil were decreased by sawdust and applied nitrogen. Sawdust had

its greatest effect when recently incorporated. (5) Available soil phosphorus was decreased by sawdust treatment, but was not effected by applied nitrogen. Neither sawdust nor applied nitrogen had any affect on available soil potassium. (6) Oxidizable organic matter in the soil was increased by sawdust, but nitrogen had no effect. Sawdust had the greatest effect when nitrogen was also applied. (7) Total carbon content of soil was increased by sawdust treatment. (8) Nitrogen content of corn leaves was decreased by sawdust and increased by applied nitrogen. And (9) phosphorus content of corn leaves was increased by sawdust and decreased by applied nitrogen. Leaf potassium was not affected by either sawdust or applied nitrogen.

In another study conducted to evaluate effects of Douglas Fir and Alder sawdust on certain soil physical properties, statistical analysis of data showed: (1) Incorporation of Fir and Alder sawdust increased content of oxidizable organic matter; and (2) soil aggregation, weight per cubic foot of soil, and non-capillary porespace were favorably affected by incorporation of Fir and Alder sawdust.

Observations showed sawdust applied as a surface mulch facilitated such operations as weed control and harvest of strawberries. It also tended to reduce rate of moisture evaporation from soil surface.

Incorporated sawdust had a definite loosening effect on soil and also tended to retain soil moisture for longer periods between irrigations.

Agr. Expt. Sta., Oreg. State Col., Corvallis, Oreg.

Robert, A. N., and Mellenthin, W. M. EFFECTS OF SAWDUST MULCHES: II. Horticultural Crops. Oreg. State Col. Tech. B. 50, 34 pp. 1959.

As part of an over-all study of effects of sawdust and other organic residues on physical, chemical, and biological properties of soil and crop response thereto, a series of experiments were designed to measure effects of such soil management on: (1) Yield of certain horticultural crops; (2) incidence of red-stele disease of strawberry; and (3) fertilizer requirement, particular nitrogen, as measured by crop response.

Based on crop responses, the following observations were made on the use of sawdust in soil management practice for horticultural crops:

1. The growth of perennial horticultural crops: (1) Sawdust was superior to either straw or oak leaves as a mulch for blueberries and azaleas, and mulching superior to clean cultivation; (2) yield of raspberries was not increased by mulching practice regardless of materials used (straw, fir sawdust, oak leaves) over that of clean cultivation; (3) rather large amounts of fir or alder sawdust could be incorporated in some soils without depressing yields of strawberry; and (4) the strawberry responded to sawdust mulching with increased yield under disease free conditions.
2. Incidence of red-stele disease of strawberry: Applications of large amounts of nitrogen fertilizer and/or sawdust as a mulch increased development of red-stele disease in strawberry.
3. Fertilizer requirement, particularly nitrogen, as measured by crop response: (1) Fir and alder sawdust used as a surface mulch did not increase the fertilizer requirement of strawberries; (2) douglas fir sawdust mixed with surface soil at the rate of 60 tons/acre (dry weight) required approximately 400 lbs. of supplemental nitrogen per acre (6.6 lbs actual N/ton sawdust) the first year, 200 lbs. the second, and 100 lbs. the third and fourth years to supply sufficient available nitrogen for a tomato or potato crop during decomposition of sawdust; (3) alder sawdust incorporated at the same rate required the same amount of nitrogen (6.6 lbs.) per ton of sawdust during the first year but only 100 lbs. N/acre the second and none thereafter for satisfactory decomposition without depressing yield of tomatoes and potatoes; (4) alder sawdust mixed with soil increased yield of tomatoes and potatoes after the second year and increased crop response to applied phosphorus and potassium; and (5) fir sawdust additions did not increase crop yield of tomatoes and potatoes during a 5-year period, and in most cases reduced yields unless supplemented annually with relatively high rates of nitrogen and phosphorus fertilizer.

Agr. Expt. Sta., Oreg. State Col., Corvallis, Oreg.

## PLANT MANAGEMENT

### Pastures and Haylands

Fletchall, O. H., and Brown, E. M. THE ESTABLISHMENT AND MANAGEMENT OF LADINO CLOVER IN MISSOURI. Mo. Agr. Expt. Sta. Res. B. 696, 78 pp. 1958.

Experiments were conducted in the field and in the greenhouse to determine the possibilities of establishing ladino clover in grass sods and to develop and refine some of the cultural and management practices for its production. This work shows: (1) Ladino clover can dependably be established in grass sods with little or no tillage. (2) Italian imported ladino clover seed was equal or superior to the certified domestic seed tested from the standpoint of type purity, but uncertified commercial seed was not consistently pure as to type. (3) Grass-ladino clover plantings produced better stands when made in late summer than when made in the spring. (4) Ladino clover seedlings which grew in the row of associated grass heaved less than those growing between the grass rows. (5) Clipping for weed control was essential for establishment of ladino clover on prepared seedbeds in the spring. (6) Ladino clover was well established and it produced well in redtop, tall fescue, orchard grass, bromegrass, and Kentucky bluegrass. (7) Ladino clover seedings in grass sods were more successful when made in the spring than when made in late summer. (8) Tillage of sods was helpful but not essential for the establishment of ladino clover. (9) Clipping for the control of the growth of associated grass was necessary for satisfactory ladino clover establishment in sods. (10) A temperature of 80° F. was more favorable than cooler temperatures for the growth of ladino clover tops; 65° and 80° were about equally better than 50° for ladino clover root growth. Top growth of tall fescue increased with each 15° increase in temperature from 50° to 80° F. Sixty-five degrees Fahrenheit was more favorable than 50° or 80° for tall fescue root growth. (11) Frequency of defoliation had a much greater influence on the growth of ladino clover than height of defoliation. And (12) frequency of defoliation produced a more marked influence on the growth of ladino clover than on bromegrass or tall fescue.

U. Mo., Col. Agr., Agr. Expt. Sta., Columbia, Mo.

Varney, K. E. BIRDSFOOT TREFOIL ITS ESTABLISHMENT AND MAINTENANCE ON LIGHT AND HEAVY SOILS. Vt. Agr. Expt. Sta. B. 608, 15 pp. 1959.

Experiments in the use of Birdsfoot trefoil were summarized as follows: (1) Birdsfoot trefoil is a persistent, long-lived forage plant well adapted to Vermont; (2) on clay soils it will tolerate extremes of wetness and drouth; (3) on sandy soils, though less persistent, it produces well for three to four years, in contrast to red clover; (4) adequate inoculation is a must for seedling establishment; (5) band seeding puts fertilizer where it feeds the seeds and not the weeds; (6) bunch grasses--like timothy--are good companion grasses for trefoil; (7) two cuts--early hay and rowen--give the highest forage yield and the most crude protein per acre; and (8) trefoil responds well to mineral fertilization.

U. Vt. and State Agr. Col., Vt. Agr. Expt. Sta., Burlington, Vt.

Klebesadel, L. J., and Smith, D. LIGHT AND SOIL MOISTURE BENEATH SEVERAL COMPANION CROPS AS RELATED TO THE ESTABLISHMENT OF ALFALFA AND RED CLOVER. Bot. Gaz. 121: 39-46. 1959.

Measurements were made of the penetration of light into six companion crops and of the available soil moisture under those crops as they advanced in maturity. Companion crops used were fall-sown winter rye and winter wheat and spring-sown oats, wheat, barley, and flax. The influence of the various companion crops on the establishment of alfalfa and medium red clover also was studied.

Winter rye and winter wheat were stronger competitors for light and soil moisture than the spring-sown companion crops and exerted these competitive effects over a much longer period. Consequently, the winter cereals caused reduced legume stands and hay yields. Winter rye was generally more competitive and less satisfactory as a companion crop than winter wheat.

Flax was least competitive of the spring-sown companion crops, and establishment of legumes was superior under flax.

The three spring-sown cereals furnished about equal competition for light and soil moisture, although barley was usually more competitive for light and oats for soil moisture. Spring wheat was generally less competitive for light than barley or oats. Legumes were slightly more vigorous under spring wheat than they were under barley and oats. Legume stands were essentially similar under the three spring-sown cereals with slightly thicker stands under wheat. Hay yields were slightly higher from legume stands established under barley than from stands established under wheat and oats and were slightly lower under oats.

The trends of both light and soil moisture beneath a given companion crop were quite similar. For example, a companion crop that caused early and extended shading also caused early and extended soil moisture stress.

Growth of weeds was always least in association with the companion crops that caused the most shading and the greatest soil moisture stress.

Wisc. Agr. Expt. Sta., Madison, Wisc.

Launchbaugh, J. L. GRAZING RESEEDED PASTURES BUFFALOGRASS, WESTERN WHEATGRASS, INTERMEDIATE WHEATGRASS, ON LOWLANDS AT HAYS, KANSAS. Kans. Agr. Expt. Sta. B. 400, 24 pp. 1958.

An 8-year grazing trial with yearling steers was conducted on reseeded buffalograss, western wheatgrass, and intermediate wheatgrass, each planted alone on a lowland site at Hays, Kansas.

Buffalograss and intermediate wheatgrass were ready to graze the year after planting. Western wheatgrass required two seasons for establishment.

The first three seasons were ideal in terms of precipitation and growing conditions. The last five years were characterized by drought. Carrying capacities declined during the drought, and intermediate wheatgrass had to be abandoned during the seventh year of the study after three years of dry weather. The other grasses maintained satisfactory stands throughout the study.

Western wheatgrass and intermediate wheatgrass produced spring grazing from 15 to 30 days earlier than buffalograss which generally was ready on May 1. Length of grazing season averaged 145 days on buffalograss, 157 on western wheatgrass, and 150 on intermediate wheatgrass. Carrying capacity in terms of steer days per acre during the years the pastures were grazed averaged 60 days on buffalograss, 80 on western wheatgrass, and 67 on intermediate wheatgrass. Steer gains averaged 161, 192, and 213 pounds per head and beef production per acre averaged 69, 100, and 112 pounds, in the same order.

Crude protein content of the grasses was highest in intermediate wheatgrass, followed closely by western wheatgrass, and lowest in buffalograss throughout the season. Available summer moisture during 1950 and 1951 stimulated regrowth which was high in crude protein content for all species, especially intermediate wheatgrass.

Of the cool-season grasses, intermediate wheatgrass, because of rapid establishment, was considered superior to western wheatgrass for short duration pasture. Western wheatgrass should be considered for permanent plantings when long-time maintenance is desired. Both cool-season grasses produced high gains from April to July, intermediate wheatgrass being the better of the two in this respect.

A cost-return analysis showed grazing intermediate wheatgrass to be most profitable, followed by western wheatgrass, and then buffalograss. Although the average net returns per acre were low for each pasture, these were calculated on the basis of prices which prevailed during the study period and serve to show relative differences between pastures rather than absolute values to be expected during any other period.

Kans. State U., Agr. Expt. Sta., Manhattan, Kans.

Kennedy, W. K. NITROGEN FERTILIZATION OF MEADOWS AND PASTURES. Cornell U. Agr. Expt. Sta. B. 935, 32 pp. 1958.

The yield increase from grass meadows of timothy, orchard grass, bromegrass, or quackgrass fertilized with 50 pounds of nitrogen averaged nearly a ton of hay per acre.

When only 25 pounds of nitrogen per acre was used on all-grass sods, the yield increase was small because most of the nitrogen was utilized by micro-organisms and was not available for plant growth. Meadows that contained small amounts of legumes, and especially those that had good stands of legumes the previous season, responded well to 25 pounds of nitrogen per acre but higher rates of nitrogen were unprofitable. The yield increase from meadows that were chiefly unproductive grasses and weeds was frequently not profitable.

Nitrogen fertilizer alone was adequate for 1 year, but lime, phosphorus, and potassium were all necessary to maintain maximum production of grass meadows of pastures and must be considered in any long-range program of nitrogen fertilization.

Both nitrogen-fertilized and unfertilized grass meadows on soils with a pH of 6.2 yielded about three-fourths of a ton more hay than meadows on soils with a pH of 5.1. The return for each dollar invested in lime was almost 4 times the return obtained with nitrogen fertilizer; the use of lime plus nitrogen, however, was about twice as profitable as using either alone.

Cattle manure was not a particularly good source of nitrogen for grass meadows but when supplemented with superphosphate it was a good source of phosphorus and potassium. Chicken manure was an excellent source of nitrogen.

Considering total yield, seasonal distribution of forage, and maintenance of stand, orchard grass was superior to timothy, bromegrass, and tall fescue for nitrogen-fertilized grass pastures. Profitable yield responses were obtained for applications as large as 300 pounds of nitrogen per acre per year.

The best yield increases with orchard grass were obtained from early spring applications of nitrogen, but 75 percent of the production was before July 1. By delaying the application of the initial increment of nitrogen until late May or early June, and by splitting the yearly application into 3 or 4 increments, the seasonal distribution of forage production was greatly modified. Sixty percent of the total yearly production came after July 1.

Irrigation of nitrogen-fertilized orchard grass resulted in an increase of 1,080 pounds of hay per acre per year during the 3 seasons. In terms of cost and return of forage, nitrogen fertilizer was a much better buy than irrigation equipment for increasing yield of summer pasture.

The use of nitrogen fertilizer on a vigorous legume and grass mixture is a questionable practice. Nitrogen fertilizer should be applied to legume and grass mixtures when the legume in the stand falls below 20 percent. Nitrogen also can be used economically on meadows or pastures with less than 40 percent legume if they are to be plowed the following year.

Nitrate poisoning, grass tetany, and trace mineral deficiencies must be considered if grass heavily fertilized with nitrogen is to be the sole source of forage for livestock. Preliminary studies indicated that the danger of nitrate poisoning in perennial grasses is not great. Oats heavily fertilized with nitrogen did accumulate quantities of nitrates which, according to presently accepted values, would be toxic.

N. Y. State Col. Agr., Ithaca, N. Y.

Austenson, H. M., and Law, A. G. EFFECT OF FERTILIZERS ON CHEMICAL COMPOSITION OF PASTURE HERBAGE. Wash. Agr. Expt. Sta. B. 591, 13 pp. 1959.

The effects of N, P, K, minor elements, and lime on an orchard-grass-Ladino clover mixture were studied at Mount Vernon, Washington. Data relating to carotene content, percentage protein and percentage crude fiber are presented. Total nitrogen was measured by the Gunning method and multiplied by 6.25 for crude protein. Crude fiber was determined using AOAC method, but the ether extraction was omitted. Crude protein and crude fiber are expressed on a percentage dry weight-basis.

None of the minor element or lime treatments affected carotene, protein, or crude fiber of either the grass or the legume.

Applications of nitrogen fertilizer increased the carotene content of the mixed herbage at two of six sampling dates. The increase was 3 to 4 p.p.m. of carotene per pound of N applied.

P and K applications did not affect the carotene content in any of the samplings.

The protein content of orchardgrass was increased by about 0.2 percent protein per pound of N applied when samples were taken 2 weeks after fertilization. Samples taken 6 to 8 weeks after N applications showed protein increases of 0 to 0.009 percent protein per pound of N applied. P and K applications did not affect the protein content of the orchardgrass.

P applications increased the protein content of Ladino clover slightly at three of six sampling dates. N and K applications did not influence protein content of the clover.

The data indicate that applications of 40 pounds N per acre at intervals of 2 to 3 weeks would maintain the protein content of orchardgrass near that of Ladino clover.

In a mixed stand, applications of 120 pounds N per acre per year slightly reduced the protein content of the herbage. This reduction resulted from a stimulation of grass which, at this level of N fertilization, was lower than clover in protein.

Samplings made at the hay stage showed that the protein content of orchardgrass was increased by 0.14 percent protein per pound of N fertilizer applied. At this stage of development, orchardgrass was about half as high in percentage protein as at the vegetative stage, 6 to 8 inches high.

Crude fiber percentage of the orchardgrass was lowered by N applications made approximately 2 weeks before sampling. The amount of the decline was approximately 0.1 percent per pound of N fertilizer applied. P and K applications did not influence the crude fiber percentage of orchardgrass. None of the fertilizer applications affected the crude fiber content of Ladino clover. Ladino clover was approximately three-fifths as high in crude fiber as orchardgrass. Because of the stimulation of grass, applications of 120 pounds of N annually increased the crude fiber content of the mixed herbage.

At the hay stage, both orchardgrass and Ladino clover were approximately two-fifths higher in crude fiber than at the pasture stage.

Wash. Agr. Expt. Sta., Inst. Agr. Sci., Wash. State U., Pullman, Wash.

Arny, A. C., and Schmid, A.R. ROTATION PASTURE STUDIES, 1936-1947. Minn. Agr. Expt. Sta. Tech. B. 223, 45 pp. 1958.

Studies related to both permanent pastures and to pastures grown on tillable land, usually in regular rotations with other farm crops, were started in 1936.

The main objects of these studies were: (1) To determine the comparative value of the different species and varieties of legumes and grasses and mixtures of them for use in the different sections of Minnesota; (2) to determine the effects of grazing these pasture crops at different stages of development, on the yield and quality of the feed and maintenance of stands; and (3) to determine the production and quality of various annual crops which might be used to supplement the biennial and perennial pasture crops.

Rotation pastures averaged nearly twice the yield per acre of total digestible nutrients produced by permanent pastures at about the same cost per hundredweight. Also the total-digestible-nutrient yields per acre of the rotation pastures were equal to those from the best hay and grain crops at less than half the cost.

U. Minn., Agr. Expt. Sta., St. Paul, Minn.

Smith, O. F., and Peaden, R. N. FORAGE PRODUCTION OF RANGER AND LAHONTAN ALFALFAS AS AFFECTED BY THE STEM NEMATODE. Nev. Agr. Expt. Sta., Tech. B. 210, 8 pp. 1959.

The extent of damage to alfalfa by the stem nematode was determined in the field plots at Reno, Nevada. The susceptible variety, Ranger, and the resistant variety, Lahontan, were grown in two sets of plots. The stem nematode was present in one set and absent from the other. In the absence of the stem nematode, Lahontan produced an annual average of 0.37 ton per acre more oven-dry hay than Ranger, while in the presence of the stem nematode, Lahontan produced an annual average of 1.81 tons per acre more oven-dry hay than Ranger. This is a net average annual reduction of 1.44 tons of oven-dry hay

per acre that can be attributed to damage by the stem nematode, or a total reduction of 7.20 tons for the 5-year period. For a longer period the extent of damage from the stem nematode would be even greater.

CRD, ARS, USDA and Max C. Fleishman Col. Agr., Agr. Expt. Sta., U. Nev., Reno, Nev.

Holt, E. C., Johnson, P. R., Buckingham, M., Hutson, H. C., Crouch, J. K., and Wood. J. R. PASTURE, HAY AND SILAGE CROPS FOR EAST TEXAS. Tex. Agr. Expt. Sta. B. 893, 26 pp. 1958.

The East Texas Timberlands area has a warm, temperate and humid climate with an average annual rainfall of 35 to 50 inches and 234 to 266 days of growing weather. From the standpoint of productivity and the need for conservation practices, the area is well suited to pasture and livestock production.

A wide range of annual and perennial crops are adapted to the area. Winter pasture crops primarily are annuals, with the small grains, particularly oats and rye, being the best producers. Mustang and Alamo oats and Abruzzi rye and Golidad barley are among the best small grain varieties. A rotation grazing system whereby parts of the pasture are rested 3 to 4 weeks between grazings increases total production and lengthens the period of production.

Annual grasses, such as fescue and ryegrass, make good winter pasture, producing 2,000 to 5,000 pounds of forage per acre, and have the advantage of reseeding themselves. Crimson clover, vetch and winter peas grown in combination with these annual grasses increase total production and the protein content of the forage.

Pearl millet as a summer annual produced more forage in Southeast Texas than Sudangrass, especially on the light, shallow soils low in fertility. Row plantings are suggested where the crop is to be grazed, while broadcast or close-drill plantings are satisfactory if the crop is to be used primarily for hay. Several Sudan varieties give satisfactory performance, including the non-sweet types, Common, Tift, and Piper, and the sweet types, Sweet, Lahoma, and Greenleaf.

Perennial winter grasses, such as fescue, brome, and Hardinggrass, have not been successful in the area.

Bermuda and Dallis are the most important perennial grasses in the area. Coastal is superior to Common Bermuda in yield, drouth tolerance and growth type. The longer internode length and more upright growth of Coastal make it ideally suited for hay production. Dallis is an important grass, especially on heavier soils and in the lower sites and usually grows in association with Common Bermuda. Annual legumes in combination with permanent grasses, especially Bermuda, lengthen the season and increase total production. White clover is one of the best legumes for pastures because it will reseed under grazing, has a long growing season and has less smothering effect on the permanent grass than many of the legumes.

Perennial summer grasses respond to fertilizer applications. Increased yields are obtained with 90 to 120 pounds of nitrogen, the amount depending on the availability of soil moisture. Phosphorus and potassium are necessary for good pasture production and applications should be based on results of soil tests. Cultivation of permanent grasses has not been beneficial.

Annual grasses, Coastal Bermuda, improved pastures and native meadows can be used for hay. Annual grasses produce high yields, but the hay generally is coarse and tends toward stemminess. Coastal Bermuda makes good quality hay, and yields are high under proper fertilization. Yields of 7 to 12 tons per acre are reported with 400 to 800 pounds of nitrogen and adequate moisture. Hay or silage should be harvested from improved pastures in periods of excess growth. Deferring grazing in some pastures increased the harvested yield. Native meadow hay yields of 2 to 2 1/2 tons per acre are reported from Tyler with good fertilization. Where fertilized and harvested in the proper stage, native meadows produce good quality hay. Corn produces good yields of high quality silage in most years. The higher-yielding sorghum varieties generally produce more silage than corn. The choice of a sorghum variety should be determined by the length of growing season or planting date and harvesting equipment. Varieties such as Red Top, Sumac and Hegari will mature in 70 to 75 days, Atlas in 80 to 90 days, Honey and Tracy

in 100 to 120 days and Sart and Hodo in 130 to 150 days. Honey, Tracy, Sart, and Hodo may reach a height of 10 to 12 feet and require auxiliary powered equipment for harvesting. Yields vary widely, depending on climatic conditions, soil fertility and variety. Row seedings for silage produce as much as broadcast seedings and are easier to harvest.

Texas Agr. Expt. Sta., College Station, Tex.

Porter, R. M., and Skaggs, S. R. FORAGE AND MILK YIELDS FROM ALFALFA UNDER THREE DIFFERENT HARVESTING SYSTEMS. N. Mex. Agr. Expt. Sta. B. 421, 9 pp. 1958.

Total forage yields from alfalfa harvested with modern field chopping machinery were greater by over 10 percent than when the crop was grazed. Unless careful grazing control is practiced, the difference would be much greater. Grazing cows can never be expected to harvest a forage crop without some loss from trampling and soiling.

The California System of controlled grazing, where the herd is confined to an area just large enough to furnish adequate feed each day, keeps forage loss at a minimum. This system also maintains milk flow at a more even level from day to day than a less intensive system of grazing where cows are allowed to remain on a larger pasture for several days. Even though forage yields are greater with mechanical harvesting than under grazing, total milk production cannot be expected to be proportionately higher. The portion of the alfalfa plant refused by cows consists largely of the lower stem. The grazing cow appears to produce more milk for the amount of feed consumed than cows fed the whole chopped alfalfa plant, either fresh or ensiled.

This experiment indicated that danger of bloat from grazing alfalfa can be greatly lessened by feeding some dry roughage to grazing cows while on pasture. Oats hay, cottonseed hulls, and dry alfalfa hay were all used in this experiment, and no bloat occurred either in grazing cows or in drylot cows fed green-chopped alfalfa. Dry roughage fed to cows receiving large amounts of succulent forage results in an increased intake of digestible nutrients.

This experiment clearly shows the economy of grazing compared to machine-harvesting alfalfa. The saving in labor when the crop is grazed results in milk produced more economically under this system. The investment necessary to secure proper machinery for chopping and handling green-chop forage makes this system far too costly for the small dairy operator. Only where the dairy operation is on a large scale and pasturing cannot be practiced satisfactorily does it appear that machine harvested forage crops might be economical. The heavy investment in machinery and the extra labor required would make maximum use of the equipment necessary to justify this system.

Good quality alfalfa silage appears to be a very satisfactory feed for dairy cows. If alfalfa is not protected by sufficient preservative, the resulting silage may be unpalatable. Ground grain added to the fresh-chopped alfalfa along with sodium metabisulfite produced superior quality silage, in 1956.

Agr. Expt. Sta., N. Mex. State U., State College, N. Mex.

Rorholm, N., Montville, F. E., and Bond, G. E. SOILAGE--WILL IT PAY FOR ME? R. I. Agr. Expt. Sta. B. 346, 15 pp. 1959.

Research has indicated that it is possible to harvest more usable forage per acre if a given crop is cut and fed green to the cows (soilage) rather than being pastured with little or no farm labor and equipment cost. Research carried on from 1954 thru 1956 indicates that cows fed soilage from fields of ladino-grass mixtures needed 0.95 acres per cow during a 150-day summer feeding period. Cows pastured on other parts of the same fields needed 1.34 acres per cow.

Acreage required per cow for soilage feeding on any one farm will depend on forage yield. Experimental fields had an average hay yield of 2.1 tons per acre.

In most cases it would be difficult, if not impossible, to set aside a given acreage and plan to use it exclusively for soilage. Typically, the result of this type of management would be an abundance of forage at certain times and a shortage at other times during the summer. By coordinating soilage with other forage harvesting activities on several fields, it is possible to feed uniform amounts without having to cut material which is too mature or too short.

Cows may be started on permanent pasture land in the spring or possibly on some rye, or wheat and vetch. As legume mixtures progress to the stage where it would pay to cut them, cows are shifted over on soilage. Later, it may be desirable to cut remaining legume stands for silage or hay to prevent them from becoming too coarse. If the field that was cut first is not yet ready for soilage, permanent pasture may fill the gap. Oats seeded as a companion crop provides a good soilage feed if not cut too late. Sudan grass is a good reserve for late July or August.

TABLE 1.--Estimated Acres Required to Soilage Feed Dairy Herds during 150 Day Summer Feeding Period at Specified Yields.

| Hay Yield Per Acre (tons) | Acres Required to feed 146 lbs. of Green Forage per Cow Daily to: Number of Cows | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 50 | 75 |
| 1.0 | 19.9 | 29.8 | 39.8 | 49.8 | 59.7 | 69.6 | 79.6 | 99.5 | 149.2 |
| 1.2 | 16.6 | 24.9 | 33.2 | 41.5 | 49.8 | 58.1 | 66.4 | 83.0 | 124.5 |
| 1.4 | 14.2 | 21.3 | 28.4 | 35.5 | 42.6 | 49.7 | 56.8 | 71.0 | 106.5 |
| 1.6 | 12.4 | 18.6 | 24.8 | 31.0 | 37.2 | 43.4 | 49.6 | 62.0 | 93.0 |
| 1.8 | 11.0 | 16.5 | 22.0 | 27.5 | 33.0 | 38.5 | 44.0 | 55.0 | 82.5 |
| 2.0 | 9.9 | 14.8 | 19.8 | 24.8 | 29.7 | 34.6 | 39.6 | 49.5 | 74.2 |
| 2.2 | 9.0 | 13.5 | 18.0 | 22.5 | 27.0 | 31.5 | 36.0 | 45.0 | 67.5 |
| 2.4 | 8.3 | 12.4 | 16.6 | 20.8 | 24.9 | 29.0 | 33.2 | 41.5 | 62.2 |
| 2.6 | 7.6 | 11.4 | 15.2 | 19.0 | 22.8 | 26.6 | 30.4 | 38.0 | 57.0 |
| 2.8 | 7.1 | 10.6 | 14.2 | 17.8 | 21.3 | 24.8 | 28.4 | 35.5 | 53.2 |
| 3.0 | 6.6 | 9.9 | 13.2 | 16.5 | 19.8 | 23.1 | 26.4 | 33.0 | 49.5 |
| 3.2 | 6.2 | 9.3 | 12.4 | 15.5 | 18.6 | 21.7 | 24.8 | 31.0 | 46.5 |
| 3.4 | 5.8 | 8.7 | 11.6 | 14.5 | 17.4 | 20.3 | 23.2 | 29.0 | 43.5 |
| 3.6 | 5.5 | 8.2 | 11.0 | 13.8 | 16.5 | 19.2 | 22.0 | 27.5 | 41.2 |
| 3.8 | 5.2 | 7.8 | 10.4 | 13.0 | 15.6 | 18.2 | 20.8 | 26.0 | 39.0 |
| 4.0 | 5.0 | 7.5 | 10.0 | 12.5 | 15.0 | 17.5 | 20.0 | 25.0 | 37.5 |
| 4.2 | 4.7 | 7.0 | 9.4 | 11.8 | 14.1 | 16.4 | 18.8 | 23.5 | 35.0 |
| 4.4 | 4.5 | 6.8 | 9.0 | 11.2 | 13.5 | 15.8 | 18.0 | 22.5 | 33.8 |

TABLE 2.--Estimated Labor Requirements for Chopping, Hauling and Feeding Green Chopped Forage by Size of Herd and Distance to Field.

| Distance to Field (miles) | Total Hours Required for Feeding Soilage Twice Daily to: Number of Cows | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 50 | 75 |
| 0.2 | 0.87 | 1.09 | 1.31 | 1.53 | 1.75 | 1.96 | 2.18 | 2.62 | 3.72 |
| 0.4 | 0.94 | 1.16 | 1.38 | 1.60 | 1.82 | 2.04 | 2.26 | 2.69 | 3.79 |
| 0.6 | 1.01 | 1.23 | 1.45 | 1.67 | 1.89 | 2.11 | 2.33 | 2.77 | 3.86 |
| 0.8 | 1.09 | 1.30 | 1.52 | 1.74 | 1.96 | 2.18 | 2.40 | 2.84 | 3.93 |
| 1.0 | 1.16 | 1.38 | 1.60 | 1.82 | 2.23 | 2.25 | 2.47 | 2.91 | 4.00 |
| 1.5 | 1.34 | 1.56 | 1.78 | 2.00 | 2.21 | 2.43 | 2.65 | 3.09 | 4.18 |
| 2.0 | 1.52 | 1.74 | 1.96 | 2.18 | 2.39 | 2.61 | 2.83 | 3.27 | 4.36 |
| 2.5 | 1.70 | 1.92 | 2.14 | 2.36 | 2.57 | 2.79 | 3.01 | 3.45 | 4.54 |
| 3.0 | 1.88 | 2.10 | 2.32 | 2.54 | 2.75 | 2.97 | 3.19 | 3.63 | 4.72 |
| 3.5 | 2.06 | 2.28 | 2.50 | 2.71 | 2.93 | 3.15 | 3.37 | 3.81 | 4.90 |

Agr. Expt. Sta., U. R. I., Kingston, R. I.

Archibald, J. G., Fenner, H., Kuzmeski, J. W., Owen, D. F. Jr., Drake, M., and Vengris, J. FORAGE TYPES FOR MILK PRODUCTION. Mass. Agr. Expt. Sta. B. 510, 22 pp. 1959.

Two types of forage, legume-grass hay designated as hay #1 and mixed grass hay designated as hay #2, have been compared for milk production over a 3-year period, using each year 16 pure-bred or high-grade Holstein cows of approximately 10,000 lbs. potential annual milk yield.

Cows were fed individually and were machine-milked twice daily. Hay was fed at the rate of 2 1/2 lbs. per 100 lbs. live weight during the first two years and 3 lbs. per 100 in the third year. No grain was fed.

Milk production on the two hay types was identical on the basis of 4% fat-corrected milk produced per lb. of dry matter eaten. Fat test was almost identical, and there were no significant differences in persistency of milk flow, in average efficiency, or in digestibility of dry matter, protein, crude fiber, nitrogen-free extract, or total energy.

The cows lost a very small amount of body weight on hay type #1, and gained considerably on hay type #2. Breeding performance was very good and substantially the same in both cases.

Correlation studies showed that crude fiber (in a negative sense) is still the best criterion of the value of hay for milk production. The relatively higher protein content of hay type #1 is accompanied by a relatively high fiber content; the initial stimulus to milk secretion noted when this type of hay was fed had largely disappeared by the time the feeding periods were half over, presumably due to the extra energy needed to digest the higher and more lignified fiber content.

A study of efficiency of the individual animals based on amount of milk solids produced per pound of dry matter consumed, showed some rather striking differences. The best cow in this respect was more than 14 percent efficient, while the poorest was less than 5 percent efficient. The high producing cows in these trials did as well on mixed grass hay as they did on legume-grass hay (predominantly alfalfa-brome grass or alfalfa-orchard grass).

U. Mass., Col. Agr., Agr. Expt. Sta., Amherst, Mass.

Rauzi, F., Lang, R., and Barnes, O. K. DUAL-PURPOSE PASTURES FOR THE SHORTGRASS PLAINS. U. Wyo. Agr. Expt. Sta. B. 359, 16 pp. 1958.

Five 4-acre pastures were fenced and seeded at the Archer, Wyoming, Substation in the spring of 1950 on Altvan vfsl. The results of this 5-year study show the following:

1. The intermediate wheatgrass-alfalfa pasture produced an average of 3.6 lbs. more lamb gain per acre than the pasture seeded with intermediate wheatgrass alone.
2. Intermediate wheatgrass and pubescent wheatgrass grown with alfalfa did not maintain their stands as well as did crested wheatgrass seeded with alfalfa.
3. Russian wildrye grass competed with the alfalfa in the mixture, and the alfalfa stand started to thin out in the second year after planting. By the end of the 5-year study period very little alfalfa remained in the stand. Lamb gains per head from the pasture seeded with Russian wildrye and alfalfa were significantly higher than those obtained from native check pasture. This pasture also produced the highest grazing capacity of any pasture studied.
4. The pasture seeded with pubescent wheatgrass and alfalfa was mostly alfalfa after the third year. This pasture produced higher lamb gains per head and per acre than did any of the other pastures. This can be attributed to the presence of a large amount of alfalfa in the pasture. Lamb gain per head from this pasture was significantly greater than the gains per head from the native range or the crested wheatgrass-alfalfa pasture. Hay yields from the pasture seeded with pubescent wheatgrass and alfalfa were significantly greater than hay yields from the Russian wildrye grass-alfalfa pasture.

5. The crested wheatgrass-alfalfa pasture maintained a good stand over the five-year study period. Hay yields averaged 655 lbs. per acre, which was significantly higher than the yields from either the Russian wildryegrass-alfalfa pasture or the pasture seeded to intermediate wheatgrass alone. Lamb gains per head and per acre from this pasture were not statistically different from those obtained from the other pastures including the native pasture.
6. Lamb gain per head from the native range was significantly lower than gain per head from any of the seeded pastures except the pastures seeded with intermediate wheatgrass alone and the pasture seeded with crested wheatgrass and alfalfa.
7. The major changes in plant composition of the seeded pastures were the decrease in alfalfa stand in the Russian wildrye-alfalfa pasture and the increase in the amount of alfalfa in the other three pastures. Forbs severely invaded all the pastures except the Russian wildrye-alfalfa and the crested wheatgrass-alfalfa pastures.
8. Protein analyses showed that the grass in the intermediate wheatgrass-alfalfa pasture had a higher protein content for the three years at the three dates of sampling than did any of the other grasses.
9. Protein content of the alfalfa was almost identical within pastures throughout the three-year period.

SWCRD, ARS, USDA and U. Wyo. Agr. Expt. Sta., Laramie, Wyo.

McKibben, G. E., Gard, L. E., Webb, R. J., Cate, H. A., and Jones, B. A. Jr. EXPERIMENTAL IRRIGATION OF LADINO CLOVER-GRASS PASTURE. Ill. Agr. Expt. Sta. B. 640, 30 pp. 1959.

A study of pasture irrigation was conducted in southern Illinois from 1948 to 1954. Its objectives were: (1) To determine the most effective amount of water and the frequency of application; (2) to find the best fertilizer treatment with irrigation from an economical point of view; and (3) study the effect of irrigation on available soil moisture, plant growth and animal gains, and species of pasture plants.

The rainfall from May through October during the 7-year experimental period was typical for the area. The rainfall was above normal for 3 years, normal for 1 year, and below normal for 3 years. The variations ranged from 6.02 inches above to 9.13 inches below the 55-year average rainfall for the area.

Two 5-acre fields were studied--one field was irrigated, and the other was a check field. To determine the effectiveness of different amounts of irrigation, the irrigated field was divided for the 1948 season. One-half of the field received 1-inch applications of water, and the other half received 2-inch applications. Soil-moisture measurements showed that the 2-inch application was more effective in changing soil moisture, particularly at the lower depths. The cost was also less per acre-inch of water applied. For these reasons, only 2-inch applications were used after the 1948 season.

Since grass-legume pasture mixtures have a long growing season, they require large quantities of water. During the 7 years of this experiment, the fields received an average of 34.25 inches of water each year (20.54 inches of rainfall and 13.71 inches of irrigation water). The total rainfall plus irrigation for June, July, and August averaged 3.23 inches for a 2-week period for 7.08 inches per month.

The fields were divided into 7 plots to study the effects of various combinations of fertilizers. Rock phosphate, superphosphate, potash, and nitrogen were added in various combinations to a basic treatment of limestone and rock phosphate. Limestone, rock phosphate and superphosphate, and potash proved to be the most economical soil treatment per ton of dry matter produced on the irrigated field. Commercial nitrogen had little effect on the yield from the irrigated plots. Superphosphate was effective when added to rock phosphate on the irrigated plots. A comparison of irrigated and nonirrigated plots with various combinations of fertilizers points up the importance of an adequate fertility program.

The dry matter produced on the irrigated field averaged 1 1/4 tons per acre per year more than that produced on the nonirrigated field. A comparison of the yields from the most responsive fertilizer-treatment plots shows an average annual increase in dry matter produced for irrigation of approximately 0.85 ton per acre. The animal carrying

capacity was 71 percent higher on the irrigated field than on the nonirrigated field--an average increase of 111 animal-unit days per acre.

The 7-unit rotation grazing system was more efficient in producing animal gain than the continuous grazing system. When cattle were changed from a continuous to a rotational grazing system, the dry matter consumed to produce a pound of animal gain dropped from 32.42 to 14.06 on the irrigated field, and from 38.75 to 13.14 on the nonirrigated field.

The legumes in a legume-grass pasture produce more than 50 percent of the forage during the summer. Irrigation was effective in maintaining legumes as 23 percent of the ground cover during the last year of the project. All of the legumes died on the nonirrigated field.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

Heinemann, W. W., and Van Keuren, R. W. FATTENING STEERS ON IRRIGATED PASTURES. Wash. Agri. Expt. Sta. B. 578, 16 pp. 1958.

Yearling beef steers were used to compare four grass-legume mixtures and two pure grass stands as pasture. The results of three years' grazing were:

1. Highest beef yields per acre were obtained from the grass-legume mixtures. The highest single year's production, 1,172 pounds of beef per acre, was on orchardgrass-Ladino clover the first year after the pastures were established. Orchardgrass-alfalfa, which had a 3-year average of 937 pounds of beef per acre, had the highest sustained yield.
2. Average daily gains were consistently higher on the grass-legume pastures. The 3-year averages were 2.07 pounds for grass-alfalfa and 1.74 pounds for the grasses. Two-year averages were 2.16 pounds for grass-alfalfa, 2.29 pounds for grass-Ladino clover, and 1.84 pounds for the grasses.
3. A higher degree of finish was attained by the cattle that grazed the grass-legume pastures. The difference was at least 1/2 grade higher than the grass cattle.
4. Beef production, as measured at 3-week intervals remained higher throughout the season for the grass-legume pastures than for the grass pastures. Thus the high rates and frequent nitrogen fertilizer applications to the grasses did not give as high beef production as the combination of a legume with a grass.
5. Bloat was not an important factor on the grass-legume pastures except the first year.
6. Greatest dollar returns per acre were obtained from the grass-legume pastures. These pastures yielded more than twice the returns of the grass pastures.

Wash. Agr. Expt. Sta., Inst. Agr. Sci., Wash. State U., Pullman, Wash.

Robertson, J. H., Jensen, E. H., Petersen, R. K., Cords, H. P., and Kinsinger, F. R. FORAGE GRASS PERFORMANCE UNDER IRRIGATION IN NEVADA. Nev. Agr. Expt. Sta. B. 196, 35 pp. 1958.

Experiments involving 53 grass varieties were begun at Reno in 1949. The work was in four progressive phases: (1) Replicated trials at each of three climatically different locations to determine the relative yield, earliness, and recovery when grown under differing environments; (2) feeding and grazing trials to determine relative palatability of hay and/or pasture; (3) fertility trials to determine responses to nitrogen; and (4) a study of the effects of the different grasses on soil properties and subsequent crop yields.

No yields were taken after the fifth year because many of the plots became infested with other species, principally Kentucky bluegrass.

Tall wheatgrass and intermediate wheatgrass yielded well at all locations. A number of species showed different responses to their environment.

The palatability trials confirmed previous impressions, e. g. tall fescue has relatively low palatability as pasture, while such fine-leaved species as red fescue rank high in this respect.

Fertilizer trials showed that most of the cool-season grasses responded well but not the same to nitrogen applications. Differences in response were noted even among varieties of the same species.

Results of the studies on effects of the grasses on soil properties were inconclusive. A discussion of the various grasses is given, including the results of these experiments, and other known information concerning them.

Max. C. Fleishmann Col. of Agr., Agr. Expt. Sta. Nev., Reno, Nev.

Wilson, M. L., Chang, C. W., and Watson, C. E. EFFECTS OF FERTILIZATION ON IRRIGATED PASTURES. N. Mex. Agr. Expt. Sta. B. 439, 38 pp. 1959.

Fertilizer trials on irrigated pastures conducted at New Mexico State University during the 1951, 1952, 1953, and 1954 seasons gave the following results:

1. Phosphorus, when used alone, increased the total yield over the check plots and those receiving only nitrogen. Ladino clover showed a much greater response to this element than did Alta fescue. Each additional increment of phosphorus gave an increase in clover yield.
2. Nitrogen, when used alone, gave less total yield than plots receiving corresponding rates of phosphorus or phosphorus and nitrogen. Alta fescue showed a very definite response to nitrogen fertilization, but nitrogen caused a reduction in clover yield.
3. Phosphorus and nitrogen used in combination affected both the clover and the grass component in the mixture. In most cases, additional increments of these elements gave an increase in yield for both the grass and clover. A good balance of grass and clover was maintained for the 3-year period.
4. Variable rates of nitrogen with phosphorus held constant at 75 pounds per acre annually affected the botanical composition. Each additional increment of nitrogen gave an increase in the grass percentage and a corresponding decrease in the clover percentage. There was no significant difference in total yields.
5. Phosphatic fertilizer, when used alone, increased the percentage of crude protein, calcium, phosphorus, and molybdenum, but decreased the percentage of ash, crude fiber, and ether extract in the forage.
6. Nitrogen fertilizer, when used alone, reduced the percentage of crude protein, calcium, phosphorus, and molybdenum, but increased the percentage of ash, crude fiber, and ether extract in the forage mixture. Results on the separates of grass and legume, however, showed that nitrogen fertilization had a tendency to decrease crude fiber and increase crude protein percentages of both grass and legume.
7. Consideration of the plant-phosphorus level in relation to individual fertilizer treatment, soil analysis, and forage yield, would lead one to suggest that, if the phosphorus content of the forage mixture is below 2 percent, the yield may be expected to respond to phosphatic fertilizer treatment.
8. In general, repetition of fertilizer treatments for three to four years had little or no effect on soil properties, including pH values, soluble salts, organic matter, and available phosphate. The available nitrate, however, tended to increase with the amount of nitrogen applied, provided phosphate fertilization was concurrently applied. Continuous production of pasture crops appeared to have increased the organic matter content of the soil over that of the clean-cultivated fields.
9. Except in the case of calcium, the selection of fertilizer treatments and cultural methods, within the range tested, may be guided by maximum yield and desirable botanical composition instead of chemical composition of the forage.

Agr. Expt. Sta., N. Mex. State U., State College, N. Mex.

Hay, J. R., and Ouellette, G. J. THE ROLE OF FERTILIZER AND 2,4-D IN THE CONTROL OF PASTURE WEEDS. Canad. J. Plant Sci. 39: 278-283. 1959.

A study was made of: (1) The response of some pasture weeds of Eastern Canada when fertilizers were applied; (2) the productivity of pastures sprayed with 2,4-D; and (3) the over-all response when both fertilizer and 2,4-D were applied. Populations of orange, yellow and mouse-ear hawkweeds, ox-eye daisy, chicory, bugleweed, strawberry, and wild carrot were decreased when nutrients were added but the numbers of dandelion, Canada thistle, tall buttercup, shore horsetail, and yarrow were unchanged. Fertilizer not only improved the quantity but also the quality of the forage by reducing the

weed content. Yield of total vegetation was not increased when weeds were controlled by 2,4-D but the forage consisted almost exclusively of desirable grasses. Best results from the standpoint of both yield and absence of weeds were obtained when fertilizer treatment was supplemented by applications of 2,4-D.

Cent. Expt. Farm, Ottawa, Ontario, Canada.

O'Dell, B. L., Regan, W. O., and Beach, T. J. A STUDY OF THE TOXIC PRINCIPLE IN RED CLOVER. Mo. Agr. Expt. Sta. Res. B. 702, 12 pp. 1959.

Second-cutting red clover hay occasionally contains a toxic factor which causes cattle and sheep to slobber and go off feed. Other symptoms of toxicity such as diarrhea, bloat, stiff joints, and even death have been observed on Missouri farms.

A knowledge of its chemical nature should prove helpful in determining the reason for its occurrence and how to prevent it. A guinea pig assay for the toxic factor has been developed and used to aid in detection of toxic hay.

Although hay cut from small grain stubble is the most common source of trouble, the toxin is associated with the red clover portion. The toxic hays do not contain a high concentration of saponins, as estimated by the usual saponin tests. The toxic principle is soluble in, and can be extracted from the hay with, water, ethyl alcohol, and chloroform. It is organic in nature and it slowly loses activity while in solution.

U. Mo., Col. Agr., Agr. Expt. Sta., Columbia, Mo.

## Rangelands

Darrow, R. A., and McCully, W. G. BRUSH CONTROL AND RANGE IMPROVEMENT: IN THE POST OAK-BLACKJACK OAK AREA OF TEXAS. Tex. Agr. Expt. Sta. B. 942, 16 pp. 1959.

Significant increases in forage and livestock production are possible in the post oak-blackjack oak area of Texas by integrating, brush control into a range management program. The acreage occupied by post oak-blackjack oak in the East and West Cross Timbers, the Central Basin and the East Texas post oak belt, a portion of the East Texas timberlands, is slightly greater than 11 million acres.

Methods and costs of treatment by various mechanical, chemical, burning, and grazing practices are described for the control of oak and associated species. Mechanical practices suitable for small areas include girdling, cutting, and mowing; for large areas, chaining is effective provided sprout growth can be controlled. Bulldozing is effective in medium-textured soils in upland sites or in bottomlands preparatory to establishment of pastures.

Recommended individual plant treatments with herbicides include basal truck spray, stump spray, frill spray, truck injection, and soil injection. Oil solutions of 2,4,5-T ester are effective for all individual plant treatments. Water suspensions of monuron or fenuron may be used in the soil injection method. Ammate as crystals or in solution may be applied to freshly cut stumps, cups or notches, and in frills.

Broadcast applications of herbicides for oak control include foliage or aerial spraying with 2,4,5-T or silvex esters and soil surface application of fenuron pellets. The 2-year aerial spray program is recommended for large-scale treatment of areas lacking crops susceptible to hormone-type herbicides. Fenuron pellets are adapted for oak control on sandy textured soil on areas with crop hazards which prohibit the use of hormone-type sprays.

Goat grazing is an effective and economical method of sprout and underbrush control on cleared areas with suitable fencing and other facilities.

Under proper management, reduction in the woody plant cover in the post oak-blackjack oak area will result in marked increases in forage production within 2 to 3 years following control. Overstory removal on a range with good cover resulted in a five to six-fold increase in total herbage production in 2 years. Costs of treatment amounting to $27.23 per acre were paid off in slightly more than 4 years on the basis of hay production.

Broadcast chemical control treatments such as aerial spraying give the additional benefit of weed control and reduced competition with forage grasses.

Tex. Agr. Expt. Sta., Tex. Agr. Ext. Serv., College Station, Tex.

Kennerly, A. B. GOATS COMBINE WITH SCIENCE IN WAR ON OBNOXIOUS PLANTS. Land Impr. 6(11): 13. 1959.

A new method of controlling the vast acreages of post oak, blackjack oak, and winged elm growing on upland sandy or sandy loam soil is by the use of 16 pounds of pellets to the acre with 25 percent fenuron as the active plant killer.

Fenuron pellets are applied broadcast to the soil surface. The chemical fenuron is leached into the soil by rain where it is taken up by the roots of the treated plants.

Much care must be used to prevent too high a dosage since it acts as a soil sterilant at high rates of application. When applying the chemical at rates that will control the oak, it is not harmful to livestock. Neither are desirable perennial grasses harmed, but annual weeds and grasses may be injured.

Since the fenuron pellets are most effective when oaks are actively absorbing water from the soil, the season of the year is important in its application. Spring and early summer is the best period and summer applications are not effective even if considerable rainfall is received.

Aerial equipment can be contracted for large acreages. Small areas can be treated by hand-broadcasting the pellets or by using a small grass seeder to scatter them. In applying the pellets by aerial equipment, they offer an advantage over sprays. Pellets do not have aerial drift habits and small amounts of drifted dusts on plant leaves are not damaging. Some places where fenuron pellets are not recommended are on clay-type soils, areas which are likely to contain roots of desirable plants, steep slopes where it might wash into areas where trees are desired, and in pine-hardwood mixtures.

Angora goats can be used to good advantage where fenuron pellets have been used to kill post oaks. Haw, greenbrier, and Spanish mulberry which commonly grow in post oak woods are not affected by fenuron. Goats can browse this growth to control them and they do a good job of it. Oaks do not resprout once they are killed with fenuron pellets.

Texas A and M., College Station, Tex.

Fisher, C. E., Meadors, C. H., Behrens, R., Robinson, E. D., Marion, P. T., and Morton, H. L. CONTROL OF MESQUITE ON GRAZING LANDS. Tex. Agr. Expt. Sta. B. 935, 24 pp. 1959.

Mesquite is an aggressive, deep-rooted, undesirable woody, sprouting shrub that occurs on approximately 55 million acres of grazing lands in Texas.

Economical control of mesquite on grazing lands depends largely on the selection of methods that will provide the greatest sustained benefits for the money expended. Where mesquite thrives, no single method or practice will give effective and economical control under widely varying conditions. Good range and livestock management are essential to obtain maximum benefits from the control of mesquite. The chief value of controlling mesquite is to increase the density, vigor, and production of palatable range forage species.

This bulletin discusses some of the factors that influence the effectiveness and cost of controlling individual plants, in thin, open stands by hand or power grubbing; oiling with kerosene and diesel fuel and basal application of 2, 4, 5-T and soil application of monuron.

Factors that influence the effectiveness and cost of controlling moderate to dense stands by chaining and cabling, use of heavy-duty brush cutters, root plowing, and aerial application of 2, 4, 5-T are enumerated.

The benefits of mesquite control include increased carrying capacity of the grazing lands, reduced cost of handling livestock, and more efficient use of other range improvement practices.

Reinfestation of grazing lands by mesquite is aided by the dissemination of large numbers of viable seed by cattle, horses, sheep, and rodents, the apparent lack of palati-

bility of mesquite foliage to most grazing animals and the failure to maintain a heavy competitive cover of perennial grasses because of overgrazing, drouth, and other factors.

The values of mesquite are limited largely to utilization of the beans by grazing animals. Some use also is made of the wood for fuel, fence posts, and a source of roughage for feeding livestock.

CRD, ARS, USDA and Texas Agr. Expt. Sta., College Station, Tex.

Cook, C. W. SAGEBRUSH ERADICATION AND BROADCAST SEEDING. Utah Agr. Expt. Sta. B. 404, 23 pp. 1958.

A seeding study was made on foothill ranges at Benmore and Tintic Valley experimental areas in central Utah from 1947 to 1956, to determine the effect of sagebrush removal and broadcast planting on seedling establishment and production of four introduced wheatgrasses, namely: (1) Crested (Agropyron desertorum); (2) intermediate (Agropyron desertorum); (3) pubescent (Agropyron trichophorum); and (4) tall (Agropyron elongatum). The species were broadcast seeded before and after sagebrush removal during spring and fall seasons of the year.

On both study areas plowing, in most cases, produced better wheatgrass stands and more forage than other methods. Plowing, except for burning, was the most effective method for eradicating sagebrush. However, the percent reinvasion of brush was somewhat greater on plowed areas than on areas where sagebrush was eradicated by other methods.

Fall seeding and eradication of sagebrush, in the majority of the cases, was more favorable for establishment of seeded stands of wheatgrass than was spring seeding and brush removal. Likewise, better kill of sagebrush was obtained from fall eradication compared to spring eradication. However, in many cases a high percentage of reinvasion occurred on areas where sagebrush was eradicated during the fall. Broadcast seeding before sagebrush removal generally was a more satisfactory method of seeding than was seeding after removal. However, broadcast seeding after brush removal was substantially better when carried out in the fall than in the spring. This was especially true when the sagebrush was eradicated by plowing. There was some indication that wheatgrass species with larger seed produced better stand than species with smaller seed when broadcast before sagebrush removal by plowing.

In some cases, stands were considered satisfactory when the seed was planted before brush removal by plowing, blading, harrowing, or railing when operations were carried out during the fall.

On both study areas, crested and pubescent wheatgrass produced more forage than intermediate and tall wheatgrass in all treatments.

Pubescent wheatgrass showed marked increase in number of plants per plot from the first to the seventh and ninth growing season; intermediate and crested wheatgrass showed a definite decrease. Rabbits were observed to prefer intermediate wheatgrass to other wheatgrasses.

Regression coefficients showed that for each increase of one percent in sagebrush cover, there was a decrease of 8.6 pounds of forage per acre, and for every increased sagebrush plant per 50-foot of line transect, there was a decrease of 6.3 pounds of forage per acre.

Utah State U., Logan Agr. Expt. Sta., Logan, Utah.

Morton, H. L., Haas, R. H., and Erickson, L. C. HALOGETON AND ITS CONTROL. Idaho Agr. Expt. Sta. B. 307, 24 pp. 1959.

Halogeton (Halogeton glomeratus) was recognized as a serious problem in Idaho in the fall of 1945, when about 1,620 sheep were poisoned in a single day near Bridge, Idaho.

It is estimated that halogeton now infests about 10.5 million acres in the western states and about 605,000 acres in Idaho. The primary infestations are found on saline, depleted desert shrub type land, but the weed is also found competing in crested wheatgrass (Agropyron desertorum) seedlings and in alternate wheatfallow fields. Here it competes for space, nutrients, and moisture, and creates a serious problem in range maintenance and livestock production.

The growth habits, the soil, and climatic requirements of this annual poisonous weed are such that several million acres in Idaho lie open to its invasion. Any plant having such characteristics can seriously interfere with normal ranch operations and the continuity of a sustained livestock industry. A discussion of the problem and the results of 7 years of research studies on this plant and its control are given in this publication.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

Gilkey, H. M. LIVESTOCK-POISONING WEEDS OF OREGON. Oreg. Agr. Expt. Sta. B. 564, 74 pp. 1959.

Yearly livestock losses from plant poisoning in the United States amount to many millions of dollars. Although the annual toll from this cause in Oregon is not spectacular, its increase in recent years is justification for calling attention to the better known toxic plants.

Some plants are toxic at only certain seasons of the year. In others, conditions not readily understood may modify the toxicity of individual plants of the same species. Many species which appear harmless if grazed casually in good pasture, may prove poisonous when taken alone or in quantity.

It is probable that when good forage is available, animals do not normally graze poisonous plants to the point where such plants would harm them. Overgrazing not only reduces the natural food supply but, its destruction of valuable range plants, stimulates the spread of undesirable species. Avoidance of poisoning in pastures and on the ranges appears to lie in wise handling, both of feeding areas and of stock. Infested hay offers a different problem, one perhaps less easily controlled.

Such plants as Larkspur, Death Camas, and Lupine, chemically produce symptoms of violent digestive disturbances which commonly prove fatal. Certain nontoxic species may be responsible for mechanical injury affecting animal health or even causing death. Long-bearded grasses and spiny-surfaced plants are capable of injuring tender mouth parts, nostrils, and eyes. The ensuing sores make feeding difficult, causing the victim to lose weight or even die of starvation. When sores become infected, loss of sight or loss of life may result. Plants with felt-like leaves may cause death by forming hair-balls in the stomach.

The various livestock-poisoning weeds of Oregon are described and illustrated for easy identification.

Agr. Expt. Sta., Oreg. State Col., Corvallis, Oreg.

Duncan, D. A., and Epps, E. A. Jr. MINOR MINERAL ELEMENTS AND OTHER NUTRIENTS ON FOREST RANGES IN CENTRAL LOUISIANA. La. Agr. Expt. Sta. B. 516, 19 pp. 1958.

This study was initiated to determine the amounts of several minor mineral elements in four important forages species native to the longleaf pine-bluestem ranges of Louisiana. Secondary purposes were to see if lack of or abundance of certain elements caused frequent grazing of pine needles, and to substantiate previous findings on the amounts of major elements and crude protein in native forage.

Samples of three grasses (pinehill bluestem, slender bluestem, and narrowleaf panicum), one forb (swamp sunflower), and long-leaf pine needles were collected at three stages of development on two distinct soil types (Beauregard vfsl and Ruston fsl) near Alexandria, Louisiana. All species sampled are common on the upland forest ranges of central and southwestern Louisiana, and with the exception of pine needles are representative of large groups of forage plants.

No important consistent differences were found in nutritive or mineral values of the forage species from the two soil types. No shortages of cobalt, iron, copper, manganese, zinc, molybdenum, magnesium, or sulphur were found in any of the species at any stage of development.

The nutrient analysis of the pine needles revealed no reasons why cattle sometimes browse these trees excessively.

All forage species contain adequate calcium and potassium at all stages of development. In most species phosphorus was deficient at all stages of development. A high-phosphorus supplement should be furnished range cattle at all times.

Generally, the grasses on forest ranges contain inadequate crude protein for breeding herds from midsummer until early spring. A protein supplement should be furnished during the deficient period.

Current practical herd tests in central Louisiana, in which range cattle are given seasonal protein supplements and yearlong bonemeal and salt, indicate that beef production of common cattle grazing yearlong on forest range can be greatly increased without use of minor-mineral supplements.

South. Forest Expt. Sta., FS, USDA and La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Lang, R. L. RANGE-PITTING TRIALS IN THE BIG HORN MOUNTAINS OF WYOMING. Wyo. Agr. Expt. Sta. B. 357, 7 pp. 1959.

In the spring of 1953, range-pitting plots were established on three sites at two locations in the Big Horn Mountains of Wyoming. Site 1 was a sloping-valley area with deep soil, while Sites 2 and 3 were shallow soil areas with south and north-facing slopes respectively.

Crested wheatgrass and Russian wildrye were seeded in one-half of each plot at time of pitting, but no seedlings were established. Apparently the pitting operation did not sufficiently reduce competition from the existing vegetation to allow for seedling establishment.

Leaf-height measurements for the principal grass and grasslike species showed that in every year except the year of treatment, individual plants produced from 30 to 50 percent more height growth on the pitted areas than on non-treated checks. Seedstalk production was observed to be more profuse on the pitted plots.

Rate-of-water-infiltration studies showed a substantially greater water intake for pitted areas. Therefore pitting would be an effective means of water conservation where it could be applied.

Forage production, as measured from clipped plots during the last three years of this 5-year study, was from 32 to 68 percent greater from pitted areas than from non-pitted areas. The difference in favor of pitting was greater on the deep soil site than on the shallow soil sites.

Although much mountain rangeland is too rough, steep, or rocky for pitting, it may be concluded that mountain-range areas similar to those treated in this study could be made much more productive by pitting. In addition, water runoff from high-intensity rains would be reduced because of the water-holding capacity of the pits and a greater rate of water infiltration into the soil.

Agr. Expt. Sta., U. Wyo., Laramie, Wyo.

Selonke, P. THE ROOT PLOW REMAKES SOUTH TEXAS. Land Impr. 6(4): 7-8. 1959.

Root plowing is changing the landscape in South Texas. During the last few years contractors have been plowing big swaths into the 55 million acres of almost impenetrable brush in the state, transforming practically worthless rangeland into highly-productive pastures of blue panicum and buffelgrass.

The farmers have fought the encroachment of mesquite, scrub oak, and other undesirable woody plants, which have been choking out the native grasses so necessary to the cattle business. They tried just about everything from dozing, cabling, chaining, and grubbing to spraying the brush with oils and chemicals. Yet nothing has proved as effective as the present root plow method.

The root plow cannot be used in all areas. But where it is practical, and the rancher follows it with sound range management practices, root plowing can bring astounding increases in cattle carrying capacity. In the last few years around 750,000 acres of brushland have been cleared and reseeded to grass in South Texas by the root plow method.

In the actual clearing and plowing operation, the root plow is attached behind a big heavy dozer that knocks down the brush which in some instances is up to 20 feet high. In turn, the rear-mounted root plow severs the roots of the brush, turns, crumbles and aerates the soil, and in this same operation, it automatically seeds the soil.

Cost of this type of brushland reclamation work is $6 to $12 per acre for root plowing and $2-$3 for reseeding. Ranchers feel that the practice pays off through better beef profits in the following years and in improved efficiency in their over-all operations.

Root plowing and reseeding alone do not bring these results. It takes good management practices, planned grazing and proper stocking, to fit these new pastures into the overall ranch program.

No address given.

Humphrey, R. R. THE DESERT GRASSLAND A HISTORY OF VEGETATIONAL CHANGE AND AN ANALYSIS OF CAUSES. The Bot. Rev. 24: 193-252. Biblio. 1958.

Extensive portions of the desert grassland of southern Arizona, New Mexico, and southwestern Texas have been invaded by woody species. Mesquite, creosote bush, cacti of the genus Opuntia, burroweed, and snakeweed are among the principal invaders. The prime factors commonly believed to have caused this change are reviewed and evaluated. These are (1) change of climate, (2) grazing by domestic livestock, (3) plant competition, (4) rodents, (5) fire. Of these various factors, change of climate seems to have had the least effect. Fires that were formerly frequent and widespread were the chief agency restricting shrub invasion. Since fires have been controlled, the introduction of domestic livestock, plant competition and rodents have been effective agents that have favored woody plants at the expense of grasses. Had fires continued to sweep the grasslands down through the years to the present with their original frequency, the desert grassland would probably occupy about the same area today as it did prior to the white settlement of the Southwest.

Ariz. Agr. Expt. Sta., Tucson, Ariz.

Dyksterhuis, E. J. ECOLOGICAL PRINCIPLES IN RANGE EVALUATION. The Bot. Rev. 24: 253-272. Biblio. 1958.

Acceptable refinements in applied range ecology are dependent upon refinements in range management that are economical and acceptable by stockmen. Modern soil survey information is lacking in many range areas and not all rangemen are able to identify and map soil-groups such as those previously named. Data to properly establish gradients of precipitation and temperature are lacking in many mountainous areas. Many, if not most, ecologic descriptions of vegetation in the literature stress climatic and biotic but not edaphic features and avoid even "metaphysical approximations" of climax communities for various types of sites. Relicts of climax vegetation have not yet been found or reestablished in certain types of sites, making it necessary to assume a climax vegetation for them from established gradation along environmental gradients. Finally, application of ecological principles in range evaluation is limited by the ecological knowledge that professional rangemen have, and that graduates from range curricula are required to have.

SCS, USDA, Lincoln 8, Nebr.

Coupland, R. T. THE EFFECTS OF FLUCTUATIONS IN WEATHER UPON THE GRASSLANDS OF THE GREAT PLAINS. The Bot. Rev. 24: 273-317. Biblio. 1958.

The Mixed Prairie grassland of the Great Plains of North America is subject to great fluctuations in weather. When drought is of sufficient duration to cause the death of native species by desiccation, a considerable modification in the floristic composition of the vegetation results. Some species are able to survive by going into drought dormancy. Reduction in basal cover, height, forage yield, and seed production are characteristic of species undergoing drought conditions, even of short duration, while depth of rooting is reduced during dry periods of longer duration. Some species are adapted in varying

degrees to endure or escape drought by their deep-rooting habit, their short-growing period in the cool part of the year, the ability of their tissues to withstand desiccation (associated with the ability to increase osmotic pressure markedly), and their ability to assume drought dormancy. Some species are able to overcome the effects of drought more rapidly than others. Notable among these is stoloniferous Buchloe dactyloides which is able to re-occupy denuded areas between plants during the first two years following a major drought.

Effects of drought are not limited to those of desiccation where layers of dust are deposited, moisture penetration may be so affected that the habitat is transformed and occupied by other species, particularly Agropyron smithii. Drought is also often accompanied by hordes of grasshoppers which accentuate an already serious shortage of forage for livestock by consuming plant material. The higher temperatures, higher rates of evaporation, and lower relative humidity associated with drought are other factors adding to the desiccation problem.

U. Saskatchewan, Saskatchewan, Saskatoon, , Canada.

Monson, O. W., and Quesenberry, J. R. PUTTING FLOOD WATERS TO WORK ON RANGELANDS. Mont. Agr. Expt. Sta. B. 543, 39 pp. 1958.

Soil erosion has been a prominent agricultural problem during recent years. Under the more humid conditions of the Midwest, thousands of acres of land have been permanently damaged by the washing away of the fertile top soil and the cutting of gullies through valuable land. The solution to this problem in the Midwest where the rainfall is abundant but poorly distributed has been: (1) To check the velocity of flow of runoff water, thereby reducing the erosive action and saving the soil; and (2) to make more receptive to moisture penetration through better cropping and cultural practices, thereby increasing the conservation and use of water and reducing the loss and waste from runoff. In the arid West the conservation of moisture is still more important.

The methods of control, therefore, change from the construction of check dams which merely check or retard the flow of water, to the use of diversion dams which force the water back onto the land. Instead of dikes and ditches which collect surplus water and convey it at a slow velocity from the fields and discharge it into a coulee or stream channel, dikes and ditches are constructed with proper grades to convey flood waters from the coulee out onto the land and spread it out so it can be absorbed by the soil. The emphasis changes from soil conservation to the conservation of water; yet both are accomplished in the same operation.

Two water spreading projects developed on the United States Range Livestock Experiment Station, Miles City, Mont., have recovered flood waters from 8 square miles of watershed and made possible the production of 500 to 600 tons of hay annually in addition to furnishing winter pasture for 500 or more mature beef cows.

In each case the basic principle has been the recovery and conservation of runoff from badly eroded rangeland. The water has been diverted from a channel where active erosion was taking place, and the diverted water has been controlled by means of dikes and ditches in order to spread it over large areas of nearly level or uniformly sloping grassland.

Prolonged ponding or excessive flooding is not recommended because of its bad effect on some of the highly desirable species of grasses such as grama and buffalograss. All grasses do not require heavy irrigation.

The water which collects and drains from the rough broken lands of the range country carries with it tons and tons of silt. When the muddy water is permitted to flow into the rivers it contributes to clogging the channels. This causes overflow and flood damage to the flood plains and lowlands bordering the rivers all the way to the Gulf of Mexico. Through the recovery of the flood water, its by-product, the silt, is also recovered and helps to fertilize the land and produce crops of grass or hay.

Mont. Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

Herbel, C. H., and Anderson, K. L. RESPONSE OF TRUE PRAIRIE VEGETATION ON MAJOR FLINT HILLS RANGE SITES TO GRAZING TREATMENT. Ecol. Monog. 29: 171-186. 1959.

An experimental area was set aside in 1949 to evaluate the response of true prairie vegetation on major Flint Hills range sites to grazing treatment. The grazing treatments compared were heavy, moderate, and light season-long stocking and deferred-rotation stocking at the moderate rate. The results are reported in terms of vegetational responses by range sites. Major emphasis is on species composition and on trends which develop under the different intensities and methods of utilization. Herbage and mulch yields also were studied.

The major factors influencing the changes in plant composition in the trials were the grazing treatments and the changing weather cycle from abundant moisture prior to mid-1951 to drought conditions that prevailed through 1955. However, major differences may be separated. Heavy stocking caused a steady decline in percent of total decreasing species of grasses in all range sites except clay upland. Little bluestem has declined more sharply than the other decreasers under the combined effects of heavy utilization and drought. In clay upland there was a slight increase in the percentage of decreasers in 1955 due largely to the sharp decline in Kentucky bluegrass. In the limestone breaks and clay upland range sites there was a significant decline of decreasers in the moderately stocked pasture because these sites are located near the source of stock water in this pasture and would be overgrazed even under light stocking. The percentage of increasing species of grasses showed a marked rise under close grazing except in 1955. The species most responsible for the change in increasers are sideoats grama, buffalograss, and blue grama.

Uneven distribution of grazing use has resulted in overgrazing of small areas in both the moderately and lightly stocked pastures.

Six years of overgrazing resulted in a decrease in amount of forage produced due to the reduction in vigor of the range plants and a shift to less productive preclimax species.

Moderate season-long stocking resulted in closer use of the forage than occurred under deferred-rotation stocking at the same average stocking rate.

Proper degree of forage use on the limestone breaks range site was suggested as being 30 to 35% rather than the 50% customary on gentler slopes if overgrazing of the latter is to be avoided.

Clay upland produced only 60% as much forage as ordinary upland and limestone breaks. This must be taken into account when calculating stocking rates for areas including such droughty, preclimax sites.

Plant density has been greatly reduced under light stocking, but the forage yields have remained unaffected. The large amount of mulch that accumulated on understocked ordinary upland and limestone breaks sites has tended to encourage excessive utilization of clay upland where the mid and short grasses prevail and where the mulch accumulation was much smaller.

Continuous overutilization of forage resulted in significantly reduced amounts of mulch. This will permit increased loss of water by runoff.

These results suggest that for sustained maximum forage production, range management based on range condition classification is essential.

Kans. State U., Manhattan, Kans.

## Plant Materials

Henson, P. R., and Hanson, C. H. ANNUAL LESPEDEZAS CULTURE AND USE. U.S.D.A. Farm B. 2113, 16 pp. 1958.

The annual lespedezas are of major importance in the eastern half of the United States as a crop for midsummer and late summer grazing, for soil improvement, and for hay and seed.

Common lespedeza has been grown to a limited extent for hay, pasturage, and soil improvement in some of the Southern States for many years. The introduction of Korean and Kobe lespedezas and the development of Iowa 6, Rowan, and Climax varieties of

Korean have increased the use of the crop in localities where it was already grown and have extended the lespedeza region to other states to the north and west.

The culture and use of the two species of annual lespedeza is presented.

ARS, USDA, Inform. Div., Washington 25, D. C.

Leffel, R. C., Ronningen, T. S., and Decker, A. M. Jr. TEN YEARS OF FORAGE CROP VARIETY TESTING IN MARYLAND, 1948-57. Md. Agr. Expt. Sta. B. 466, 47 pp. 1959.

Species of forage crops tested during the past 10 years and reported herein include: Alfalfa (Medicago sativa), Ladino white clover (Trifolium repens "var. Ladino"), Birdsfoot trefoil (Lotus corniculatus), Sweetclover (Melilotus alba and M. officinalis), Red clover (Trifolium pratense), Crimson clover (Trifolium incarnatum), Common vetch (Vicia sativa), Hairy vetch (V. villosa), Lespedeza (Lespedeza stipulacea and L. striata), Orchardgrass (Dactylis glomerata), Timothy (Phleum pratense), Bromegrass (Bromus inermis), Tall fescue (Festuca arundinacea), Tall oatgrass (Arrhenatherum elatius), Pearlmillet (Pennisetum glaucum), Sudangrass (Sorghum vulgare var. sudanense), and Sorghum (Sorghum vulgare).

Specific details relative to the design, establishment, and management of each forage experiment are given in its respective summary table. Fertilizer treatments, insect control measures, and harvest dates were those corresponding to good agronomic practices. Least significant differences and coefficients of variation are included in all summaries for which individual plot data were available.

U. Md., Agr. Expt. Sta., College Park, Md.

Decker, A. M. MIDLAND BERMUDAGRASS A NEW FORAGE GRASS FOR MARYLAND. Md. Agr. Expt. Sta. B. 465, 22 pp. 1959.

The results of Midland Bermudagrass research at the Maryland Agricultural Experiment Station are brought together. The establishment, management, and utilization practices necessary for the successful production of Midland Bermudagrass are outlined.

The author makes the following conclusions: (1) Midland Bermudagrass is a productive hybrid of Coastal and a winter hardy Indiana variety. It is well adapted to Maryland conditions. (2) Midland Bermudagrass is best adapted to the Coastal Plain area of Maryland. It may have wider adaption. (3) Midland Bermudagrass is superior to other permanent-type grasses with regard to summer production. (4) Cereal grains are easily established in Midland sod in September or October with a single seeding operation over the field. (5) The combination of Midland plus rye makes possible the production of 600 to 800 pounds of beef per acre under Maryland conditions. (6) Excess pasture production from Midland can be harvested for either hay or silage. (7) Few seed heads are produced on Midland, and these heads rarely contain viable seeds. (8) Midland Bermudagrass can be contained within a specific pasture by seeding a strip of tall fescue around the area, or by the use of herbicides. (9) Cultivated row crops such as corn can be grown in rotation with Midland. (10) It is strongly recommended that farmers who expect to plant large acreages of Midland start by establishing a farm nursery. (11) To insure quick establishment and good stands, plant plenty of fresh sprigs in moist soil; leave 1 to 2 inches of sprig tip above ground; firm soil around sprigs; control weeds either by cultivation or with chemicals; and fertilize liberally, especially with nitrogen. And (12) a liberal fertilization program is necessary for high forage production.

U. Md., Agr. Expt. Sta., College Park, Md.

Henson, P. R., and Stephens, J. L. LUPINES. U.S.D.A. Farm. B. 2114, 12 pp. 1958.

The authors summarize their work as follows:

1. Advantages: (1) A valuable legume for winter cover and for greenmanure; (2) sweet, or low-alkaloid, varieties provide good winter and early spring grazing; (3) does well on sandy soils of low fertility; (4) stands are easily obtained; and (5) the blue varieties produce abundant and easily harvested seed.

2. Requirements: (1) Inoculate seed at time of seeding; (2) rotate lupines with other crops to avoid or reduce injury from diseases; (3) use superphosphate on soils of low fertility; and (4) seed only deep enough for contact with moisture.

3. Precautions: (1) Do not allow hungry livestock in bitter lupine fields when other feed is not available as bitter lupines contain an alkaloid poisonous to livestock; and (2) to avoid serious seed loss, harvest blue lupines before pods are sufficiently ripe for shattering, and clean and dry seed immediately after combining.

ARS, USDA, Inform. Div., Washington 25, D. C.

Hodges, H. F., Mulvey, R. R., Douglas, C. F., Patterson, F. L., Beeson, K. E., Compton, L. E., Schafer, J. F., and Caldwell, R. M. SMALL GRAIN VARIETIES FOR INDIANA. Purdue U. Agr. Expt. Sta. Res. B. 691, 20 pp. 1959.

The Agricultural Experiment Station at Purdue University maintains a coordinated research program for developing improved varieties of small grains and for evaluating these and other varieties at several locations in Indiana. Experimental results are summarized and reviewed annually to determine the best varieties to recommend for seeding the following year. These recommendations are presented in the first section of this bulletin.

Results of small grain varietal tests conducted during the last 5 years, 1955-59, are reported in the second part of this bulletin.

The development of new varieties, changes in agricultural practices, and the constantly changing disease hazards make a new evaluation necessary each year.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Petr, F. C., and Stevens, H. PARK OATS FOR IDAHO. Idaho Agr. Expt. Sta. B. 290, 4 pp. 1958.

Park was recently released to certified seed growers in Idaho. It is recommended for production in irrigated areas of the State because of its high yielding capacity and outstandingly stiff straw. Park is also recommended for the more humid of the non-irrigated areas of Idaho. It was first released in Montana in 1953.

Park is a white-kerneled oat with quality comparable to Overland, but its test weight is inferior to that of Bannock.

Park is sufficiently disease resistant for Idaho conditions. It is moderately resistant to stem rust and smut, but susceptible to Victoria blight.

Park is about two days later in heading than Overland and Cody, but it is earlier than Bannock.

Park is a relatively short oat. Even under conditions of high fertility and moisture it maintains its resistance to lodging and does not produce excessive straw. These characteristics make Park a desirable companion crop in the establishment of alfalfa and clover.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

Fitzgerald, P. J., and McKay, H. C. ITANA AND COLUMBIA NEW HARD RED WINTER WHEATS FOR IDAHO. Idaho Agr. Expt. Sta. B. 297, 6 pp. 1959.

Itana and Columbia are improved hard red winter wheats recommended for planting in the dryland wheat areas of southeastern and southern Idaho. Because of their better yield, improved quality, and smut resistance, they may be expected to replace much of the acreage now being used for the production of Wasatch, Cache, and Turkey.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

Mississippi Agriculture Experiment Station CROP AND FERTILIZER RECOMMENDATIONS FOR MISSISSIPPI. Miss. Agr. Expt. Sta. C. 212, 16 pp. 1958.

At timely intervals the Experiment Station issues this set of general crop and fertilizer recommendations based on the latest research findings at State College and at the ten branch Experiment Stations in the State. This report presents information on fertilization, varieties, and rates and dates of seeding for crops generally grown in Mississippi.

Miss. State Col., Agr. Expt. Sta., State College, Miss.

Simpson, W. R. THE OWYHEE TOMATO. Idaho Agr. Expt. Sta. B. 298, 4 pp. 1959.

Curly top is the most serious and destructive disease of the tomato in Idaho. It is often responsible for the elimination of entire tomato plantings.

Curly top is a virus disease, transmitted by the beet leafhopper, (Circulifer tenellus Baker).

Control of this disease by the use of insecticides, sanitation, or modified cultural practices is not satisfactory.

Owyhee tomato was produced by the breeding of commercial varieties to a wild tomato resistant to the disease.

The vine type of Owyhee is indeterminate and bears a close resemblance to that of Sioux. The plant growth is sufficiently compact to supply ample shade to minimize sunburn, and yet open enough to favor good fruit-set and even ripening. The untrained plant has a space requirement of 10 - 16 square feet per plant. The leaflets are medium in size and dark green in color.

The fruit of Owyhee is sub-oblate in shape, smooth, uniform, and equal in size to Sioux. Tomatoes are attractive in the pink stage and ripen uniformly. The fruit is moderately "meaty" with thick outer and interlocular walls and five or more locules. The seed cavities are small and the fruit remains firm during the ripening period. The stem connection is small, slightly recessed, with smooth shoulders moderately free of radial or concentric cracks and catfacing. The flesh is red in color with little core or fiber (usually well colored) at the stem connection.

Owyhee has the early-setting habit which is an important characteristic for tomato production in southern Idaho. Maturity is classified as midseason-early or about five days later than Sioux, the commercial variety commonly grown in the area.

The Owyhee tomato is not immune to curly top, but it has exhibited good field resistance to the disease in southern Idaho.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

Stevenson, E. C., Johnson, K. W., and Tomes, M. L. PERFORMANCE OF PROCESSING TOMATO VARIETIES IN INDIANA, 1956-1958. Purdue U. Agr. Expt. Sta. Res. B. 684, 11 pp. 1959.

Three year yield summaries from tomato variety trials at Purdue and other locations in the State indicate that the more commonly grown canning tomato varieties are all capable of producing satisfactory yields in Indiana. Common varieties include Purdue 1361, Rutgers, Urbana, Improved Garden State, Kokomo, Homestead 2, and R x P-$F_2$. Since yields are comparable, other factors should be considered when choosing varieties for a particular area. Among such other factors are earliness, disease resistance, quality of the raw product, and suitability of the raw stock for various products. These factors are discussed and comparisons with certain new varieties are made in this bulletin.

Yield summaries of other varieties grown in observation plots at Lafayette, Indiana, during the past three years are included.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Murphy, H. J., Goven, M. J., Schark, A. E., and Blood, P. T. MAINE POTATO VARIETY TRIALS FOR 1959. Maine Agr. Expt. Sta. Misc. P. 638, 30 pp. 1959.

Cooperative potato variety trials are conducted annually by the agronomy departments of the Maine and New Hampshire agricultural experiment stations and the horticultural crops division, ARS, USDA.

Varieties included in these trials can be grouped into four general categories: (1) New varieties from other potato producing areas that may be adapted to the Maine and New Hampshire potato producing areas; (2) old standard varieties whose quality and growth characteristics have been well established and which are used as check varieties; (3) unnamed seedling varieties which, on the basis of tests conducted by entomologists,

pathologists, and plant breeders, have certain characteristics that indicate they may be equal to or superior to varieties already in commercial production; and (4) special purpose varieties which may be produced in Maine or New Hampshire by the potato industry for processing into a number of potato products.

These trials offered an opportunity to compare the newer promising varieties with the older accepted varieties in growth characteristics, disease resistance, yield, and dry matter content of tubers, and their potential for various processed potato products. By conducting these trials in various locations in Maine and New Hampshire they also serve as a basis for varietal suggestions for the different potato producing areas involved.

Maine Agr. Expt. Sta., U. Maine, Orono, Maine.

Zielinski, Q. B., Sistrunk, W. A., and Mellenthin, W. M. SWEET CHERRIES FOR OREGON. Oreg. Agr. Expt. Sta. Sta. B. 570, 19 pp. 1959.

A description and preliminary evaluation of numerous sweet cherry varieties grown in Oregon is given.

Agr. Expt. Sta., Oreg. State Col., Corvallis, Oreg.

Nash, N. THE ANSWER TO INSECTS? Mo. Conserv. 21(2): 5. 1959.

The culture and care of growing multiflora rose hedges as performed by Mr. T. P. Smith, a farmer in Missouri are described.

A cash outlay of about $750 has provided for 11 miles of multiflora rose fence, while good hog-tight metal fence would cost him about $900 a mile.

Mr. Smith is firmly convinced that multiflora rose helps control insects on his farm, adds beauty to it, and makes him good, economical fences.

No address given.

Bushong, C. WHAT ABOUT MULTIFLORA ROSE? Outdoor Ind. 2(6): 28-30. 1958.

The planting and care of multiflora rose for cattle fence, hog fence, and wildlife plantings are described.

No address given.

Park, J. K., and Webb, B. K. SEED HARVESTING IN THE SOUTHEAST. S. C. Agr. Expt. Sta. B. 461, 38 pp. 1958.

The following is a summary of what are considered to be more significant conclusions from these harvesting studies of legume and grass seed: (1) Time of harvest is one of the most important factors affecting harvested yield in seed crops. Highest direct combined yields usually occurred when a small percent of seed were still slightly green. (2) Direct combining was generally the best method of harvesting seed crops in this area. (3) Chemical defoliation usually increased harvested yield and reduced seed moisture content, sometimes by differences which made the treatment profitable. (4) Chemical control of the clover head weevil increased harvested yield of crimson clover by as much as 100 percent. (5) Seed quality was usually reduced by high moisture and/or high temperature in storage and by harvesting at a very early stage of maturity. (6) Maintenance, operation, and adjustment of combine were always important. (7) Variations in combine components were also often important. (8) Cutterbar shatter losses were usually 10 percent or more in these shattering crops. Cutterbar loss was reduced and cutting performance was improved by use of a tinned pickup reel. (9) Cleaning losses varied with crop condition and with combine design and adjustment. (10) Angle bar cylinders threshed more and damaged less crimson clover seed than rasp bar cylinders. (11) High cylinder speed and close spacing was necessary to thresh crimson clover seed satisfactorily. (12) Low ground speed was necessary to minimize seed losses in crimson clover. (13) Weather and cutterbar shatter losses often totaled 50 percent in fescue and rescue. However, direct combining was the best harvest method in the tests conducted. (14) Seed damage was a most important consideration in harvesting combine peas and soybeans. (15) Weather shatter and cutterbar shatter were the important losses in harvesting lespedezas, often

totaling 50 percent. Threshing and cleaning losses were normally quite small. And (16) in sesame, high cylinder speeds resulted in high harvested yield and low germination.

AERD, ARS, USDA and S. C. Agr. Expt. Sta., Clemson, Agr. Col., Clemson, S. C.

## Woodlands

Zahner, R. SITE-QUALITY RELATIONSHIPS OF PINE FORESTS IN SOUTHERN ARKANSAS AND NORTHERN LOUISIANA. Forest Sci. 4: 162-176. 1958.

The study attempted to obtain basic data from which to develop a method for evaluating site quality for loblolly and shortleaf pines (Pinus taeda L.) and (P. echinata Mill.) on upland and terrace soils in southern Arkansas and northern Louisiana.

Site characteristics and site index were measured in 206 even-aged stands of loblolly and shortleaf pines in southern Arkansas and northern Louisiana. Through regression analysis site index was related to soil and topographic variables. Site factors that help regulate soil moisture and soil aeration were highly correlated with site index. Areas studied had site indices (at age 50 years) ranging from 67 to 108 for loblolly pine, and from 63 to 93 for shortleaf pine.

On mature upland soils with well-differentiated horizons, both loblolly and shortleaf pines are influenced similarly: (1) As the thickness of surface soil increases, site index also increases, but only to a soil depth of about 18 inches. Site index then levels off, and finally decreases somewhat for still deeper surface soils. (2) As the clay content of the subsoil increases from 10 to 25 percent for loblolly pine, and from 10 to 35 percent for shortleaf pine, site quality first increases and then levels off. There is a final decrease in site quality for the higher values of clay content. And (3) site index decreases with increases of slope.

On immature soils with poor horizon development, loblolly pine site index is associated with three factors: (1) As the silt content of the surface soil increases, site quality was found to decrease. The effect of surface silt is greater for those soils with low subsoil silt-plus-clay content than for those with high subsoil silt-plus-clay content. (2) As the silt-plus-clay content of the subsoil increases from 35 to 65 percent, site quality first increases and then levels off. For higher values of silt-plus-clay, site index decreases. And (3) site index is better on areas with just adequate surface drainage than on flat areas with no drainage or on slopes with good drainage.

Shortleaf pine does not usually occur in high proportion with loblolly pine on azonal soils. In general, the best sites for loblolly pine in the region studied are the better drained small stream bottoms. Next, loblolly and shortleaf pines both grow well on the better drained loess, upland terrace, and flatwoods soils. The upper slopes and ridges generally are poorer sites. In all topographic positions, the best sites are those of moderately deep sandy loam surface soils with clay loam subsoils. Poorest sites are shallow surface soils overlying heavy clay subsoils, or deep sandy surface soils overlying sandy subsoils. Extremely flat soils of high silt and clay content, with no surface or internal drainage, are also relatively poor.

Southern Forest Expt. Sta., FS, USDA, Crossett Res. Cent., Crossett, Ark.

Crandall, D. L. GROUND VEGETATION PATTERNS OF THE SPRUCE-FIR AREA OF THE GREAT SMOKY MOUNTAINS NATIONAL PARK. Ecol. Monog. 28: 337-360. 1958.

The southern spruce-fir forest extends along the higher ridges of the Great Smoky Mountains National Park from Mt. Sterling in the northeast to Silers Bald in the southwest. The spruce, (Picea rubens), enters the canopy around 4,500 ft. elevation but the stands are usually mixed with hardwoods or hemlock up to 5,000 ft. or more. Even above these elevations in the gaps, yellow birch, (Betula alleghaniensis) or beech, (Fagus grandifolia), may predominate. Mixed stands of spruce and fir occur from 5,000 ft. upward, and above 6,200 ft. Fraser fir, (Abies fraseri), may be the dominant canopy tree. Pyrus americana is the important deciduous tree at these higher altitudes and Betula alleghaniensis at lower altitudes in the spruce-fir forest.

Following fire the development of spruce and fir stands with characteristic ground cover is extremely slow. In such areas various shrubs, yellow birch and fire cherry usually are the dominant vegetation for many years. Even after more than 20 years only occasional spruce and fir trees are encountered in such devastated areas.

Windthrow damage is characteristic of much of the high altitude fir forest, which is shallowly rooted. Following the overthrow of the canopy trees, fir seedlings develop rapidly, producing pole stands of even-aged trees. This cyclic type of reproduction appears characteristic of the high altitude stands.

In contrast, in the mid-altitude spruce-fir and the lower altitude spruce forests individual trees are occasionally uprooted or broken off, and old trees of spruce and fir may die and remain standing for many years after death. With the gradual replacement of these scattered individuals, uneven-aged stands are produced.

Although many species of herbaceous plants are found throughout the altitudinal range of the southern boreal forest, certain species or species combinations are more characteristic of specific forest types. More herbaceous species, generally of less coverage, are present at the lower elevations, while fewer species, although frequently of very high coverage, are present at higher elevations.

Dept. Biol., Randolph-Macon Woman's Col., Lynchburg, Va.

Jokela, J. J., and Lorenz, R. W. PINES SURPASS HARDWOODS ON UPLAND SOILS. Ill. Res. 1(1): 18. 1959.

Sandy soils too poor for annual crops, pasture, or hardwoods can be profitably used for growing pines. There are about 1/4 million acres of such land in northern and central Illinois.

The Department of Forestry has compared the growth of eastern white pine with that of upland, native hardwoods in Sinissippi Forest, Ogle County. In rotations up to 80 years long, pine stands on sandy soils are expected to yield at least twice as much sawtimber as hardwoods on good sites and at least five times as much as hardwoods on poor sites.

Following are growth and yield per acre at age 80 of the highest-yielding hardwood stands on three sites and of a 46-year-old plantation of white pine on sandy soil.

| Forest type | Productivity rating of site | Present annual growth, bd. ft.[a] | Sawtimber yield, bd. ft.[a] |
|---|---|---|---|
| Mixed oak | Good | 235 | 10,350 |
| White oak | Medium | 180 | 7,150 |
| White oak | Poor[b] | 150 | 3,950 |
| Eastern white pine | Medium | 925 | 16,050 |

[a] International 1/4-inch rule.
[b] Poor hardwood site.

The above figures are for unmanaged stands. Management would substantially increase growth and yields. This would be particularly true of pine yields, because pine is more marketable in the smaller sizes than hardwood.

Pine, in addition to its faster growth and earlier marketability, has another advantage over hardwood: It yields more lumber from a given cubic tree volume. According to Sinissippi Forest utilization practices, total cubic-foot volume of marketable pine trees is converted into board feet of lumber by a factor of 5 to 6.5. A factor of only 3 to 4 is used for hardwood.

U. Ill., Col. Agr., Ext. Serv. Agr. and Home Econ., Urbana, Ill.

Tryon, E. H., and Carvell, K. L. REGENERATION UNDER OAK STANDS. W. Va. Agr. Expt. Sta. B. 424T, 22 pp. 1958.

The abundance of reproduction under mixed oak stands was studied on 28 permanent plots and 40 temporary plots. The amount of reproduction under these stands was high. There was an average of approximately 39,000 individuals per acre oomposed of some 50 different species, and over 6,000 were oaks. The stocking, or frequency, of oak reproduction was high, indicating an even distribution of oak seedlings over the area.

This abundance of regeneration suggests the possibility of using the one-cut shelterwood silvicultural method, removing the entire overstory in a single removal cut (Hawley and Smith 1954). Factors such as logging damage, size and condition of seedlings present, and death of seedlings due to exposure after the mature stand is cut influence the number of oak seedlings. The initial growth rate of other species and of oaks must be considered. In spite of these factors, certain selected oak stands may be adequately handled by the one-cut shelterwood method, if logging damage is kept to a minimum.

One-half of the permanent plots were rated high in abundance of oak reproduction, and the other half low. The number of acorns collected during a 4-year period was essentially the same on both sets of plots. Thus the difference in amount of oak reproduction appears to be the results of site factors acting on the acorn after falling from the tree, or on the resulting seedling.

The abundance of white oak reproduction exceeded that of the red oak and the relationship between the two was close to that of white oak and red oak in the overstory. For both the reproduction and overstory trees the white oak exceeded the red oak by more than 70 percent.

Most of the seedlings, including the oaks, were found in the smallest height class. Their abundance reduced rapidly with increasing height. This is a normal condition under a forest canopy and is a result of low light intensity and competition.

Red maple seedlings, which were the most abundant under the oak stands, were noted to die out rapidly after the first growing season.

W. Va. U., Agr. Expt. Sta., Morgantown, W. Va.

Lemmien, W. A., and Rudolph, V. J. GROWTH AND YIELD OF RED PINE IN THREE SPACINGS. Mich. Q. B. 42(2): 421-427. 1959.

The growth and yield of 25-year-old red pine planted in 6 x 6-, 8 x 8-, and 10 x 10-foot spacings have been studied in plantations established in 1932 on abandoned fields in the Kellogg Forest in southern Michigan. Portions of the stands were thinned in 1947 and again in 1954.

At 25 years of age, and after two thinnings, 19 percent of the stems in the 6 x 6 stand are still unmerchantable, 5 percent in the 8 x 8 stand, and 1 percent in the 10 x 10 stand. In nine years, the 6 x 6, 8 x 8, and unthinned 10 x 10 stand increased 1.8 inches in d.b.h., while the thinned 10 x 10 stand increased 2.5 inches. Height growth of all stands has been similar, with the unthinned 10 x 10 stand showing somewhat smaller height growth.

The thinned 10 x 10 stand has much larger crop trees, with 98 trees in the 9- and 10-inch classes. The 8 x 8 stand has 66 trees, the unthinned 10 x 10 has 38, and the 6 x 6 stand has 18.

The 6 x 6 stand has produced 171 square feet of basal area; the 8 x 8 stand, 151 square feet; and the thinned and unthinned 10 x 10 stands, 141 and 136 square feet, respectively. The three stands have each produced between 28 and 29 cords of pulpwood per acre. Since 1947, each thinned stand has grown 18 cords of pulpwood per acre.

After 25 years of growth, the 10 x 10 spacing appears superior to the 6 x 6 and 8 x 8 spacings, because it has produced larger crop trees and almost as much merchantable volume per acre. The first thinnings in the wider spacings, although coming later than the first thinnings in the closer spacings, are more likely to be profitable, since larger-sized material will be cut, with a greater volume per tree.

Thinnings in the wider spacings are more easily applied, since there are fewer unmerchantable trees in the stand. With wider spacings, planting cost per acre are lower. Furthermore, the wider spaces between rows permit easy access for cultural operations.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Hopkins, W. C. RELATIONSHIP OF STAND CHARACTERISTICS TO QUALITY OF LOBLOLLY PINE. La. Agr. Expt. Sta. B. 517, 27 pp. 1958.

Present management practices in the loblolly pine region are largely directed toward the growth of pure pine stands. The philosophy underlying such practices, production of the greatest volume of the most valuable species, is sound. At the same time there is widespread concern over the generally low quality of second-growth southern pine, loblolly included.

The field work for this study to learn the effects of hardwood mixtures on pine quality, was conducted during the summer of 1955 in southeastern Louisiana. A total of 194 sample plots were randomly located in loblolly pine-hardwood stands of sawtimber size. Data were collected which permitted the calculation of the following plot characteristics: (1) Pine quality index; (2) gross plot value; (3) total basal area; (4) percentage of basal area in dominant hardwoods; (5) percentage of basal area in sub-dominant hardwoods; (6) age of the stand; and (7) site index for pine.

The data obtained were analyzed statistically with the following results:

1. The relationship between quality index of pine and five stand characteristics--total basal area per acre, percentage of total basal area in dominant hardwoods, percentage of total basal area in sub-dominant hardwoods, age of stand, and site index--was found to be statistically significant.
2. Pine quality index was shown to be generally higher in older stands and in stands composed of sub-dominant hardwoods growing with pine.
3. In middle-aged and mature stands of loblolly pine, present stand density, site index, and the presence of dominant hardwoods have little to do with the quality of the butt log.
4. The relationship between gross plot value in dollars and the same five stand characteristics was significant.
5. Site index had no significant effect on gross plot value.
6. Plot value was generally higher in older stands, in stands with high total basal area, and in stands with low amounts of dominant hardwoods.
7. The relationship between percentage of the basal area in sub-dominant hardwoods and gross plot value is curvilinear. It appears that the optimum amount of sub-dominant hardwoods is about 5 percent of the total basal area.

These results may be summed up in three general conclusions:

1. If the objective of management is to grow loblolly pine which has long, clear boles which will produce a high proportion of the finish grades of lumber, management has two principal alternatives: (1) Select 70 to 100 crop trees per acre at an early age of the stand and by artificial pruning carried out in 3 or 4 stages produce this number of trees with the first 32 feet of the bole having a knotty core not more than 5 inches in diameter; or (2) employ a long rotation, possibly 80 to 100 years, and maintain 5 percent of the stand basal area in sub-dominant hardwoods which are well distributed.
2. Dominant hardwoods have no place in the management of loblolly pine within the area under consideration.
3. The chief values of mixtures in enhancing natural pruning in loblolly pine appear to result from the sub-dominant hardwoods. It is strongly suspected that this relationship may apply to other coniferous species.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Croker, T. C. Jr. DIRECT SEEDING LONGLEAF PINE IN SOUTH ALABAMA AND NORTHWEST FLORIDA. Ala. Conserv. 30(5): 18-19, 27. 1959.

Direct seeding of southern pines, a pipe dream to most foresters a few years ago, has been transformed by painstaking research into a powerful new tool for wide-awake forest managers.

Scientists first determined the major causes of direct-seeding failures, then started developing methods to eliminate these failures. The first break-through came with the discovery of a crow repellent made in Germany, that would protect pine seed from birds. Since then more powerful repellents to protect seed from birds, rodents, and insects have been developed cooperatively by the Southern Forest Experiment Station, the U.S. Fish and Wildlife Service, and several chemical companies.

Discovery of effective repellents was only a start. Methods of preparing seedbeds had to be developed, and sowing techniques had to be tested for all important species. Solutions have been found for many problems, and direct seeding is rapidly becoming an important supplement to planting.

Private landowners have applied the research results to seed successfully many thousands of acres. Most of the seeding, though, has been west of the Mississippi river.

This article gives the results of Gulfcoast trials of direct seeding of 1956 for sand pine, longleaf pine, slash pine, loblolly pine, and shortleaf pine.

South. Forest Expt. Sta., FS, USDA, New Orleans, La.

Stone, E. C., and Schubert, G. H. ROOT REGENERATION BY PONDEROSA PINE SEEDLINGS LIFTED AT DIFFERENT TIMES OF THE YEAR. Forest Sci. 5: 322-332. 1959.

Regeneration of a new root system by transplanted ponderosa pine seedlings is dependent, after root pruning, upon the elongation of the short laterals already formed and the initiation and elongation of new laterals.

Root elongation and root initiation of transplanted seedlings displayed a distinct seasonal periodicity. This periodicity was evident under greenhouse conditions where the soil moisture and nutrients were abundant, the soil temperature was held constant, and the air temperature was not allowed to fall below 20° C (68°F) at night.

In general root elongation and root initiation did not occur on seedlings transplanted into the greenhouse in July and August. Root elongation was evident only on seedlings transplanted from December to June; however the greatest activity was in spring immediately before the terminal bud broke.

The data presented, although incomplete, suggest that the seed collection zone, the nursery in which the seedling is raised, or both affect the physiological condition of the seedling and its subsequent response when transplanted.

The physiological behavior of ponderosa pine seedlings when transplanted suggest that spring planting has more in its favor than fall planting. In the spring a greater number of the short laterals elongate per unit time than in the fall. Furthermore, since a large percentage of the springlifted seedlings initiate new laterals, replacement of those roots that dry out and are killed during spring transplanting is possible. Also, the seedling can regenerate a new root system at a lower soil temperature in the spring than in the fall.

Sch. Forestry, U. Calif., Berkeley, Calif.

Woodwell, G. M. FACTORS CONTROLLING GROWTH OF POND PINE SEEDLINGS IN ORGANIC SOILS OF THE CAROLINAS. Ecol. Manag. 28: 219-236. 1958.

Increasing land and timber values in recent years have stimulated interest in improving the timber yields of the extensive low-quality wetlands of the Southeast called "pocosins." Drainage has not always resulted in improved tree growth and descriptive studies have indicated that on certain of these sites soil characteristics might be more important than flooding in determining site quality for pond pine, the principal commercial tree. The present study was designed to discover the factors which control the growth of pond pine in pocosin soils.

From this work it is apparent that soil nitrogen and phosphorus together are the principal factors controlling pine seedling growth in the pocosin soils studied. Physiological variation occurs within the pond pine taxon and may influence apparent site quality.

Dept. Bot., Duke U., Durham, N. C.

Ovington, J. D. STUDIES OF THE DEVELOPMENT OF WOODLAND CONDITIONS UNDER DIFFERENT TREES: VII Soil Calcium and Magnesium. J. Ecol. 46: 391-405. 1958

Three series of forest plots, originally designed to compare the growth of different tree species, have been examined to determine the effects of forest on exchangeable calcium and magnesium in the soil.

The litter accumulated over the mineral soil of the forest plantations contains large amounts of calcium and magnesium, the greatest weights being present under conifers

There is no evidence from this investigation that the growth of the tree crops has resulted in a significant change in the exchangeable magnesium content of the mineral soils but exchangeable calcium, particularly in the surface mineral soils, has decreased as a result of forest plantation.

The effects of different tree species on soil calcium varies considerably but the loss under conifers or exotic tree species is not significantly greater than under hardwoods or native species respectively.

The implications of the long-term relationship between the trees and soils for the preparation of forest management plans are discussed.

The Nature Conservancy, Merlewood Res. Sta., Grange-over-Sands, Lancashire, England.

Wright, T. W. USE OF FERTILISERS IN THE AFFORESTATION OF DEEP PEAT. J. Sci. Food and Agr. 12: 645-650. 1959.

Phosphorus is frequently the primary limiting factor to tree growth on deep peat, and phosphate manuring is now routine Forestry Commission practice. Recent experiments have shown the value of foliage analysis in diagnosing phosphate deficiency, and suggest that, as the trees mature, natural supplies of other nutrients, particularly potassium, may be exhausted.

Macaulay Inst. For Soil Res., Craigiebucker, Aberdeen, Scotland.

Ashby, W. C. LIMITATION TO GROWTH OF BASSWOOD FROM MINERAL NUTRIENT DEFICIENCIES. Bot. Gaz. 121: 22-28. 1959.

Vigorous growth was shown by two accessions of basswood seedlings (Tilia americana L.) receiving complete nutrient solution in sand culture under conventional greenhouse conditions.

Highly statistically significant lower total dry weights and visual symptoms of deficiency were established in basswood for deficiencies of nitrogen, phosphorus, potassium, calcium, or magnesium.

No differences from controls were demonstrated for seedlings presumably deficient for sulfur. (Note: The same author and E. S. Mika (1959) found that sulfur was needed when the seedlings were grown in a chamber with sealed atmosphere. They concluded that under certain environmental conditions, the atmosphere may have sufficient sulfur for the growth of basswood.)

Growth periods for roots, except of calcium-deficient plants, were appreciably longer than for shoot elongation.

Solution culture studies on a preliminary basis showed nutrient requirements evident for iron, less evident for manganese, zinc, and boron, and not evident for copper.

U. Chicago, Chicago, Ill.

Hellmers, H., and Kelleher, J. M. CEANOTHUS LEUCODERMIS AND SOIL NITROGEN IN SOUTHERN CALIFORNIA MOUNTAINS. Forest Sci. 5: 275-277. 1959.

Because Ceanothus species are common in the mountains of southern California and because the soils in which these species grow are usually of low fertility, ceanothus-soil relationships were studied. Ceanothus species constitute a major component of the fire-type vegetation on the San Gabriel and other mountains of southern California.

This study has shown that plants of Chaparral whitethorn, (Ceanothus leucodermis) on three of the soils from the San Gabriel Mountains in California markedly improved the growth of a succeeding crop of tomatoes.

At least one of the factors affected in improving the soil is an increase of available nitrogen.

Ceanothus leucodermis removed more nitrogen from the soil than was originally present and in addition left almost twice as much available nitrogen in the soil to be used by following crops.

The author concludes that Ceanothus leucodermis is a beneficial plant in developing the mountain soil. This species, or an associated organism, is capable of fixing atmospheric nitrogen for plant use or the plants alter the soil conditions so as to allow this process to be carried on by soil organisms.

Calif. Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Vinokurov, M. A., and Tyurmenko, A. N. MATERIALS IN THE FOREST'S BIOLOGICAL CYCLE OF NITROGEN AND PHOSPHORUS. Soviet Soil Sci. 7: 787-791. July 1958.

In 1955, observations on the dynamics of total humus, nitrogen, and phosphorus were carried out on the Raif forest reserve. For this purpose, three pines and three birch of the same age (25 to 30 years) and harvest condition were chosen. The soil under pine was moderately podzolized friable sand, and under birch weakly podzolized coarse clay loam.

The following conclusions were reached: (1) The dynamics of humus, nitrogen, and phosphorus contents in the upper and lower soil horizons show quite definite regularity, expressed as a gradual decrease in the content of these elements in the first half of the growing season, and an increase in the last half. (2) The minimum content of these elements in the soil occurs at the end of June or beginning of July. And (3) the dynamics of nitrogen and phosphorus contents in roots and leaves show about the same regularity as their dynamics in soils, though the seasonal decrease in roots is somewhat more drawn out than in leaves. At the end of the growing season the nitrogen and phosphorus contents in roots increase. In leaves these elements behave in an opposite manner, namely, the nitrogen content at the end of growing season decreases, but phosphorus, on the contrary, increases.

Amer. Inst. Biol. Sci., 2000 P St. N.W., Washington 6, D.C.

Hacskaylo, J., Goslin, W. E., and Diller, O. D. MANAGING SCOTCH PINE FOR QUALITY CHRISTMAS TREES. Ohio Agr. Expt. Sta. Res. C. 64, 12 pp. 1959.

Christmas tree production is a growing industry in Ohio. Among the species used Scotch pine is the most popular, accounting for over one-half of the trees being planted. The characteristics of good strains of Scotch pine which make it a desirable Christmas tree are: (1) Its excellent needle retention; (2) pleasing shape and type of branching; (3) good color; (4) hardiness; and (5) ample growth rate.

Since so many landowners in Ohio and surrounding states have already planted or are planning to plant millions of Scotch pine which they expect to harvest as Christmas trees, it is important that they produce high quality trees which are acceptable to consumers. There is already a surplus of low quality trees which cannot be marketed at a profit.

In order to produce high grade trees certain cultural practices must be followed. These include selection of a suitable planting site, a satisfactory strain or seed source, proper planting techniques, control of competing vegetation, control of insects and diseases, and shearing to improve form and density. Prospective growers who are not prepared to meet the above requirements cannot expect to obtain satisfactory results.

Ohio Agr. Expt. Sta. Wooster, Ohio.

Zahner, R. HARDWOOD UNDERSTORY DEPLETES SOIL WATER IN PINE STANDS. Forest Sci. 4: 178-184. 1958.

Soil water depletion by well-stocked, even-aged pine stands with and without hardwood understories was measured through four summers in southern Arkansas. The hardwood understory was completely eradicated on some plots by chemical means and left undisturbed on others. Another set of plots received two prescribed burns as a hardwood control measure. Midsummer water loss rates were about 25 percent faster in plots in understory left in place than in those with hardwoods eradicated by chemicals. While the soil was moist, evapo-transpiration from all treatments was nearly equal. By July, however, as the soil dried, moisture levels in plots with no hardwood understory were

more than 50 percent greater than in plots with the understory present. Soil moisture on burned plots was slightly higher than on control plots but considerably lower than on chemically treated plots. It is concluded that understory hardwoods compete significantly for soil moisture in upland pine forests of the Midsouth.

Southern Forest Expt. Sta., FS, USDA, Crossett Res. Cent., Crossett, Ark.

Laessle, A. M. THE ORIGIN AND SUCCESSIONAL RELATIONSHIP OF SANDHILL VEGETATION AND SAND-PINE SCRUB. Ecol. Monog. 28: 361-387. 1958.

Most of the unconsolidated silicious sands and clays of peninsular Florida were transported from the Appalachians and the Piedmont of the Carolinas and Georgia. Easterly flowing rivers of these states, such as the Savannah and the Altamaha, carried these materials to the Atlantic, probably during the Pleistocene. The generally southerly longshore currents of this period transported the sediments to the peninsula. Where these deposits were well drained they developed into the soils supporting sandhill and scrub vegetation.

Some of these deposits were severely washed and sorted both by water and wind, leaving little but silicious sands. Such deposits occur where they would be expected in the light of well-established Pleistocene shore lines and likely wind and current directions.

All of these extremely strongly washed and sorted deposits are occupied by scrub vegetation where drainage is good, or by hammock where fire has been excluded or minimized.

Most of the other well-drained deposits, less severely washed and sorted, are occupied by sandhill vegetation (Longleaf pine/Turkey-oak Association).

There is no successional relationship between scrub and sandhill vegetation as borne out by the fact that shore line features formed at least as far back as mid-Pleistocene support scrub, while older deposits both above and below the influence of Pleistocene seas support sandhill vegetation.

On circumstantial evidence it is concluded that the tremendous contrast in the flora of these communities is related largely to nutrition, and that a certain element is, or particular elements are, lacking in the severely washed and sorted sands supporting scrub.

Scrub and sandhill vegetation represent the two most prevalent well-drained sub- or fire-climax communities in peninsular Florida. Each in the absence of fire would eventually, and often very rapidly, be succeeded by predominately evergreen hardwood tree communities, known in much of the Southeast, as hammocks.

Biol. Dept., U. Fla., Gainsville, Fla.

Roth, L. F. NATURAL EMPLACEMENT OF DWARFMISTLETOE SEED ON PONDEROSA PINE. Forest Sci. 5: 365-369. 1959.

Needles of ponderosa pine rather than stems are the primary interceptors of dwarfmistletoe seeds. An effective biological adaptation brings the seeds into contact with stem tissues of the most susceptible age and also positions the seeds on the stems, usually in the axil of the fascicle, or at the fascicle opening.

This adaptation seems essential to survival of pine dwarfmistletoe. Naked stems in a position to be hit by flying seeds offer a relatively small target; they retain the seeds poorly and are too old to be readily infected. Foliated stems in themselves present even smaller targets and are so clothed with needles that direct stem hits seldom occur. On the other hand, the numerous and widely spreading needles offer a target of great area and because of their individual flexibility they are ideally suited to seed interception. As a result of their large numbers and distribution they literally screen the seeds from the air. At this point a means of transferring the seeds from the needles to the susceptible stem becomes necessary. This is provided by movement attending gelatinization of the viscin during rainy weather.

On the tree studied for this report approximately 20 percent of the seeds had been transferred to the twigs by the end of the year. Twenty-five percent remained on the needles and 55 percent were washed off or otherwise removed.

This movement of the seeds appears significant when considered with respect to the branching and foliar characteristics of the tree. Ponderosa pines vary widely with respect to these characteristics. In the juvenile stages all intergrades are found between trees with long drooping needles and small, sometimes pendent, branches and trees having an erect branching habit and erect, rigid needles. It appears likely that trees of the later type would transfer a higher percentage of intercepted dwarfmistletoe seeds to the susceptible stems and thereby would be more liable to damage by the parasite.

Oreg. State Col., Corvallis, Oreg.

Anderson, R. L., and Kaufert, F. H. BROOMING RESPONSE OF BLACK SPRUCE TO DWARFMISTLETOE INFECTION. Forest Sci. 5: 356-364. 1959.

The parasitic plant dwarfmistletoe (Arceuthobium pusillum Peck) causes witches'-broom and is one of the most serious diseases of black spruce (Picea mariana (Mill.) B.S.P.). It infects trees of all ages and all crown and vigor classes from rapidly growing dominants to severely suppressed trees.

There are marked variations in host reaction to dwarfmistletoe infection of black spruce. Almost all infections cause the formation of witches'-brooms. The very few infections that do not form brooms apparently are of little consequence. The form of brooms seems to be determined by host vigor and age. The brooms are of three types, called bush-type, leader-type, and weak-type as indicative of their characteristics.

On very young trees infection can result in complete elimination of the original tree, leaving a tree-shaped, leader-type witche's-broom that gives the erroneous impression of systemic infection. For the first 5 to 10 years brooms grow very rapidly, and the dwarfmistletoe produces much seed. An abrupt decline in vigor follows. The age of a broom can be determined by examining the annual rings on infected branches and noting the period of marked growth stimulation. Infections cause a marked decline in trunk growth, especially in younger trees. The disease also causes considerable mortality. Dying trees usually have 75 percent or more of their foliage on infected branches. In the areas examined, older trees survived as long as 45 or 50 years following infection with dwarfmistletoe.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Toole, E. R., and Broadfoot, W. M. SWEETGUM BLIGHT AS RELATED TO ALLUVIAL SOILS OF THE MISSISSIPPI RIVER FLOODPLAIN. Forest Sci. 5: 2-9. 1959.

Seventy-six sweetgum stands in the lower Mississippi River floodplain were sampled to determine the relationship between blight and soil properties. A blight disease index was determined for each plot, and bulk and undisturbed soil-core samples were collected from each 12-inch layer down to 4 feet. Various chemical and physical laboratory determinations were made on these samples, and the results correlated with disease index.

Stands on slack-water soils had significantly more blight (disease index 2.2) than those on the soils of natural levees (disease index 1.2). For all the samples, blight increased as potassium increased in the 1- to 2-foot soil level, as sodium increased in the 2- to 3-foot level, and as bulk density decreased in the surface foot.

The data strongly suggest that sweetgum blight in the area studied is primarily a reaction to soil moisture shortages.

Southern Forest Expt. Sta., FS, USDA, Stoneville, Miss.

## Windbreaks

Read, R. A. THE GREAT PLAINS SHELTERBELT IN 1954. Nebr. Agr. Expt. Sta. B. 441, (Great Plains Agr. Council Pub. 16) 125 pp. 1958.

Field windbreaks planted by the Prairie States Forestry Project between 1935 and 1942 in the Eastern Plains from North Dakota to Northern Texas were re-evaluated during 1954.

This bulletin presents (1) an up-to-date review of the status of these tree plantings, most of which are now close to 20 years old, and (2) suggests a research program aimed at solving the most pressing problems brought out by this report.

Forty-two percent of the windbreaks samples rated good or excellent as effective windbarriers; 31 percent rated fair; 19 percent poor; and 8 percent had been destroyed. Sixteen percent of all plantings had an effective summer height of 50 feet or more; 40 percent were between 35 and 50 feet tall. Effective height of conifers was less than 10 feet in 60 percent of the windbreaks.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, and U. Nebr., Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

Randel, G. L. CONIFEROUS WINDBREAK SPECIES AND SPACING TESTS AT THE BIG SPRING FIELD STATION. Tex. Agr. Expt. Sta. B. MP-360, 2 pp. 1959.

Results obtained in the conifer species and spacing test at the Big Spring Field Station indicate that an effective farm or ranch windbreak can be developed by using a single row, or two or more rows, of Arizona cypress or Eastern red cedar.

For a single row planting to give partial protection from southerly summer winds, a row of Arizona cypress spaced 12 feet apart is adequate. The west and north windbreaks should have two or three rows, with two rows of Arizona cypress or one row each of the Arizona cypress and Eastern red cedar.

If a three-row planting is desired, the row nearest the buildings can be Eastern red cedar with Arizona cypress in the other two rows. In such plantings, a spacing of 12 feet should be used between trees in the rows and the rows spaced 24 feet apart. This wide interval between rows is a practical spacing because of the increased use of heavy farm machinery for cultivation of the planting.

Tex. Agr. Expt. Sta., College Station, Tex.

Afanasiev, M., Engstrom, A., and Johnson, E. W. EFFECTS OF PLANTING DATES AND STORAGE ON SURVIVAL OF EASTERN RED CEDAR IN CENTRAL AND WESTERN OKLAHOMA. Okla. Agr. Expt. Sta. B. B-527, 19 pp. 1959.

This report is based on the results of field planting red cedar during three consecutive years beginning in 1955. The three planting and growing seasons happened to include very poor, fair and very favorable conditions.

The date of planting appears to have a definite effect on the success of field planting, even if sometime this effect might be obscured by the effects of soil and weather conditions at the time of planting. During the years of 1955-58, the optimum periods of planting were between the middle of December and the middle of March.

Weather and soil conditions at the time of planting and immediately after, have a strong effect on the success of field planting. These conditions in Oklahoma vary widely from year to year. In general planting during the months of January and February has a better chance of success than that before or after this period. Planting in November or delaying planting till late March or April is especially risky.

Leaving seedlings for an extra week in packages in which they arrived from the nursery had very little, if any, effect on survival. The planter should be reminded, however, that exposing stores stock to drying or to extremes of temperature would usually cause serious injury to the plants. If planting is to be delayed, the packaged stock must be stored in a barn, shed or cellar, free from danger of freezing and with packing material continuously moist, though not wet.

Observations at all four locations suggest that the precipitation and the resulting quantities of soil moisture does have a pronounced effect on survival of plants. High mortality of 1956-57 and 1955-56 trials was caused by deficiency of soil moisture during the time of planting and immediately following planting.

The comparative results of planting during severe drought and during seasons of good moisture shows the negative results that can be anticipated during very dry years. During drought years it would be better to do no planting at all, use potted plants, or provide for supplemental irrigation.

Use of potted stock during the years of low precipitation resulted in an exceptionally high survival as compared with the survival of the bare-rooted stock. The combined average survival of potted plants in 1956 and 1957 was 95.69%, while bare root stock was 69.86%. The superior performance of potted plants, was not as evident, during the year of abundant rainfall and generally favorable growing conditions because all stock, bare-rooted as well as potted, survived to the extent of over 93.70%.

Planting of freshly dug stock shows a 10% advantage in survival over stock packaged and in shipment two days or stock stored 7 additional days in the package.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

## Management of Coffee Plantations

Beaumont, J. H., and Fukunaga, E. T. FACTORS AFFECTING GROWTH AND YIELD OF COFFEE IN KONA, HAWAII. Hawaii Agr. Expt. Sta. B. 113, 39 pp. 1958.

An attempt has been made to evaluate a number of factors affecting the growth and yield performance of the coffee tree (Coffee arabica var. typica) in the Kona District of Hawaii. The discussion is based primarily on trees growing under favorable light, moisture, and soil conditions at 1,500 feet elevation and without competition of shade trees.

Fertilized, unpruned trees naturally fall into a rather extreme alternate bearing cycle because of the dominant inverse relationship of yield and growth in the same year. Adverse weather is a definite factor in initiating alternate bearing cycles.

The alternate bearing habit occurred with topped trees and was aggravated by fertilization. These experiments demonstrated conclusively the importance of fertilization to improve yield of coffee trees but also emphasized the problem of controlling in some degree the alternate bearing tendency of the plant aggravated by heavy cropping. Control of the size and age of tree by pruning and of the growth or vigor of the trees by fertilization was attempted.

Observation indicated that the 3- and 4-year-old rows shaded each other and that dehorning of alternate rows, i.e., in a 1-3-2-4 sequence, might yield better results. Under the conditions of the test, the 8-foot spacing between rows is too close for the 4-year dehorning cycle but undoubtedly would be about right for a 3-year dehorning cycle.

Heavy fertilization of the 3-year-old row would seem to be a good horticultural practice in that it helps to maintain the growth and foliage of the third year and if so contributes to the yield of the fourth year.

The test demonstrated that under Kona conditions the systematic dehorning of rows of trees as a commercial practice may be entirely feasible so far as health and vigor of the tree is concerned, that no material sacrifice in yield occurs, and that other advantages may materialize.

U. Hawaii, Hawaii Agr. Expt. Sta., Honolulu, Hawaii.

## Fruit and Nut Crops

Tukey, L. D. PERIODICITY IN THE GROWTH OF FRUITS OF APPLES, PEACHES AND SOUR CHERRIES WITH SOME FACTORS INFLUENCING THIS DEVELOPMENT. Pa. Agr. Expt. Sta. B. 661, 21 pp. 1959.

The fact that a "rhythm of growth" of fruits of apple, peach, and sour cherry exists seem fairly well established from a series of experiments done in 1957 at University Park, Pa. Conditions during the night hours seemed to favor, while those during the daylight hours seemed to inhibit, fruit enlargement. During the daylight hours, fruits showed either little or no enlargement, or even shrinkage. In general, during the morning hours fruits did not enlarge and often lost size; during the afternoon fruits enlarged slightly and frequently recovered from morning shrinkage. Duration, occurrence, and extent of shrinkage seemed to be related to temporary deficiency of moisture in the tree. This deficiency seemed to be caused by the rate of moisture loss through foliar transpiration exceeding the rate of moisture uptake by the roots from the soil.

Withdrawal of moisture from the fruit, shown by fruit shrinkage, as well as loss from the limbs and trunk of the tree has been indicated by other workers. Conditions leading to rapid transpiration, reduced moisture uptake, restricted moisture translocation, and reduced moisture supply within the plant are suggested as some of the factors influencing the occurrence, duration, and extent of fruit shrinkage. Observations also indicate that high solar radiation mornings, especially those with rapid rises in solar radiation, do much initially to induce moisture stresses in the plants especially when soil-available water supplies are low. In some instances a moisture stress may become excessive in a few hours, while in others a longer period may be necessary. Other climatic conditions favoring moisture loss by the plant, such as wind velocity, and vapor pressure deficit and temperature, may aggravate the condition. The plant itself through the condition of its roots, trunk, and limbs may play a role in influencing this condition. Further, nutrition may have an important influence.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Brase, K. D., and Way, R. D. ROOTSTOCKS AND METHODS USED FOR DWARFING FRUIT TREES. N. Y. State Agr. Expt. Sta. (Geneva) B. 783, 50 pp. 1959.

Information obtained by experimentation with fruit tree rootstocks that can serve as dwarfing mediums for apple, cherry, peach, pear, and plum trees is summarized.

Historical aspects of dwarfing fruit tree rootstocks are reviewed, steps leading to the standardization of clonal apple rootstocks are presented and certain recommended clonal apple rootstocks having dwarfing and semi-dwarfing tendencies are discussed in detail.

Propagation technics that can bring about dwarfing effects as well as methods that help to control incompatibility factors, such as those commonly encountered when quince is used as the dwarfing rootstock for certain pear varieties, are described.

Results are reported with seedling rootstocks of three Prunus species as possible dwarfing mediums for cherry, peach, and plum.

N. Y. State Agr. Expt. Sta., Cornell U., Geneva, N. Y.

McMechan, A. D., and Fisher, D. V. THE BULK BIN METHOD OF HANDLING FRUIT: I. Cooling and Bruising of McIntosh Apples. Canad. J. Plant Sci. 38: 440-444. 1958.

Experiments were conducted to compare the rate of cooling and amount of bruising and stem puncturing of apples handled in 25-bushel bulk bins, and in conventional bushel boxes.

Fruit in bins with no facilities for ventilation cooled more slowly than in bushel boxes; fruit in bins with a 1-inch opening on all sides of the bin, at floor level, cooled almost as quickly as in bushel boxes.

McIntosh apples in good condition, dumped from the containers soon after being picked, suffered less bruising when handled in bins than when handled in boxes. There was no difference in the amount of stem puncturing caused by the two methods. When the apples were stored for 7 days without refrigeration before being dumped from the containers, there was no difference between the methods in the occurrence of bruising but there were more stem punctures in the bin-handled fruit. When the apples were held in cold storage for 36 days before being dumped, there was no difference between the methods, in either bruising or stem puncturing.

Canada Dept. Agr., Summerland, British Columbia, Canada.

Beattie, J. M. NITROGEN FERTILIZATION OF APPLES. Ohio Agr. Expt. Sta. Res. B. 817, 22 pp. 1958.

In a series of fertilizer experiments for apple trees in Ohio, the results were summarized as follows:

1. Annual applications of nitrogen are required for the successful production of apples in Ohio. Unless nitrogen is supplied by applications of manure or by the

maintenance of a permanent mulch, the annual requirements must be met by applications of commercial nitrogen fertilizer materials.

2. The most reliable and precise indicator of nitrogen needs found in these experiments was foliar analysis for total nitrogen. For this purpose, mid-shoot leaves sampled during late July were used. The optimum nitrogen content of these leaves is believed to be from 1.90 to 2.20 percent of the dry weight.
3. Nitrogen needs were found to vary within these limits from season to season and with size of crop. In years when light crops are produced, levels of leaf nitrogen near the lower limit of 1.90 percent appear to be adequate. When large crops are produced, better growth and production are obtainable when the July leaf nitrogen content approached the 2.20 percent level.
4. Leaf nitrogen was found to vary with tree age. Young vigorously growing trees up to 15 years of age were found to produce foliage which was highest in nitrogen. During the period from 16 through 25 years, the leaf nitrogen content was lowest. Trees 26 years and older were found to produce foliage with intermediate nitrogen contents.
5. Unless accurate methods for leaf analysis for total nitrogen and for the interpretation of the results are available, growers are urged to evaluate their nitrogen fertilizer program by careful observations of tree response.
6. All of the readily available forms of commercial nitrogen carriers are suitable for supplying the nitrogen needs of apple trees. On the basis of these experiments, foliage applications must be considered as a supplement to rather than a substitute for soil applications.
7. Soil applications of nitrogen should be made in the early spring each season about 6-8 weeks preceding bloom.
8. The rate of 1/4 lb. of a 16 percent nitrogen carrier per year of tree age is a good average recommendation, but in certain cases this amount is inadequate while in others it may be too much.
9. The results of the present work indicate that twice normal applications of nitrogen were of decided benefit in helping correct biennial bearing of Baldwin apples.
10. Nitrogen fertilizer application was shown to influence the accumulation of other essential elements, particularly that of potassium.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Nour, M. NUTRITIONAL STATUS OF APPLE ORCHARDS IN NEW MEXICO. N. Mex. Agr. Expt. Sta. B. 443, 23 pp. 1959.

Eighty-six apple orchards were visited and 182 leaf samples and the same number of soil samples were collected in the last week in July and the first 10 days of August. The leaf samples were collected from the five commercially-grown varieties in the state, Golden Delicious, Red Delicious, Jonathan, Stayman Winesap, and Rome Beauty.

The orchards samples were located in the four main apple-growing areas in the state: Hondo Valley; Middle Rio Grande Valley; Espanola Valley, and San Juan County.

Leaf samples were analyzed for nitrogen, phosphorus, potassium, calcium, magnesium, boron, and iron.

The results of the analyses showed that the majority of the trees were low in nitrogen, phosphorus, and iron, adequate in potassium, calcium, and boron, and high in magnesium.

Soil analyses showed that organic matter and phosphorus were low and pH high. Salt concentration was fair in most soils.

Recommendations were made to the growers to improve their fertilizer practices and program based on the results of this survey.

Agr. Expt. Sta., N. Mex. State U., State College, N. Mex.

Berg, A., Berg, G. C., and Orton, C. R. INTERNAL BARK NECROSIS OF APPLE RESULTING FROM MANGANESE TOXICITY. W. Va. U. Agr. Expt. Sta. B. 414T, 28 pp. 1958.

Internal Bark Necrosis is a non-parasitic disease affecting the apple tree. It is of primary importance on the variety Delicious and its sprouts, although other varieties may be affected.

In the early stages of the disease small elevations are visible on the epidermis and young bark which, if cut open, reveal dead area within the cortex and inner bark which oftentimes extend into the wood. As the disease develops, the older bark becomes rough and scaly, the affected limbs unthrifty, and death frequently follows.

The disease occurs when susceptible trees, under some conditions, take up manganese from the soil in such quantities that the tissues become poisoned as it accumulates within them. Manganese toxicity resulting in Internal Bark Necrosis develops most commonly on trees growing in soils of high manganese content and which are also usually highly acid.

Manganese is a minor element essential in minute quantities for plant growth. It is insoluble in neutral or alkaline soils, but becomes progressively more soluble as the soil acidity increases beyond the 6.5 pH level. Internal Bark Necrosis never developed on apple under experimental conditions when the soil pH was above 5.3. Consideration should be given to the fact that treatments which acidify the soil tend to increase the quantity of available manganese. The application of sodium nitrate was found also to favor development of the disease without causing any increase in soil acidity such as resulted from the addition of ammonium sulfate. The application of lime and other neutralizing substances reduced the availability of manganese. The incidence and severity of Internal Bark Necrosis usually can be controlled by such soil-neutralizing treatments.

W. Va. U., Agr. Expt. Sta., Morgantown, W. Va.

Sullivan, D. T., and Enzie, J. V. CULTURAL MANAGEMENT METHODS IN A YOUNG APPLE ORCHARD UNDER IRRIGATION. N. Mex. Agr. Expt. Sta. Res. Rpt. 19, 12 pp. 1959.

Three systems of orchard management under irrigation were compared: (1) Permanent sod; (2) alfalfa hay mulch; and (3) no tillage using chemical sprays to keep weeds in check.

The following results were found: (1) The alfalfa hay mulch treatment produced larger apple trees than permanent sod or chemical sprays for weed control after eight years of testing. (2) Greater total yield of fruit was produced by trees in the sprayed plots than those in the mulched plots and considerably more than those in sod. Since the mulched trees were the largest, presumably the situation may change in time. (3) The sod trees produced fruit with more red color which indicated a nitrogen and/or water deficiency in comparison with the other two treatments. (4) Little difference in fruit size was noted as a result of treatment. And (5) frequency of irrigation in 1957 was based upon irrometer readings which showed considerably more fluctuations in moisture level in the sod plots than in the other two treatments. Approximately twice as much water was applied to the sod plots as to the mulched and sprayed plots.

Agr. Expt. Sta., N. Mex. State U., State College, N. Mex.

Fleming, H. K. GROWTH AND MORTALITY IN A YOUNG SWEET CHERRY ORCHARD. Pa. Agr. Expt. Sta. B. 662, 12 pp. 1959.

Annual records of trunk circumference, yield, and tree mortality were taken in a young sweet cherry orchard from planting through its tenth year. The orchard was set with trees of two scion varieties. Napoleon and Windsor, each on two seedling rootstocks, Mazzard and Mahaleb. Each scion-stock combination was grown under two systems of soil management: clean cultivation with ryegrass cover seeded in early August, and permanent Ladino-clover sod.

All four scion-stock combinations grew faster under the clean cultivation-cover crop system than in sod. Surviving Windsor trees in a guard row cultivated on one side only were smaller than those in the cultivated blocks and larger than those in the sod blocks. Differences in final size of trees due to system of culture were highly significant; those due to scion variety or rootstock were not statistically significant.

Average annual yields from surviving trees for the last five years were closely correlated with sizes of trees. Those in cultivated blocks bore significantly more fruit than those in sod. There were no significant differences in yield due to scion variety or rootstock.

Tree losses were heavier where Napoleon was the scion variety. Factors inherent in the scion variety apparently have a profound effect on survival through the critical pre-bearing period.

Mortality was the same in cultivated and sod sections of the orchard. Retarding the rate of growth by sod competition offered no advantage in tree survival under the conditions of this experiment.

Fatalities were equally divided between trees on Mazzard and Mahaleb rootstocks. Half of the losses on Mahaleb were Napoleon. All losses on Mazzard, however, occurred where Napoleon was the scion variety. This scion-rootstock interaction in tree mortality was highly significant.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Lombard, P. B., and Cardinell, H. A. CHEMICAL THINNING OF PEACHES USING NAPHTHALENEACETIC ACID, N-1-NAPHTHYL PHTHALAMIC ACID, AND 3-CHLORO IPC. Mich. Q. B. 41(1): 147-156. 1958.

Peach thinning sprays of NPA, 3-chloro IPC and NAA were applied to Halehaven and Redhaven trees in 1955, 1956, and 1957 with the following results:

1. Redhaven trees were overthinned by NPA at 300 p.p.m. applied 3 days after full bloom in 1956. However, the use of NPA at 200 and 400 p.p.m. in 1955 and 200, 250, and 300 p.p.m. in 1957 did not over-thin. Trees treated in 1957 required further hand-thinning.
2. In 1956 Halehaven trees were thinned significantly with 300 p.p.m. of NPA at 200 and 400 p.p.m. in 1955 and at 200 and 250 p.p.m. in 1957 did not result in significant thinning.
3. The use of 3-chloro IPC at 400 p.p.m. on Redhaven and Halehaven 4 weeks after bloom in 1956 and 1957 did not thin sufficiently to eliminate hand-thinning. It did hasten ripening of the fruit as measured by firmness of flesh and did result in unfavorable "beaked" peaches. Because of the resulting misshapen fruit of both the Redhaven and Halehaven varieties, 3-chloro IPC is not suggested for peach thinning in Michigan.
4. Fruit size of Redhaven and Halehaven was increased in 1956 by the use of NPA at 300 p.p.m. However, the use of 3-chloro IPC at 400 p.p.m. increased the size of the fruit of only the Redhaven variety.
5. NAA at 30 p.p.m. applied 2 weeks after shuck-off in 1957 gave significant fruit thinning of both Redhaven and Halehaven and may warrant re-evaluation as a thinning agent for peaches. Although some terminal flagging occurred, twig and leaf injury did not appear to be of commercial importance.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Cation, D. SOME FUNGICIDE TRIALS ON TREE FRUITS IN 1958. Mich. Q. B. 41(3): 685-698. 1959.

Twenty-four fungicidal materials, or combinations of materials were tested on apples, pears, peaches, and sweet and sour cherries. Comparative apple scab control was not determined.

Of the Olin Mathieson materials, OM PRB-32, OM 1763 and OM G-1143, showed no perceptible injury to Jonathan apples. OM-2086 caused some fruit russet. All of these materials showed some degree of brown rot control on peaches. G-1143 showed promise in control of powdery mildew on apples.

Cyprex at 1/2 and 3/4 lb. dosage on Stayman and Jonathan apples ranked favorably in fruit finish with other materials. Cyprex showed no practical control of powdery mildew. On Bartlett pears it showed no injury and resulted in satisfactory fruit finish. Cyprex did not control brown rot on sweet cherries or peaches and seemed to increase cracking of the cherries. One-half pound Cyprex gave good control of leaf spot on sour cherries but retarded fruit ripening.

The borate and phthalate salts of Cyprex were indicated as possible materials for sour cherry leaf-spot control. The borate salt materially increased russeting of Stayman apples and fruit cracking on sweet cherries.

Glyodin in combination with mercuries (Phix and Panogen) resulted in favorable fruit finish on Stayman apples, and Bartlett pears. In combination with ferbam it increased russeting on Jonathan apples. Glyodin alone and in combinations appeared to increase cracking of sweet cherries. A Ferbam-Glyodin combination again gave satisfactory leaf spot control on Montmorency cherries but appears to need protective renewal sooner than copper sprays, Phaltan or Cyprex. Pears sprayed with Glyodin alone or in combination had good finish.

Captan was used only with ML-104 sticker. It was not outstanding in rot control on peaches or sweet cherries, and showed a late season breakdown in protectiveness on sour cherries. It does not control powdery mildew on apples. Phaltan was second best in reducing cracking of sweet cherries. It was effective against brown rot on peaches and sweet cherries but gave severe injury, consisting of a few burned spots, on sweet cherry leaves. It was outstanding in leaf spot control on sour cherries.

U9547 gave good leaf spot control but was least active of all materials in correcting lead injury on Montmorency cherries. Its activity against apple mildew is not enough for good control.

Actidione at 1 p. p. m. used with Glyodin reduced the size of sweet cherries, distorted the fruit, retarded ripening, and injured foliage. In combination with Ferbam, Actidione 1 p. p. m. applied to Montmorency cherries retarded fruit size in three preharvest sprays and with no long range protectivity it left the trees vulnerable to late season defoliation.

Bordeaux 3-6-100 resulted in severe lentical russeting of pears but one spray of 2-6-100 in the open blossom stage did not appear to influence the finish in this season.

A combination of low soluble copper plus sulfur and lime was outstanding in rot control and in preventing cracking of sweet cherries. However, it gave an unfavorable residue for fresh fruit sales. Low soluble copper plus lime again controlled leaf spot on sour cherries but resulted in reduced fruit size and foliage injury.

Thylate showed good indications in control of brown rot but had no deterrent effect on fruit cracking of sweet cherries.

Phybam and Ferbam-sulfur-Glyodin, both containing equivalent amounts of sulfur, were outstanding in retarding powdery mildew infection on Jonathan apples. This test showed the value of 2 to 3 lbs. of sulfur included in early apple sprays where mildew is a problem.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Taylor, J. STEM CANKER AND RELATED BLUEBERRY DISEASES. N. C. Agr. Expt. Sta. Tech. B. 132, 24 pp. 1958.

The most important limiting factor in production of highbush blueberries (Vaccinium australe Small), in the southern blueberry region is the stem canker disease, caused by (Botryosphaeria corticis (Demaree and Wilcox) Arx and Muller). This disease is present in most of the cultivated highbush blueberry (Vaccinium australe Small) plantings in North Carolina, and in most unselected plantings of the rabbiteye species (V. ashei Reed) in Georgia, Florida, Alabama, and Mississippi. It occurrs on wild plants in all of these areas and has been found in cultivated plantings as far north as New Jersey. Although the stem canker disease has been controlled by the use of canker-resistant varieties, a sound breeding and control program depends upon a more adequate knowledge of stem canker and related diseases.

Certain stages of the stem canker disease may be confused with stem fleck caused by (Gloeosporium minus Shear), Septoria canker caused by (Septoria albopunctata Demaree and Wilcox), and stem blight caused by an apparently undescribed species of (Botryosphaeria). The stem blight fungus is morphologically distinct from B. corticis. Studies reported in this paper give additional information on the canker disease, the causal fungus and other diseases which may be confused with stem canker.

Chemical control experiments indicated that ferbam and maneb will control most leaf diseases and some stem diseases of blueberries. Captan was ineffective in controlling any of the diseases which were prevalent in the nonsprayed check plots.

When ferbam sprays were applied at two-week intervals beginning in May or June and continuing through August, a significant reduction of leaf spots resulted.

Agr. Expt. Sta. N. C. State Col., Raleigh, N. C.

Cox, J. A., and Fleming, H. K. EFFECTS OF CERTAIN SPRAYS ON GROWTH AND YIELD OF CONCORD GRAPES. Pa. Agr. Expt. Sta. B. 652, 17 pp. 1959.

Experiments to determine the effects on growth and yield of Concord grapes from spray programs of DDT, bordeaux mixture, low soluble copper, captan, and ferbam were conducted on "balanced pruned" vines. Fertilizer and cultural programs were uniform for the treatments in two vineyards. Response to spray treatments was first apparent in growth of vine and differences in fruit yield one year later. Sprays of bordeaux mixture and DDT-bordeaux mixture reduced both growth and yield. In certain seasons sprays of DDT-low soluble copper and lime were depressing, but sprays of DDT, DDT-Captan, and DDT-ferbam had little or no effect on the growth of the vines. None of the treatments stimulated growth or increased yields.

Insects and diseases caused little or no economic losses in the experimental vineyards. Each year copper injury was apparent on vines treated with bordeaux mixture but was more pronounced during cool wet summers.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Larsen, R. P., Kenworthy, A. L., Bell, H. K., Benne, E. J., and Bass, S. T. EFFECTS OF NITROGEN, PHOSPHORUS, POTASSIUM AND MAGNESIUM FERTILIZERS ON YIELD AND PETIOLE NUTRIENT CONTENT OF A CONCORD GRAPE VINEYARD. Mich. Q. B. 41(4): 812-819. 1959.

The effects of nitrogen, phosphorus, potassium, and magnesium fertilizers on yield, petiole analysis, and soil analysis of a bearing Concord vineyard were designed to study 40 versus 80 pounds actual nitrogen per acre, no phosphorus versus 80 pounds, $P_2O_5$ per acre, no potassium versus 120 pounds $K_2O$ per acre, no magnesium versus 60 pounds $M_gO$ per acre, and potassium sulfate versus potassium chloride.

There were no significant differences between yield or soil test results with any fertilizer treatments of nitrogen, phosphorus or magnesium.

There was a highly significant reduction of petiole potassium in the no potash treatment and this was accompanied by a significant increase in petiole magnesium in the same treatment. This interactive effect between potassium and magnesium was further evidenced by a significant negative correlation.

The results further suggest that: (1) High yields of Concord grapes in Michigan can be maintained with lower rates of nitrogen than are now being applied by many growers; (2) phosphorus and magnesium need not be included as a part of the normal grape fertilizer in vineyards without annual applications of potassium; (3) potassium sulfate and potassium chloride are of equal value as a source of potash fertilizer; and (4) magnesium deficiency can be induced by excessive applications of potassium.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Sherman, M., and Tamashiro, M. TOXICITY OF INSECTICIDES AND ACARICIDES TO THE PAPAYA, (CARICA PAPAYA L.). Hawaii Agr. Expt. Sta. Tech. B. 40, 56 pp. 1959.

The phytotoxicity of proprietary formulations of the following pesticides to papaya was determined: parathion, EPN, malathion, schradan, demeton, TEPP, Aramite, Chlorobenzilate, ovex, aldrin, DDT, dieldrin, heptachlor, sulfur, and the triethanolamine salt of dinitro-o-sec-butyl phenol.

Phytotoxicity was measured in three ways: (1) Effect on seedling growth; (2) gross leaf pathology; and (3) fruit injury. A spray apparatus which was specially developed to apply the formulations to the papaya seedlings is described. The applications to the fruits were made with compressed air sprayers.

The effects of applying pesticides singly are summarized in table form. The emulsifiable formulation of a pesticide was usually more phytotoxic than the corresponding wettable powder. Most organic phosphates were highly toxic to papaya. Malathion, however, whether applied as an emulsion or as a suspension of a wettable powder was innocuous to papaya.

The fruits were more sensitive to the organic acaricides and to the emulsifiable formulations of the chlorinated hydrocarbons than were the seedlings. However, the fruits were more resistant than the seedlings to the organic phosphates; especially parathion.

The effect of combining certain of these pesticides was also studied. Injury occurred in several instances where materials were combined at concentrations which were innocuous when applied singly. Chlorobenzilate, in particular, appears to be hazardous when combined with other materials at concentrations usually recommended for mite control. Sulfur, although compatible with a large number of pesticides, can cause foliar injury when combined with emulsions.

U. Hawaii, Hawaii Agr. Expt. Sta., Honolulu, Hawaii.

Cibes, H., and Samuels, G. MINERAL-DEFICIENCY SYMPTOMS DISPLAYED BY RED SPANISH PINEAPPLE PLANTS GROWN UNDER CONTROLLED CONDITIONS. Puerto Rico Agr. Expt. Sta. Tech. Pa. 25, 32 pp. 1958.

Red Spanish pineapples grown in sand cultures in the greenhouse were allowed to develop deficiency symptoms caused by lack of major and minor mineral elements. The most important results were as follows:

1. The absence of nitrogen and phosphorus had the greatest influence in retarding growth in plants at 11 months of age.
2. The complete treatment gave highest yields of fruit at harvest. The minus-nitrogen and minus-phosphorus treatments failed to produce any fruit. The smallest fruits were produced in the absence of boron and potassium.
3. The ratio of fruit itself to the crown was found to be 7.2 for the complete treatment.
4. Slip and sucker production was highest under the complete treatment and none were produced when nitrogen and phosphorus were witheld.
5. Nitrogen, phosphorus, and potassium deficiencies cause the most severe decreases in total plant material produced, in that order.
6. The nutrient content of the pineapple leaf is not constant for the various components of the leaf and for the various plant materials produced.
7. The nitrogen content of the pineapple plant was lowest when nitrogen was omitted, and there was a large accumulation of phosphorus, potassium, manganese, and boron.
8. The average phosphorus content of the plant was highest for plants at 11 months, a little lower at harvest, and lowest for the suckers.
9. The potassium content of the plant was highest while actively growing and lowest at time of harvest. The omission of nitrogen, phosphorus, calcium, and magnesium all caused accumulations of leaf potassium. The omission of potassium caused an accumulation of leaf calcium.

10. Unlike nitrogen and potassium, calcium did not move from the older to the new plant parts.
11. There was little change in the magnesium content of the plant, except in the absence of magnesium.
12. The lowest leaf-sulfur values occurred when sulfur was absent from the nutrient solution.
13. The general iron content of the plant remained highest for the older plant at harvest. The iron did not tend to move into the slips.
14. Unlike iron, manganese was higher in the young plant than at harvest. Extremely high manganese values were found under the minus-nitrogen treatment.
15. The boron content of the plant averaged higher at 11 than at 22 months.
16. The nitrogen deficiency was the first to appear, and it was characterized by a lighter green color in the young leaves. In the intermediate stages of the deficiency, all new leaves showed a reddish margin as well as a pale lemon-yellow color; in the later stages, there was a complete loss of green color by all the leaves of the plant.
17. There was no chlorosis of the leaf for the minus-phosphorus treatment; the color of the new leaves were dark purple-green.
18. The leaf remained green, under potassium deficiency, but there was a drying up of the leaf tip and necrotic spots and blistered areas appeared on the surface. Under severe potassium deficiencies the older leaves turned brown and dried up; the younger leaves had a reddish-brown color with considerable tipburn.
19. The omission of calcium produced a pale-green leaf with some yellow mottling.
20. The chlorosis attributable to a magnesium deficiency began in the older leaves as a yellow-green mottling which coalesced to almost a yellow stripe along the leaf margin.
21. The symptoms caused by a sulfur deficiency were similar to those produced by a mild nitrogen deficiency, a light-green color with a slight yellow mottling.
22. Iron-deficiency visual symptoms appeared as a slight reddish tinge of the leaf plus a light green color.
23. No visual symptoms of deficiency were obtained when manganese or boron were omitted from the nutrient solution.

U. Puerto Rico, Agr. Expt. Sta., Rio Piedras, Puerto Rico.

Darrow, G. M. STRAWBERRY CULTURE SOUTH ATLANTIC AND GULF COAST REGIONS. U. S. D. A. Farm B. 1026, 36 pp. 1958.

Strawberry growing is an important industry in certain regions of the South Atlantic and Gulf Coast States. Because of the mild climate the plants grow almost all year. Flower buds usually are formed in the fall, winter, and spring.

Strawberry-growing practices in parts of the South are very different from those followed in other parts of the country, and for this reason directions for strawberry growing in other parts of the country are of little value.

Fruit from the South Atlantic and gulf coast regions is usually marketed when there is little or no competition. Strawberries are shipped to northern markets from the different areas throughout the winter and early spring. The shipments total about 11 percent of the entire crop of the United States.

ARS, USDA, Inform. Div., Washington 25, D. C.

Mead, P. K., and Kays, W. R. CHEMICAL WEED CONTROL EXPERIMENTS WITH STRAWBERRIES AND BLACKBERRIES. Okla. Agr. Expt. Sta. B. B-530, 15 pp. 1959.

The results of using herbicides to control weeds and grasses in strawberries indicate that the responses of similar treatments on plants grown on newly cleared land may not be the same as those with plants grown on "old" land. The reasons for this are not known although it suggests that differences in soil composition such as organic matter content and the ratio of stone to soil, may be associated with the difference in response.

The responses of similar treatments on plants grown on "old" land with mulch may not be the same as with those plants not mulched. Again the reasons are not known

although the differences in response are thought to be associated with differences in soil composition and perhaps available moisture and cooler root temperatures.

Under the conditions of these experiments the best herbicidal treatments were: On newly cleared land, not mulched--1 1/2 lbs. per acre, 2,4-D; on "old" land, not mulched-- 1 gal. per acre CIPC; and on "old" land, mulched--8 lbs. per acre, 2,4-DES.

Mulching of strawberries on "old" land more than tripled the total yield as compared with non-mulched plots on newly cleared land.

The results of using herbicides to control weeds and grasses in blackberries, indicate that most of the herbicides used, which satisfactorily controlled weeds and grasses, were injurious to blackberry plants as evidenced by visual injuries, reduction in berry size, and total yield. Under the conditions of these experiments the best herbicide treatment was 1 1/2 lbs. 2,4-D per acre.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

## Field Crops

Long, O. H. ROOT STUDIES ON SOME FARM CROPS IN TENNESSEE. Tenn. Agr. Expt. Sta. B. 301, 41 pp. 1959.

Depth of penetration and total yield of roots were measured under field conditions over a 3-year period on cotton, corn, alfalfa, wheat, a tall fescue-Ladino clover pasture mixture, soybeans, and burley tobacco in several soils.

Soil samples were taken in the various soil horizons and were subjected to certain physical and chemical analyses in an attempt to relate soil properties with growth of the crop both above and below ground.

Roots of cotton were the least extensive of the crops studied; depth of penetration by mature plants ranged from 18 to 37 inches, and root yields were from 297 to 3,229 pounds per acre, ovendry basis. Root systems of alfalfa were the most extensive; depth of root penetration ranged from 22 1/2 inches to 7 feet, and root yields from 3,079 to 11,912 pounds per acre.

Root studies also were made on cotton, corn, and soybeans at 2 to 3 stages of plant growth on a poorly-drained soil. Early growth of corn both above and below ground was much more rapid than that of cotton; soybean growth was intermediate, Cotton also was studied at 3 stages of growth on a well-drained soil.

In general, growth above and below ground appeared to be related more to the effective moisture content and degree of aeration of the soil than to its fertility status. Rarely did a crop root deeply in gray and yellow soils--colors indicative of restricted drainage and aeration. Usually associated with gray and yellow colors were dense and relatively impermeable layers within the rooting zone. However, intimate mixing of lime and fertilizer with the soil to a depth of 30 inches in three acid yellowish-brown subsoils of low fertility did result in a deeper, more extensive cotton root system and higher lint yields than were obtained where lime and fertilizer were incorporated in the surface layer only. Alfalfa yields also were higher on the deep-incorporation treatment.

A low fertility status of the subsoil in well-drained brown and red soils did not appear to hinder root development, and above ground yields usually were higher than they were on the poorly-drained soils. In both soil groups the roots showed a tendency to follow crevices between the large structural aggregates in the subsoil, and large volumes of soil were untouched by roots at the greater depths.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

Mortimore, C. G. KERNEL MOISTURE AND YIELD OF CORN AS INFLUENCED BY PRE-HARVEST FOLIAR DESICCATION. Canad. J. Plant Sci. 39: 39-42. 1959.

Experiments conducted in 1956 and 1957 showed that pre-harvest chemical desiccation of the foliage did not accelerate appreciably the loss of moisture from corn kernels. Severing of the stalks 6 inches above ground had no effect on the drying rate of the grain. Both treatments reduced yields substantially.

Forage Crops Div., Expt. Farms Serv., Ottawa, Ont., Canada.

Koehler, B. CORN EAR ROTS IN ILLINOIS. Ill. Agr. Expt. Sta. B. 639, 87 pp. Biblio. 1959.

Corn ear rot diseases continue to be of importance wherever corn is grown. In Illinois, they occur in practically every field and in every season, although they vary greatly in prevalence and amount of damage, not only between years, but from place to place in the same year.

As used in this bulletin, the term "corn ear rot diseases," includes the occurrence of rots and molds in ears or in shelled corn, in the field or in storage. Investigations were limited to ear rots on dent corn, although similar rots may be found on sweet corn, popcorn, and other kinds of corn.

Descriptions of ear rot diseases are given, long-time records of ear rot prevalence are reported, and estimates are made of financial losses. These sections are followed by a discussion of experiments on various factors influencing the prevalence of ear rot, and on methods for artificially inducing ear rots as an aid in selection for resistance.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

Extension Service*

* SOYBEAN KERNEL DAMAGE. Kans. State U. Ext. Serv. L. 57, 6 pp. 1959.
* GRAIN SORGHUM KERNEL DAMAGE. Kans. State U. Ext. Serv. L. 58, 6 pp. 1959.
* CORN KERNEL DAMAGE. Kans. State U. Ext. Serv. L. 59, 6 pp. 1959.

These three leaflets all show: (1) Colored pictures of kernel damage; (2) special grades and other grading factors; and (3) charts on grade requirements for their respective crops.

Kans. State U., Ext. Serv., Manhattan, Kans.

Tso, T. C. PHYSIOLOGY OF THE TOBACCO PLANT. Ann. Rev. Plant Physiology 9: 151-174. Biblio. 1958.

A partial review of the literature on the physiology of the tobacco plant. Quality is an important factor in production and has its basis in the physical and chemical properties of the leaf. Much could be done to modify these properties through cultural, curing, and fermentation practices if sufficient information was available to determine desirable effects, and the manner in which they could be manipulated. Instrumentation of the physical elements of quality has lagged, but the increasing knowledge of the chemical components of the tobacco leaf and their normal interactions may well lead to additional improvements in the future once they have been correlated with quality.

CRD, ARS, USDA, Beltsville, Md.

Scott, W. A. INVESTIGATIONS ON CURING BURLEY TOBACCO WITH ARTIFICIAL AIDS. Canad. J. Plant Sci. 39: 284-292. 1959.

Two methods of providing supplementary aid to natural curing of cigarette burley tobacco were investigated through five consecutive curing seasons. In one method temperature and humidity controlled heaters were used, and in the other a specially constructed calcium chloride dehydrator was used. Both methods were compared concurrently with natural air curing in respective pilot barns of three-quarter acre capacity. A similar comparison of curing was made in heated and unheated 3-acre capacity barns through two curing seasons.

The author concludes that: (1) The optimum average relative humidity of 65 to 70 percent for curing cigarette burley could be maintained approximately by supplementary heating in air-curing barns when the relative humidity in barns without heat averaged 90 percent at night and 77 percent during the day; (2) supplementary heating substantially improved quality and to some extent increased the yield of cigarette burley tobacco; (3) dehydration with calcium chloride was much less effective than auxiliary heating in controlling the relative humidity and the quality and yield of burley tobacco; (4) the optimum

relative humidity was obtained with an average temperature increase of 5 to 7° F. above that in unheated air-curing barns; (5) nighttime evaporation was more than doubled and daytime evaporation increased slightly with the application of auxiliary heat as measured by a Piche evaporimeter; (6) conversely, evaporation from tobacco tended to decrease during the day and increased during the night only with auxiliary heating; (7) auxiliary heating increased the average acre value of cigarette burley in a wide variety of curing seasons by 138 dollars at a cost of 32 dollars per acre for propane fuel; and (8) negligible monetary gain was obtained in only one year out of five when the curing season was abnormally cool and dry.

Canad. Dept. Agr., Harrow, Ontario, Canada.

Bowman, D. R., Nichols, B. C., and Jeffrey, R. N. TIME OF HARVEST--ITS EFFECT ON THE CHEMICAL COMPOSITION OF INDIVIDUAL LEAVES OF BURLEY TOBACCO. Tenn. Agr. Expt. Sta. B. 291, 19 pp. 1958.

Burley tobacco grown under conventional procedures was harvested 0, 11, 21, and 31 days after topping and the cured leaf was designated according to leaf position with each leaf position constituting a separate sample. The dry matter, total nitrogen, acid-insoluble nitrogen, nicotine, crude ash, Cl, P, K, and Ca, contents at each leaf level were determined separately on cured tobacco from each harvesting date.

The gain in dry matter of the leaves at the top of the plant was greater than its loss at the bottom of the plant.

The total nitrogen percentage was higher in the less mature leaves regardless of their position on the plant or the time of harvest. As maturity approached the other substances constituting the dry matter of the plant increased more rapidly than the nitrogen. This resulted in dilution of the nitrogen. The dilution occurred in spite of an increase in nicotine in the top leaves so rapid that the quantity in the top leaf was 19 1/2 times as much in the last harvest as it had been 31 days earlier.

The top of the plant contained more acid-insoluble nitrogen in the earlier harvests, but the bottom of the plant contained the most total nitrogen in the later harvests.

The nicotine content of the leaves increased with maturity of the plant. The earlier harvests showed the maximum in nicotine content at different positions on the plant. These maxima occurred at successively higher positions on the plant as it matured. At the first harvest the maximum was at the 5th leaf level; at the second harvest it was at the 8th leaf level; at the third harvest it was at the 10th leaf level; and at the fourth harvest the nicotine content continued to increase to the top of the plant. These results explain the conflicting statements in the literature as to the location of the maximum nicotine content on the plant.

The crude ash content of the leaves decreased from the bottom to the top of the plant. There was no significant difference among the ash contents for the different harvest dates.

The chlorine content of the leaves tended to increase from the base to the top of the plant. The increase was greater in the upper leaves at the later harvests.

The phosphorus content of the leaves showed a nearly constant value in all harvests except the first.

The potassium content of the leaves from the first two harvests was higher than that from the last two harvests. This finding showed that the potassium migrated from mature to growing tissue. The last two harvests were of mature tobacco.

The values for the calcium content, when compared with those for the potassium content, strikingly showed the difference between the results obtained with an element which migrates with one which does not, once it enters the leaf.

The nitrogen summary gives a partial breakdown of the nitrogenous fractions of the leaf. In each harvest the non-nicotine soluble nitrogen increased from the base to the top of the plant. In general the ratio of acid-insoluble nitrogen to total nitrogen was highest in the lower third of the plant, leveled off near the middle of the plant, and remained relatively constant for the upper part of the plant.

CRD, ARS, USDA and U. Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Nichols, B. C., and McMurtrey, J. E. Jr. PRIMING TESTS WITH BURLEY TOBACCO. Tenn. Agr. Expt. Sta. B. 285, 14 pp. 1959.

Priming tests with burley tobacco were conducted at the Greenville, Tennessee Tobacco Experiment Station over a 5-year period. The usual harvesting procedure of stalk cutting was compared with priming once, twice, and three times. Two varieties, Kentucky 16 and Burley 1, were compared in the first 4 years, and Kentucky 16 the final year.

Data presented show that priming once gave significant increases in yields and acre values of tobacco over stalk cutting. The influence of priming on tobacco quality factors evaluated was less favorable than on yield and acre value. It is suggested that the taking of one priming from burley would usually be profitable. Priming more than once is not likely to be justified.

The Kentucky 16 and Burley 1 varieties were shown to have similar yielding abilities. Burley 1, however, was superior to Kentucky 16 in quality and acre value.

CRD, ARS, USDA and U. Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Walker, E. K., and Vickery, L. S. SOME EFFECTS OF SPRINKLER IRRIGATION ON FLUE-CURED TOBACCO. Canad. J. Plant Sci. 39: 164-174. 1959.

Supplemental irrigation experiments were conducted to determine the effects of variable amounts of water on the yield, quality, maturity, chemical composition, and physical characteristics of flue-cured tobacco.

Irrigation improved the yield, quality, and maturity for four consecutive years, although by a comparatively small amount in one year because of favorable distribution of rainfall. Neither the yield nor the quality was improved by applications of water in excess of optimum amounts. Tobacco irrigated according to time intervals or stages of growth received either too much or too little water. Thornthwaite evapotranspiration estimates and resistance blocks for determining soil moisture were found to be suitable methods for scheduling irrigation.

Leaves from irrigated plots contained less total nitrogen, total alkaloids, and petroleum ether extract but more total sugars, potassium, and chlorine than leaves from unirrigated plots. The phosphorus content of the leaf was unaffected by irrigation. Irrigation had little effect on the leaf thickness, length of burn, filling power, and strip yield.

Tobacco Div., Expt. Farms Serv., Canad. Dept. Agr., Ottawa, Ontario, Canada.

Reynolds, E. B. COTTON PRODUCTION IN TEXAS. Tex. Agr. Expt. Sta. B. 938, 47 pp. 1959.

Cotton is the most valuable cash crop in Texas, although it now ranks second in acreage to sorghum for grain. For the 5 years, 1952-56, the Texas cotton crop, including lint and seed, had an average yearly value of more that $720,000,000.

The High Plains, Rolling Plains, Blackland Prairies, and the Lower Rio Grande Valley are the great cotton production areas in Texas. In recent years, much of the cotton production has shifted to areas where water is available for irrigation. Cotton grows well on many kinds of soil, but is seems to do best on moderately fertile, deep loam and sandy loam soils in good structure and having permeable subsoils.

There are about 80 varieties of cotton available to Texas growers. For convenience, these varieties are classed into seven broad types or classes having different characteristics. The relative acreages of these types grown in the several land resource areas of the State are given. The storm-resistant, big-boll type seems to be more widely grown than other types.

Cultural practices used in growing cotton in Texas are similar to those used in growing other row crops. Preparation of the seedbed usually is done in the fall or early winter. Preparation may include disking, chiseling, flat breaking, or bedding (listing). In the humid part of the State, most of the cotton is planted on beds. In areas having less than 25 inches of average yearly rainfall, it usually is planted in lister furrows.

Cotton usually is planted after the average date of the last killing frost in the spring. Much of the cotton in Texas is planted to a stand, using 20 to 30 pounds of seed per acre. Plant populations of 40,000 to 60,000 plants per acre are about optimum for mechanical stripper harvesting, and 25,000 to 60,000 plants for machine picking.

The amount of cultivation done depends on the amount and distribution of rainfall, with a cultivation after each good rain. In the humid parts of the State, several cultivations usually are needed to control weeds. Cultivation and hand hoeing are the principal methods of controlling weeds in cotton. Rotary hoeing, the use of weed-control chemicals and flame cultivation are supplementary practices.

Many of the soils in Texas respond to fertilizers, but, where the average yearly rainfall is less than 30 inches, moisture generally is the limiting factor in yields of cotton on dryland. Fertilizer recommendations are given for the several land resource areas.

Cotton is grown only under irrigation in the Trans-Pecos area and under supplementary irrigation on the High Plains, in the Lower Rio Grande Valley, scattered areas on the Rio Grande Plain and the Rolling Plains. On the High Plains, about 25 to 30 inches of water, including rainfall and irrigation, are about optimum for cotton production. Methods of controlling the various insects and diseases are given.

The use of preharvest chemicals for defoliating and desiccating cotton is discussed. Defoliation aids in the control of insects and greatly reduces the cost of machine harvesting. Cotton is harvested principally by hand, but an ever-increasing proportion is harvested by mechanical pickers and mechanical strippers.

Tex. Agr. Expt. Sta., Tex. Agr. Ext. Serv., College Station, Tex.

Raskopf, B. D. COTTON YIELDS AND QUALITY IN TENNESSEE. Tenn. Agr. Expt. Sta. B. 298, 26 pp. 1959.

During the 31 year period, 1928-58, cotton in Tennessee has maintained its position as the leading cash crop despite the decline in acreage. The loss in income from acreage reduction has been offset by increases in yield and increase in prices which resulted from improvements in cotton quality.

Since 1928 the average yields in both the variety tests and for all farmers growing cotton have shown an annual average increase of 8 pounds per acre annually.

Increase in cotton lint yields per acre is closely associated with increased use of commercial fertilizer. From 1932 to 1958 the proportion of cotton acreage in the state that was commercially fertilized increased from 13 to 99 percent, and the rate of application of commercial fertilizer used per acre on cotton planted increased from 22 to 496 pounds.

The estimated reduction from full yield of lint cotton per acre from 1928 to 1954 averaged 11.2 percent because of deficient moisture, 2.6 percent from excessive moisture, 5.1 percent from other adverse climatic conditions, 3.1 percent from boll weevil, 1.8 percent from other insects, and 1.6 percent from plant diseases.

During 15 years of cotton acreage controls, compared with 16 years of uncontrolled acreage, the plantings average 202,000 fewer acres annually. However, lint yield per acre averaged 46 pounds higher for all growers and 66 pounds higher in recommended variety tests. During the years of acreage controls, compared with no controls, growers applied an average of 41 more pounds of commercial fertilizer per planted acre.

The average staple length of cotton in 32nds of an inch increased steadily from 29.2 in 1928 to 33.6 in 1958 and averaged 31.8 for the 31 years. The proportion of cotton 1 inch and longer in staple length increased from 6.2 percent in 1930 to 97.6 percent in 1958.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

Lane, H. C. SIMULATED HAIL DAMAGE EXPERIMENTS IN COTTON. Tex. Agr. Expt. Sta. B. 934, 16 pp. 1959.

Cotton grown on the High Plains and in the Trans-Pecos area of Texas frequently is damaged by hail. The damage varies from a few punctured or destroyed leaves and fruiting structures to complete destruction of the stem and bark to ground level. A number of experiments have been carried out to simulate hail injuries. Spacing, defoliation, various stalk cutoffs, stem bruises, and combinations of injuries have been inflicted by hand. The main features of the results of these treatments follow.

Stands were thinned substantially from the average stand found in the areas without reducing the yield. An optimum stand was found to be two plants per foot of row.

Total defoliation retarded recovery and delayed maturity. The cotton plant, however, was not affected markedly by removal of one-third or two-thirds of its leaves. Furthermore, the cotton plant regenerated new leaves rapidly.

The terminal bud is not necessary for growth and fruiting of the cotton plant. Topping height decreased nor increased yields significantly.

Early-season stem injuries did not affect growth and fruiting. Treated plants did not lodge after a boll crop was made.

The cotton plant recovered after the stem was severed above the lowest node. The buds at the node forced into growth and a new plant was realized. Early-season injuries did not reduce yield greatly, but considerable loss in yield resulted from treatments later in the season. Results of severing the stem at the middle joint were similar for early treatments, but this injury did not depress yields as much as the low cutoff during the later stages.

A test of the effect of various levels of defoliation in combination with other injuries revealed that no large additional decreases resulted from the combinations except for the 100 percent level of defoliation.

Tex. Agr. Expt. Sta., College Station, Tex.

Staten, R. D., and Hodges, R. J. SOYBEAN PRODUCTION IN TEXAS. Tex. Agr. Expt. Sta. B. 919, 14 pp. 1958.

Soybeans have been grown in Texas for more than 40 years, but have not become an important crop although their potential value is recognized. The development of better adapted varieties, the use of better production methods, and the development of adequate marketing facilities could increase the use of soybeans.

Soybeans can be grown in most irrigated sections of Texas. Average yields under irrigation are approximately 25 bushels per acre, but some relatively large plantings have produced 30 to 40 bushels per acre. At this level of production, soybeans do not give as much cash return as does grain sorghum. Soybeans, however, are valuable in soil-improving rotations, and weed control following soybeans is not as serious a problem as following grain sorghum. Soybeans are grown principally for seed, which are used to produce soybean oil and meal.

Soybeans are adapted to about the same soil and climatic conditions as corn or cotton. They do best on well drained, mellow, fertile sandy loams, but good results can be obtained on most properly-drained soils when irrigated.

Lee is the most important soybean variety in Texas, primarily because of its high degree of shatter and disease resistance. Other varieties used for seed production include Ogden, Dorman, Jackson, and Improved Pelican.

Soybeans generally are planted in 36-to 42-inch rows at a rate to give 10 to 12 plants per foot of row. The date of seeding soybean is important because of the sensitivity of the plants to day length and temperature. Optimum planting dates occur when the minimum soil temperature is above 65° F. and after the day length reaches 14 1/2 hours.

Soybeans should be harvested when fully mature, but before the first pods begin to shatter. Defoliating soybeans with chemicals to hasten maturity reduces the yield and the quality of the bean.

Several leaf-eating insects may damage soybeans. These include the bean leaf beetle, legume caterpillar, corn earworm, green cloverworm, and fall armyworm. Most insect damage occurs in August and September.

Tex. Agr. Expt. Sta., College Station, Tex.

Price, C., and Stokes, I. E. SWEET SORGHUM GROWING IN SOUTHERN CALIFORNIA. U.S.D.A., A.R.S. 34-10, 11 pp. 1959.

Sweet sorghum, a relatively new crop in southern California, is especially valuable to the farmers there who plant restricted acreages or who have livestock to feed. Livestock feeding is an important industry in the Imperial Valley, where sorghum is grown

as a forage crop. As forage, sweet sorghum is used chiefly as fodder (placed in pit silos and later fed to cattle in feedlots); occasionally the crop is pastured.

Sweet sorghum is potentially valuable for sugar production, and is being considered as a source of sugar by sugar companies in California. The U. S. Department of Agriculture conducted an extensive research program from 1942 to 1945 to study the possibilities of sweet sorghum for sugar production in some of the major sugar-beet-growing areas. These tests showed that the old established varieties were not adequate. The yield per acre was satisfactory, but the quality of juice (sugar content) was unsatisfactory. The most promising of these tests were in the Imperial Valley of California.

A breeding program was accordingly initiated in 1946 to produce varieties of sweet sorghum that were adapted to the Imperial Valley of California and possessed lodging resistance, high sucrose content, and high purity. Hundreds of varieties from other countries and from different sections of the United States were studied to determine their adaptability to the area. Hybridization of the best varieties resulted in hundreds of new selections for testing in the Imperial Valley. The new variety Brawley, released for commercial production in 1958, resulted from this research.

ARS, USDA, Inform. Div., Washington 25, D. C.

Grimes, D. W., and Musick, J. T. HOW PLANT SPACING, FERTILITY, AND IRRIGATION AFFECT GRAIN SORGHUM PRODUCTION IN SOUTHWESTERN KANSAS. Kans. State U. Agr. Expt. Sta. B. 414, 17 pp. 1959.

Studies were conducted from 1952 through 1958 on the Garden City Branch Agricultural Experiment Station, on spacing and fertility and irrigation of grain sorghums.

The effects of stand thickness and row widths on yields, tillering, and size of heads were determined. Their effect of seasonal water use and efficiency of water use for grain production were studied also.

The following conclusions were drawn from the experiments: (1) An area from 50 to 60 square inches per plant is most desirable with ample moisture. This corresponds to a plant population of slightly more than 100,000 plants per acre. (2) Narrower rows, with adequate irrigation, yielded more than wide rows, when area per plant remained the same. Rows should be kept as narrow as possible while maintaining a weed-free condition and most effective irrigation. (3) With optimum stands (50 to 60 inches per plant), each head produced approximately 25 grams of threshed grain. (4) With optimum stands, there was little or no tillering. (5) Spacings made no difference on fertilizer response. (6) With limited moisture, which occurred with only pre-planting irrigation in 1955 and 1956, wide rows and lower seeding rates produced higher yields. (7) Seasonal water use was not affected significantly when stands varied from 28 to 112 square inches per plant, 224,000 and 56,000 plants acre, respectively, in 1957 and 1958. (8) When width of row was 14 inches or more, moisture was depleted faster directly under plants when midway between rows. This effect was more pronounced as width of row increased. Differences diminished as the drying cycle between irrigations continued.

SWCRD, ARS, USDA and Garden City Branch Agr. Expt. Sta. Kans. State U., Garden City, Kans.

Quinby, J. R., Kramer, N. W., Stephens, J. C., Lahr, K. A., and Karper, R. E. GRAIN SORGHUM PRODUCTION IN TEXAS. Tex. Agr. Expt. Sta. B. 912, 35 pp. 1958.

Grain sorghum is the second crop in Texas in money value, being exceeded only by cotton. The average annual monetary value of the crop in Texas, since 1949 has been 130 million dollars. Sorghum is grown on substantial acreage for grain in about 135 Texas counties. The large areas of concentrated production are the High Plains, and the Rio Grande Plain.

The chief use for sorghum grain in the United States is as feed for poultry, cattle, sheep, and swine. The grain, which contains 12 percent protein, 3 percent fat, and 70 percent carbohydrates, compares favorably with corn as a feed grain. The starch from sorghum grain can be used for food products, adhesives, and sizing for paper and fabrics.

Cultural practices for sorghum are similar to those required by other row crops such as cotton and corn. The method of seedbed preparation and and later cultivation depends largely on the soils, climate, and the kind of equipment available. In the more humid areas of the State, sorghum is planted in the top of beds, but in the drier areas, it is planted in the bottom of a lister furrow. The optimum depth of planting is about 2 inches. The amount of cultivation required is determined largely by rainfall, with a cultivation necessary for weed control after each rain. Planting rates vary from 2 to 10 pounds of seed per acre.

Many Texas soils will produce a profitable crop of sorghum grain without the addition of plant food, but other soils are deficient in one or more of the three major plant nutrients. The value of a grain sorghum crop on dryland does not justify a large outlay for fertilizer. Where water is available for irrigation and high yields are obtained, fertilization usually is profitable.

Although sorghum is a drouth-tolerant crop, it responds well to supplemental irrigation. In most of Texas, rainfall will provide half or more of the 21 to 23 inches of water needed for large yields of sorghum grain.

The sorghum grain crop is threshed from standing stalks with a combine, usually before frost. In the drier areas of the State, the moisture content of grain threshed from green stalks frequently is low enough to allow immediate storage of grain without drying. In the more humid areas, however, it usually is necessary to dry the grain before it can be stored safely.

Diseases and insects which attack sorghum in Texas are described briefly in this publication, along with some methods of control.

Sorghum has been grown in Texas since about 1857. Only forage and sirup varieties were available at first, but grain varieties were being grown before 1900. Sorghum improvement in Texas began in 1904. The important grain varieties were first headed by hand, but since 1940 shorter varieties of combine height have been grown. The problems of hybrid seed production in sorghum were solved recently and hybrids were grown widely for the first time in 1957.

Sorghum is a species of tropical origin, but is cultivated now in latitudes as high as 40 degrees and at altitudes as high as 5,000 feet. Sorghum is a "short day" species, but many of the varieties grown in the United States are relatively insensitive to photoperiod. The time of heading in sorghum is influenced by temperature as well as by photoperiod, and sorghum varieties vary in their sensitivity to both temperature and photoperiod.

CRD, ARS, USDA and Tex. Agr. Expt. Sta., College Station, Tex.

Leggett, G. E. RELATIONSHIPS BETWEEN WHEAT YIELD, AVAILABLE MOISTURE AND AVAILABLE NITROGEN IN EASTERN WASHINGTON DRY LAND AREAS. Wash. Agr. Expt. Sta. B. 609, 16 pp. 1959.

The results of ninety fertility experiments conducted on dry land wheat in eastern Washington during the period 1953-57 were used to determine the relationship between wheat yield and available moisture. The maximum wheat yield obtained from each experiment was plotted against the sum of the available soil moisture in the spring of the crop year (about April 1) and the rain which fell between the time of sampling and the time the wheat was mature. Analysis of the data indicates that 4 inches of water are required to grow the crop to the heading stage and that each additional inch of water increases the yield approximately 6 bushels per acre.

The results of sixty-two experiments were used to determine the relationship between wheat yields and available nitrogen. The maximum yield obtained from each experiment was plotted against the nitrate-nitrogen in the unfertilized plots about seeding time plus the fertilizer nitrogen required to give maximum yield. Linear regression analysis of these data indicates that approximately 3 pounds of nitrogen per acre are required to increase the wheat yield 1 bushel per acre over the range where nitrogen is limiting yield.

It is possible to calculate nitrogen fertilizer recommendations from the results of soil tests for nitrate-nitrogen and available soil moisture by use of these relationships. It is essential, however, that the soil samples be taken when the results of the analyses will be most meaningful. Thus, the moisture supply can be evaluated most accurately in

the spring of the crop year. Nitrate-nitrogen should be determined before the addition of $NH_4$-type fertilizer or after such fertilizer has been completely nitrified and before a significant amount of nitrate-nitrogen has been absorbed by the crop.

Wash. Agr. Expt. Sta., Inst. Agr. Sci., Wash. State U., Pullman, Wash.

Martin, J. E., Martin, L. R., and Toussaint, W. D. DRYING WHEAT AND CORN ON NORTH CAROLINA FARMS. N. C. Tech. B. 128, 49 pp. 1958.

Grain producers have five alternative grain handling procedures from which to select the one that will maximize net income. These five alternatives are: using no drier, drying with natural or heated air for immediate sale and drying with natural or heated air for storage and sale at a later date. The purpose of this report is to develop the information needed by grain producers in order to make a rational choice among these alternatives. The conditions that affect this decision are the season, amount, and type of grain produced and whether the producer already owns drier and bins, bins only or either. The information required includes fixed costs of the bins and a breakdown of the variable and fixed costs of driers for 1, 3, and 5 HP natural air driers and for 3 and 5 HP heated air driers.

Agr. Expt. Sta., N. C. State Col., Raleigh, N. C.

Holt, E. C. SMALL GRAINS FOR FORAGE. Tex. Agr. Expt. Sta. B. 944, 16 pp. 1959.

Small grains produce good yields of high quality forage at a season of the year when green grazing is limited. Forage production generally is more dependable and yields higher than for any other crop grown for winter pasture. Acreage of small grains grown for forage exceed that of any other winter grazing crop.

Clipping management studies have shown that forage yields may be reduced 20 to 80 percent by early and frequent pasturing or clipping. Allowing the plant to become well established, 6 to 8 inches high, before grazing begins is particularly important if maximum yields are to be obtained.

Growth studies with oats have shown a direct relationship of growth to temperature. Winter temperatures generally are mild enough south of College Station for continuous growth. The management program should allow for residual or accumulated growth for use during periods of growth stoppage north of College Station. Growth is related to rainfall or available moisture during the growing season. Apparently about 20 inches of rainfall from September through April is adequate in most areas. Excessive rainfall for maximum growth may occur, especially in the coastal area.

A number of varieties, especially of oats, are adapted for forage production. These include Mustang, New Nortex, Alamo, Camelia, Bronco, and Victorgrain oats; and Cordova, and Goliad barley, and Abruzzi rye. Several new varieties, including Gator and Elbon rye and Mid-South oats, show promise for both early and sustained production.

Small grain varieties differ in growth habit, some producing maximum forage in the fall and others during the spring. Mixtures of spring and winter-type oats have not produced more than either type in pure stands. Cross-seedings also have shown no yield advantage, but they might improve footing for grazing animals under wet conditions.

Legumes interplanted with small grains are used to some extent. This practice has improved yields only slightly, but it may increase the protein content of the forage.

Seeding rates from 48 and 112 pounds per acre appear to have little influence on total forage production, except that production is favored to some extent by the heavier seeding rates in the Eastern Area.

Tex. Agr. Expt. Sta., College Station, Tex.

Atkins, I. M., Gardenhire, J. H., and Porter, K. B. OATS FOR GRAIN, WINTER PASTURE AND OTHER USES. Tex. Agr. Expt. Sta. B. 929, 20 pp. 1959.

Oats are one of the most widely grown crops in Texas. Although they are important as a cash crop only in the concentrated production areas of Central Texas, their indirect

contribution for farm income as winter pasture, greenchop feeding, hay or silage often equals their value for grain.

The oats acreage is widely distributed in Texas. The type and varieties grown in an area are determined by winter temperatures, disease resistance, and uses made of the crop. Most of the oats are fall sown except in seasons of favorable spring rainfall or when winterkilling occurs.

The acreage of oats has expanded in recent years because of increased use of the crop as winter pasture and for other forage uses. The crop responds well in increased forage yields to applications of fertilizer. A new use of oats for forage is green-crop feeding of livestock. The crop also may be used for silage and hay and is a high yielding green-manure crop.

Winterkilling is a major hazard of production but the recent development of adapted hardy varieties such as Mustang and Bronco have increased the dependability of fall-sown oats in the northwestern part of the State.

Diseases are important factors in production of oats for both grain and forage in Texas. The major diseases are crown rust, stem rust, Helminthosporium blights, and smut. These and other diseases are described and control measures are suggested.

The major insects attacking oats are greenbugs (aphid), spider mites, and army or cutworms. Insecticides are now available for control of these insects. Breeding (work) to develop oat varieties resistant to greenbugs is in progress.

CRD, ARS, USDA and Tex. Agr. Expt. Sta., College Station, Tex.

Crosier, W. F., Nittler, L. W., and Waters, E. C. THE QUALITY OF SEED OATS COLLECTED FROM NEW YORK FARMS IN 1958. N. Y. State Agr. Expt. Sta. (Geneva) B. 785, 33 pp. 1959.

In 1958, vocational agricultural students collected 588 samples of oats from drills or bags in 25 counties. Of these samples, 240 represented seed stocks purchased from dealers or sales agents. The 348 samples of farm-grown seed were taken from 107 uncleaned, 80 farm-cleaned, and 161 custom-cleaned stocks. Dealers' lots were better cleaned than farmers' lots, laboratory tests revealing that the average pure seed contents were 99.43 and 97.71 percent, respectively, and the average weed seed contents 0.03 and 0.19 percent, respectively. Cleaning improved the quality of farm grown oats since the average percentages of pure seed were: uncleaned, 95.83; farm-cleaned, 98.09; and custom cleaned 98.75. The average percentages of weed seeds were 0.35, 0.06, and 0.08 respectively. A seed treatment was present on 88 percent of the dealers' samples, but on only 43 percent of the farmers' seed. The Garry and Rodney varieties accounted for 84 percent of the 588 samples and for 81 percent of the 11,379 acres planted in the survey. Seed of excellent, good, and poor quality was planted on 2,820, 5,068, and 3,491 acres respectively.

N. Y. State Agr. Expt. Sta., Cornell U., Geneva, N. Y.

Atkins, I. M., Gardenhire, J. H., and Porter, K. B. BARLEY PRODUCTION IN Texas. Tex. Agr. Expt. Sta. B. 918, 15 pp. 1958.

Barley is a relatively minor crop in Texas, but it has a dual value to growers as a grain crop and as winter pasture for livestock. The use of barley as a winter pasture crop for livestock has expanded considerably in recent years.

The barley acreage is distributed widely over the State. The type and varieties of barley grown in an area are determined by winter temperatures and uses made of the crop. All barley grown for grain in Texas is used for livestock feed. Large acreages are grown exclusively for winter pasture and grazed to maturity.

Most of the barley is fall sown, although when conditions are favorable, some is spring sown in the northwestern part of the State. Winterkilling is one hazard of production in the northwestern part of Texas. Barley does best on well-drained land and responds well to fertilizer applications for grain and forage production.

All barley varieties grown in Texas are of the common six-row awned type. True winter-type varieties such as Kearney, Reno, and Ward are the most winter hardy. Intermediate winter-type varieties make up the majority of the acreage. Spring-type varieties

may be grown in South Texas for forage purposes. Barley performance tests are conducted throughout the small grain growing areas of Texas. Recommendations are based on yield tests at several locations in each area.

Diseases are important in barley production some years, especially in the southern half of the State. The major diseases are net blotch, leaf and stem rust, and the smuts. These and other diseases are described in this bulletin and control measures are suggested where known. The major insect of barley in Texas is the greenbug. Insecticides now are available for control of this insect. Other insects which may cause serious damage some seasons include other species of aphids, the winter grain mite, armyworms, and cutworms.

CRD, ARS, USDA and Tex. Agr. Expt. Sta., College Station, Tex.

Cook, R. L., and Davis, J. F. AN ANALYSIS OF PRODUCTION PRACTICES OF SUGAR BEET FARMERS IN MICHIGAN--1958. Mich. Q. B. 42(2): 401-420. 1959.

Data from a comprehensive field survey of cultural practices for sugar beets used in the Michigan Sugar Company area have been analyzed and are summarized as follows: (1) Average yields from 45,895 acres of mineral soils and 2,578 acres of muck soil were 16.0 and 13.8 tons, respectively; (2) the average yields of beets obtained from 35,124 acres of tiled land and from 10,771 acres of untiled land were 16.7 and 13.5 tons per acre, respectively; (3) highest yields of beets were obtained where beans was the preceding crop and lowest yields where beets followed beets in the rotation; (4) best yields on the average were obtained on fields plowed 10 to 12 inches deep; (5) the average yield of beets decreased as the number of times worked between plowing and planting increased; (6) an application of approximately 700 pounds of fertilizer per acre was on the average the most practical amount to use; (7) the sugar beet crop is very responsive to N, $P_2O_5$ and $K_2O$. An application of 80 to 100 pounds of N, 100 to 150 pounds of $P_2O_5$, and 50 to 100 pounds of $K_2O$ per acre is on the average a practical amount to apply; (8) higher yields on the average were obtained where X:2:1 ratio of fertilizer was used than where the ratio was X:1:1; (9) higher yields were associated with early planting dates; and (10) the summary of the data is based on weather conditions of 1958.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Coppock, R. IN SUGAR BEETS: LABOR BOTTLENECKS BROKEN. West. Crops and Farm Mangt. 9 (7): 22. 1960.

It looks like the last big labor bottlenecks in sugar beet production--weeding and thinning--are about to be smashed by new advances in technology.

Throughout California's Central Valley last season, a new pre-emergence spray material, Endothal, did a good job under commercial conditions.

Mechanical thinning proved itself even in the highest yielding sugar beet fields. All spokesmen emphasize that there is no substitute for experience when a grower takes up mechanical thinning. The most common mistakes made by beginners are (1) failure to remove enough plants because the field is so thoroughly, if temporarily, beat up after mechanical thinning; and (2) failure to prepare seedbeds carefully enough to get a uniform stand so the machine, chopping at random, can remove the right number of young plants. It is estimated that $5 per acre will pay for the mechanical operation, after which from $3 to $10 may be needed to "trim"--that is, remove weeds and clean out occasional clumps of young beet plants. With hand crews, thinning and hoeing often cost $35 per acre or more.

Endothal is so soluble that irrigation water carries it into the center of the beds, between the plant rows. In single row plantings there is no problem. Compared to the cost of hand labor, weed sprays save even more money than mechanical thinning. At presently recommended rates, Endothal costs the grower about $7 per acre plus the costs of application. TCA is even less expensive. It can cost up to $60 per acre to control a really serious weed infestation with hoes and sweat.

Vittum, M. T., Tapley, W. T., and Peck, N. H. RESPONSE OF TOMATO VARIETIES TO IRRIGATION AND FERTILITY LEVEL. N. Y. State Agr. Expt. Sta., (Geneva) B. 782, 78 pp. 1958.

During the five-year period 1952-56, irrigating whenever "available" water in the upper 24 inches of soil dropped below 50 percent reduced early yields of marketable tomatoes but significantly increased late and total yields. Yield increases, averaging 6.65 tons per acre per year, were obtained in 1954 and 1955.

Doubling the recommended application of complete fertilizer slightly increased early and late yields, and significantly increased midseason and total yields of fruit. The average annual increase was 0.87 ton of tomatoes per acre, which would normally pay for the extra fertilizer. Although the interaction of fertility level X irrigation was not statistically significant over the 5-year average, the response to extra fertilizer was considerably greater on irrigated plots than it was on nonirrigated plots in the two years 1954 and 1955.

When results for all year, irrigation treatments, and fertility levels are averaged, Red Jacket was the highest yielding of the six varieties which was grown for each of five years, with an average of 11.38 tons per acre per year. It was followed by Red Top, Gem, Longred, John Baer, and Stokesdale, with 10.51, 9.81, 9.10, 8.97, and 8.61 tons per acre per year, respectively. In the three years in which it was included in the experiment, Geneva 11 outyielded Red Jacket by an average of 1.92 tons per acre per year.

Varieties responded differentially to irrigation. Over the 5-year period, irrigation increased the yield of John Baer by 2.77 tons per acre per year, whereas it increased the yield of Gem by only 0.53 ton per acre per year.

Varieties also responded differentially to fertility level. Extra fertilizer increased the yield of Red Top by an average of 2.13 tons per acre per year, whereas it increased the yield of John Baer by only 0.02 ton per acre per year.

Largest yields of tomatoes, averaging 12.60 tons per acre per year for the 5-year period, were obtained from irrigated plots of Red Jacket which received extra fertilizer.

N. Y. State Agr. Expt. Sta., Cornell U., Geneva, N. Y.

Richardson, L. T. EFFECT OF INSECTICIDES AND HERBICIDES APPLIED TO SOIL ON THE DEVELOPMENT OF PLANT DISEASES: II. EARLY BLIGHT AND FUSARIUM WILT ON TOMATO. Canad. J. Plant Sci. 39: 30-38. 1959.

The effects of several insecticides and herbicides on the development of early blight and Fusarium wilt on tomato were investigated. Young tomato plants were grown in sand to which solutions or suspensions of these chemicals were applied repeatedly before the foliage was inoculated with spores of Alternaria solani and either before or after the roots were inoculated with spores of Fusarium oxysporum f. lycopersici. On the basis of lesion counts, increased early blight development resulted from applications of lindane, 2,4-D, and isodrin, and decreased disease from endrin, MH, NPA, dieldrin, IPC, dalapon, demeton, and aldrin. Lindane, isodrin, and dalapon increased the severity of Fusarium wilt whereas endrin, aldrin, TCA, DDT, and dinoseb reduced it. 2,4-D and MH affected wilt development in a susceptible and a resistant variety in different ways according to the time of application in relation to inoculation, but they did not alter the reaction of an immune variety.

Canad. Dept. Agr., London, Ontario, Canada.

Strong, M. C. FUNGICIDAL SPRAY TRIALS ON TOMATOES, 1957-58. Mich. Q. B. 41(4): 853-858. 1959.

A good fungicidal spray program will greatly increase total marketable yield of tomatoes. Thorough coverage and proper timing are necessary for best results. A tank-mix combination of a fixed (water insoluble) copper plus ziram or zineb each at one half the manufacturer's recommended rate of application will provide good control of anthracnose and the three blight diseases. Niacide Z or M plus COCS and tribasic copper sulfate plus Parzate or Dithane Z-78 are examples of such combinations.

Dyrene at 3 lbs. per 100 gallons or maneb are also recommended fungicides.

Phaltan has given much promise in two seasons' tests and may be recommended after further testing. Agrimycin 500 plus ziram also has given very satisfactory results in the 1957 and 1958 trials, but as of this date may not be used on tomatoes after fruit set because it has not been accepted by the U. S. Food and Drug Administration for such use.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Linn, M. B., and Luckmann, W. H. TOMATO DISEASES AND INSECT PESTS: IDENTIFICATION AND CONTROL. U. Ill., Col. Agr. C. 809; 59 pp. 1959.

Like most crops, the tomato is subject to a number of diseases and is attacked by several insects. While not all cause serious losses, a number require definite attention if the crop is to be grown with profit. The information given in this circular is designed for home gardeners, commercial tomato growers, cannery fieldmen, and all others interested in growing tomatoes.

In addition to specific control measures for specific troubles, there are several general practices that all tomato growers should follow to keep losses from diseases and insects at a minimum. These are: (1) Select disease-free seed; (2) treat seed; (3) plant on clean soil; (4) see that seedbeds are well ventilated; (5) use only healthy transplants; (6) ventilate southern-grown plants as soon as received; (7) pay close attention to sanitation; (8) rotate crops; (9) keep out of field when plants are wet; and, (10) watch for first signs of diseases and insect pests. Apply proper sprays or dusts promptly. To control diseases satisfactorily, it is usually necessary to apply fungicides before the diseases appear.

Ill. Nat'l. Hist. Survey and U. Ill., Col. Agr., Ext. Serv. Agr. and Home Econ., Urbana, Ill.

Wilson, J. D. NEW VERSUS OLDER FUNGICIDES FOR THE CONTROL OF LATE BLIGHT. Ohio. Agr. Expt. Sta. Res. C. 69, 22 pp. 1959.

Late blight was severe on both potatoes and tomatoes in the fall of 1958, and this made it possible to evaluate a variety of fungicides on the basis of their ability to control the disease on both crops at various locations in Ohio.

The authors conclude that it seems apparent that maneb is the best of the present-day fungicides for the control of late blight of potato and tomato, and that it may be expected to give good control of the diseases of tomato. Also, Phaltan offers promise as a tomato fungicide, and if it is used at 3 pounds per acre per application, it should give good control of the tomato disease complex.

Zineb probably ranks somewhat below maneb in the control of late blight on potato and tomato and in the control of tomato anthracnose, especially in a 10-day schedule of spray application.

The fixed coppers, including copper zinc chromate, are effective in the control of late blight on both crops but fail in the control of tomato anthracnose.

Ohio Agri. Expt. Sta., Wooster, Ohio.

Jacob, W. C. STUDIES ON INTERNAL BLACK SPOT OF POTATOES. Cornell U. Agr. Expt. Sta. Memoir 368, 86 pp. 1959.

Internal black spot of potatoes, a physiological disorder, has been a serious problem on Long Island since 1939. This tuber defect has been costing the Long Island potato growers thousands of dollars each year because of the failure of tubers to make No. 1 Grade. The studies reported herein have covered field, laboratory, and storage work carried on since 1950, in an effort to determine the causes and the control of internal black spot. The results of approximately 65 experiments may be summarized as follows: (1) Of the mineral elements investigated, potassium seemed to exert the most influence on black spot; increasing the amounts of potassium decreased the occurrence of the black spot disorder. It was necessary to apply approximately 600 pounds of potash per acre to obtain commercial control. (2) To a certain extent, sodium seemed an adequate substitute

for potassium. (3) The effect of irrigation cannot be described very accurately; sometimes it increased and sometimes it decreased black spot. (4) Variety is the most positive answer to the black spot problem at the present time. (5) On Long Island potatoes planted after the first of June are much less likely to blacken than are those planted in April. (6) Storage temperature and humidity influence the time of occurrence of black spot but are not the controlling factors. (7) Bruising is the single most important factor in bringing about black spot occurrence. If potatoes are not bruised they will never turn black. (8) Chemical composition of the tubers seems to be related to the susceptibility to black spot. When chemical composition is altered by fertilization practice: higher tyrosine is associated with higher black spot index; higher soluble nitrogen fraction; and higher specific gravity. When variety or date of planting or location is the influencing factor on black spot occurrence, high tyrosine seems to be associated with low black spot. (9) Specific gravity of the tuber seems to be related to black spot occurrence within lots only. (10) Storage at 40° F. seems to permit less black spot to develop than does storage at a lower or a higher temperature. And (11) A 2-day heat treatment at 70° F. will completely inhibit blackening even though tubers are subsequently bruised. However, storing tubers for 2 weeks at 40° will overcome the effects of the heat treatment.

Cornell U., Agr. Expt. Sta., N. Y. State Col. Agr., Ithaca, N. Y.

Cunningham, C. E., Murphy, H. J., Goven, M. J., and Akeley, R. V. DATE OF PLANTING, LENGTH OF GROWING SEASON, VINE KILLING, DATE OF HARVESTING. . . AND HOW THEY AFFECT YIELDS, SPECIFIC GRAVITY AND MATURITY OF POTATOES. Maine Agr. Expt. Sta. B. 579, 31 pp. 1959.

Studies to determine the effects of date of planting, date of harvesting, and the length of the growing season on the yields and specific gravities of Katahdin and Kennebec potatoes were conducted in 1953. The effects of date and method of vine killing and the date of harvest on yields, specific gravity, and tuber maturity of several varieties were studied over the 5-year period, 1952-56.

Tuber growth rate depended among other factors on the date at which the potatoes were planted and upon the portion of the season during which rate of growth was determined. Late planted potatoes grew more rapidly than early planted tubers, but early killing frosts were a limiting factor to increasing the length of the growing season in order to have tubers of high specific gravity. Therefore, early planting appeared to be more desirable particularly with late-maturing varieties. Potatoes of any one variety should be top killed in the same order in which they were planted in order to obtain the greatest length of growing season.

Delay in vine killing resulted in higher yields of tubers in most seasons. For all seasons and all varieties, killing vines with an arsenical vine killer resulted in slightly higher yields of tubers than when the vines were cut to simulate rotobeating. The greater rate of growth of the Kennebec and Cherokee varieties resulted in higher tuber yields at all dates of kill than were obtained with the slower growing Katahdin potatoes.

Since potential yields are reduced by vine killing, each individual grower must try to estimate for each field and variety the vine killing date that will result in the greatest marketable yield of good maturity potatoes per acre. Other factors such as the danger of late blight tuber rot when potatoes are harvested from green vines, and the losses that might result from harvesting immature or field-frosted tubers must be considered by each grower.

The specific gravity of tubers usually increased up to the period September 4 to 9, but it did not always increase further when vine killing was delayed beyond that time. Tubers harvested from green vines on the day that the vines were killed were of higher specific gravity than tubers harvested 10 days after top killing. The use of arsenical vine killers usually resulted in potatoes of higher specific gravity than when the vines were cut to simulate rotobeating. The decision between arsenical killers and rotobeating must consider information on the varieties concerned because the tubers of some varieties are susceptible to vascular discolorations as a result of using arsenicals.

Tuber maturity increased as the vines increased with age even though the vines were still green and actively manufacturing carbohydrates. Tubers skinned less easily when they were harvested 10 days after the vines were killed than when they were harvested from green vines.

When tubers were allowed to remain in the ground for 20 days after top killing the degree of skinning indices at 10 days and at 20 days was greater with early top killing dates. Therefore as the season progresses the interval of time between vine killing and harvest can be reduced without any appreciable change in the amount of skinning. The danger of late blight tuber rot is reduced however if the vines are completely dead before the potatoes are harvested.

Tubers released from the vines more easily at later dates of harvest. When tops were killed at an early date, vine release was easier after the potatoes had been left in the ground for 10 days.

CRD, ARS, USDA and Maine Agr. Expt. Sta., U. Maine, Orono, Maine.

Eldredge, J. C., and Thomas, W. I. POPCORN . . . ITS PRODUCTION, PROCESSING AND UTILIZATION. Agr. and Home Econ. Expt. Sta. B. 127, 15 pp. 1959.

This is a brief summary of many years of research on all phases of the popcorn industry.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

Vittum, M. T., Peck, N. H., and Carruth, A. F. RESPONSE OF SWEET CORN TO IRRIGATION, FERTILITY LEVEL, AND SPACING. N. Y. State Agr. Expt. Sta. (Geneva) B. 786, 45 pp. 1959.

A split, split-plot design was used to determine the effect of irrigation (as main plots), fertility level (as sub-plots), and spacing or plant population (as sub-sub plots) on the growth, yield, and quality of sweet corn.

During the 5-year period 1952-56, irrigation, whenever "available" water in the upper 24 inches of soil dropped below 50 percent significantly increased the number of marketable ears per plant, the average weight per ear, the gross yield of unhusked ears, and the percentage usable corn which could be cut from these ears.

Irrigation had no effect on plants per acre, or on quality as measured by percentage moisture in the cut corn. Irrigated plots, on the average, were harvested 2.2 days later than nonirrigated plots. For the four years when irrigation was necessary, nonirrigated plots averaged 4.46 tons of marketable ears, whereas irrigated plots averaged 5.85 tons per acre. This increase of 1.39 tons per acre per year, or 31 percent was highly significant.

Doubling the recommended or "normal" application of complete fertilizer caused no significant changes in plants per acre, ears per plant, average weight per ear, gross yield, percentage cut corn, or percentage moisture in the cut corn. Average annual applications on "normal" fertility level plots were 48-32-32 pounds per acre, respectively, of $N$-$P_2O_5$-$K_2O$.

Close spacing, up to 15,800 plants per acre, significantly reduced the marketable ears per plant and the average weight per ear, but it significantly increased the acre yield. Close spacing increased the percentage of usable corn which could be cut from the ears.

Over the 5-year period, interactions of irrigation, fertility level, and spacing were not statistically significant.

Largest yields of marketable ears for the 5-year period, averaging 6.32 tons per acre, were obtained from irrigated plants spaced 9.7 to 10.9 inches apart in 3-foot rows, which received the normal application of fertilizer.

N. Y. State Agr. Expt. Sta., Cornell U., Geneva, N. Y.

Stark, F. C., and Matthews, W. A. IMPROVING QUALITY OF CANTALOUPES AND TOMATOES BY FOLIAR FEEDING. Md. Agr. Expt. Sta. B. 464, 19 pp. 1958.

Foliar feeding studies were conducted with cantaloupes for 6 years and with tomatoes for 4 years on a light sandy loam at Salisbury, Maryland. Numerous materials were tested on both crops.

The work leads to the following conclusions: (1) Boron and magnesium were not sufficiently available from this soil in most seasons to produce the highest quality cantaloupes and tomatoes. (2) Foliar applications of borax and magnesium sulfate supplied the boron and magnesium needed to enhance the fruit quality of both crops. (3) Spray applications

of magnesium sulfate at 4 lbs./A. and borax at 2 lbs./A. were most beneficial when applied with zineb or maneb (fungicide). (4) Foliar feeding was equally beneficial on six varieties of cantaloupes tested. Less response was obtained to foliar feeding on early plantings of cantaloupes than on late plantings. (5) Response to foliar applications of magnesium and boron was not reduced by soil applications of these materials. (6) Time of application of nutrient salts is important to obtain the maximum response in quality and yield. And (7) an economic study of the value of foliar feeding on tomatoes indicates a net return of $37.44 per acre.

Results of frequency and timing of applications reported in this study amplified by observations under commercial conditions, suggest that with moderate applications of lime and fertilizer, two foliar feedings would be optimum. These applications appear to be best applied as follows:

Cantaloupes--(1) When the vines begin to run; and (2) when the crown fruit is 1 to 2 inches in diameter. Tomatoes--(1) When the crown fruit begins to turn; and (2) during the third week of harvest.

An additional application to tomatoes may be made during the fifth week of harvest if it is desired to prolong the harvest period.

U. Md., Agr. Expt. Sta., College Park, Md.

McCall, W. W., Lucas, R. R., Hansen, C. M., and Hulburt, W. C. FERTILIZER PLACEMENT STUDIES WITH THE PICKLING CUCUMBER. Mich. Q. B. 40(3): 637-645. 1958.

The development of new equipment for fertilizer placement made possible more accurate placement studies with vegetable crops.

Fertilizer placement studies with pickling cucumbers were conducted on Conver 1 in 1956 and 1957. A 12-12-12 fertilizer was applied at the rate of 300 lbs. per acre in 1956 and 420 lbs. per acre in 1957.

Plots which produced the greatest yields were those on which the nitrogen was broadcast and the phosphorus and potassium were placed in a band 2 inches to the side and 2 inches below the seed. The average yield was 134 hundred weights per acre for the 2 years.

Lowest yields, 78 hundred weights per acre, were obtained from plots broadcast with fertilizer after they had been plowed.

When one-half of the fertilizer was broadcast and the other half was placed in a band 2 inches to the side and 2 inches below the seed, the plot produced an average of 107 hundred weights per acre.

Maximum yields were obtained by broadcasting the plant nutrient (nitrogen) carrier which causes the greatest salt content in the soil.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

LeBaron, M., Hungerford, C. W., Portman, R. W., and Myers, V. I. BEAN PRODUCTION IN IDAHO. Idaho Agr. Expt. Sta. B. 282, 23 pp. 1958.

Idaho ranks first among the states in the production of garden bean seed and second in the production of field beans. This position is possible because of Idaho's unique geographic location which is conducive to the production of high-quality, disease-free seed. The gross income to the farmers from beans is approximately $20,000,000 annually, placing this crop among the leaders in Idaho agriculture.

The major bean production area extends along the Snake River from south-central to southwestern Idaho. The soils of this region are predominantly silt loams with sandy loams in some localized areas. The extent of bean production in this general region is limited only by the length of the frost-free growing season. An area of lesser importance is in northern Idaho, where beans are grown on non-irrigated farms along the ridges above the Clearwater River in Latah, Nez Perce, Lewis, and Clearwater counties. The soils of this region are silt loams.

This is a complete culture and care bulletin for the growing of beans in Idaho. This bulletin contains a section on disease control. A more complete report on disease of beans can be obtained in the Idaho Agriculture Experiment Station Bulletin No. 293 also published in 1958.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

## ECONOMIC AND SOCIAL

### Costs and Returns

Swanson, E. R. HIGHEST RETURN FARMING SYSTEMS FOR DRUMMER-FLANAGAN SOILS. Ill. Agr. Expt. Sta. B. 629, 24 pp. 1958.

This bulletin presents the highest-return farming systems (combinations of crop and livestock enterprises) for various situations on Drummer-Flanagan soils. These soils are highly productive, dark-colored prairie soils found primarily in east-central Illinois.

By use of the method of linear programming, the following three types of highest-return farming systems were developed: (1) Maximized labor income per acre of land farmed; (2) maximized labor income per hour of labor used; and (3) maximized cash balance per dollar of money spent.

Two labor supply situations were considered: one man, and one man and one boy. Commodity prices used were the 1946-1955 average Illinois farm prices.

The effect of varying corn, hog, and cattle prices on the selection of highest-return systems was analyzed for a 160-acre one-man farm and a 320-acre one-man and one-boy farm.

MAXIMUM LABOR INCOME PER ACRE OF LAND. In order to meet this objective one-man farms in the size range of 50 to 95 acres need to feed rather large numbers of hogs and cattle and to have 40 percent of the land in standover legumes. With farm size increasing beyond 95 acres, litters of hogs increase and cattle feeding decreases. Total labor income reaches a maximum at a farm size of 257 acres.

The relation of size of farm to systems giving highest returns per acre for the one-man and one-boy labor situation is similar to that for the one-man labor supply. The added labor of the boy, together with the change in the seasonal distribution of available labor, causes the livestock system to contain more cattle relative to hogs than the one-man labor supply systems. Maximum total labor income occurs at 343 acres.

MAXIMUM LABOR INCOME PER HOUR OF LABOR. When less than two-thirds of the one-man labor supply (12 months) is used, highest returns per hour of labor are received with a rotation of C-C-Sb-W (C1) and no livestock. Increasing labor use from this level to the 12 months available requires addition of pasture-fed cattle and a small hog enterprise in order to maintain maximum return per hour.

A cash-grain system gives highest returns per hour for the one-man and one-boy labor supply when actual labor use is less than 9 months of the total 15.3 available months. Labor use beyond 9 months requires introduction of cattle fed on pasture in order to maximize labor income per hour spent working. Hogs are necessary to attain this objective when labor use goes beyond 14.5 months.

MAXIMUM CASH BALANCE PER DOLLAR OF CASH EXPENSES. With annual cash expenses at $1,600, a one-man 160-acre farm would obtain highest return per dollar spent by growing soybeans. As cash expenses increase, corn replaces soybeans. Between $2,500 and $9,100 the maximum amount of corn is grown at "medium level of management." Spending beyond $9,100 requires shifting to a "moderately high level of management" for corn which entails heavier fertilizer applications. Hogs are a part of the highest-return system beginning at $3,000 cash expenses; cattle feeding is required beyond the $10,400 level.

The pattern of highest-return systems as related to level of cash expenses is similar for the 320-acre one-man and one-boy operation. The primary difference is that the changes in systems necessary to maintain highest return occur at higher levels of cash expenses.

EFFECT OF PRICE CHANGES ON HIGHEST-RETURN FARMING SYSTEMS. A study of the effect of changes in hog and corn prices on highest-return farming systems indicated the various hog-corn price combinations necessary to make profitable shifts in organization ranging from systems containing no hogs to very intensive hog farms. Similarly, the feeder-cattle and slaughter-cattle price combinations necessary to make profitable

livestock organization changes ranging from systems with no cattle to large numbers of cattle are presented. The results show that, in the situations considered, the hog-corn price ratio necessary to break even is not a constant but is higher with lower prices for corn. The price margin between feeder and slaughter cattle necessary to break even is higher for lower prices of feeder cattle.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

Blosser, R. H. ECONOMICS OF FARMING ON PAULDING SOIL. Ohio Agr. Expt. Sta. Res. B. 838, 35 pp. 1959.

Paulding soil is difficult to manage because of fine texture and poor drainage. But under ideal conditions, this soil will produce high crop yields. Crop yields vary considerably on Paulding soil. High yields occur under optimum conditions which include good surface and internal drainage, moderate applications of fertilizer, and proper distribution of rainfall, particularly during the planting and early growing season.

Low yields of corn and soybeans often occur because of late plantings and poor stands. Late plantings are common on Paulding soil because of very slow drying after a rain. In extremely wet years, some farmers are unable to plant all of the corn and soybeans they had hoped to raise.

Oats yields are usually low on Paulding soil because of late seeding. But wheat yields are generally satisfactory when plantings are made not later than the first week in October. Soybeans are grown on more acres than any other single crop because they can be planted later than oats or corn.

Crop yields were affected more by drainage than any other single factor. Annual profits from the best drained land were calculated to be about $5.50 more per acre than net returns from the poorest drained land. If all of this additional profit were capitalized at four percent, a landlord owning poorly drained land could afford to invest about $42 an acre in additional drainage installations to get this increased income. An owner-operator might be able to justify a slighly higher investment. Surface drainage and the filling of shallow depressions should be considered as a means of reducing the amount of tile needed.

Response from fertilizer depended upon how well the land was drained. Above average drained land produced greater profits from a given amount of fertilizer than below average drained land.

More meadow crops did not seem to contribute much to increasing grain yields per acre. A cropping program with 19 percent meadows gave about the same corn yields as one having 35 percent.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Robbins, P. R., Juillerat, M. E., and Ohlroggee, A. J. CROP COSTS AND RETURNS ON MAJOR SOIL ASSOCIATIONS IN NORTHERN INDIANA, 1956. Purdue U. Agr. Expt. Sta. Res. B. 673, 24 pp. 1959.

Major objectives of this study were to measure physical inputs and costs, to determine yield expectations for major crops under specified situations in northern Indiana, and to compute net returns for various crops and for various rotations. The group survey method was used in obtaining data. Only "better-than-average" farmers were included. Some of the major findings of the study were as follows:

1. When comparable sized power and equipment were used, there was little difference in time requirements, between soils, for performing various operations in crop production, except a slight difference in time required for plowing.
2. Total cost for performing an operation such as disking, usually decreased as size of power and equipment increased, provided power and equipment were properly matched as to size.
3. Most of the increased cost for labor, power, and equipment, associated with higher yields, was required for crop harvest. Harvesting costs, however, did not increase greatly as yields increased.

4. Fertilizer on most farms, especially in the production of corn, was one of the largest items of cost in crop production.
5. Based upon net return per acre, corn was the most profitable crop on all soils studied. First-year corn after a good legume sod was more profitable than second or subsequent corn crops.
6. Wheat generally ranked second to corn in profitableness, but in some cases it was more profitable than second or other years corn. The average cost of raising an acre of wheat was $47.
7. Soybeans were a little less profitable than wheat on all soils, but were considerably more profitable than oats or meadow crops. Wheat returns averaged about $8 more profit per acre than did soybeans. The cost of raising an acre of soybeans was about $45.
8. Spring oats was a low-profit crop on all soils studied. The average cost of producing an acre of oats was about $42.
9. Considering only market value of feed produced, meadow was a low-profit crop on all soils. Since meadow is a low-profit crop, growing more than is necessary to maintain fertility at a satisfactory level usually reduces the net return from crop production.
10. If the comparison of costs and returns can be considered typical, the following changes seem logical for the future: (1) More corn appears to be in prospect; (2) farmers will make greater use of commercial nitrogen; (3) meadow intercrops are likely to replace more and more standover meadow; (4) oats will likely make up a smaller percentage of the rotation; (5) wheat will be substituted for oats whenever possible; and (6) as the use of commercial nitrogen becomes widespread and grain drying facilities are available on more farms, corn will likely be substituted for more soybeans in the rotation.
11. Potential yields as estimated by the Purdue University Agronomy Department from agronomic research data indicate that many farmers in the area could increase profits from their cropping program by: (1) Modernizing their rotation; (2) using the most profitable amounts of fertilizer; and (3) doing a better job on cultural practices.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Mosher, M. M. THE ECONOMIC VALUE OF SEVENTEEN WESTERN WASHINGTON FARM FORESTS. Wash. Agr. Expt. Sta. B. 596, 27 pp. 1958.

The seventeen case studies represent a cross section of farm forestry in western Washington. It is evident that the farm woodland has played a significant part in the economy of these farms. It cannot be said that all of the harvests of timber followed the best forestry practices or perhaps even good forestry practices. In several cases the timber was exploited to improve the agricultural phases of the farm. In other cases the timber was over-cut to provide needed income for family maintenance. From the standpoint of farmers in the borderline agricultural areas, the presence of woodland on the farm is like a bank account. As long as it stands the forest will continue to grow and increase in volume and value. Then when an emergency arises, it can be cut to provide the needed income.

The best way to manage farm woodland areas is to make annual or periodic harvests designed to remove the amount of annual or periodic growth of the woodland. This could be a thinning, a partial cut, or a clear cut by small areas at a time. It is better to plan the cutting so that part of the woodland will have trees near merchantable size at all times.

The cases reviewed here indicate that the woodland portion of the farm, although containing only 33.9 percent of the land area, return 49.8 percent of the farm income. This return required just 7 percent of the operator's time.

It may be pointed out that this record of good income for the time involved was accomplished by overcutting or liquidating of the timber crop on some of the farms. It is possible that both agricultural and forest resources were depleted on several of the farms studied. The best solution to problems found in this 10-year study seems to be a combination agricultural-forestry operation without sacrificing good management of one to the benefit of the other.

The information gathered in this study indicates the desirability of continued ownership of forest land by farmers. A forest crop is much like an agricultural crop in that after the harvest, the land is still there, ready for growing a new crop. The fact that these farmers received 49.8 percent of their farm income over a 10-year period without expenditure for land preparation, seeding or planting is another indication of the desirability of owning forest land. Forest land should be cared for and properly managed to secure the maximum benefit from it.

Wash. Agr. Expt. Sta., Inst. Agr. Sci., Wash. State U., Pullman, Wash.

Corty, F. L., and Stevens, J. J. PINE PLANTING AND PROFITS IN NORTH LOUISIANA. La. Agr. Expt. Sta. B. 525, 28 pp. 1959.

The data and analyses apply particularly to loblolly pine and growing conditions found in North Louisiana.

In light of the price relationships existing in the past and the price outlook for the future, it has been conservatively estimated that for the next 40 years the stumpage price of pulpwood will maintain the same relative position with respect to the composite wholesale price of all commodities. The price for sawlogs and poles, however, is expected to show a substantial relative increase.

In terms of current (1958) dollars, the net profit to be expected from pulpwood harvest at 25 to 30 years will probably amount to $4 or $5 per acre per year. The annual net return to sawlogs at 40 years, on the basis of current dollars, will be slightly more than $8 per acre, and by the 70th year will be more than $20 per acre.

The returns, as stated, assume that the landowner has idle fields on which to plant trees and that he will receive no government subsidies. If government aid is available, in the form of cost-sharing or rental payments, the returns will be substantially greater.

Assuming that the landowner wishes to have a more rapid turnover for reinvestment purposes, without loss of capital earnings, the desirable rotation for pulpwood appears to be about 25 years. If discounted net revenue is to be maximized, a 60-year sawtimber rotation is suggested.

The compound interest rate resulting from timber growth is at a maximum at 25 years of age. It amounts to 12.4 percent when the only cost involved is a planting cost of $13.57 per acre. This rate of return is even higher than that possibly realized from sawtimber production at the 97 percent higher price predicted for the year 2000.

If a charge of $1.27 for management, taxes, and fire protection is added to the planting cost of $13.57, a compound interest rate of approximately 8 percent is realized either from a pulpwood harvest at 20 to 25 years or from a sawtimber harvest at 40 years, assuming a 97 percent higher price for sawtimber 40 years hence.

The forest management practice illustrated by the growth and harvest data used in this report is designed to have the forest regenerate itself, thus eliminating the need for replanting after the initial stand is harvested. This implies that future generations of forest owners may avoid the initial cost of tree planting and have only the nominal cost of management, taxes, and fire protection to be considered. The rate of return under such conditions would be considerably higher than those presented in this analysis.

On the basis of pulp of pulpwood production it does not appear advisable to exceed $50 per acre for site preparation. A sum of $50 for site preparation added to the cost of planting, management, and taxes, will just about cancel out any profits realized beyond the normal four percent return expected from a conservative long-term investment.

If a person were satisfied with a normal four percent return on a 40-year investment, he could afford to pay $50 per acre for land which requires no site preparation prior to tree planting.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Doll, J. P., Heady, E. O., and Pesek, J. T. FERTILIZER PRODUCTION FUNCTIONS FOR CORN AND OATS; INCLUDING AN ANALYSIS OF IRRIGATED AND RESIDUAL RESPONSE. Agr. and Home Econ. Expt. Sta. Res. B. 463: 363-394. 1958.

This study includes predictions of fertilizer production functions for four experiments. The experiments on Clarion sil and McPaul sil soils contain predictions of total and marginal yields, isoquants and marginal rates of substitution, isoclines and economic optima. Similar analyses for the other two experiments, conducted on Carrington sil soil during successive growing seasons, were not warranted because insufficient rainfall limited yield responses. The experiments included in this study were based on partially replicated factorial designs.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

Orazem, F., and Herring, R. B. ECONOMIC ASPECTS OF THE EFFECTS OF FERTILIZERS, SOIL MOISTURE AND RAINFALL ON THE YIELDS OF GRAIN SORGHUM IN THE "SANDY LANDS" OF SOUTHWEST KANSAS. J. Farm Econ. 40: 697-708. 1958.

This study was designed to enable prediction of yields of grain sorghum under varied soil moisture, rainfall, and fertilizer conditions on sandy soils in southwestern Kansas. It is based on experimental data compiled during the years 1951-56.

All three factors, soil moisture at seeding time, rainfall during the growing season, and nitrogen are important in determining crop yields. Statistical tests indicate that the best positive relationship among the three factors considered in this particular set of circumstances is that between the yields and soil moisture at seeding time. The crop's response to soil moisture within the range considered (24 to 60 inches) indicates increasing returns.

Rainfall, during the growing season, and nitrogen also affect the crop yields. However the effects are not uniform since they are dependent on soil moisture conditions at seeding time. The greater the depth of soil moisture at seeding time the greater are the effects of rainfall and nitrogen on yields. Grain sorghum response to phosphorus was found negligible even at higher levels of moisture.

Kans. State U., Manhattan, Kans.

Walkup, H. G., and Fuqua, J. E. COST OF OPERATING THE PULL-TYPE THREE-HOPPER FERTILIZER SPREADER. U. Ky. Coop. Ext. Serv. C. 564, 8 pp. 1959.

The results of experiments on the use of the pull-type three-hopper fertilizer spreader are reported.

The decision to use a three-hopper spreader and straight materials or a single-hopper spreader and mixed fertilizer can be made by comparing all costs--overhead, operating, and fertilizer costs. Since overhead costs get lower as more acres are fertilized, the number of acres a farmer expects to fertilize each year tends to determine whether he will buy or use a three-hopper spreader or a single-hopper spreader.

A typical farm organization of crops and pasture in Kentucky and recommended fertilizer application rates are used to compare the two types of spreading. Total costs of three-hopper fertilizer spreading and straight materials are about equal to total costs of using a single-hopper spreader and mixed fertilizer when 35 acres are fertilized each year. With more acres fertilized, three-hopper spreading would be cheaper than single-hopper spreading; for less than 35 acres, the single-hopper spreader would be cheaper.

Table 1.--Costs of Straight Fertilizer Materials and Mixed Fertilizers Compared on a Plant Nutrient Equivalent Basis, Kentucky, 1957.

| Grade or Equivalent | Mixed Fertilizer | Straight Materials | Cost Difference |
|---|---|---|---|
| | dollars/ton | dollars/ton equivalent | dollars |
| 10-10-10 | 59.00 | 50.23 | 8.77 |
| 5-10-15 | 56.00 | 47.90 | 8.10 |
| 4-12-8 | 46.00 | 32.90 - 35.30[1] | 10.70 - 13.31[1] |
| 0-20-40 | 80.00 | 62.77 - 67.11[1] | 12.89 - 17.23[1] |

[1]The lower cost equivalent of plant nutrients in straight materials included calcium metaphosphate as the phosphate component. Concentrated superphosphate was included as the phosphate component in the higher cost equivalent of plant nutrients.

Table 2.--Operating Costs per Acre for Single-Hopper and Three-Hopper Spreaders, Kentucky, 1957.

| Cost Item | 8-Foot | | 10-Foot | |
|---|---|---|---|---|
| | Single-Hopper | Three-Hopper | Single-Hopper | Three-Hopper |
| | (cents) | | (cents) | |
| Labor | 20 | 25 | 18 | 22 |
| Lubrication | 01 | 01 | 01 | 01 |
| Pulling power | 35 | 40 | 30 | 35 |
| Repairs | 10 | 16 | 09 | 14 |
| Total | 66 | 82 | 58 | 72 |

In areas where three-hopper custom spreading is available at $2 per acre, the cost of using a single-hopper spreader and mixed fertilizers was higher for all acreages fertilized. The saving on straight fertilizer materials plus the cost of owning and operating the single-hopper spreader was greater than the custom spreading charge for the three-hopper spreader.

The cost of owning a three-hopper spreader is greater than custom hiring unless about 100 acres or more are fertilized each year at recommended rates. When 200 acres are fertilized annually, owning the three-hopper spreader would save the owner 60 cents per acre. For 500 acres 95 cents per acre would be saved.

A custom operator profits from custom operations if he fertilizes more than 105 acres annually. This profit is over and above his wages of $1.25 per hour, and 5 percent return on his average investment.

U. Ky., Coop. Ext. Serv., Agr. and Home Econ., Lexington, Ky.

Hughes, Wm. F., and Magee, A. C. COSTS AND RETURNS OF IRRIGATED PEANUT PRODUCTION, WEST CROSS TIMBERS, 1953-57. Tex. Agr. Expt. Sta. B. 917, 10 pp. 1958.

Five years of experience in the West Cross Timbers area of Texas show that wells of low capacity (25 to 120 gallons per minute, g.p.m.) can be used profitably in the production of irrigated peanuts. Special handling techniques are needed to accumulate a water supply and to distribute water over the deep sandy soils where peanuts are grown. The small heads of water (25 to 120 g.p.m.) combined with the types of equipment needed result in an irrigation development cost that ranges from $146 to $391 per acre irrigated.

Heavier seeding rates, increased quantities of fertilizer, more hoeing and cultivation, and additional harvest costs are incurred when peanuts are irrigated. Additional labor is needed to lay out, move, and retrieve sprinkler systems.

Yields of peanut on irrigated land averaged 34 bushels per acre compared with an average dryland yield of 14 bushels per acre. Irrigation improved the quality of peanuts produced, particularly during the dry years of 1954 and 1956. Irrigation increased hay yields about 20 bales per acre.

Costs for irrigation water averaged $5.09 per acre-inch, or $33 per acre. The cost of labor for irrigation and other costs associated with irrigation ranged from $10.04 to $16.67 and averaged $13.66 per acre for the 5-year period. The average total cost of irrigation, including operating and overhead, on individual farms, ranged from $37.96 to $63.34 per acre of irrigated peanuts for all farms.

The 5-year average net return from irrigated peanut production on individual farms ranged from $39.65 to $59.64 per acre. The lowest net return amounted to $10.25 per acre, whereas the highest was $196.40 per acre.

The 5-year average annual net return per farm from irrigated peanut production was equivalent to a return ranging from 18.9 to 33.4 percent on the amount invested in irrigation facilities on these farms.

FERD, ARS, USDA and Tex. Agr. Expt. Sta., College Station, Tex.

Hughes, W. F., Magee, A. C., Jones, D., and Thaxton, E. L. Jr. ECONOMICS OF WATER MANAGEMENT FOR COTTON AND GRAIN SORGHUM PRODUCTION, HIGH PLAINS. Tex. Agr. Expt. Sta. B. 931, 17 pp. 1959.

Improved water management affords an alternative to the measures commonly used to offset the effects of a declining water supply.

Because of competition for water during the first 2 weeks of August, the independently developed cotton and grain sorghum irrigation practices that maximize yields cannot be advantageously combined on the same farm.

Four alternative water management systems may be followed if the operator prepares for them in advance. These alternatives, designated in this report as water management systems 1, 2, 3, and 4, differ only after August 1. With system 1, which uses the smallest amount of water, only cotton is irrigated after August 1. With system 2, which uses a little more water than system 1, a full-season hybrid sorghum is the only crop irrigated after August 1. System 3 combines the cotton irrigation program of system 1 with irrigation of sorghum hybrids planted about July 1. In system 4, the first water application on the full-season sorghum hybrids is made as in system 2, after which the water is shifted to the late-planted sorghum hybrids.

The cotton-grain sorghum planting ratio of 1 acre of cotton to 1.75 acres of grain sorghum (seven-eighths acre of full-season sorghum hybrids and seven-eighths acre of short-season sorghum hybrids) permits the use of the most advantageous water management system on August 1.

For appraisal purposes, the cotton-sorghum planting ratio of 1:1.75 is converted to a management unit of 2.75 acres. Grain sorghum preplanting irrigation occurs at a time when the water is not needed on cotton; grain sorghum receives a postplanting irrigation only when it is more profitable to use the water on sorghum than on cotton. The management unit approach permits a determination of the most economic water use, irrespective of the head of water available.

Based on the 1946-56 average prices received for cotton lint, cottonseed, and grain sorghum, water management system 2 is most profitable. At the yield levels used, system 2 returned more or lost less than system 1 in 9 of the 11 years, 1946-56.

With management system 2 and 1946-56 average cotton and sorghum grain prices, the tenant's annual residual return--the amount available to defray his portion of water costs--on a typical 320-acre fully irrigated farm would be $22.15 per acre. This constitutes his breakover point for water costs; that is, his expenditures for water cannot exceed this annual amount over a period of time without dissipating his operating capital or reducing his income below what he might obtain from comparable dryland farming. Irrigated farming is more profitable than dry farming, his principal alternative, to the extent that his annual per acre water costs are below the breakover point.

The annual residual return, under the same conditions, to the landlord of this typical farm would be $14.40 per acre. It is the amount available to defray the cost of providing and maintaining a well and pump, to pay interest on the cost of irrigation facilities, exclusive of the pump power unit, and to provide a return on that part of his investment that exceeds the value of the undeveloped land plus irrigation development costs per acre.

The owner-operator's breakover point for water expenditures is slightly higher than the total of the tenant and landlord at all price levels. With system 2, and with cotton and sorghum grain prices at the 1946 to 1956 average, the breakover price for water for an owner-operator of the typical 320-acre farm is about $38 per acre.

FERD, ARS, USDA and Tex. Agr. Expt. Sta., College Station, Tex.

Sullivan, G. D., and Wiegmann, F. H. IRRIGATION COSTS AND RETURNS: For Cotton in the Mississippi and Red River Delta Areas of Louisiana. La. Agr. Expt. Sta. B. 512, 32 pp. 1958.

The primary objective of this study was to provide irrigation costs and returns for cotton irrigation.

The primary data used in the study were collected by personal interview with 39 farmers irrigating cotton with flooding systems and 32 farmers irrigating cotton with sprinkler systems in the Mississippi and Red River Delta Areas of North Louisiana. Most of the farmers also grew cotton which they did not irrigate. The yields of irrigated and non-irrigated cotton were compared in order to obtain the added yield resulting from irrigating.

The average level of investment in sprinkler systems generally exceeded that of flooding systems, ranging downward from $198 per acre at 30 acres to $48 per acre at 270 acres for sprinkler systems, and from $75 to $51 per acre for flooding systems. Farmers' estimates of the "potential" acreage capacity of flooding systems generally exceeded the actual acreages over which they were being used. However, farmers using sprinkler systems indicated that they had already extended the use of these systems beyond their estimated potential acreage capacity.

Land leveling was a major item of investment for flooding systems, while no land leveling was required for sprinkler systems. The total investment for land preparation for flooding systems ranged from $373 at 30 acres to $5,018 at 300 acres, while the range was from $260 to $1,794 for sprinkler systems for the same range in acreage.

The investment in equipment made up the major portion of the average investment requirement in irrigation systems on the farms included in the study. The average investment in pipe for sprinkler systems ranged downward from $82.91 per acre at 30 acres to $39.07 at 270 acres. For the same size range the average investment in pipe for flooding systems ranged from $29.93 to $8.52 per acre.

The total cost of irrigation includes fixed and variable costs. Fixed cost includes charges for depreciation and interest on the total investment. Depreciation was computed at 6.7 percent of the total investment and averaged from $9.13 per acre at 30 acres to $3.33 per acre at 270 acres. Interest was computed at 6 percent of one-half of the total investment and ranged from $4.07 per acre at 30 acres to $1.50 per acre at 270 acres.

Labor was one of the major items of cost in the operation of both sprinkler and flooding systems. Most of the labor cost was for indirect items, such as chopping, picking the additional cotton, and extra cultivations and poisoning, rather than for the irrigation operation itself. The cost per acre of labor for "additional" operations increased from about $8.10 per irrigation at 30 acres to $12.84 per irrigation at 270 acres. The cost per irrigation of labor expended directly in the irrigation operation decreased from $1.66 to $1.13 per acre per irrigation over the same range.

The average total cost of irrigation on the 71 farms in 1956 ranged upward from $1,207 at 30 acres to $11,110 at 270 acres. Average cost per acre was about $41.

No appreciable differences in yield of seed cotton were between the two irrigation systems. The average additional yield resulting from irrigation for each 30-acre increase in acres irrigated was about 26,160 pounds. Added yields increased from 622 pounds of seed cotton per acre at 30 acres to 844 pounds per acre at 270 acres. The added gross revenue per acre resulting from irrigation was related to increases in

acreage in the same manner as added yield per acre. The average net added revenue per acre from irrigation increased from $45 at 30 acres to $75 at 270 acres.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Hoglund, C. R. ECONOMICS OF IRRIGATING CORN. Mich. Q. B. 40(3): 669-678. 1958.

Corn yields are influenced not only by the quantity of water available, but also by the stalk population and quantity of fertilizer applied. Agronomists suggest that an optimum stalk population for the sandier soils such as Fox sl are about 12,000 to 14,000 without irrigation and 18,000 with irrigation. Comparable figures for moderately productive soils such as Miami sil are 16,000 without irrigation and 18,000 with irrigation. The available water-holding capacity of Fox sl is low and of Miami sil is moderate.

It is estimated that under price relationships existing during 1957, it would pay to apply 200 pounds more fertilizer on the irrigated corn at pre-planting or planting time for the Fox soils and 150 pounds for the Miami soils. Increase of 60 pounds of nitrogen applied on the Fox sl and 40 pounds applied on the Miami sil soils were used in calculating the additional expense of sidedressing the irrigated corn.

Experimental data and farmer experiences indicate that under average weather conditions corn yields on Fox sl soils can be increased by 40 to 60 bushels per acre by irrigation, a higher stalk population, and the use of more fertilizer. During 1956, when climatic conditions were better than normal during the growing season, the irrigated corn produced 51 bushels more than the non-irrigated corn.

It is estimated that corn yields can be increased by 25 to 30 bushels per acre when irrigation water is applied to corn grown on Miami sil. Average acreage increases of 50 bushels for the Fox sl and 28 bushels for the Miami sil were used in calculating the additional returns resulting from irrigation.

With corn valued at $1.00 per bushel, net income would be increased by $1,508 when water was obtained from reservoirs and applied to 150 acres of Fox sl. When it was necessary to invest in a deep well, net income was increased by $1,070. The investments in an irrigation system on the farm with Fox sl soil, with corn priced at $1.00 per bushel, earned 18 percent and 11 percent, respectively for the systems using reservoirs and a deep well as sources of water.

Fifteen hundred more dollars were added to net income at the $1.20 price for corn. Investment in irrigation equipment on the farm with the sandier soil would be extremely profitable if corn sold at $1.40 per bushel. On the basis of the calculated changes in production and expenses, investment in irrigation equipment would not be profitable if the price of corn dropped much below $1.00 per bushel.

Investment in an irrigation system to be used in irrigating large acreages of moderately productive soil such as Miami sil does not appear profitable unless the price of corn is at least $1.40 per bushel.

Mich. State. U., Agr. Expt. Sta., East Lansing, Mich.

Tramel, T. E., Crowe, G. B., and Abel, J. F. Jr. SUPPLEMENTAL IRRIGATION, INVESTMENT AND OPERATING COSTS IN THE DELTA AREA OF MISSISSIPPI. Miss. Agr. Expt. Sta. B. 559, 27 pp. 1958.

This study was designed to give some insight into the cost of developing sources of irrigation water and to compare investment and annual operating costs for alternative methods of distributing water.

When natural surface sources of water are conveniently located and properly used, they are cheaper than wells as a source of irrigation water. A surface source of water may not be dependable. Wells in the Delta area offer a dependable and fairly cheap source of irrigation water. It is possible to develop and equip a well delivering 2,000 gallons of water per minute for approximately $5,000. Annual pumping costs for such a well could be expected to average around $0.45 per acre-inch. For smaller wells, these pumping costs may go as high as $1.00 per acre-inch. For large wells (2,500 gallons per minute) annual costs range from 25 to 35 cents per acre-inch.

Based on the 145 farms included in the study, investment in irrigation equipment averaged $73 per acre irrigated for sprinkler systems, $57 for gated-pipe systems, $36 for siphon-tube systems, and $50 for other gravity systems. Average investment for the 145 farms was $56 per acre irrigated.

Annual operating costs per acre irrigated averaged as follows: Sprinkler systems, $18; gated-pipe systems, $18; siphon-tube systems, $8; and other gravity systems, $12. Average annual costs for all systems amounted to $15 per acre irrigated.

The planning and management of the individual operator continues to be the chief factor affecting labor requirements and costs. As management and labor gain more knowledge and experience, efficiency in the use of irrigation is expected to occur. In addition to reducing the costs of irrigation, these increased efficiencies may also alter the cost relationships existing among the various distribution methods.

With present practices and techniques, and 1956 prices, an increase in yield of 255 pounds of seed cotton, 15 bushels of corn, or 7 bushels of soybeans per acre would be required to cover the direct and associated cost of two irrigations.

FERD, ARS, USDA and Miss. State U. Agr. Expt. Sta., State College, Miss.

Thomas, D. W., and Slater, G. R. IRRIGATION--COSTS AND RETURNS SOUTHWESTERN INDIANA, 1955. Purdue U. Agr. Expt. Sta. Res. B. 668, 15 pp. 1958.

This study was designed to provide data for planning farm businesses under irrigated conditions and to determine the economic and physical conditions under which irrigation may be profitable in humid areas. It was limited to 23 Southwestern Indiana farms on which field crops were irrigated in 1955. These farms irrigated about 3,000 acres of crops (2,550 acres of field corn). Information was obtained by survey, directed records, and observation. Growing season rainfall was slightly below the 20-year area average. Rainfall was fairly well distributed through the season.

Capital investment in irrigation equipment averaged nearly $9,000 on the 23 cooperating farms and ranged from $3,200 to $17,000. This was equivalent to $100 per acre irrigated in 1955 and $60 per acre of system capacity.

A majority of these farms used ground water for irrigation. Fourteen farms drilled wells at an average cost of $1,560 per well. The cost per foot of depth ranged from $8.64 for 6-inch wells to nearly $40 for 16-inch wells.

Fixed costs averaged 61% of total irrigation costs. Depreciation and interest charges constituted 90 and 55% of fixed and total irrigation costs, respectively.

Thirty-nine percent of total irrigation costs were variable. This ranged from 14 to 59%. Labor and fuel constituted 83 and 31% of variable and total costs, respectively.

The total cost of applying an acre inch of water averaged $6.08 and ranged from $1.66 to $16.24. Costs per acre irrigated and per acre application averaged $21.75 and $13, respectively.

Fixed, variable, and total irrigation costs per acre inch of water applied decreased with increased system use. Variable unit costs decreased with increased amounts of water applied per application. Fuel costs per acre inch of water applied were less with diesel and propane power units than with gasoline units.

An average corn yield increase of about 18 bushels per acre was attributable to irrigation. Yield increases ranged from none to over 80 bushels per acre. About 60% of the variation in corn yields was associated with the level of soil moisture maintained during the 30-day period following tasseling. Other factors affecting irrigated corn yields were plant population, nitrogen applied, and soil type.

On 19 farms, the value of the additional yields averaged nearly $4,200 per farm. This ranged from $138 to $16,000. Gross returns to irrigation averaged about $31 per acre irrigated and 7.10 per acre inch of water applied.

The value of additional crop yields attributable to irrigation exceeded total irrigation costs on 9 of the 23 farms. Net returns to irrigation on these farms averaged about $4,650 per farm and $32 per acre irrigated.

Irrigation, on these 23 Southwestern Indiana farms in 1955, was highly profitable in some cases; unprofitable in others. In general, unit irrigation costs tended to be lower on those farms which: (1) Used the system extensively; (2) had systems requiring relatively low capital investment in equipment and water source; and (3) made relatively

heavy applications per irrigation. High gross returns to irrigation tended to be associated with those farms which: (1) Irrigated naturally droughty soils; (2) prevented soil moisture from dropping to low levels during the period following tasseling; and (3) adjusted other crop inputs to irrigated conditions.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Rogers, R. O., and Stucky, H. R. COTTON HARVESTING: A COMPARISON OF MACHINE VS. HAND PICKING IN ELEPHANT BUTTE IRRIGATION DISTRICT, NEW MEXICO. New Mexico Agr. Expt. Sta. Res. Rpt. 17, 30 pp. 1958.

Machines picked about 15 percent of New Mexico's 223,000 bales of upland and 13,000 bales of long-staple cotton in 1957. This bulletin presents the findings obtained from interviews with 101 Elephant Butte Irrigation District, New Mexico, cotton growers, 40 of whom owned and operated 46 mechanical cottonpickers during 1957. About 25 percent of the growers custom machine harvested cotton during 1957.

Mechanical cotton picking is economically feasible with 1957 costs and prices for:

1. One row picker when: (1) Used at least 200 hours on upland cotton with at least 490 pounds seed cotton harvested per hour; or (2) used at least 160 hours on long staple cotton with at least 350 pounds of seed cotton harvested per hour.
2. For 2-row picker when: (1) Used at least 250 tons on upland cotton with at least 756 pounds of cotton harvested per hour; or (2) used at least 165 hours on long staple cotton with at least 525 pounds of seed cotton harvested per hour.

Hand picking cost per bale including miscellaneous costs in 1957 were $42.00 for upland cotton and $61.50 for long-staple cotton.

Machine-picking costs of $39.00 and $42.00 per bale for the 1-row and 2-row machine for upland cotton were based on 250 hours annual use and an hourly performance rate of 490 and 756 pounds of seed cotton for the 1-row and 2-row machines.

Machine picking costs of $49.00 and $50.00 per bale for the 1-row and 2-row machines for long-staple cotton were based on 250 hours annual use and an hourly performance rate of 350 and 525 pounds of seed cotton for the 1-row and 2-row machines.

Agr. Expt. Sta., N. Mex. State U., State College, N. Mex.

Southern, J. H., and Hendrix, W. E. INCOME OF RURAL FAMILIES IN NORTHEAST TEXAS. Tex. Agr. Expt. Sta. B. 940, 32 pp. 1959.

In recent decades, industrial progress in northeastern Texas has brought about a large shift from agricultural to nonfarm employment. Number of farms decreased from about 103,000 in 1930 to 49,000 in 1954. Also living in the area in 1954 were 39,000 nonfarm families.

Average annual net money income per rural family in the area in 1955 was about $2,500. When a value was placed on rent and on home-produced food, cash and noncash income averaged some $3,300 per family, about half the average income of the Nation's nonfarm families. The median income was about $2,000.

Full-time, part-time, and residential farm families had average total net money incomes of $1,960, $3,280, and $2,170, respectively. About two-thirds of the part-time farm families had incomes above $2,000. The full-time farm families, comprising about 17 percent of all rural families, obtained about 77 percent of their total cash and noncash income from the farm. Most residential and some part-time farm families lost money on their cash farm operations. Families with incomes of less than $1,000 received about half their income from nonwork sources, usually pensions of one kind or another.

Income levels in the area are a result of long-run factors in both the general and the farm economy, but differences in employment characteristics of the family head are a major factor accounting for differences between families in the current income situation.

About 77 percent of all families with incomes below $1,000 had a family head who was 65 years of age or over, had a physical handicap limiting the kind or amount of work possible, was female, or had completed fewer than five grades in school. In the income class $1,000 to $1,999, 65 percent of the families had one or more of these

characteristics. Among the full-time farmers, 74 percent of the families with incomes below $2,000 had such limitations on productivity of the human resource, or had farm resources of less than $15,000. Nearly 40 percent of all full-time farmers had total farm resources of less than $15,000.

This study is part of a research program undertaken to provide research analysis for the Rural Development Program. It is based on a sample of 1,189 families in the area.

FERD, ARS, USDA and Tex. Agr. Expt. Sta., College Station, Tex.

Metzler, W. H., and Armentrout, W. W. FARMING, FARM PEOPLE, AND FARM EXPANSION IN FAYETTE, RALEIGH, AND SUMMERS COUNTIES, WEST VIRGINIA, 1958. W. Va. Agr. Expt. Sta. B. 439, 12 pp. 1959.

Income from farming in the 3-county area could be increased by use of more credit for farm development, more careful selection of crops, greater use of up-to-date farm practices, and more complete use of soil resources.

According to a survey made for the Area Redevelopment Committee in May 1958, based on a random sample of 297 farms, only 14 percent of the farm families in the area obtain all their income from farming, and these families are close to the bottom of the income scale.

A third of the farms are less than 30 acres in size. Only 10 percent are large enough to occupy the full time of a worker.

In 1957, total sales, which were mainly sales of livestock and livestock products, averaged $1,200. The highest return both per farm and in total was poultry. Biggest expense to farmers was purchase of feed and hay for poultry and livestock.

Many farmers were not interested in farming adjustments because they had other work or were not interested in farming. But 1 in 8 of the farmers under 50 years of age said they would like to expand livestock operations; an equal number would like to clear or improve additional land; others would like to add to machinery and equipment or to use more fertilizer. Most of these were part-time or subsistence farmers. Failure to make changes usually was ascribed to lack of capital.

W. Va. Agr. Expt. Sta., Morgantown, W. Va.

Eisgruber, L. M., and Janssen, M. R. CHANGES IN FARM ORGANIZATION AND OPERATION IN A CENTRAL INDIANA TOWNSHIP - 1910 TO 1955. Purdue Agr. Expt. Sta. Res. B. 686, 20 pp. 1959.

Many changes occurred in central Indiana agriculture during the last half-century, as revealed by studies of records of farm organization in Forest Township, Clinton, Ind., in 1910, 1913-19, 1932, 1945 and 1955.

Average size of farms increased from 116 acres in 1910 to 182 acres in 1955, with the most significant increase occurring between 1932 and 1945.

Long-time crop changes from 1910 to 1955 include a larger percentage of cultivated crops in the rotation. From 1910 to 1932, more acres were in corn. Later, tomatoes and soybeans were introduced. Acreage of soybeans increased through 1955; no tomatoes were grown in 1955.

Numbers of colts and beef cattle decreased from 1910 to 1945; numbers of poultry, dairy cattle, and hogs increased slightly. This trend was reversed between 1945 and 1955.

Despite an increase in crop acreage and livestock per farm from 1910 through 1955, the amount of labor used remained constant at about 19 months until 1945; by 1955, it had decreased to 14 months. This increase in labor efficiency was made possible by increased mechanization. In 1955, more than half the farmers used trucks, cornpickers, combines, and more than one tractor.

Farm capital per farm was about $25,000 between 1910 and 1919. By 1932, it was down to $12,000. By 1945, it had risen to $42,000, and by 1955, it had reached $74,000. The marked increase during the last two decades was caused mainly by higher prices for land and larger acreages farmed. In 1910-14 dollars, farm capital declined from $24,000 in 1910-15 to nearly $17,000 in 1916-19 and to $13,000 in 1932, then rose to $27,000 in 1945 and to $30,000 in 1955.

Average labor income per farm was $3,647 in 1947, the highest on record for the township. Average labor income, as well as returns to investment, were lower in 1955 than in 1932.

Proportion of operators of rented farms using the livestock share lease increased from 1910 to 1945, but decreased between 1945 and 1955. In both 1945 and 1955, cash rent was practically nonexistent.

Although the total population of Forest Township stayed about the same between 1930 and 1955, the number of farm operators decreased. There were almost twice as many business establishments in the township in 1955 as in 1945.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Walrath, A. J. IMPACTS OF CHANGES IN LAND USE: A STUDY OF AN URBAN-RURAL AREA OF SOUTHEASTERN WISCONSIN. U.S.D.A., A.R.S. 53 pp. 1959.

Thirty-six farmers in the urban-rural area of southeastern Wisconsin were interviewed to determine the effects of urbanization of their farming operations. There was no evidence that, as of 1955, any of these farmers had changed the organization of their farms because of urbanization, but they were handicapped in expanding their units because of the high prices of land.

Within the urban-rural area, farm problems are transitional; a change in ownership means a change in land use. But community problems that arise may remain a long time. Some of the suggestions made by the author for dealing with these problems are: (1) Apply subdivision-control ordinances to all division of land; (2) enlarge school districts to give a broader and larger tax base for financing school operations; (3) use "original occupancy" permits and taxes to provide additional operation funds to school districts; and (4) if necessary, restrict residential development until an adequate sewage-disposal system is in operation.

ARS, USDA, Inform. Div., Washington 25, D.C.

Corkern, R., Wiegman, F. H., and Johnson, A. IMPROVING INCOME ON A MACON RIDGE COTTON FARM--A STUDY IN FARM PLANNING. La. Agr. Expt. Sta. B. 522, 66 pp. 1959.

The purpose of this analysis was to evaluate alternative systems of farming that might be adapted to a small cotton farm in North Louisiana and to illustrate the procedure for making such evaluations. The present and three alternative systems were budgeted for a "Case" farm. Net profits were then compared with profits under the present system.

It was assumed that the acreage in the farm would remain 93 acres, cotton acreage would remain 24.5 acres, and maximum net farm income would be the farm goal.

When farm acreage is limited, farm income can be increased by: (1) Increasing yields, (2) changing enterprise combinations, (3) reducing costs of production, or (4) a combination of (1), (2), and (3). Enterprise yields are expected to increase as a result of improved levels of practices and improved land capabilities. As soil fertility increases, yields are obtained for lower unit costs. The most profitable yield for a particular enterprise may not be the most profitable when considering the farm as a unit. This is true when resources are limited and can be used in other enterprises which may result in higher returns. Yields on the Case farm are relatively low under the present system. Under the alternatives these yields have been increased at additional cost. But for each enterprise the expected returns exceed expected costs.

Enterprise combinations have been changed in the alternatives. The crop enterprises have been organized around cotton. When combining enterprises, rotation systems, enterprise relationships, feed requirements, soil capabilities and resources available were considered. Under the given price relationships the combination of enterprises that yields the highest net return to the farm is the combination of cotton, corn, soybeans, broilers, and winter grazing beef calves. In this alternative all available resources are not fully used; family labor is an example. Usually all available resources cannot be fully utilized because a particular resource becomes limited. On this farm major limitations are total acres and cotton acres.

The cost of production has been reduced for the broiler enterprise under the alternative organizations. This was made possible by having the feed custom mixed and feeding the birds more often to prevent wastage. The change will result in a reduction of approximately $2,744 in cost. In the alternatives the total cost of production has increased for each enterprise except broilers. Cost per unit of production decreased. The yields obtained are thus consistent with the increase in cost.

The budgets indicate that the net farm income can be increased. To increase net farm income on the Case farm, adjustments are needed. These adjustments require only small increases in capital investments over the present organization. Increases in yields and the effect of a recombination of enterprises are reflected in the changes in the net farm income that can be expected from the alternative organizations. Returns to operator's family and labor are increased for each alternative over the present organization. These increases have been obtained for an increase in expenses in two of the plans. A budget analysis indicates that any of the three alternatives would be more profitable than the present system.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Schrumpf, W. E., and Pullen, W. E. GROWING DRY BEANS IN CENTRAL MAINE, 1956. Maine Agr. Expt. Sta. B. 577, 26 pp. 1958.

This study was initiated with the encouragement of the Maine Dry Bean Growers' Association to help Maine growers meet the increasing competition of other areas. The report includes costs and returns with emphasis on inputs of labor, machinery, and materials in growing and harvesting dry beans in 1956.

The dry-bean acreage ranged from 2 to 190 and averaged 29 acres per farm or 32 percent of the total crop acreage of the farms included.

The Yellow Eye variety was planted on 94 percent of the acreage. The varieties making up the remaining 6 percent were Soldier, Jacob's Cattle, Red Kidney, Marrowfat, King's Early, Sulfur, and White Kidney.

The farm capital investment ranged from $3,000 to $60,000 and averaged $16,492 per farm. Of the total farm capital, two-fifths was invested in land and buildings.

In 1956 low yield rates caused by adverse weather resulted in small profits for dry-bean growers. The farmers' total cost of growing and handling averaged $120 an acre including $9 of operators' labor. The value of the dry beans sold or saved for home planting was $114 an acre making a net loss to management of $6 an acre.

The cost of growing and harvesting (grading and selling omitted) averaged $1.07 an acre. Fertilizer and labor were the largest items making up respectively, 26 and 19 percent of the total cost. Other items in order of size were seed 15 percent, equipment 14 percent, tractors and trucks 11 percent, land use 7 percent, weed and spray materials 4 percent, and other costs 4 percent.

The costs per acre of the major operations in growing and harvesting were: plowing $5.17, picking stones $3.32, harrowing $5.96, planting $4.56, spraying $1.87, cultivating $5.49, hand hoeing $3.89, machine pulling $3.62, hand pulling $12.76, machine windrowing $2.68, hand windrowing $4.21, combining $11.02, and stationary threshing $16.67.

When the dry beans were pulled and windrowed by machine and threshed from the windrow by combine, the harvesting cost was $17.32 an acre. In contrast the per-acre cost was $33.63 when the dry beans were pulled and windrowed by hand and hauled to a stationary thresher and threshed.

Cost per 100-pounds of dry beans decreased and net return per acre increased as yield rate increased; in each case, however, at a decreasing rate. The expected cost per 100 pounds at a yield rate of 600 pounds per acre was $19.90 and the expected net return was a loss of $39; at the yield rate of 1,200 pounds per acre the cost was $10.10 and the net return was $57; and at a yield rate of 1,800 pounds per acre the cost was $7.70 and the net return was $90 per acre.

The farms above average in acreage and yield rate of dry beans had only slightly higher costs than the average, $108 compared with $107 per acre but, largely because of higher yield rate and smaller percentage of cull beans, the net return to the operator for

his labor and management was nearly four times as large or $60.11 compared with $15.57 an acre.

Maine Agr. Expt. Sta., U. Maine, Orono, Maine.

Schrumpf, W. E. COST REQUIREMENTS IN GROWING POTATOES IN CENTRAL AND SOUTHERN AROOSTOOK COUNTY, MAINE, 1955. Maine Agr. Expt. Sta. B. 574, 35 pp. 1958.

This study of cost requirements and farm management practices in growing potatoes was initiated in Aroostook County in 1956. The basic information was obtained by the survey method from a systematic-geographical sample comprising 224 farms in central and southern Aroostook County, Maine. The following conclusions were made from the study:

1. The average cost of growing, digging, and hauling the potato crop from the field was $274 an acre or $1.61 a barrel (165 lbs.).
2. The farms on which the potatoes were produced ranged in size mostly between 50 to 700 acres and averaged 218 acres. Potato acreages ranged from 7 to 190 acres per farm and the average was 43 acres.
3. Of the 14 different varieties of potatoes grown, Katahdin accounted for 81.2 percent.
4. There was a wide range in capital investment per farm, $10,000 to $100,000. The average value of land, building, tractors, trucks, and machinery used on potatoes amounted to $28,475 per farm.
5. Labor, seed, and fertilizer comprised about two-thirds of the production cost of $274 an acre ($1.61 a barrel).
6. Of the 3,345 hours of labor per farm on potatoes nearly three-fifths was for custom help.
7. The fertilizer used comprised many different ratios of $N$-$P_2O_5$-$K_2O$, but the most common ratios were 1-1.5-2.0 and the 1-1.5-1.5. The average per-acre application to potatoes was 157 pounds of N, 230 pounds of $P_2O_5$, and 270 pounds of $K_2O$.
8. The rate of seeding ranged from 5 to 18 barrels an acre.
9. Weeds were spray-killed on one-half of the potato acreage at an average cost of materials of $2.90 an acre. Potatoes were vine-killed on 73 percent of the acreage and the materials cost $4.09 an acre. The cost of materials in spraying potatoes for disease 8.5 times was $7.70 and for insects 5.4 times, $2.60 acre.
10. Of all the potatoes harvested 73.6 percent were sold as U. S. No. 1 grade.
11. Of the 15 or more operations in growing and harvesting, the most costly was picking up potatoes which averaged 36.5 hours valued at $37.12 an acre. The cost for the barrels and baskets used in picking up was $1.69, a total of $38.81 an acre. Hauling from the field required 7 hours of labor and 25 miles of truck use and the cost including barrels used for hauling was $13.93 an acre. Hours of labor for digging averaged 4.1 and for tractor use 3.1 an acre. The digging cost including use of digging machine was $10.86 an acre. The more costly remaining items were spraying $8.31, plowing $6.46, cultivating and hilling $6.40, and picking stones $6.02 an acre.
12. Small businesses (less than 20 acres of potatoes) were in general less efficient than large businesses (60 or more acres of potatoes). The small farms had an average yield per acre of 149 barrels compared with 173 barrels on the large farms; acres of potatoes per man was 8.2 and 22.5 respectively and farm capital investment averaged $1,058 and $597 per acre of potatoes in the respective farm groups.
13. Differences in yield rate are shown to have a similar influence on cost of potato production regardless of size of business, increasing the cost per acre but decreasing the cost per barrel. Increased labor efficiency was accompanied by a decrease in production cost both per acre and per barrel.
14. A comparison of twenty least-cost farms with the averages for all farms shows cost per acre of $250 and cost per barrel of $1.34 compared with the all-farm average of $274 an acre and $1.61 a barrel.

Maine Agr. Expt. Sta., U. Maine, Orono, Maine.

Andrews, R. A. A STUDY OF THE SWEET CORN INDUSTRY IN THE MIDWEST FARM ECONOMY. Minn. Agr. Expt. St. Tech. B. 232, (North Central Region P. 95) 116 pp. 1959.

In the past three decades, the sweet corn industry has undergone a marked change, both in type of product marketed and in the area of production. Frozen sweet corn has been introduced and its market expanded. Sweet corn for fresh market has increased in importance. White cream-style canned sweet corn production has declined while golden cream-style and golden whole-kernel sweet corn production has increased. Wisconsin, Minnesota, and several far western states have risen in importance as producing areas of sweet corn for processing. Florida, Texas, and California have risen in importance as producing areas of sweet corn for fresh market.

To keep abreast of these industry developments, several Midwest regional studies have been made covering the economic aspects of marketing of fresh market sweet corn, the grade yield-price relationship of raw sweet corn sold to processors, and an analysis of existing pricing systems used in grower-processor markets. To round out the work on the sweet corn industry in the North Central States, it seems desirable to look at the overall industry in the current setting and consider its potentialities as well as the problems that it may encounter.

The primary objective of this project is to describe and appraise the prospective position of the sweet corn industry in the Midwest farm economy in the decade ahead. This involves such secondary objectives as describing the past and current economic position of sweet corn in the Midwest farm economy, appraising the role processors play in the industry, analyzing the prospective demand for sweet corn, and appraising the competitive position of sweet corn in the Midwest with other crops and other areas.

U. Minn., Agr. Expt. Sta., St. Paul, Minn.

Fuqua, J. E., Byers, G. B., and Jensen, H. R. CORN AND SMALL GRAIN HARVESTING COSTS. Ky. Agr. Expt. Sta. C. 558, 15 pp. 1958.

Harvesting costs make up a large part of the cost of producing crops. The amount of profit from a crop and from the farm is affected by the size of these harvesting costs. Whether a crop is profitable may depend on the efficiency of harvesting.

Most modern harvesting machines have high initial costs which result in large fixed costs in the form of depreciation, interest on the investment, housing, taxes, and insurance. Spreading these fixed costs over more acres, tons, or days annually reduces unit costs. The acreage of crops on many Kentucky farms is so small that fixed costs per unit of owning harvesting machines are high.

This publication provides farmers with information on: (1) The effect of the amount of annual use on machinery costs; (2) comparative costs of custom hiring and individually owned machines in harvesting corn and small grains; (3) costs of complete harvesting operations for corn and small grains; and (4) ways of reducing unit costs of owning harvesting machinery for corn and small grains.

Ky. Agr. Expt. Sta., U. Ky., Lexington, Ky.

Bondurant, J. H., and Hole, E. TOBACCO GROWERS' COSTS AND RETURNS IN KENTUCKY BY TYPE OF TOBACCO AND LOCATION. Ky. Agr. Expt. Sta. B. 661, 104 pp. 1958.

This study is based on an economic analysis of production costs, receipts, and returns to family labor, land, operating capital, and management for 5 types of tobacco, including 14 production areas. Information was obtained from 555 tobacco growers and a number of businessmen in 29 selected counties in the state for the period 1951-53. The period was a relatively stable one with reference to costs and returns for the production of the various types of tobaccos and for the different production areas. The labor used, costs of materials, tobacco yields, and prices received did not vary significantly during the three years.

Production costs exclusive of family labor, management, land, and investment for burley tobacco averaged $265 per acre for the nine burley producing areas studied. Receipts from burley tobacco averaged $840 per acre. Returns to labor, land, management, and investment averaged $575. Labor used per acre of burley tobacco averaged 409 hours, varying from 523 hours in the Mountain area to 318 for the Inner Bluegrass. The average percentage family labor of total labor was 83 percent for the entire burley area. However, the hours of family labor used per acre varied from 197 hours in the Inner Bluegrass to 429 hours in the Mountain area. An important reason for this difference is the extent to which tractors and mechanized equipment are used in tobacco production. Another reason is the acreage produced per grower, varying from an average of 1.8 acres in the Mountains to 8.6 for the Inner Bluegrass. Production of burley tobacco per acre, for all nine areas, averaged 1,598 pounds.

Production costs for fire-cured tobacco averaged $145 per acre. The receipts averaged $449 per acre and returns to labor, land, management, and investment were $304 for the two fire-cured areas. The total labor per acre was 356 hours, varying from 403 hours in the Pennyroyal to 313 hours in the Purchase. Family labor was 91 percent of the total for the fire-cured area, or 324 hours; the hours of family labor were 365 hours per acre for the Pennyroyal and 286 hours for the Purchase. The dark fire-cured production per acre averaged 1,229 pounds.

Dark air-cured tobacco production costs averaged $166 per acre. Receipts per acre of tobacco averaged $469. The return to labor, land, management, and investment averaged $303, ranging from $347 in the Pennyroyal to $216 per acre in the Purchase. The total labor per acre of dark air-cured tobacco averaged 327 hours, with no significant differences among the three production areas. Family labor was 89 percent of the total labor, or 293 hours per acre; the range was from 302 hours in the Pennyroyal to 256 hours in the Purchase. In the Lower Ohio Valley area, the family labor used per acre of tobacco was 294 hours per acre, and the returns to labor, land, and management was $284 per acre.

Ky. Agr. Expt. Sta., U. Ky., Lexington, Ky.

Embry, L. B., Dittman, A. C., and Gastler, G. F. WINTERING CALVES WITH ALFALFA HAY OR PRAIRIE HAY. S. Dak. Agr. Expt. Sta. B. 466, 12 pp. 1958.

All the rations used in this experiment may have a place in winter feeding of calves. The supply of feeds on the farm or ranch, market value of feeds and cattle, subsequent feeding systems that will be followed, and when the cattle will be sold are some factors affecting the choice of ration. The results of this experiment give the amount of feeds needed and the gains that may be obtained with the various rations.

Two winter feeding trials with steer calves gave the following results:

1. Alfalfa hay alone gave: (1) An average daily gain of 1.03 pounds when fed at rate of 14.2 pounds; (2) a gain of 145 pounds per ton of hay fed; and (3) a feed cost of $17.47 per 100 pounds of gain and of $27.36 per calf for the winter feeding period.

2. Alfalfa hay and prairie hay gave: (1) An average daily gain of 0.73 pound when fed at the rate of 4.1 pounds of alfalfa hay and 9.5 pounds of prairie hay; (2) a gain of 107 pounds per ton of hay fed (603 pounds of alfalfa and 1,397 pounds of prairie hay); (3) a feed cost of $20.29 per 100 pounds of gain and of $22.58 per calf for the winter feeding period; and (4) a feed replacement value for alfalfa hay of 4 pounds of alfalfa hay equal to 3 pounds prairie hay and 1 pound of soybean meal when compared to calves fed prairie hay and soybean meal pellets (both rations about 10% protein).

3. Prairie hay and soybean meal pellets gave: (1) An average daily gain of 0.74 pound when fed at the rate of 12.7 pounds of prairie hay and 1.10 pounds soybean meal pellets; (2) a gain of 117 pounds per ton of hay when 173 pounds of soybean meal pellets were fed with each ton of hay; and (3) a feed cost of $22.73 per 100 pounds gain and of $25.62 per calf for the winter feeding period.

4. Prairie hay alone gave: (1) An average gain of 0.31 pound when fed at the rate of 13.2 pounds; (2) a gain of 47 pounds per ton of hay fed; and (3) a feed cost of $43.12 per 100 pounds of gain and of $20.44 per calf for the winter feeding period.

5. Summer pasture phase gave: (1) Calves wintered on alfalfa hay alone and which gained 1.03 pounds daily made an average daily gain of 1.41 pounds during the summer

on native pasture; (2) calves wintered on prairie hay alone which gained 0.31 pound daily made an average daily gain of 1.73 pounds during the summer on native prairie pasture; and (3) total winter and summer gain was 59 pounds more per calf for those fed alfalfa hay than for those fed prairie hay during the winter.

Agr. Expt. Sta., S. Dak. State Col., Brookings, S. Dak.

Pingrey, H. B., and Dortignac, E. J. ECONOMIC EVALUATION OF SEEDING CRESTED WHEATGRASS ON NORTHERN NEW MEXICO RANGELAND. N. Mex. Agr. Expt. Sta. B. 433, 80 pp. 1959.

Forage yield can be increased from 50 pounds of native grass per acre annually to 600 to 1400 pounds of crested wheatgrass per acre by clearing and seeding sagebrush range. Nearly 70 acres of sagebrush range is necessary to supply one AUM (animal unit month) but 2.5 to 7 acres of crested wheatgrass range will furnish forage for one AUM in the spring, depending on the site location.

In the spring when green and succulent crested wheatgrass, air-dry basis, has 24 percent more digestible protein and 38 percent more total digestible nutrients than alfalfa hay. Although total digestible nutrients decrease with maturity in the summer, crested wheatgrass can be grazed with satisfactory daily gain in weight of cattle compared to that obtained on native range.

Daily gain in weight of cows varied from 2 to 4.3 pounds a head when grazed on crested wheatgrass in the spring compared to 1.3 pounds a head on native range. Seasonal gain in weight, May to November, averaged 80 pounds per head daily on crested wheatgrass compared to 0.63 pound daily on native grass range.

Daily gain of suckling calves on crested wheatgrass in the spring varied from 2.2 to 2.3 pounds a head, compared to 1.1 pounds for calves on native range.

Daily gain in weight of yearling cattle grazed on crested wheatgrass from May to November averaged 1.45 pounds a head, compared to 1.50 pounds a head for those grazed on crested wheatgrass for one month in the spring and native range during the summer.

Slaughter grade of cows in the fall, off crested wheatgrass, was better than for those cows grazed on native range.

When measured as a differential return to capital investment in the ranch business, crested wheatgrass range for spring use by cattle has a value varying from $2.82 to $4.18 per cow-calf month of grazing in comparison with the use of low-producing sagebrush range.

On sites with favorable over-winter and annual precipitation, crested wheatgrass range can be grazed at a rate of two to three acres per animal-unit month. Such intensity of grazing of crested wheatgrass in comparison with native range results in a differential return to capital investment of $23.65 per animal-unit for cow-calf production under yearlong grazing. Other factors associated with such a return are a 7 1/2 percent increase in calf-crop; higher price for cattle because of grade; decrease in winter supplemental feed for cattle on crested wheatgrass and a slightly larger daily gain of cows.

Seeding of crested wheatgrass for production of beef versus the use of land for dryland crop production in northern New Mexico is not justifiable from an economic standpoint. Land used for production of beef shows a return over cost of $1.15 an acre compared to $1.36 an acre for dry beans; $4.05 an acre for wheat and $3.37 an acre for hay production.

Agri. Expt. Sta., N. Mex. State U., State College, N. Mex.

Carpenter, J. C. Jr., Phillips, S. A., and Brown, P. B. THE VALUE OF RYEGRASS PASTURES FOR BEEF STEERS. La. Agr. Expt. Sta. B. 528, 16 pp. 1959.

In a study of ryegrass pastures for beef steers the authors made the following conclusions: (1) It is profitable to buy weanling calves in the fall, graze them through the winter and spring on well-fertilized ryegrass pastures, and then market; (2) the feeding of grass hay to steers grazing lush ryegrass pastures is not profitable and will not control scouring; (3) the supplemental feeding of cottonseed meal or oats on ryegrass pastures, after the ryegrass begins to mature, is not profitable; (4) the supplemental feeding

of beef cattle on pasture does not improve the live grade; (5) more total gain is obtained when steers are fed while grazing; however, the value of the increased total gain will not offset the cost of the additional feed; (6) when priced as stocker steers at the end of a test, the additional finish carried by the fed steers does not increase their value; (7) the use of diethylstilbestrol implants increases the daily gain of steers grazing ryegrass pastures; and (8) more net profit per steer is made from well-fertilized ryegrass grazed alone than by supplemental feeding of grain or cottonseed meal.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Godbey, E. G., Wheeler, R. F., Kropt, D. H., Godley, W. C., and Starkey, L. V. WINTER FORAGE FOR FATTENING STEERS. S. C. Agr. Expt. Sta. B. 469, 15 pp. 1959.

Steers weighing approximately 675 pounds were fattened in dry lot, on winter forage with grain feed, or on winter forage alone. The ground grains fed on rye grass and crimson clover pasture were shelled corn, milo, barley, oats, and a mixture of corn, oats, and cottonseed meal. The daily gains made by the steers were not affected by the rations used.

When the feed required for 100 pounds of gain used by the cattle fed on forage was compared with that required in dry lot, the forage replaced all the roughage and about two-thirds of the concentrates. The feed cost per 100 pounds of gain was highest when steers were fed in dry lot and lowest for those on forage alone. When oats were fed it cost less to produce 100 pounds of gain than when mixed feed was used. No other significant differences were found in feed cost per 100 pounds of gain.

The profit per steer was largest for the cattle on forage alone and least for those fed in dry lot. The cattle fed oats on forage were the only group that returned a profit that was not significantly lower than that made by the steers on forage alone. The steers on oats also returned a higher profit than those fed milo for the mixed ration. No significant differences in profit per steer were found between those fed oats, barley, or corn.

No significant difference was found in carcass grade, dressing percentage, calculated separable bone, fat, or lean; percentage fat (marbling) of the rib eye, or area of the rib eye.

The lower iodine number of the fat from the steers fed in dry lot indicated that the fat was firmer than that produced by the steers on the other rations.

The lower specific gravity of the rib cuts from steers fed in dry lot indicated that they were fatter than steers fed corn, milo, or oats on forage; or those on forage alone. The specific gravity indicated that steers fed barley or mixed feed on forage were fatter than those on forage alone.

S. C. Agr. Expt. Sta., Clemson Agr. Col., Clemson, S. C.

Moore, C. V., Sitterley, J. H., and Shaudys, E. T. COSTS OF HAY CONDITIONING FOR FASTER FIELD CURING. Ohio Agr. Expt. Sta. Res. B. 834, 13 pp. 1959.

Owners of hay conditioners reduced hay curing time by one day. This cut exposure time 25 to 30 percent and allowed them to take advantage of more periods of favorable weather. Twenty conditioner owners reported improvement in the quality of hay harvested.

Criteria for determining the desirability of purchasing a conditioner are: (1) The importance of hay to the farm operation. If hay limits the size of the livestock enterprise, then an increase in yield is very important. (2) The relative advantage of investing capital elsewhere in the farm operation. And (3) reduction in feed cost is made possible by feeding high quality hay. Higher quality hay yields greater returns meat or milk, than to breeding stock such as beef brood cows. Increased value if conditioned hay is sold.

Costs per acre decrease as the acreage conditioned is increased. On the larger acreages, it is possible to recover most of the added cost of conditioning through reduced yield losses. More of the added costs must be met by gains from improved quality when small acreages are harvested.

Ohio Agr. Exp. Sta., Wooster, Ohio.

Walker, D. L., and Bevan, R. C. COST OF BALING AND CHOPPING HAY IN SOUTH CENTRAL IDAHO. Idaho Agr. Expt. Sta. B. 315, 16 pp. 1959.

Hay harvesting costs are analyzed in this publication for nine combinations of baling or chopping equipment and two custom harvesting possibilities. The costs as shown are for the south central Idaho irrigated area.

Custom hay harvesting is more expensive than harvesting with owned equipment in almost all cases for farms producing 125 tons of hay or more.

Farmers who feed all their hay on the farm, and who can use chopped hay, will have lower costs by chopping their hay instead of baling it. The advantage will range from a few cents to as much as $2 per ton. Farmers who sell a part or all of their hay will usually find it necessary to have it baled in wire-tied bales. Chopped hay is less expensive because: (1) No wire or twine is needed; (2) the initial cost of choppers is less; and (3) choppers last longer than balers.

Power take-off balers and choppers are cheaper to operate than those powered by auxiliary motors. If 250 tons of hay are produced, the saving ranges from 24 cents to 42 cents per ton.

Baled hay tied with twine costs 45 cents less per ton than that tied with wire. Offsetting this advantage is the greater breakage loss from twine-tied bales.

If trucks needed to haul chopped hay are not already owned or available through exchange work arrangements, unloading wagons will be more economical than investing in additional trucks.

Some farmers can pull the chopper with the truck being loaded. In this case, the chopper will be powered by an auxiliary motor. This saves one man and the operating expense of the tractor used to pull the chopper. It is more difficult to make sharp turns with this combination; consequently, it cannot be used on some fields. If the method can be used, it is one of the lowest cost combinations.

The smaller farms have higher costs per ton than the larger farms. On a 240-acre farm costs are from 80 cents to $1.55 less per ton than those on an 80-acre farm.

Little difference in the ranking of the various methods results whether all labor is included as a cost or none of the labor charge is counted. In both cases the high cost methods are the baling combinations and the low cost ones are the chopping combinations.

When costs are adjusted to include only the typical amount of temporary labor for each farm size and each method, very little change occurs in the ranking of the methods tested. The lowest costs are still obtained when the chopper driven by a power takeoff or the chopper pulled by the truck being loaded are used.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

Kline, R. G., and McPherson, W. W. CHOICE OF FORAGE CROPS AND METHODS OF STORAGE AN ECONOMIC ANALYSIS. N. C. Agr. Expt. Sta. Tech. B. 130, 64 pp. 1958.

On farms in the Piedmont Areas of North Carolina, when both grass crops and corn for silage are grown on land available for row crops, a given feed value (tons of alfalfa number one hay equivalent) can be produced at a lower cost as corn silage than as grass silage from either alfalfa, oats and lespedeza, or lespedeza (oats for grain). However, when the grass crops are grown on land available for non-row crops only and corn for silage is grown on land available for row crops, a given feed value output is produced at a lower cost as alfalfa silage, oats and lespedeza silage, or lespedeza (oats for grain) silage than can be produced as corn silage.

This analysis indicates that, in the Piedmont Areas of North Carolina, a given value (tons of alfalfa number one hay equivalent) would be produced at least cost as lespedeza following small grain, when sufficient non-row cropland is available to produce the desired output. When the desired output cannot be produced as lespedeza following small grain on non-row cropland, alfalfa enters the least cost forage crop combination.

For outputs up to 50, 70, 90, and 110 tons of alfalfa number one hay equivalent on representative dairy farms with 33, 76, 91, and 128 acres, respectively, of cropland, corn for silage does not enter a least cost forage crop combination. Corn silage comes in as an economical forage crop when it is necessary to use row-crop land to produce the

desired output of feed. Corn silage would come in on farms where high proportions of the land are row cropland. When non-row cropland is not suitable for alfalfa but produces high yields of oats, this crop would come into a least cost forage crop combination.

The results of the analysis indicate that for representative dairy farms in the Piedmont Areas of North Carolina, producing a part of the forage as grass silage offers possibilities in economical forage production. Farm units that plan an expansion of the forage output can store an increased quantity of feed value cheaper in the form of silage than in the form of field-cured hay when additional storage space must be provided.

On farm units where a forage harvester and blower are owned, it is economical to store as silage rather than field-cured hay, grasses and legumes that are ready for harvest during the season of the year when the probability of favorable hay harvesting weather is low. Even when rain damage to the first three cuttings of alfalfa causes losses no greater than 8 percent dry matter, 10 percent estimated digestible protein, and 10 percent estimated net energy, forage production costs per unit of feed value preserved would be less when the forage is stored as silage rather than field-cured hay.

The results of this study indicate that, when a farm unit owns only a hayloader, power fork, and hoist, it may be economical to purchase an ensilage cutter and corn binder or to hire a custom operator to harvest forage for silage during the spring and early summer months. Even with the additional investment for a silo, forage feed value production costs would be reduced compared with an all hay system unless a large percentage of the forage is lespedeza (following small grain).

When silage is included in a forage system, risks are reduced in two ways: (1) The risk of weather damage after the crop is cut is reduced; and (2) it is possible in any one year for corn which was planted for grain to be used as silage.

Agr. Expt. Sta., N. C. State Col., Raleigh, N. C.

Brooks, L. K., Walker, S., and Weber, J. ANALYZING DAIRY FARMS FOR MAXIMUM PROFIT. Idaho Agr. Expt. Sta. B. 301, 32 pp. 1959.

This bulletin is designed to help dairy farmers adjust their operations to changing technology and marketing conditions. Each farmer has a different set of circumstances, resources, and markets that will have a great influence on how he adjusts to his situation. To make these adjustments, farmers must have the answers to questions like these:

Can I cut production costs?
Can I cut my investment in equipment or building?
Would I be better off buying all my feed?
If I need more land should I buy or rent it?
How many cows can I handle?
Can I make changes that will make me more money?

The answers lie in the dairy farmer knowing his costs. A simple-to-follow method of cost analysis for a dairy farm is presented. The dairy farmer who works it out thoroughly will know just what his costs of producing milk, silage, hay, and grain are; and he will be in a position to answer questions such as those posed above and adjust his operation to make more money.

A better understanding of costs for a particular area would be gained by a dairy farmer if he worked this through with a group of neighbors, each analyzing his own farm, but working in a group.

U. Idaho, Col. Agr., Agr. Expt. Sta., Moscow, Idaho.

Brown, J. F. SOME INVESTMENT ALTERNATIVES FOR RHODE ISLAND DAIRY FARMS. R. I. Agr. Expt. Sta. B. 347, 14 pp. 1959.

Business minded dairy farmers will continually evaluate the relative merits of many investment opportunities.

Partial budgeting provides an excellent tool for determining the profitability of an investment alternative. This technique is illustrated in an actual farm situation with irrigation, soilage, and increased fertilizer usage as investment alternatives. The partial budgets are compared with respect to changes in net profit, increase in investment,

amount returned per dollar cost, and percentage return on investment. Other factors to consider on farms with limited capital are type of investment, salvage value of equipment and/or livestock, and the length of time before returns are realized.

Summary of Investments and Returns for Irrigation, Soilage, Fertilization and the Combination.

| Practice | Increase in Investment | Increase in Net Profits | Amount Returned Per Dollar Cost | Percentage Return on Investment |
|---|---|---|---|---|
| Irrigation | $4,968 | $44 | $1.02 | .89 |
| Soilage | 3,008 | 243 | 1.10 | 8.08 |
| Fertilization | 2,224 | 183 | 1.09 | 8.23 |
| Combination of above three | 10,230 | 454 | 1.08 | 4.43 |

Agr. Expt. Sta., U.R.I., Kingston, R. I.

Magee, A. C., and Rogers, R. H. COMBINING LIVESTOCK WITH CASH CROPS ON BLACKLAND FARMS. Tex. Agr. Expt. Sta. MP-376, 11 pp. 1959.

Adjustments have been made on many Blackland farms since the beginning of World War II, when the number of people living on farms began to decline rapidly. The Blackland area was chiefly a cash crop area raising cotton. Under the cotton acreage-control programs grain sorghum and oats acreages have increased. A number have increased their businesses by adding one or more livestock enterprises. Operations on more than 100 farms were studied in 1957 to learn how farmers have combined livestock with cash crops to increase returns, to utilize available labor fully, and to sell homegrown feeds and forage through meat animals and poultry.

The farms studied averaged 340 acres, with 235 acres in cultivation and about 100 acres in permanent grass. Cotton, the major source of income, was produced on about a third of the cropland, corn or grain sorghum on two-fifths, and small grain, chiefly oats, on about a fourth of the cultivated land.

Labor and feed requirements and other production costs provide a guide in considering the following enterprises; cow-calf, stocker steer, feedlot steer, sheep, hogs, and laying hens. The added investment for buildings and facilities varied between $760 and $2,750, depending on the enterprise.

Average prices received and paid in 1957 were used to develop enterprise budgets for typical farm situations. These budgets can be used to guide farmers in considering one or more of the livestock systems to be added to cash crop production.

The relatively low feed prices, compared with livestock prices, yielded favorable returns from the added enterprises in 1957, except laying hen flocks and market egg production. Average returns per hour of labor were: beef cows, $3.04; stocker steers, $13.08; feedlot steers, $6.68; ewes, $2.22; brood sows, $3.25; and laying hens, 68 cents.

On farms with a cow-calf operation, herds numbered 10 to 30 cows. Three to 4 acres of native grass per cow are desirable. In general, creep feeding of calves was profitable.

Less time is required with stocker cattle than with other livestock. This enterprise can be profitable when grazing is available. For drylot feeding, animals usually were brought in the fall, grazed about 60 days, and then fed for 150 days. Feedlot animals were sold prior to the beginning of spring crop operations.

Sheep alone, or with other grazing livestock, were maintained on some farms in flocks of 25 to 150 head. Forage that will support one cow will support five ewes. Lambs marketed near Easter were more profitable than those marketed later.

Confined sow-pig production was the common hog enterprise. Only a few pastures in the area were developed primarily for hogs. Ten to 15 sows were handled economically. In starting a hog enterprise, equipment costs averaged $275 per sow for a 10-sow herd.

Ordinarily, family labor was used to tend 500-hen flocks that required about 3 hours of labor per day. Floor feeding, housing, and equipment cost about $4 per layer. Costs ran higher for cage layers.

Tex. Agr. Expt. Sta., College Station, Tex.

Blosser, R. H. ECONOMICS OF IMPROVING HILL LAND FOR BEEF PRODUCTION. Ohio Agr. Expt. Sta. Res. B. 822, 22 pp. 1958.

Income figures (estimates) based on farm budgeting procedures show that with top grade management beef cattle can pay for a major soil improvement program in southeastern Ohio. This conclusion is based on raising a beef breeding herd on 500 acres of hill land, and selling the young cattle at slaughter weights averaging 850 pounds. Top grade management included above average quality livestock, a minimum investment in machinery, fences and buildings, efficient use of labor, a well balanced pasture program, high crop yields, and a 93 percent calf crop sold.

Crop production, livestock numbers, capital requirements, labor needs, receipts, expenses, and net income were determined by farm budgeting procedures so that all factors could be held constant except the one under consideration at a particular time. In this way, changes in income could be attributed solely to better soil management.

Calculations were made for nine consecutive years which should reflect most of the increases in crop yields. Yields before and after establishing the soil improvement program were based on the best experimental data and farm experience available. Farm product prices and production costs used in calculating income were averages for the five year period 1951-55.

Soils studied were Muskingum and associated types which cover about one-half of southeastern Ohio. Soil improvement programs on this type of land usually require contour strip cropping if corn is to be raised, and heavy applications of lime and fertilizer on both the cropland and permanent pasture.

With top grade management, a soil improvement program will increase profits after the initial expenditures for lime and fertilizer have been recovered. But until the fifth year, net cash income will be less than before any changes were made. About seven years will be needed to increase the hourly returns to labor. Under average management, more time would be required.

Length of time needed to finance a soil improvement program out of cash receipts and increases in inventory will depend upon the price of beef and the amount produced. If annual production of beef averaged 195 pounds per acre of cropland and improved permanent pasture used for the beef enterprise, slaughter cattle would have to sell for about $23.00 net per hundred pounds over a 10 year period to pay all additional costs.

If production of beef were only 150 pounds per acre, the price of slaughter cattle would have to average about $25.50 per hundredweight after deducting hauling charges to pay all costs in a 10 year period.

If any capital were borrowed, additional income would be needed to make repayments on principal. Since lending agencies usually require some repayment on loans each year, most beef farmers would have considerable difficulty borrowing any sizable amount of money during the early stages of a major soil improvement program.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Lloyd, R. D., and Hecht, R. W. OVERHEAD LABOR ON NORTHERN NEVADA CATTLE RANCHES. Nev. Agr. Expt. Sta. B. 209, 32 pp. 1959.

Nevada cattle ranchers had larger overhead labor loads than farmers in other States where studies were made. In 1957, the average northern Nevada cattle ranch had 620 head of cattle, 381 breeding cows, 10,097 acres of land, and 2,572 animal unit months of grazing permits on public ranges. On the average, 10,133 man-hours of work per ranch was performed by 2 family and 5 hired workers. Nearly 20 percent of this was for overhead jobs. The most time-consuming overhead jobs were maintenance and repair of machinery, business trips, construction and maintenance of buildings, construction and maintenance of land improvements, and construction and repair of fences. Others were

record keeping, construction and repair of stockyards, establishment and maintenance of permanent pasture, and work to improve and maintain rangeland productivity.

Nonfarm labor was hired to do 9 percent of all overhead work; frequently this consisted of repair and maintenance of buildings, work on rangeland, maintenance and repair of machinery, and construction of fences.

These estimates are based on data obtained in a field survey of 80 northern Nevada cattle ranches conducted during the summer of 1957.

The authors conclude that ranchers can boost profits through minimizing overhead labor costs. Overhead jobs should be planned so that: (1) As many jobs as possible are done with farm rather than nonfarm labor, which is usually paid at higher rates; (2) seasonal hired labor is not used for overhead jobs; (3) as many jobs as possible are done during seasons when crop and livestock labor requirements are relatively low; (4) machinery maintenance is adequate and timely; (5) machinery overhauling is done before the haying season; (6) repairs and maintenance of buildings and fences are timed to take advantage of the normal ranch labor supply; (7) construction of new improvements makes the best possible use of ranch labors; (8) business trips are minimized; and (9) records help to improve management.

U. Nev., Agr. Expt. Sta., Reno, Nev.

Woods, H. S., and Buddemeier, W. D. INCREASING PRODUCTION AND EARNINGS ON FARMS WITH BEEF-COW HERDS IN THE UNGLACIATED AREA OF SOUTHERN ILLINOIS. South. Ill. U. School of Agr. P. 6, 41 pp. 1959.

Many southern Illinois farmers with beef-cow herds could increase substantially the earnings on their existing units of land by one or more of the following: (1) Increased crop production; (2) increased volume of business; and (3) improved management of the herd.

To determine the potentials from use of more capital and labor and greater efficiency in resource use on such farms, data were obtained in 1954 from a sample of 66 farms in southern Illinois. Based on existing land resources and general land-use programs, alternative budgets were prepared for a representative farm in each of three classes. The first plan assumed increased crop production from improved fertility and crop production practices and the addition of beef cows to utilize the additional roughage produced. The second added to this enough hogs to utilize all corn produced.

The results were as follows: (1) On a 288-acre part-time farm with less than $9,000 annual inputs and using 10 months or less of labor, the first plan would increase farm and family earnings, and the second would increase them still further, but off-farm income would still be needed for an adequate level of living. (2) On a low-volume full-time farm of 262 acres, with annual inputs of less than $9,000 but with more than 10 months of labor used, the first plan would increase earnings from $2,489 to $5,808, and the second would raise them to $8,917. And (3) on a high-volume full-time farm of 520 acres, with annual inputs of more than $9,900 and using more than 10 months of labor, the first plan would increase earnings from $2,990 to $7,578, and the second plan would further increase them to $9,760. For both the low- and high-volume farms, either alternative would result in an adequate to good level of living.

Additional alternatives considered were pasturing feeders, fattening cattle in drylot, dairying, and combining beef-cow and fruit enterprises.

Sch. Agr., Southern Ill. U., Carbondale, Ill.

Henderson, H. A., and Atkins, S. W. COSTS AND RETURNS FROM SHEEP IN TENNESSEE. U. Tenn. Agr. Expt. Sta. B. 306, 20 pp. 1959.

This report deals with a procedure for estimating costs and returns from a 30-ewe flock producing spring lambs under different resource situations. The situations range from no idle resources to shelter and all pasture available, at no cost, to sheep.

For the four resource situations assumed for the study reported, net returns from the flock would vary widely. Estimates of returns to labor range from $63 when no idle resources are available to sheep to $454 when shelter and pasture are available without cost.

For some producers, information on net returns above cash expenses is a useful guide in determining relative returns from different production situations. Using this measure, net returns range from $225 to around $520.

Spring lamb production will probably be profitable for some producers even when prices are low. Total costs on farms with idle resources, as assumed in Situation A, should not exceed $10 per hundredweight. Except in the 1930's spring lamb prices have averaged more than $10 for the last 25 years. If the sheep enterprise must pay for all resources used, profit may be very small or nonexistent even with high prices for lambs. Lamb prices would need to exceed $24.70 per hundredweight to return a profit above all costs. Only during 1949-52 has the average price been more than this amount since the mid-20's.

Because of the supplementary nature of the sheep enterprise, producers need to study their own resources and then estimate probable costs and returns. The budgets presented in this report may be used by individual operators as guides in preparing these estimates.

Tables, Graphs, and Maps.

FERD, ARS, USDA and U. Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Hill, H. L., and Staniforth, S. D. ADJUSTING LIVESTOCK-SHARE LEASES TO MEET INCREASED CAPITAL REQUIREMENTS. J. Farm Econ. 41: 63-69. 1959.

Through the use of family transfers and more liberal credit, progress has been made in overcoming the capital shortages of individual farmers. But for those farmers without the required family assistance or credit, some means are needed to permit opportunities for savings after adequate standards of consumption have been met. Changes of the type examined here, where the terms of livestock-share leases are adjusted to permit combining a limited amount of tenant resources with a larger amount of landlord resources, appear to offer some possibilities in this direction.

How readily changes of this type would be accepted is not known. Landlords might be very reluctant to accept changes requiring them to provide more resources than tenants. However a possible incentive to landlords, aside from any personal interest there might be in the progress of a particular tenant, could exist in the wider choice of tenants that might result. This would be important where an opportunity exists to obtain a tenant with superior managerial ability who has not acquired other resources customarily supplied by tenants.

It is unlikely that continuous adjustment in tenant shares would be acceptable or even practicable to the extent demonstrated. Rather, it would be more feasible to select a few sharing arrangements, such as 30 to 70 or 40 to 60 leases. These shares (with the tenant providing the smaller share) could be consistent with good leasing practices and could afford an expansion of economic opportunities through leasing.

FERD, ARS, USDA and U. Wisc., Madison, Wisc.

Olson, R. O. SOME OPPORTUNITIES FOR IMPROVING FARM INCOME IN SOUTHEASTERN OHIO. Ohio Agr. Res. B. 832, 39 pp. 1959.

In southeastern Ohio, soils are relatively unproductive, farm labor frequently is not fully employed, and farm incomes are low. Soils and topography limit farmers' opportunities to increase earnings. But with better management of land, labor, and capital, many could achieve higher incomes. This study considers how farmers in Athens, Jackson, Meigs, Vinton, Lawrence, Hocking, and Gallia Counties which are in the unglaciated Appalachian foothills could change their farm organization to increase income. Creek valleys are typically narrow and hills are generally steep and rough. Soils are largely Muskingum sil with some Meigs sicl.

A full-time off-farm job, along with as much farming as can be carried on with the time remaining, was found by linear programming to be the most profitable livestock enterprise. However, this class of livestock was not considered a practical alternative unless a herd of 7 or more cows could be kept. Unless more the $3,000 of additional capital was available, hogs and poultry were the more profitable livestock enterprises.

With a full-time job off the farm, the highest net income was obtained from the typical 120-acre farm. The operator would be financially ahead to sell or rent out any acreage in excess of 120 acres.

Higher incomes under the optimum use of resources would come chiefly from raising more and better livestock than was done under the 1952 program. To make this change would require the application of more capital and labor.

Computations show that net income could be increased about $2,000 for farms of all sizes if about $12,000 additional capital were available to convert some of the permanent pasture to cropland, improve the permanent pasture, and maintain a good-quality dairy herd.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Kelsey, M. P. CHANGES IN FARMING, 1947-57 AS SHOWN BY MICHIGAN FARM ACCOUNT RECORDS. Mich. Q. B. 42(2): 287-309. 1959.

Farmers are continually making changes in the organization and operation of their farms. Except for 1951-52, the period from 1947 to 1957 has been one of gradually declining farm prices and continually increasing costs. This has put tremendous pressure upon farmers to adjust their operations to meet the "cost-price squeeze."

Results from individual farms throughout Michigan have been obtained from farmers keeping farm records in cooperation with their county Cooperative Extension Service offices and the Agricultural Economics Department of MSU. These records provide a basis for studying the physical and financial changes made in farm organization and operation. This article brings together information from the annual reports for the years 1947 through 1957. The information presents the farm price situation in the state during this period, the physical and financial changes on all farm account farms, and the 11-year averages for each of the type-of-farming areas.

In 1947, these farmers had an average labor income of $3,486. The average labor income declined for two years, then rose to a peak in 1951 of $3,782. The earnings figure then declined sharply each year to a low of $993 in 1955 but recovered in 1956 and 1957 to above the same level as in 1953 of about $2,500.

Mich. State U., Agr. Expt Sta., East Lansing, Mich.

Corbridge, I. L., and Nelson, G. T. CAN YOU STAY IN BUSINESS? Farm Mangt. 8 (5): 28-31. 1959.

Farm population has declined from 32 million in 1910 (34% of the population) to less than 20 million today (less than 12% of the population). This trend is expected to continue up to about 1975 when about 7% of our population will be farmers. In spite of this reduction in number of farmers, agricultural output has continued to increase. Fifty years ago, each farmer raised enough for himself and six others. Today he produces enough for himself and 23 others.

For the next 10 to 15 years, surpluses rather than shortages are likely to continue a major problem. As many as 25% of our marginal farmers could be withdrawn from agriculture without hurting our productive capacity, provided the remaining farm units were efficiently operated.

The national average value of all productive assets per farm in 1958 was about $30,000. Since 56% of the total number of farms have annual sales of only $2,500 or less, balance of the farms - which really produce the bulk of our needs - obviously require a capital investment far in excess of the above average figure. Many farms have capital assets in excess of $100,000. The average person working in agriculture today is working with far more fixed capital than the average non-farm worker.

We are now entering a period in which a smaller share of farm earnings is likely to be devoted to capital accumulation and a greater share for family living. Fewer farm people will be willing to spend 40 years of reduced living standards in order to own their own farms. More will be satisfied to rent at least part of the farm unit and/or enter into some type of financial agreement wherein a third party will put up some of the capital even on a permanent basis. A further extension of family partnerships and corporations

is very likely. These permit the economies of continued and unified operations yet do not require all the capital from one individual or family.

The well-managed family farm, large enough to enjoy some of the advantages of size yet small enough to allow close attention to details, is likely to continue as the dominant form of farm business. Part-time farms, on the other hand, are increasing in number as ever more people are supplementing their incomes with outside employment - even to the extent of relying on non-farm employment as their major source of income. Commercial farms, generally, are increasing in size.

Small and large farms are likely to continue to exist side by side. However, the trend toward better managed and often larger units is undoubtedly to continue. A commercial business cannot afford to employ a man doing only half a job. Similarly, ill-managed and inefficient farm units cannot continue to justify themselves.

Decreasing number of farmers, increasing capital requirements, and increasing farm size are currents underlying the farm scene. Surpluses and relatively depressed farm prices are likely to continue to be the rule rather than the exception for the next 15 years. Any legislative subsidy, however, to perpetuate inefficiencies in farming will boomerang to the ultimate detriment of farmers themselves.

Brigham Young U., Provo, Utah.

## Institutional and Educational

Mosher, M. L. FARMS ARE GROWING LARGER. Ill. Agr. Expt. Sta. B. 613, 44 pp. 1958.

This study had two major objectives: (1) To show how farms of different sizes differ in the efficiency with which they use land, labor, capital, and management; and (2) to study the relation of size of farm to family, community, and national welfare now and in the future. The report is divided into three parts: (1) The relationship of size of farm to the efficiency of individual farms in terms of 1954 data; (2) eight hypothetical counties, each made up entirely of farms of one size, ranging from small farms to very large ones, are compared in various ways; and (3) the author's opinions are given of some implications of the growth in size of farm.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

Farm Economics Research Division. INCREASE IN FARM ASSETS, DEBTS AND EQUITIES, 1959. U.S.D.A., A.R.S. 43-100, 42 pp. 1959.

For most farmers, the financial outlook for the near future is not as favorable now as it was a year ago. In 1958, bumper crops and high prices of cattle and hogs raised farm income substantially and promised continued high income well into 1959. Moreover, farm assets and equities rose sharply in 1958. The financial position of farmers at the beginning of 1959 was favorable. Farm income has dropped substantially from the high 1958 levels, and a further decline seems to be in store for 1960. Farm assets and equities continued to increase in 1959 but by only 2 1/2 percent - the lowest percentage increase since 1955. There is a strong possibility that the rise in farm assets and equities may stop for a time in 1960 or 1961. Farm debts rose during 1959 and are likely to increase further in 1960.

By far the greater part of the increase in farm asset values during 1959 resulted from rising prices of farm real estate, increasing numbers of cattle, and additions of motor vehicles and machinery on farms. Lower farm income will remove some of the stimulus to the land market and may discourage purchases of motor vehicles and machinery by farmers. A substantial decline in prices of cattle could reduce very quickly the value of the cattle inventory.

Farm debts seem more likely to continue upward than do farm asset values. The farm-mortgage debt has risen each year since the end of World War II. Because of the trend toward farm enlargement and improvement, the debt has risen each year since the end of World War II.

The liquid financial reserves of farmers are likely to show little change in 1960, despite lower farm incomes. Since their sharp wartime increase, these assets have not responded sensitively to changes in farm income, although they increased substantially in 1958 as a result of high income.

The farm financial outlook varies considerably by types of farming and areas. The outlook for the operators of the larger and more productive farms and of those operators who have been able to expand their volume of business is considerably better than for those on smaller, less productive farms.

ARS, USDA, Inform. Div., Washington 25, D.C.

Brewster, J. M. THE IMPACT OF TECHNICAL ADVANCE AND MIGRATION ON AGRICULTURAL SOCIETY AND POLICY. J. Farm Econ. 41: 1169-1184. 1959.

The heart of any serious policy problem is a conflict of deep-seated value judgments. The author discusses the following five questions: What are the main value judgments that have guided national agriculture policy making since early times? What is the model of social organization that traditionally has been viewed as promising fulfillment of these values, and what important events shaped it? What is the connection between these values and the tremendous drive for technical advance that unfolded our Machine Age, including modern scientific agriculture with its burdensome excess capacity and relatively low income? Does outfarm migration offer a long-run solution to this excess capacity and low income position of agriculture? What are the implications of our findings on these questions for national policy formation, especially for farm policy and programs?

One-third of the people on farms in 1930 had left the farms for better paying non-farm employment by 1955. In 1956, the estimated income gaps between farm and non-farm families of similar labor capacity was roughly $2,000 in favor of the non-farm families. The rate of technical advance has been so rapid, that total farm capacity averaged 8 percent more than consumptive needs from 1949 through 1956, and no letup of excess capacity is forecast.

The author concludes that: (1) Agriculture is a competitive industry in a larger world where less than fully competitive markets are widespread, and where there is normally much less than full employment; (2) agriculture is also afflicted with a rate of technical advance that expands aggregate farm output appreciably faster than the growth of effective demand for farm products; (3) these conditions preclude outfarm migration by itself from providing a long-run solution to the problem of excess capacity and the relatively low income in agriculture; and (4) three implications deserve mention: (a) No simple solution is in sight for the Nation's underemployed manpower in agriculture because America, by and large, has no clear conception of what she most wants; (b) this does not mean that our older sense of values must be junked. It does mean that our older creeds are in for some teeth-jarring shakeups that may lead to wider visions of their essential means and the forms of organization and action appropriate to their fulfillment; and (c) in this re-examination of our older creeds, the economist has a unique role to play.

FERD, ARS, USDA, Washington 25, D. C.

Journal of Farm Economics ON AGRICULTURAL POLICY: A SYMPOSIUM. J. Farm Econ. 41: 173-193. 1959.

This is a group of five papers by agricultural economists who were asked to comment briefly on past, current, and prospective developments in the field of agricultural policy. The papers and addresses of authors are: (1) Benedict, M. R., THE SUPPLY, PRICE AND INCOME DILEMMA, U. Calif., Berkeley, Calif.; (2) Brandow, G. E., REFLECTIONS ON FARM POLICY, PAST AND FUTURE, Pa. State U., University Park, Pa.; (3) Hathaway, D. E., UNITED STATES FARM POLICY: AN APPRAISAL, Mich. State U., East Lansing, Mich.; (4) Penn, R. J., FEDERAL AGRICULTURAL PRICE AND INCOME POLICY, 1955-59, U. Wisc., Madison, Wisc.; (5) Schultz, T. W., AGRICULTURAL POLICY FOR WHAT?, U. Chicago, Chicago, Ill.

Farm Economics Research Division CHANGES IN FARM PRODUCTION AND EFFICIENCY: A SUMMARY REPORT. U.S.D.A. Stat. B. 233, 27 pp. 1959.

This is the sixth issue of an annual publication that is designed specifically to present the major statistical series on farm production, production inputs, and efficiency. It provides in one place the latest information for each of the several series that have been developed to appraise such things as production in peace and war, changes in farm inputs and practices, improvement in labor productivity, and progress of farm mechanization.

In previous issues of this publication, data for certain series were presented for nine census geographic divisions beginning with 1919. In this issue, data are presented for 10 farm production regions beginning with 1939. For these series except that on use of fertilizer, data for the United States only are available for 1938 and previous years.

Although the publication consists basically of statistical series, a brief digest of what each series shows to date is included, as is an explanation of the methods used in developing each statistical measure.

ARS, USDA, Inform. Div., Washington 25, D. C.

Cochrane, W. W. FARM TECHNOLOGY, FOREIGN SURPLUS DISPOSAL AND DOMESTIC SUPPLY CONTROL. J. Farm Econ. 41: 885-889. 1959.

The author's purpose is to do three principal things: (1) Describe and dramatize the technological revolution in American agriculture together with its surplus implications; (2) describe the pre-eminent role that foreign surplus disposal has assumed in domestic agricultural policy together with its potential role; and (3) argue the necessary linkage of effective supply control to foreign demand expansion, if good and stable incomes are to be realized on representative farms in the United States.

His thesis is that advancing technology in American agriculture is forcing, first, the acceptance of foreign surplus disposal and second, the acceptance of comprehensive supply control. And the logical result must be the integration of--the marriage of--these seemingly opposing lines of action into a unified policy. And it is the purpose of this paper to record--to legitimatize--this marriage of foreign surplus disposal and comprehensive supply control.

U. Minn., St. Paul, Minn.

Agricultural Research Service ECONOMIC ASPECTS OF SOVIET AGRICULTURE REPORT OF A TECHNICAL STUDY GROUP. U.S.D.A., A.R.S., 78 pp. May 1959.

In brief, the conclusions reached by the study group were that agriculture today cannot be considered the "Achilles' heel" of the Soviet economy; climate tends to limit the potentialities of agriculture in the Soviet Union; the 90 million acres of new land developed from 1953 to 1957 apparently included most of the readily accessible area that is suitable for crops and that could be made available without clearing, drainage, or irrigation. The current 1959-65 plan does not call for large-scale new-land programs; Russian agricultural leaders recognize that their greatest opportunity for expanding output involves the use of more commercial fertilizer and other improved practices that will increase yield per acre; it seems likely also that farm output could be increased by greater attention to regional specialization, a subject now under discussion in Soviet agricultural circles; progress in mechanization of crop production is most striking in such operations as plowing and harvesting, which lend themselves to use of heavy duty equipment; many new dairy barns and hog and poultry houses have been built but apparently construction cost and labor economy were not given adequate consideration in building design and location; milking machines and feed and litter carriers have been installed on many farms. Fragmentary evidence suggests that farm output per worker is only about one-fourth as high as in the United States; it should be possible to carry out the production job in agriculture with a much smaller number of workers. Appraisal of the advantages and disadvantages of large-scale farming as practiced on the huge collective and state-operated farms is difficult; central planning and supervision of agriculture,

although less centralized than in earlier years, permit the marshalling of all available resources to reach a specific goal; large-scale efforts of this type can achieve startling results but can produce costly mistakes. The Soviet Union has potentialities for increasing both farm output and production efficiency.

U.S. Govt. Printing Office, Washington 25, D. C. - 45¢

Smith, Hon. N. BASIC FACTS - A PROPOSAL TO STABILIZE AGRICULTURE. Land and Water 10 (2): 13-15. 1959.

The author tells why industry through supercorporate combinations have been able to limit the production of goods to the amount that can be converted and sold at a profit.

The farmers have no such structure to cut back production. Expecting an open market alone to do this for agriculture is penalizing farmers drastically for increased efficiency by making them give away the abundance they produced and would be expecting too much of an open market.

We have a choice of either finding a way through government for farmers to divide their production and gauge it to the Nation's needs or the alternative will certainly be that a supercorporate structure will emerge wherein a relatively few non-Government non-elected officials determine the supply and price of our food. We are heading toward the latter alternative very fast. There are now 4 million less farmers than 6 years ago working approximately the same 60- to 65-hour week and for less money. Farm assets are now only 83 cents of each $1 compared to $1.87 for each $1 owed 15 years ago. Thus the farm financial situation has become ripe for an integration drive, and it is well under way.

If we are to divide production equitably and provide stable prices, we must withdraw and increase either labor, capital, or land as needed or some combination of the three for those are the three ingredients that produce our food. If we were to withdraw capital, we would not preserve our extra capacity to produce and to expand production when needed. In order to withdraw labor, we must withdraw land.

There are two basic ways to accomplish the withdrawal of land and be within the long-term goals for consumers and farmers. One is for the Government to set the production goals and lease the productive land not needed to meet those goals. This is the soil bank method. The other way is to set production goals and offer some assurance that if he withdraws some land, the productive land remaining will give an efficient family farmer a reasonable income if he works a reasonable work week.

The soil bank method would mean a continuing large appropriation of Federal money. The latter method would mean a small total cost to the taxpayer if set up properly. The latter method is embodied in H. R. 7710 and in some other bills before the committee.

H. R. 7710 would briefly operate as follows:

1. Corn, oats, rye, grain sorghum, and barley would be tied together as feed grains instead of being under separate programs, and each grain would be given a comparative value according to nutrient value.
2. Production would be equitably divided among farm units and each farmer would be free to raise whichever feed grain or feed grains he pleases so long as the total feed grains raised does not exceed his total nutrient allotment as measured by comparative units.
3. Wheat raised without an allotment would be counted against the feed grain allotment for the farm.
4. Support nonrecourse loans would be limited to the normal production on the acreage allotment for the farm. Bushels raised in excess of normal yields would not be supported.
5. Since it is a voluntary program, an equalization payment is provided for feed grains fed by a producer so that livestock and poultry products will not have to turn their grain over to the Government and buy replacement grain in order to receive some security of price for grain within an allotment.
6. Support loans and equalization payments on feed grains fed would be limited to those who stay within their allotment and observe cross-compliance.
7. Feed grains in Government ownership in excess of a 1-1/2 billion bushel reserve would only be sold at the rate of 1 bushel for each $2 spent for meat, dairy, and

poultry products purchased by the Government and distributed to the needy, institutions, and the school lunch program. Thus, grain held would pay for more than one-half of the protein foods cost.

8. It provides a referendum to let farmers decide whether they prefer this program.

House of Representatives from Altoona, Iowa.

Butz, E. L. THE AGRICULTURAL DILEMMA. Amer. Soc. Farm Managers and Rur. Appraisers J. 22 (2): 8-18. 1959.

Modern agricultural science and technology are bringing far-reaching sociological and economic changes. This, of course, calls for adjustment in our whole agri-business complex.

The main effect of many governmental programs in agriculture is to slow down adjustment to change that would take place in the absence of such programs.

Agriculture is in the midst of a far-reaching scientific and technological revolution which is shaking the very foundation of its traditional institutional patterns.

We are now experiencing the third great agricultural revolution in this country. The first came in the middle of the nineteenth century, when we substituted animal power for human power. The second great revolution occurred beginning in the 1920's, with the substitution of mechanical power for animal power. This change likewise brought a tremendous increase in productivity per worker.

Agriculture is now in the midst of its third great revolution. It is changing from a way of living to a way of making a living. It is changing from a business of arts and crafts to a business undergirded with large amounts of science and technology. Productivity per worker on our commercial farms is increasing phenomenally. Still greater increases lie ahead, as we substitute more capital and technology for labor.

The five fundamental characteristics of the current agricultural adjustments which bear on the problem under discussion are: (1) Capital requirements for agriculture will grow, in total, per farm, and per man; (2) the trend toward larger and fewer commercial farm units will continue; (3) management has become a key factor in successful farm operation; (4) the commercial farm will increasingly assume the characteristics of a manufacturing establishment; and (5) our countryside will be "Rurbanized."

Dean Agr., Purdue U., Lafayette, Ind.

Schifferes, J. J. BEYOND SUBURBIA. Land and Water 9 (1): 7-11. 1959.

The author sketches the historic, economic, and psychological backgrounds and traditions upon a new type of American culture and civilization that has been created along the highways and byways of America.

This new rurapolitan civilization (from rura(l) (and metro)politan) has as its ideal a home in the "country" with all the conveniences of the city. Rurapolia, U.S.A., already houses the bulk of the white American population between the ages 0 and 17 and 25 to 60. It is the frontier of the interior.

Livingston, N. J.

Krausz, N. G. P., and Mann, F. L. CORPORATIONS IN THE FARM BUSINESS. U. Ill. Col. Agr. C. 797, 44 pp. 1959.

Larger needs for capital and credit, and family inheritance problems, are primarily responsible for a close look at corporate farming. Inflated land prices and more mechanization have raised capital needs to as high as $100,000 per farm worker. The movement of farm boys and girls to cities has created the serious question of how to hold the farm together for operating efficiency and still provide a fair inheritance for all of the children.

In some cases the farm corporation offers a solution to these problems. Incorporation can bring together the assets of several persons in a pooling of capital, and its more formal type of organization can improve the credit opportunities of the business. It allows each member of the family to share fully in the inheritance but can at the same time regulate his rights to sell his interest and to manage the farm.

This circular shows when and how the farmer may use incorporation in his farm business. Adapting the corporation type of organization to the individual farm business will usually require expert legal help.

U. Ill., Col. Agr. Ext. Serv. Agr. and Home Econ., Urbana, Ill.

McCracken, W. EQUIPMENT LEASING ... Farm Mangt. 7 (10): 20-21. 1958.

Leasing is no cure-all for the problems involved in acquiring the use of capital assets. The grower must have: (1) A more profitable use of the cash funds made available when equipment is leased; (2) a credit standing wherein his signature alone is adequate to justify entering into the transaction; (3) an earning capacity that places him in a 50% tax bracket; and (4) the equipment must be used in a business enterprise.

As to what equipment should be leased and on what terms, certain fundamental factors must be considered. Among these are: (1) Normal useful life of the equipment involved; (2) expected income created by the equipment use; (3) foreseeable duration of this income; and (4) longest bank lending terms available.

The lease term should be controlled so that the rental is paid out of earnings created by the equipment, thus creating a self-liquidating transaction and leaving a profit to the rancher each month. In nearly every case, any item of capital equipment that can be depreciated over a 4-year term or less should more properly be purchased rather than leased.

A lease obligation will undoubtedly be a part of the rancher's over-all credit line. However, since the lease payments are paid before taxes, the total obligation will not reflect to the same extent as a direct loan. A rancher should be able to lease several times as much as he could borrow. Thus, if he had a $100,000 credit line, he could probably lease $200,000 or $300,000 of equipment. This expansion of credit line is created because of the rancher's ability to pay substantially more out of income before taxes. At a 50% tax bracket, he could pay twice as much; at a 66 2/3% tax bracket, he could pay three times as much. Thus, the tax bracket is the yardstick. Leasable items include: Farm machinery, trucks and automobiles, airplanes, irrigation systems, packaging machinery, and processing machinery.

Most leases will contain renewal options. Beware of a lease with an option to purchase. A lease with an option to purchase has been construed by the Internal Revenue to be a conditional sale.

Staff Writers for Farm Mangt.

Pine, W. H., and Trock, W. L. LEASING IRRIGATED LAND. Kans. State U. Agr. Expt. Sta. C. 370, 15 pp. 1959.

Irrigation farming requires a lot more investments and costs per acre, so it must return more money. Additional skills and techniques are required for successful irrigation. Landlords and tenants who are thinking about irrigation or who are now irrigating and want to check their leases need to know what additional costs are required and how the costs should be shared. This circular describes a basis for developing equitable leases and suggests some leasing arrangements for irrigated land. Farms differ and circumstances of landlords and tenants vary, so leases must fit specific situations.

Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

Schruben, L. W. CHANGE IN * CROPS PROSPECTS DURING A GROWING SEASON IN THE UNITED STATES AS MEASURED BY OFFICIAL PRODUCTION ESTIMATES.

* GRAIN SORGHUM. - Kans. Agr. Expt. Sta. B. 401, 14 pp. 1958.
* OATS. - Kans. Agr. Expt. Sta. B. 405, 14 pp. 1959.
* BARLEY. - Kans. Agr. Expt. Sta. B. 406, 15 pp. 1959.
* CORN. - Kans. Agr. Expt. Sta. B. 407, 15 pp. 1959.

Changes in crop prospects during the growing season present a serious economic problem in agricultural adjustment. While it is well understood that changes occur, the extent of such changes and their frequency are not so well understood.

Each bulletin presents the data for its respective crop. Differences between official early-season estimates of production in the United States and estimates released the following Decembers have been analyzed and the results are presented in each bulletin. Such differences provide the most reliable indicator available of changes in crop prospects on a national scale. By using these data, farmers and businessmen serving farmers can better adjust to changes during a given crop season as such changes occur.

The analysis is based on the frequency, direction, and extent of changes in crop prospects which have occurred during past growing seasons. The estimates which were analyzed were those made by the Crop Reporting Board of the United States Department of Agriculture. This study is concerned only with those official estimates.

Kans. State U., Agr. Expt. Sta., Manhattan, Kans.

Davis, W. D. Jr., and Miller, F. LAND PRICE TRENDS IN MISSOURI. Mo. Agr. Expt. Sta. Res. B. 686, 55 pp. 1959.

During the 1947-56 ten-year period, farm land prices in Missouri did not reflect farm commodity prices or over-all levels of farm income. In most sections of the state, land prices continued to advance despite lower farm income. The increase was greatest in level areas where the soils are medium in productivity, but respond well to applications of fertilizer.

The market was not speculative. Buyers were less inclined to resell in the second five-year period than in the first.

A great many tracts smaller than 100 acres were sold to owners of other land to increase the size of existing units.

High quality land in a county that has a large acreage of low grade soils can be bought for a lower price per acre than can high grade land in an area where most of the acreage is above the average of the state in productivity.

Most of the farms on the market were either estates or sold because of old age, bad health, or retirement of the owner. Small tracts were bought to enlarge adjoining or nearby operating units, for part-time farms, or for retirement homes. Other farms were bought primarily to provide a home and a business.

A few sales establish a bench mark for the asking price. In a seller's market, the asking price tends to become the sale price. In a buyer's market, the bid price tends to prevail. The land market in the 1947-56 period definitely was a seller's market.

U. Mo., Col. Agr., Agr. Expt. Sta., Columbia, Mo.

Agriculture Research Service THE FARM COST SITUATION. U.S.D.A., A.R.S. 43-114 (FCS-27) 37 pp. 1959.

Farm production expenses totaling about $26 billion in 1959 are at a new peak for the third consecutive year; production expenses of about 68 cents per dollar of gross income are a fraction below the record high in 1932, and are likely to be higher in 1960.

Expenditures in 1960 for many major classes of production items, particularly overhead items such as taxes, interest, and depreciation charges, and items of nonfarm origin are expected to be as high or higher than they were in 1959. Expenditures for feed are expected to be about the same or slightly lower, because of lower prices, but quantities of feed bought may be the same or slightly larger. Expenditures for livestock are expected to be lower.

Prices paid for production goods and services in 1959 were higher than in 1958. For the year, they are estimated to be 2 to 3 percent higher than in 1958 and 20 percent above the 1947-49 average. Prices paid for goods and services from nonfarm sources have risen faster. They will average 34 percent above 1947-49. Since 1947-49, the largest increases in cost was wage rates for hired labor. Prices of building materials and motor supplies also have risen more than average.

Since 1947-49, annual farm production expenditures in the United States have risen about 45 percent - from nearly $18 billion in 1947-49 to about $26 billion in 1959. A little more than half of this increase resulted from higher cost rates; the rest was due to outlays for more goods and services.

The volume of purchased production inputs were about 22 percent larger in 1959 than in 1947-49. Purchases of feed and livestock represent about 70 percent of this increase. Feed purchases increased by 47 percent and purchases of livestock increased by 77 percent.

Because farms are getting larger and the number of farms is declining, production expenditures per farm have risen faster than aggregate expenditures. From 1947-49 to 1959, production expenditures per farm rose 80 percent.

The increase per farm in physical assets has paralleled the increase in farm output. About two-fifths of the increase resulted from more land per farm. Almost a fourth of the increase in physical assets, however, consisted of new and remodeled buildings and other depreciable structures, and another fourth was additional machinery and motor vehicles.

Operation, maintenance, and replacement of these depreciable assets at sharply higher prices account for more than 40 percent of the increase in production expenditures in the last decade.

Investments and operating costs have increased substantially on all type of farms, but net incomes have not necessarily risen with more inputs.

Tables, Graphs, and Maps.

ARS, USDA, Inform Div., Washington 25, D. C.

Agriculture Research Service THE FARM REAL ESTATE MARKET. U.S.D.A., A.R.S. 43-118, (CD-54) 44 pp. 1959.

The slower rate of increase in market values of farm real estate, first apparent in the March to July 1959 period, continued in the 4 months ending November 1. The national index for the latest date was 171 (1947-49=100), only 1 percent above that of last July but 5 percent above the index a year earlier. As of November 1, the total dollar value of farm real estate was estimated at $127.8 billion, or about $110.50 per acre; this was 2 percent higher than in March.

No significant change in values between July 1 and November 1 was reported in about half the states. Most of these States were in the eastern Corn Belt, the central South, and the Great Plains. The remaining States showed increases of 2 to 4 percent and were concentrated chiefly in New England, and in several other States that contain the large east-coast centers of population. Values in Florida, and in a tier of States extending from Minnesota to Louisiana continued to advance. Values in several Mountain States were up also.

The volume of sales in the summer and early fall of 1959 did not change much nationally from a year earlier, but several regional differences were apparent. Sales volume appeared to be lower in the spring wheat and western Corn Belt areas, partly because of drought. It was slightly higher in the Northeast, northwestern wheat, and general farming areas. Foreclosures remained within the low range of 1.0 to 2.3 farms per 1,000 that has prevailed since 1945.

Both dealer and nondealer reporters agreed that fewer people were looking for farmland last summer and early fall than a year earlier. Dealer's inquiries continued to come chiefly from farmers already owning land and from nonfarmers. Within the latter group, investors accounted for 23 percent of dealers' total inquiries nationally, but the proportion ranged to more than a third in areas where nonfarm influences are most prevalent.

Financing of farm transfers last fall was said to be generally more difficult than a year earlier. Although interest rates were a little higher for most lenders last October, the increase shown in central money markets had not yet been fully reflected in the rates for farm mortgages. Several lenders reported a sharp decline in their loan commitments in the fourth quarter of 1959 compared with a year earlier. Present levels of interest

rates are likely to cause increasing downward pressures on market values of land for farming purposes.

Charts, Graphs, and Maps.

ARS, USDA, Inform. Div., Washington 25, D. C.

Botts, R. R. LIFE INSURANCE FOR FARM FAMILIES. U.S.D.A., A.R.S. 43-92, 62 pp. 1959.

Life insurance is becoming increasingly important in farm financial planning. For those who advise farm families in this field, a rather technical knowledge of the various forms of life insurance and of the more important aspects of each, is indispensable.

The report covers the various types of policies, the needs served by each, and the more important policy provisions, such as the nonforfeiture and settlement options. It explains how greater use may be made of these options in the programming of life insurance to fit changing needs and circumstances.

ARS, USDA, Inform. Div., Washington 25, D. C.

LeRay, N. L. EMPLOYMENT AND UNDEREMPLOYMENT OF RURAL PEOPLE LOW-INCOME GROUPS IN ARKANSAS, MARYLAND, AND WEST VIRGINIA. U.S.D.A., A.R.S. 43-109, 26 pp. 1959.

This report incorporates the principal findings of five published technical studies conducted by the Farm Economics Research Division, Agricultural Research Service, in cooperation with the Agricultural Experiment Stations of Maryland, Arkansas, and West Virginia.

The surveys were conducted in the Upper Monongahela Valley, W. Va., during July 1954; in the Arkansas Ozarks during June 1956; and in southern Maryland (Calvert County) during March 1957.

A surplus labor force exists in each of the low-income areas studied. A large proportion of the individuals available for work expressed a preference for nonfarm employment. A majority of these individuals were young men and young women.

Underemployment was especially high among farmers. Many farm enterprises were too small to provide sufficient employment and income.

The extent to which development of commercial agriculture offers a solution of the low-income problem seems limited for many of the households in the areas studied, but this avenue of improvement merits further investigation. It would appear that any program to develop the low-income areas studies must be planned primarily along the lines of nonagricultural employment in the area or the outmigration of a large segment of the labor force to areas that offer nonfarm employment opportunities.

Although agriculture was not a major source of household income, it was an important supplement to earnings from nonwork and nonfarm work sources. Part-time farming is used in several different ways: (1) As a transition stage from full-time farming to full-time nonfarm work, (2) as a permanent way of life, and (3) as a transitional stage from nonfarm employment to full-time farming or from farming a small unit to farming a larger place full-time. Part-time farming provides an opportunity for nonfarm work without the necessity of giving up a sense of security derived from living on a farm. It also helps to tide families over periods of industrial unemployment and underemployment.

The final objective of these programs should be not to increase employment or income, but rather to develop and conserve the human and natural resources of the area. This is possible only when opportunities are available to all individuals. The Rural Development Program now offers a promising approach to the development and conservation of resources in the low-income areas studied.

ARS, USDA, Inform. Div., Washington 25, D. C.

Agricultural Research Service TAXES LEVIED ON FARM REAL ESTATE IN 1958. U.S.D.A., A.R.S. 43-106, 11 pp. 1959.

Taxes levied on farm real estate in the United States totaled a record $1,102.9 million in 1958, an increase of 5.7 percent over the amount levied in 1957. This is the 16th consecutive year that taxes levied on farm real estate have increased.

State and local government levies on farm real estate averaged $1.03 per acre in 1958, compared with $0.97 in 1957. This is the first year the average tax per acre has exceeded the $1 mark. The average tax per acre was almost 50 percent higher than in 1950 and more than double that of 1945. The increase in 1958 pushed the index of taxes levied per acre up 26 points to a record of 496 (1909-13 = 100).

Taxes levied on farm real estate in 1958 were higher than in 1957 in nearly every State. The largest increase (17.9 percent) was found in Arkansas, where a reappraisal program has caused a significant increase in taxable valuations. Besides Arkansas, four States--Arizona, Delaware, Connecticut, and Rhode Island--showed a rise of 10 percent or more.

Differences between States in the average tax per acre of farm real estate reflect variations in the value of farmland, as well as differences in tax systems. Thus in New Jersey, where the average tax per acre amounted to $8.31, the highest in the country, the property tax occupies a relatively important place in the State-local fiscal structure. The lowest tax per acre ($0.10) was found in New Mexico, where much of the land is relatively low-value grazing land, and where the property tax produces a relatively small part of State and local revenue.

Last year's 5.7 percent increase in taxes was slightly less than the gain in the value of farm real estate from 1957 to 1958. The value of farmland and buildings increased 3 percent in the year ended March 1, 1959. As a result, taxes on farm real estate decreased from $0.91 per $100 of full value in 1957 to $0.89 in 1958.

Maps, Charts, and Graphs.

ARS, USDA, Inform. Div., Washington 25, D. C.

Farm Economics Research Division FARM-MORTGAGE LENDING EXPERIENCE OF LIFE INSURANCE COMPANIES, THE FEDERAL LAND BANKS, AND THE FARMERS HOME ADMINISTRATION, *

* JANUARY THROUGH MARCH 1959. U.S.D.A., A.R.S. 43-104, 11 pp. 1959.
* APRIL THROUGH JUNE 1959. U.S.D.A., A.R.S. 43-112, 15 pp. 1959.
* JULY THROUGH SEPTEMBER 1959. U.S.D.A., A.R.S. 43-116, 15 pp. 1960.
* OCTOBER THROUGH DECEMBER 1960. U.S.D.A., A.R.S. 43-122, 26 pp. 1960.

The above reports are published by the Farm Economics Research Division, ARS. They give detailed reports and numerous tables on the farm-mortgage experiences of 23 life insurance companies, Federal Land Banks, and Farmers Home Administration for the year 1959.

ARS, USDA, Inform. Div., Washington 25, D. C.

Coutu, A. J., McPherson, W. W., and Martin, L. R. METHODS FOR AN ECONOMIC EVALUATION OF SOIL CONSERVATION PRACTICES. N. C. Agr. Expt. Sta. Tech. B. 137, 48 pp. 1959.

The purposes of this report were: (1) To present an analysis of conditions necessary for terracing and selected conservation inputs to be profitable on individual farms; (2) to describe the technical and economic information required and to illustrate procedures used to determine whether any particular set of conservation inputs would be profitable; and (3) to illustrate the conditions under which specific actions of individual farmers would be inconsistent with the public interest, especially due to conflicts arising from differences in discount rates and/or the length of the decision making period.

Only three mechanical erosion control practices were considered in this study, although the procedures developed for economic evaluation are generally applicable to any soil conservation or other measure that requires long term investments. The three practices selected for study are ones frequently recommended and/or frequently followed by farmers: (1) Complete terracing program with contour cultivation and recommended runoffs, and waterways; (2) terracing and meadow outlets without contour cultivation; and (3) complete terracing with contour cultivation and strip cropping. The crops included in the analysis are tobacco and cotton.

Whether any specific practice will pay depends upon: (1) The length of the planning period; (2) differences between yields, over the appropriate time period, when the particular practice is employed compared with not using the practice; (3) product and factor prices over the appropriate time period; and (4) discount rates.

Agr. Expt. Sta., N. C. State Col., Raleigh, N. C.

Fischer, L. K., and Timmons, J. F. PROGRESS AND PROBLEMS IN THE IOWA SOIL CONSERVATION DISTRICTS PROGRAM: A PILOT STUDY OF THE JASPER SOIL CONSERVATION DISTRICT. Iowa Agr. and Home Econ. Expt. Sta. Res. B. 466: 424-451. 1959.

The Iowa Soil Conservation Districts Program was initiated in 1939. Since that time, about 22 percent of the farms in Iowa have plans developed with soil conservation districts. But 78 percent of the farms have not been planned as yet, and satisfactory adoption of land-use practices has been achieved on only part of the land in the planned farms.

In this investigation various factors were identified and analyzed in terms of their association with farmers' acceptance of district plans and application of district recommendations. The data obtained indicate that district progress was impeded significantly by: (1) Small size of farm; (2) tenant operatorship; (3) cash and crop-share leasing arrangements; and (4) high inherent productivity of the land. Other factors tested were: (1) The length of the operators' planning horizons; (2) the ages of the operators; and (3) the types of livestock programs being pursued. However, statistical tests of significance of these latter factors were inconclusive.

The attainment of program objectives on any given soil usually requires the application of, not one, but a combination of conservation measures. The reasons why farmers apply, or fail to apply, specific land-use practices, however, are basic in determining courses of action which will best encourage compliance with district recommendations. The following are reasons, beliefs or attitudes most often expressed by farm operators as contributing to their failure to follow district recommendations: (1) Insufficient cooperation between landlords and tenants in arranging for adoption and maintenance of recommended practices; (2) belief that the practices were not necessary either because they would not adequately control erosion or because erosion was not excessive now; (3) insufficient knowledge of the district's program and of the practices recommended; (4) belief that application of recommended practices would increase capital and labor requirements without yielding commensurate additional income; (5) farm and/or field layout would be such as to make recommended practices impractical; and (6) pressure of current financial obligations precluded the possibility of introducing practices which would increase current investment and/or reduce current income.

In contrast to the factors listed above which have impeded the progress of the district's program, the following are expressed reasons, attitudes or beliefs which account for farm operators complying with district recommendations: (1) Practices were established before the present operator's tenure, and established practices were maintained; (2) landlords initiated and/or financed the application of the practices; (3) farm and field layouts were well adapted to recommended practices; (4) net incomes of farms were increased by application of the recommended practices; (5) operators took pride in maintaining, or felt morally obligated to keep, soil productivity at high levels; (6) soil conditions were such that erosion control was a minor problem; and (7) a good financial position with little pressure for current income enabled operators to make immediate investments in land necessitated by recommended practices and wait for deferred income.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

Fischer, J. L. RURAL DEVELOPMENT PROSPECTS IN THE WEST. J. Farm Econ. 41: 1084-1094. 1959.

The Rural Development Program is basically designed to alleviate conditions described in the report leading to the enactment of the special legislation. The main causes or conditions of low income are listed as: (1) Dense rural settlement; (2) high birth rates; (3) few outside jobs; (4) topographic obstacles to use of machinery; (5) "overcrowding" of land; and (6) an abundance of hand labor. The program logically "follows through" and is reasonably well designed to meet the above conditions.

In a study of Rural Development prospects in the west the author makes the following conclusions:

1. The West is different.
2. Although Rural Development probably has some potential, the really serious problems in the high risk and uncertain areas are above and beyond the scope of the program.
3. Much greater attention needs to be given to the very serious Indian situation. The idea that Uncle Sam can be out of the Indian business in a few years is misleading and a social disservice to the nation. The problem of social and psychological adjustment is severe and needs special attention. Rural Development type programs have some potential but they must be more adequately geared to the special situation.
4. Irrigated valleys with too many small farms may be able to help themselves through the Rural Development approach; however, they have many obstacles to overcome. Distance from markets, isolation, and small labor pools limit the potential.
5. Stability in the timber and mining industries is badly needed and would aid in the satisfactory social and economic adjustments of many areas. A few substantial "pools" of labor are to be found in areas distressed by this cause, and, where so, Rural Development could help. Those close to markets have greater opportunity.
6. The West is a big country. If Rural Development is to be a useful tool, the opportunity to more readily adapt it to a variety of special situations is needed.

Mont. State Col., Bozeman, Mont.

Dean, G. W., Heady, E. O., Husain, S. M. A., and Duncan, E. R. ECONOMIC OPTIMA IN SOIL CONSERVATION FARMING AND FERTILIZER USE FOR FARMS IN THE IDA-MONONA SOIL AREA OF WESTERN IOWA. Agr. and Home Econ. Expt. Sta. Res. B. 455: 176-196. 1958.

The purpose of this study is to determine profitable erosion-control systems of farming for operators with different amounts of capital and for two different sizes of farms. Emphasis is on profit maximization for the farm as a whole. Since Ida-Monona soils respond readily to fertilization, the plans considered allow an integration of investment in crops, fertilizer, and livestock. Conservation systems which primarily control erosion either through land cover or mechanical practices are compared by the linear programming technique.

The results show that a combination of: (1) Rotations which include a maximum of corn within the range of rotations considered; (2) mechanical erosion-control practices (terracing, contouring, and listing); and (3) high levels of fertilization provide the most profitable land-use program for most of the capital and resource situations studied. However, in instances where capital, labor or building space are not restricting resources, profits are maximized with a high-forage rotation. This type of rotational program allows maximum profits only at very high capital levels--where grain can be purchased and where the limit to cattle numbers is imposed by forage production.

For "typical" amounts of capital, labor, and buildings, investment priority for either 160-acre or 280-acre farms followed this order: (1) Crops; (2) fertilizer; (3) hogs; and (4) cattle.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

## BIOLOGY

### Fish

Crance, J. H. PLANNING YOUR FISH POND. Ala. Conserv. 31(4): 10-11, 26. 1959-60.

This article for Alabama describes and illustrates: (1) Ways to make a fish pond; (2) how to stock it; and (3) how to manage it.

No address given.

Brown, C. J. D., and Thoreson, N. RANCH FISH PONDS IN MONTANA. Mont. Agr. Expt. Sta. B. 544, 26 pp. 1958.

The most practical means of increasing the area of fishing waters within the state of Montana is through the proper development and management of ranch ponds and reservoirs. Few ranches are without pond sites and sufficient runoff water to fill them. However, all ponds are not suitable for fish any more than all soils are suitable for crops. Fish production depends upon suitable physical and chemical conditions, as well as the stocking of the right species in proper numbers.

Practical information is available on the construction of farm fish ponds, but there is very little information on fish production which can be applied specifically to Montana. Ponds in this state are subject to relatively low temperatures with long periods of ice cover and consequently short growing seasons.

Information on developing and managing fish ponds appropriate for Montana concerning small ponds (up to 50 acres) is presented. Montana laws pertaining to fish ponds can be found in the appendix.

Mont. Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

Eipper, A. W. TROUT FOR FARM PONDS. N. Y. State Conserv. 13(5): 20-22. 1959.

By current estimates, 15,000 farm ponds are in New York State, and new ones are being constructed at the rate of roughly 1,000 a year. The majority of these ponds are eight to ten feet deep, with surface areas up to about an acre. Altogether this amounts to some 5,000 acres of impounded water that have been added to the State's resources during the past fifteen years.

Most owners want to have fish in their ponds, and for the past ten years the State and Cornell University conservation departments have conducted an intensive research program aimed at developing fish production techniques tailored to the needs of New York farm ponds. This program has been concerned with management of ponds for: (1) Bait minnow production; (2) warm-water game and pan fish; and (3) trout.

This article summarizes the findings on trout ponds in central New York and discusses management recommendations that have resulted from this information.

Cornell U., N. Y. State Col. Agr., Ithaca, N. Y.

Huggins, E. J. PARASITES OF FISHES IN SOUTH DAKOTA. S. Dak. Agr. Expt. Sta. B. 484, 73 pp. 1959.

This study constitutes the first extensive investigation of the parasites of fishes in South Dakota. The survey for the study involved the various kinds of parasitic worms (flukes, tapeworms, roundworms, spiny-headed worms, leeches) and the parasitic crustaceans (fish lice). More than 500 fishes were examined from 33 different bodies of water, largely lakes.

The purpose of this publication is not only to list the parasites found, but also to briefly discuss each parasite, including prominent recognition features, information on life cycles, and position in the Animal Kingdom. It is hoped that the bulletin will aid in

answering the questions of fishery biologists, game wardens, sportsmen, and others interested in parasites of fishes.

S. Dak. Dept. of Game, Fish and Parks and Agr. Expt. Sta., S. Dak. State Col., Brookings, S. Dak.

## Upland Wildlife

Peterle, T. J. GAME MANAGEMENT IN SCOTLAND. J. Wildlife Mangt. 22: 221-231. 1958.

Game management in Scotland is based on the principle of the landowner's exclusive use of his own land. The killing of game species is recognized as a valuable property asset that may be leased or sold. The Protection of Birds Act of 1954 does not involve many of the game species such as the pheasant, partridge, blackgame, red grouse, and ptarmigan. The landowner controls seasons and bag limits on these species. A staff of gamekeepers hired by the estate owner is responsible for the actual program. On the large estates hand-rearing of pheasants is an important part of management. Pheasants are released to the coverts at about six weeks of age and are shot in December. The game is driven to the guns by beaters, for more efficient harvest and greater enjoyment of the actual shooting. Partial recovery of costs is accomplished by sale of game to dealers and leasing the shooting. Predators are controlled as an intrinsic part of management.

Red grouse and heather management are practically synonymous. Heather is managed by burning every 3 to 7 years. Grouse are shot by driving the birds over lines of shooting butts. Partridge, blackgame, and capercaillie are taken incidentally to other game species. Red deer are becoming too numerous in some areas, and recommendations for a reduction in numbers are being considered. As the area of forest plantations increases, roe deer numbers also increase and cause damage to coniferous species.

The future of Scottish game management seems secure in that it supplies an additional income to some estate owners, and in the case of red grouse management, is compatible with grazing for sheep. Groups of sportsmen, who form Game Protection Societies and purchase shooting rights from small landowners, will probably become more widespread.

Mich. Dept. Conserv., Lansing, Mich.

Nagel, W. W., and Hicks, K. UPLAND GAME PRODUCTION AND HARVEST. Mo. Wildlife 21(3): 3-5, 14-15. 1959.

There are two problems to managing upland game: one is production, the other is harvest. The solution to both problems is simple to state, for it depends on natural principles. Carrying it out, however, is not simple in either case; for it depends, in large part, on the interests and behavior of people.

This article goes into the production of upland wildlife and gives pointers on good farmer-hunter relations.

No address given.

Myers, H. NOW...PLANT WILDLIFE FOOD PATCHES. Va. Wildlife 20(4): 20-21. 1959.

Since 1948, when the Farm Game Restoration and Development Project was initiated, the Virginia Game Commission has made wildlife planting materials available to landowners and sportsmen. In 1958, a total of 97,963 pounds of annual and perennial seed was distributed throughout the state, an amount sufficient to have seeded 35,742 one-eighth-acre wildlife plots.

The adoption of the following suggestions on wildlife seeding should produce a high yield and result in our farms becoming more productive of wildlife:

1. Choose a good location. Since odd corners of farm land are usually set aside for wildlife, it is important to consider planting possibilities along such areas as drainage ditch banks, fence and hedge rows, woods borders, stream banks, ponds, and small areas of cropland which are cut off from larger fields.
2. Prepare a good seedbed. A level and firm seedbed free of clods will tend to hold more moisture, provide uniform growth, and reduce competition from undesirable plants.
3. Seed at proper time. With the annual mixture, planting time is similar to that of corn, for seeds such as milo, buckwheat, and millet tend to produce best after the soil begins to warm. Annual plantings seeded after May 15 tend to hold up longer and produce better cover throughout the winter months.
4. Select correct planting material for chosen locations. All locations and soil types should be seeded in accordance with land use and needs. Annual seeds require good soil, more moisture and produce best in areas exposed to sunlight. Perennials (sericea and bicolor lespedeza) will grow on practically any type of soil but are not adapted to wet areas. They are especially valuable for erosion control.
5. Use a good seeding method. Best results are obtained from the use of a grain drill which insures a more uniform rate at a uniform depth. Broadcasting by hand or through use of a cyclone seeder is also efficient and is usually more practical since wildlife areas are of comparatively small size. Annual seed should be covered with from one to two inches of soil, depending upon soil conditions. Care should be taken to prevent covering too deep. This is especially important with sericea and bicolor since they have small seeds.
   During seeding it is also important to use the proper seeding rate per acre, often overlooked when broadcasting by hand.
6. Use proper amount of fertilizer. The use of liberal amounts of fertilizer at times of seeding assures improved stands and high yields.
   Annual mixtures, which yields a grain crop under favorable conditions, deplete the soil of certain nutrients and should always have some fertilizer. The most common farm analyses are all suitable for wildlife seeding.

No address given.

Burkholder, B. L. MOVEMENTS AND BEHAVIOR OF A WOLF PACK IN ALASKA. J. Wildlife Mangt. 23: 1-11. 1959.

A pack of ten wolves, observed and followed by airplane continually over a period of 6 weeks, moved in a clockwise direction over an area 100 miles long by 50 miles wide and covered an estimated 700 lineal miles. The average distance traveled per day was 15.5 miles, and the greatest distance was over 45 miles. The longest sustained travel was 88 miles in an estimated 4-day period.

These wolves killed, on the average, once each 1.7 days and averaged 24 miles between kills. A total of 31 kills of moose and caribou was located and attributable to the pack, 22 of these being made during the period of observation. Wolves and Dall sheep were observed in close proximity but no sheep kills were located. There was no species preference indicated between moose and caribou. It was more a function of local availability. All of the dead animals checked were judged to be in excellent condition, insofar as this factor could be determined.

No selectivity was noted in the age, sex, or condition categories in the case of caribou; however, no calves were identified in the sample. This omission of calves was thought to be a function of occurrence (percent of calves per total herd) coupled with the observer's inability to age smaller animals that had been entirely consumed by wolves.

In the case of moose, selectivity was indicated in the age category. Calf moose were killed in the ratio of 6:1, the exception being a yearling.

The wolves caught their prey by a process of surprise and charge, and no chase was observed to last more than 350 yards. Even single wolves had no difficulty catching and killing apparently healthy adult caribou. They killed their prey by biting and tearing, apparently at random. The neck, ribs, and flanks were eaten first, and often the entire animal was consumed, except for the stomach contents.

U. S. Fish and Wildlife Serv., P. O. Box 6123, Anchorage, Alaska.

Hanson, R. P., and Karstad, L. FERAL SWINE IN THE SOUTHEASTERN UNITED STATES. J. Wildlife Mangt. 23: 64-74. 1959.

Feral swine range over about 145,000 square miles of the Coastal Plain region of the southeastern United States. Their numbers probably approximate one and one-half million animals. Believed to have been introduced into Florida as early as 1539, they have survived and multiplied in competition with wildlife and livestock.

The importance of feral swine to livestock owners is due to their adverse effect on improved blood lines by interbreeding with domestic swine and their potential as hosts for the perpetuation of livestock diseases. For individuals engaged in wildlife management and forestry, feral swine are usually considered to be a nuisance by virtue of: (1) Their destructive effects on game habitat; (2) their destruction of young trees and wildlife food plantings; and (3) their direct competition for food with native fauna. Their value as game animals is minimized by their close relationship to domestic swine, and the fact that, in some areas, domestic swine are allowed to run at large.

Their diet in nature is chiefly vegetable, supplemented by small amounts of a wide variety of animal life. Their conformation is, generally, that of an unimproved domestic hog of mixed breeding. In a few areas, where their range coincides with that of the introduced true European wild boar, interbreeding has occurred and its effects are apparent.

While relatively little is known about the diseases of feral swine, they have been found to be hosts to several helminth, arthropod, viral, and bacterial parasites. Their close association with native wildlife and their relationship with domestic stock makes them at least potentially important as reservoirs for diseases of other animal species. Occasional die-offs among swine on certain coastal islands may be due partly to overpopulation with the resultant nutritional deficiencies and partly to disease of an infectious nature.

Dept. Vet. Sci. and Bact., U. Wisc., Madison, Wisc.

Chambers, R. E., and Sharp, W. M. MOVEMENT AND DISPERSAL WITHIN A POPULATION OF RUFFED GROUSE. J. Wildlife Mangt. 22: 231-239. 1958.

From June 1954 to May 1956, 128 grouse were banded on a 1,470-acre study area in central Pennsylvania. These included 86 juveniles and 18 adults banded during the summer and fall of 1955 and represented approximately one-half of the total population. Movement information was obtained on 43 grouse or 34 percent of the total banded.

It appears that the cruising radius of most grouse broods on the study area in 1955 did not exceed one-fourth of a mile. Intermingling of broods occurred frequently that year. Information was obtained on the dispersal of six grouse broods. Dispersal began in mid-September and reached its peak in October.

Random dispersal movements of 17 juveniles banded in 1955 were obtained by the return of bands by hunters. These represented 20 percent of those banded during that summer. Fifty-nine percent of these juveniles moved farther than 1 mile from their original point of capture during the fall dispersal. A dispersal movement as great as 7.5 miles was recorded. Movement data indicated that one-half of the juvenile population was lost from the study area due to egress during the fall of 1955.

Movements of 12 adults indicated that, following the first mating season, grouse became relatively sedentary, particularly males. Only one male, banded as an adult, was reported farther than 1/4 mile from the banding site, although females were known to move farther than 1 mile.

Dept. Zool. and Ent., Pa. State U., University Park, Pa.

Lovaas, A. L. MULE DEER FOOD HABITS AND RANGE USE, LITTLE BELT MOUNTAINS, MONTANA. J. Wildlife Mangt. 22: 275-282. 1958.

A mule deer food-habits and range-use study was conducted in the Little Belt Mountains, Montana, from the summer of 1956 to the spring of 1957. The four main vegetative types represented in the area were prairie, ponderosa pine, lodgepole pine, and spruce. Methods used included observation of deer on various vegetative types, rumen-sample analyses, and feeding-site examinations.

Deer were found to move to higher elevations during the summer, and a downward movement trend was noted in September. The most important winter range was found to be in the prairie type, while other types were used to lesser extents. Forbs were found to be the most prominently used forage class in the summer. Browse and forb use were about equal in the fall. Browse was the most prominent class in the winter and was still prominent, along with grass, in the spring. Common juniper and creeping juniper were each found to be the most utilized winter browse species on one of two winter range types. Deer wintering in the overutilized creeping juniper areas were found to take a higher percentage of forbs and to be in a poorer physical condition than those wintering where less utilized common juniper was prevalent. Deer reproduction in the study area was found to be poor.

Mont. Fish and Game Dept., Billings, Mont.

Hundley, L. R. AVAILABLE NUTRIENTS IN SELECTED DEER-BROWSE SPECIES GROWING ON DIFFERENT SOILS. J. Wildlife Mangt. 23: 81-90. 1959.

From September 1954 through October 1955, proximate analyses were run on five preferred deer-browse species growing on four study areas located near Blacksburg, Virginia. The soil types tested were somewhat similar in chemical composition, and the nutritional content of twigs taken from them showed no consistent differences between areas. Protein content rose generally during the dormant months. Moisture content decreased from June through December and was followed by a rise that lasted until June. There was a rise in ether-extract values from September through April, whereas the level of ash content was erratic during this period. Crude fiber was fairly stable in red maple and black locust, although erratic in flowering dogwood. There was a decrease in the nitrogen-free extract during the winter.

Of the three browse species collected from all the study areas, flowering dogwood was generally high in moisture content, ether extract, ash, and nitrogen-free extract, while being average in protein and low in crude fiber. Black locust was high in protein and crude fiber and low in moisture ether extract, and nitrogen-free extract. Maple was generally high in ether extract, crude fiber, and nitrogen-free extract and low in protein and ash.

Rhododendron and buffalo nut were collected from one study area only. In comparison with the other three species sampled from that area, rhododendron was: (1) Very high in moisture and nitrogen-free extract; (2) average to low in protein, ether extract, and crude fiber; and (3) average to high in ash. Buffalo nut was: (1) Very high in moisture, protein and ash; (2) average in ether extract and crude fiber; and (3) low in nitrogen-free extract.

The different species had different nutritive values when growing on the same soil. During April and August, the different soils had their greatest effect on the nutritive value of plants. Moisture content was greatly affected by the soil, and protein content was only slightly less affected. Except for the months of February and August, at least three of the six nutritive qualities of the plants were affected by the interaction between the plant and the soil.

Black locust had the highest phosphorous and cobalt content; flowering dogwood had the highest calcium content; red maple had the highest manganese content. On three of the four study areas, the manganese content of red maple exceeded the toxic level for bovines. On the chert area, dogwood, and red maple were deficient, by bovine standards, in cobalt.

Va. Coop. Wildlife Res. Unit, Blacksburg, Va.

McNeel, W. Jr., and Kennedy, J. PREVENTION OF BROWSING BY DEER IN A PINE PLANTATION. J. Wildlife Mangt. 23:450-451. 1959.

Very severe fall and winter deer browse damage has occurred during the past four years in a young plantation in Lower Michigan composed of white pine (Pinus strobus), red pine (Pinus resinosa), and jack pine (Pinus banksiana).

In the fall of 1958, as deer damage was commencing, the terminal buds and some lateral buds of 500 pine including all three species were covered with pieces of plastic stapled securely. Pieces 3" x 4" were found adequate to cover the buds and allow sufficient surplus for stapling the ends of the plastic together. Two methods of covering the buds were used. On some trees the plastic was folded down over the tops of the buds. On the other trees the plastic was wound around the buds and stapled. Both methods prevented deer damage to the covered buds. The latter method described is more satisfactory, however, as the plastic is easier to apply and is more quickly removed by simply pulling the cover upward over the buds without removing any staples. Also, this method does not distort growth of new spring shoots should the plastic not be removed early enough in spring.

The use of polyethylene plastic as a protection against deer browse damage was found to be completely satisfactory. Its use can be recommended in any type of plantation, whether for Christmas trees, windbreak, soil erosion, or ornamental purposes, where deer damage is likely to occur.

Central Mich. Univ., Mt. Pleasant, Mich.

Smith, R. L. CONIFER PLANTATIONS AND WILDLIFE--PART II: MANAGING THE PLANTATION FOR WILDLIFE. N. Y. State Conserv. 13(5): 10-11. 1959.

The effects of various plantation management techniques that influence wildlife are given.

Chief examples stressed are: (1) Use of unplanted areas; (2) checkerboard planting of different species; (3) use of chemicals and cutting to retain wildlife areas; (4) fire lanes and fire trails; (5) water in the right places by ponds and wildlife marshes; (6) mixture of conifers; (7) periodical removal of conifers for Christmas trees; (8) stands of uneven height; (9) use of thinning practices; and (10) use of hardwood thickets.

No address given.

Davison, V. E. PINE TREES AND WILDLIFE. Va. Wildlife 20(3): 10-12. 1959.

Wildlife biologists think they are hard-pressed to counter industry's clearing of hardwoods to make room for pine trees. A mixture of oaks, gums, hackberries, dogwoods, elms, and other native deciduous trees are known to be more valuable than pines for most species of wildlife.

We will not exterminate any kind of game by timber stand improvement alone, though it may reduce some huntable species. We must consider each kind of wildlife individually and work to favor them through woodland management and other conservation of soils, plants, and water.

Deer present one problem. They eat acorns and fatten readily, but they do not depend on oaks or other hardwoods alone for survival. Deer needs can be met in spite of acres-of-pines. They prosper on clovers, green grasses, succulent weeds, corn, and incidental browse.

Take squirrels: Their important foods in fall and winter are acorns, beechnuts, pecans, hickory nuts, and dogwood berries. Corn is equally good or better. In spring and summer they eat buds of elm, blackcherry, maple, oaks, and summer fruits. By August they find the pine seeds in the green cones a choice food. They do best in good hardwood areas. A man who wants squirrels can manage for them.

Experience in Virginia and all the South indicates that the high-income position of pine-tree products need not do serious and irreparable damage to wildlife populations.

Uplands which are best suited to pine trees are often the least productive of wildlife foods, cover, and water. Most of our mountain areas are primarily hardwood lands, and will remain. The live oaks and water oaks do well on upland, too. Throughout the vast

majority of our southern acreages, pineland areas are interspersed with streams, ponds, lakes, and swamps where hardwoods and baldcypress do best, and pines grow poorly or not at all. Wildlife results are obtained best in these lowlands which are suitable for oaks, gums, pecan, and other hardwoods. It is there that good management pays dividends in squirrels, ducks, deer, and wild turkeys--often in bobwhites, too. By planning carefully, an owner can save many of the wildlife food trees.

The dilemma of solid pine stands--without blackberries, huckleberries, legumes, grasses, and browse plants--is a temporary condition. An area begins to recover from its 10-to-20-year-old heavy pine cover as the trees are harvested. Each tree removed lets sunlight in, and accompanying ground disturbance causes reproduction of new plants.

The loss of "den-trees" is not critical. Good squirrel populations can be raised with commercial hardwoods, which also have small den-holes. Nest boxes for squirrels would be less expensive than to keep large den trees of no commercial value. This does not deny that a higher squirrel population may be supported with large den trees; but the difference is too small to make ourselves unhappy by quarreling about it with landowners.

The concern therefore is to fit wildlife comfortably into modern land use economies on both public and private lands. Wildlife and pine trees can be produced increasingly in every southern community. A surprising amount of pleasure and satisfaction comes with man-managed wildlife conservation. The "wilderness" does not hold the only joys for the wildlife enthusiast. Landowners, hunters, and wildlife technicians will produce more recreational sport in our woodlands, as they apply economically feasible management--combinations of agriculture and silviculture.

SCS, USDA, Athens, Ga.

Noyes, F. HERBICIDES MAY HELP WILDLIFE. Outdoor Amer. 25(3): 8-9. 1959.

This article tells of some research on weed and brush control chemicals to manipulate plant growth by: (1) Opening thickly forested areas to provide needed clearing to encourage low growing plants; (2) use of a single light application to tree foliage to get succulent sprouts for deer; (3) holding back of grasses, sedges, and cattails that invade waterfowl marshes; (4) use of spray on rocky, hilly, or boggy land where conventional farm implements cannot be used to improve areas for wildlife; and (5) use of herbicides in maintaining little used forest roads and trails that become overgrown with brush.

No address given.

Scott, T. G., Willis, Y. L., and Ellis, J. A. SOME EFFECTS OF A FIELD APPLICATION OF DIELDRIN ON WILDLIFE. J. Wildlife Mangt. 23: 409-427. 1959.

A field application of dieldrin, one of the highly toxic chlorinated hydrocarbon insecticides, at a rate of 3 pounds per acre was investigated for its effect on wildlife. Several losses occurred among wildlife populations despite supervision of the program by professional pest control personnel. Most losses occurred during the week following application. Meadowlarks, robins, brown thrashers, starlings, common grackles, and ring-necked pheasants resident on the area at the time of application were virtually eliminated. Horned lark populations appeared to have taken heavy losses. Bird populations remained depressed in the treated area throughout the spring and early summer, and it was thought that this was to some extent a result of a food shortage in the form of a markedly reduced insect population. Ground squirrels, muskrats, and rabbits were virtually eliminated, and short-tailed shrews, fox squirrels, woodchucks, and meadow mice appeared to have taken heavy losses. White-footed mice, house sparrows, and mourning doves seemed to exhibit a relatively high resistance to dieldrin poisoning. Wildlife populations appeared to have recovered or to have been well on the way towards recovery by the following year. Recommendations designed to minimize wildlife losses from dieldrin poisoning were suggested.

Ill. Nat'l. Hist. Survey, Urbana, Ill.

Clawson, S. G., and Baker, M. F. IMMEDIATE EFFECTS OF DIELDRIN AND HEPTACHLOR ON BOBWHITES. J. Wildlife Mangt. 23: 215-219. 1959.

An experimental area was treated with heptachlor and dieldrin near Camden, Alabama, with 2 lbs. per acre of technical material for fire ant control. It was the purpose of the research herein reported to learn the immediate effects, if any, of this treatment on the bobwhite (Colinus virginianus) population.

All resident quail disappeared from the test area. Only two of 76 quail disappeared on the check area. Two marginal coveys survived. One covey was observed during its period of decline and five of the original 10 were recovered dead. Evidence of the death of quail in other coveys was found. Chemical analysis made of quail found dead on the test area revealed the insecticides in their tissues. It is concluded that this application of heptachlor and dieldrin resulted in the death of all or nearly all resident quail.

Ala. Coop. Wildlife Res. Unit, Ala. Polytech. Inst., Auburn, Ala.

Barker, R. J. NOTES ON SOME ECOLOGICAL EFFECTS OF DDT SPRAYED ON ELMS. J. Wildlife Mangt. 22: 269-274. 1958.

The spring after elm trees on 430 acres at Urbana, Illinois, were sprayed with 6 percent DDT, 21 dying robins were found. Analyses of leaves, soil, earthworms, and robins suggested that fewer than 100 earthworms can accumulate 3 mg. of DDT. This was approximately the median concentration found in dying robins in this study. The importance of concentrators of toxins in assessing long-range biological effects is emphasized.

Ill. State Nat. Hist. Survey, Urbana, Ill.

## Wetland Wildlife

Beshearns, W. W. Jr. FISH AND WILDLIFE OPPORTUNITIES IN SMALL WATERSHED PROGRAM. Ala. Conserv. 31(4): 4-5, 19, 23. 1959-60.

In a step to protect Alabama's land and water resources and to preserve the state's fish and wildlife, some 28 watershed projects are now underway in 32 counties encompassing nearly 18 million acres of water under the federal Small Watershed Program.

Today, the Small Watershed Program is a booming business. Landowners and local sponsoring organizations have been quick to recognize the tremendous benefits--both immediate and long-term--to be gained through participation in the program.

Fish and wildlife opportunities are great in a majority of the small watershed projects in Alabama. The basic problem thus far, however, has been failure to get local groups to recognize more widely the importance of fish and wildlife resources in their planning of improvement measures. For this reason, increased emphasis now is being given fish and wildlife phases of watershed-planning assistance. This includes: (1) Attendance at planning meetings; (2) discussion with local groups the effect of proposed improvements on fish and wildlife resources; (3) presentation and explanation of recommendations; and (4) encouragement to local groups to include recommended improvements for fish and wildlife in their watershed work plans.

The following fish and wildlife measures are eligible for Federal, technical, and financial assistance when included by a sponsoring local organization in a small watershed project work plan:

1. Additional storage capacity.
2. Modification of reservoir structures.
3. Stream channel improvement.
4. Marsh and pit development.
5. Wildlife food and cover plantings.
6. Aid to public groups: Federal cost sharing and other assistance will be given only to qualified State agencies and local organizations. Individuals or private groups desiring to add storage or other fish and wildlife improvements for their own use, may negotiate with the sponsoring organization to pay in full the costs allocated to fish and wildlife purposes.

7. Public access required: In order to obtain Federal cost-sharing, the local organization or State agency installing fish and wildlife improvements must obtain title or perpetual easements for public access or use in accordance with applicable State laws and regulations.
8. Ineligible measures: Federal cost-sharing will not be allowed for measures providing benefits classified as "recreation"; such as boating and water-skiing; measures to facilitate the use of fish and wildlife resources, such as access roads, parking areas, and boating facilities, and construction of propagation facilities such as fish hatcheries and rearing ponds.

No address given.

Hanson, W. C., and Browning, R. L. NESTING STUDIES OF CANADA GEESE ON THE HANFORD RESERVATION, 1953-56. J. Wildlife Mangt. 23: 129-137. 1959.

Nesting studies of Canada geese were conducted on the Hanford Reservation in southeastern Washington during 1953-56. Complete histories were made on 1,032 nests. Nesting density on the islands varied from 0.003 to 4.0 nests per acre. Selection of cover type was apparently incidental to other factors, such as availability and visibility from nest. Seventy-one percent of the nests hatched, 13 percent were destroyed by predators, 11 percent were deserted, and 3 percent were flooded. Hatchability of eggs in successful nests averaged 92 percent; 6 percent contained dead embryos, and 2 percent of the eggs in successful nests were infertile. A majority of the dead embryos were found to be in the first and fourth weeks of development. Average clutch sizes were 5.3 in 1953 and 1955, and 5.5 in 1954 and 1956. This resulted in production of 4.9 young per nest in 1953 and 1955, 5.2 young per nest in 1954, and 5.0 young per nest in 1956. Peaks of hatching occurred from the third week of April to the first week of May, and varied with the average daily temperature during the 4 years. The peak was usually near the last week of April. Total length of the nesting season was 12 weeks in 1953, 11 weeks in 1954 and 1955, and 10 weeks in 1956. The breeding population of approximately 300 territorial pairs produced an estimated 810 to 980 young per season. No adverse effect on the adult geese, their eggs, or young were noted even though they were subject to low levels of radioactive contamination by the Hanford reactor operations.

Biol. Operations, General Electric Co., Richland, Wash.

Atwater, M. G. A STUDY OF RENESTING IN CANADA GEESE IN MONTANA. J. Wildlife Mangt. 23: 91-97. 1959.

A study of renesting Canada geese was conducted among 12 reservoirs in Phillips County, Montana, during 1956 and 1957. Twelve females were live-trapped at their nests during the egg-laying or incubation stage. Eggs were removed from these nests to simulate natural nest destruction. The geese were individually marked and released. Eleven marked birds were observed 78 times after release. Two of the marked birds renested; one renested twice, the other once. These were the only ones trapped during the egg-laying stage. Each took 2 to 2.5 weeks to renest the first time. One started a third nest within a week after the second nest had been terminated during incubation. Neither numbers of eggs nor differences in nest structures and amount of down distinguished original nests from renests. Renest locations were quite different from first-nest locations. One bird nested three times on the same reservoir, while the other moved 24 miles to a larger water area to renest. Unsuccessful nesting pairs usually moved away from the original nest sites and remained by themselves. They were generally characterized by restlessness and considerable flying and wandering around among the reservoirs. Data from the marked birds indicated that a nest placed near the site of an earlier unsuccessful nest was not necessarily that of the same pair renesting. Two 2-year-old females were found nesting on the reservoir where they had been banded as juveniles. These geese were undoubtedly nesting for the first time.

Paper #427 J. Ser., Mont. State Col., Agr. Expt. Sta., Bozeman, Mont.

Weller, M. W. PARASITIC EGG LAYING IN THE REDHEAD (AYTHYA AMERICANA) AND OTHER NORTH AMERICAN ANATIDAE. Ecol. Monog. 28: 333-365, Biblio. 1959.

Parasitic egg laying in the Redhead and other waterfowl was studied in the Delta Marsh in southern Manitoba and in the Knudson Marsh in Utah.

Parasitizing females located nests of hosts by searching the vegetation and probably by following the host, or other parasitic females, to the nests. They did not lay in artificial nests. The average number of eggs laid by each parasitic female in the Knudson Marsh was 10.8. As many as 13 hens were trapped on one host's nest but 3 or 4 was the usual number. Clutches of as many as 87 eggs were formed. More than half of the parasitic eggs were laid after the host had started incubation and thus were destined not to hatch.

Both adult and yearling birds were trapped while parasitizing nests. None of the 42 females trapped while parasitizing a nest had a brood patch; thus none had nested or was nesting during the period of parasitism.

Parasitism preceded nest initiation in the Redhead. Some females must have been completely parasitic for parasitism continued throughout the nesting period. Only one-half of the Redhead population in the Knudson Marsh attempted nesting in 1955.

Nest parasitism, as well as egg parasitism, was found in this species. Clutch sizes reported in the literature vary from 9 to 14 because of intra-specific parasitism. Unparasitized nests examined in the present study showed that the true clutch ranged from 5 to 9.

Behavior of nesting Redheads during incubation is similar to that described for the Mallard and Canvasback. At hatching, females seem to take excellent care of the young. After the hatching period, the female's brooding drive wanes. Feigning behavior is poor and is usually restricted to the newly hatched brood. Both the semiparasitic Redhead and the Ruddy Duck desert their broods earlier than do other diving ducks or dabbling ducks.

No relation was found between cover quality and the degree of parasitism. The contention among other workers that changing water levels increases nest losses and parasitism was not supported in this study. The degree of parasitism was influenced by the chronology of nesting of the host and the parasite. The most important factor influencing the degree of parasitism was the ratio of hosts per parasite. When this ratio increased by 20%, there was a proportional increase in the average number of parasitic eggs laid per nest.

If the host is on the nest when the Redhead comes to lay, she pecks the parasite but usually cannot deter her. The host will accept any foreign egg which resembles her own. Some are occasionally buried but much of this is accidental. Desertion is a common reaction to constant parasitic intrusion and it is most common in the non-broody and semiparasitic Redhead and Ruddy Duck. Broodiness of nesting birds was measured by flushing distances and showed the incubation drive stronger in Cinnamon Teal, Mallard, and probably Canvasback, than in the Redhead.

Parasitism reduced the number of eggs laid by the host by 20% and decreased both egg and nest success. But this was not measurable until 60 to 70 percent of the nests were parasitized and 4 to 6 eggs were added per nest. Because the breeding range and habitat preference of the Redhead coincides with that of the Canvasback, this species suffers most from Redhead parasitism.

At its present stage, parasitism is no asset to the Redhead. Approximately half the population never nests and the success of parasitically laid eggs and normal nests is poor. In addition, the late nesting results in high mortality of young during the hunting season.

The parasitic habits of the Redhead are a natural consequence of the deterioration of maternal instincts. The exact cause of parasitism is still unknown but the host, more than the parasite, may be of chief importance in the successful development of parasitic laying. Three stages seem apparent in its development: (1) Egg parasitism; (2) nest parasitism; and (3) complete or obligate parasitism.

Dept. Zool. and Ent., Iowa State Col., Ames, Iowa.

Olsen, P. F. MUSKRAT BREEDING BIOLOGY AT DELTA, MANITOBA. J. Wildlife Mangt. 23: 40-53. 1959.

During the summers and harvest seasons of 1955 and 1956, an investigation of muskrat ecology and population dynamics were conducted on 2,500 acres of marshland at Delta, Manitoba. Record-high water levels prevailed during the period of study and resulted in a great reduction in the density, distribution, and quality of emergent muskrat food and cover plants. Southern Manitoba is an area of intergradation among three subspecies of muskrats (O. z. cinnamominus), (O. z. zibethicus), and (O. z. albus).

The average litter size was 7.1 and 7.3 young, respectively, for 1955 and 1956. Average litter sizes were found to vary with increasing age of the litters and with progression of the breeding season. Males constituted 58 percent of the members of 69 complete litters during 1956. A progressive unbalancing of the sex ratio toward an excess of males was observed to be correlated with increasing age of the litters.

Recapture of tagged animals allowed the construction of a muskrat growth curve. Juvenile muskrats at Delta have a very rapid growth rate during the relatively short period during the summer when growth conditions are optimum. The rate declines rapidly after early fall; and little, if any, growth occurs from November through March.

Dept. Wildlife Mangt., U. Mich., Ann Arbor, Mich.

Arata, A. A. ECOLOGY OF MUSKRATS IN STRIP-MINE PONDS IN SOUTHERN ILLINOIS. J. Wildlife Mangt. 23: 177-186. 1959.

A study of the ecology of the muskrat in strip-mine ponds in southern Illinois was part of a program to determine the wildlife potential of such lands. A total of 360 dens was recorded on some 142 acres of strip lands. The density ranged from 0.3 to 9.0 dens per acre, averaging 2.8. This constituted 2.4 dens per 1,000 feet of shore line. Males constituted 57 percent of the population. Subadults comprised 43 percent of the animals. Observations indicated that reproduction was low, with but two litters produced annually, averaging 3.4 kits.

Only two types of internal parasites were found, with low rates of incidence recorded, probably owing to the lack of intermediate hosts.

Field observations indicated that cattail, sweet clover, broomsedge, and goldenrod formed a substantial part of the summer diet, whereas the winter diet was composed largely of cattail rootstocks and willows. Stomach analysis indicated that stonewort and pondweeds also make up a large part of the winter diet. Both availability and preference are important in the selection of food items by muskrats.

Movement was greatest in February at spring dispersal, and in late summer when low water levels caused the abandonment of dens.

Experimental plants of arrowhead, water-lily, and bulrush were successful in the strip-mine ponds, although several other muskrat food plants did not become established owing to the adverse ecological conditions.

Intensive management for muskrats on the strip lands studied is not recommended because of economic infeasibility, but incidental management could be practiced secondarily to other management procedures.

Dept. Biol., U. Fla., Gainesville, Fla.

Chamberlain, J. L. GULF COAST MARSH VEGETATION AS FOOD OF WINTERING WATERFOWL. J. Wildlife Mangt. 23: 97-101. 1959.

Marsh-plant utilization by wintering waterfowl was determined by analysis of 1,251 gizzards from 17 species of ducks and geese. Emphasis was placed on frequency of occurrence of foods because volumetric measurements comprised less than half of the total records of items in the gizzards. Forty-nine plant species were identified. Seeds of Cladium, Scirpus, and Eleocharis were most frequently taken. Plants of Cyperaceae and Gramineae produced the most important foods. Distinct differences occurred in items taken by ducks wintering in different types of marshes.

Dept. Biol., Randolph-Macon Woman's Col., Lynchburg, Va.

Hunt, G. S., and Lutz, R. W. SEED PRODUCTION BY CURLY-LEAVED PONDWEED AND ITS SIGNIFICANCE TO WATERFOWL. J. Wildlife Mangt. 23: 405-408. 1959.

An excellent production of curly-leaved pondweed seeds occurred in a marsh at the west end of Lake Erie in 1958. A reduction in water levels to a depth of 3 to 12 inches caused this excellent reproductive response.

Seeds collected from two milacre plots indicated that one acre would support 500 to 1,000 mallard-sized ducks for one day. A food habits study showed that 11 ducks of 15 collected had used the seeds of this pondweed.

Pending replication of the conditions above, the author suggests water level management as follows: (1) Draw down in spring to leave 3 to 12 inches of water over P. crispus beds; and (2) maintain those depths throughout the growing season.

Sch. Nat'l. Res., U. Mich., Ann Arbor, Mich.

## SUPPLEMENT

### Problems Affecting Agriculture

Guyer, G., and Wells, A. EVALUATION OF INSECTICIDES FOR CONTROL OF THE CHLORINATED HYDROCARBON RESISTANT ONION MAGGOT. Mich. Q. B. 41(3): 614-623. 1959.

In 1958 a study was established in three onion growing areas of Michigan to evaluate insecticides for control of chlorinated hydrocarbon resistant onion maggots. The results indicate that:

1. Onion maggot populations resistant to chlorinated hydrocarbon insecticides were present in all major onion growing areas of Michigan by the fall of 1957.
2. There was considerable variation in the magnitude of maggot populations in the three areas studied.
3. The most effective treatment were Diazinon, Thimet, American Cyanamid 18133, and American Cyanamid 12880. Other materials which produced yields significantly greater than the control were parathion. Ehtion, Trithion, Guthion, Disyston, EPN-300, Co-Ral, and VC-13.
4. Treatments applied as granulated or dust formulations were more effective than liquid treatments at comparable rates.
5. There was no indication of off-flavor or reduction in quality of onions treated with parathion or Diazinon.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Penfold, J. W. THE FIRE ANT. Outdoor Amer. 24(2): 5-7. 1959.

According to the U. S. Department of Agriculture, (Solenpsis saevissima richteri), the "imported fire ant", came to the Gulf States from South America about forty years ago. It has since spread to about 27 million acres in 10 southern states.

This article tries to present both sides of the controversy over the fire ant and control by use of a crash program.

The author makes the following conclusions:

1. The fire ant is a pest which is expanding its area of habitation. The pest is not as serious as painted. Studies of the fire ant indicate it may be actually beneficial (Argentina thinks it is). Admittedly it is a nuisance. The present control program, which emphasizes aerial broadcasting of highly lethal poisons, appears to be damaging beneficial forms of wildlife more seriously than is the fire ant. It poses immediate dangers to humans, pets, and livestock through mis-application, concentration in streams, etc. And the long range cumulative results may be still more serious for man and beast alike.
2. It is recommended: (1) That broad-scale aerial bombardment of the fire ant with highly toxic chemicals be stopped immediately; (2) that surface machinery and hand application methods be employed so as to hit directly at the specifically infested areas where the nuisance occurs; (3) that research into these new

chemicals and safe methods for their use be greatly expanded at Federal, state and local levels; and (4) looking to a future of new pests and still more lethal poisons--the Federal government achieve far greater co-ordination among all agencies having direct or indirect concern with the health and safety of insects, plants, animals ... and man.

No address given.

Adkinsson, P. L., Wilkes, L. H., and Johnson, S. P. CHEMICAL, CULTURAL AND MECHANICAL CONTROL OF THE PINK BOLLWORM. Tex. Agr. Expt. Sta. B. 920, 16 pp. 1958.

A review of the life and seasonal history of the pink bollworm is presented along with description of damage resulting to cotton from attacks by this pest. Spring emergence records for several areas of the State are given. Data presented for the College Station area indicated that peak emergence of pink bollworm moths occurred from late May through early June. Emergence continued into August in every year (1953-57) records were taken except 1956.

Cage tests indicated that pink bollworm infestation levels up to about 50 percent infested bolls cause relatively small decreases in the value of the cotton produced, provided the infested bolls averaged less than 2 larvae per boll. Field experiments indicated there was a trend toward a lower-per-acre return with an increase in infestation.

Guthion and DDT were the most effective insecticides for controlling the pink bollworm in field and laboratory tests. Control of the pink bollworm by insecticides was done by adult mortality, reduction in oviposition, and death of developing embryos and newly hatched larvae.

The use of defoliants delayed the build-up of pink bollworm infestation 2 to 3 weeks following defoliation.

Mortalities of approximately 90 percent of the larvae remaining in the field after harvest were obtained by modified stalk shredders and ensilage harvesters.

Different spray nozzle arrangements and gallonages of spray per acre were tested. One nozzle per row was as effective as any arrangement tested. There were no appreciable differences in control with gallonages of spray ranging from 2 to 30 gallons per acre.

ERD, ARS, USDA and Tex. Agr. Expt. Sta., College Station, Tex.

Hawkins, J. H., McDaniel, I. N., and Murphy, E. WIREWORMS AFFECTING THE AGRICULTURAL CROPS OF MAINE. Maine Agr. Expt. Sta. B. 578, 40 pp. 1958.

Wireworms annually cause a loss of thousands of dollars to agricultural crops in Maine. Wireworms are the young or larvae of elaterid beetles known as "skipjacks" or "chick-beetles." The life stages are egg, wireworm or larva, pupa, and adult.

Wireworms are known to thrive on a long list of plants. They injure crops by feeding on the underground parts of plants. Occasionally, they may invade and live in the lower portions of the stems of plants. Potatoes are probably more severely injured by wireworms than any other crop in Maine, but corn, grass, ornamentals, and many vegetable crops are also injured.

Wireworms are distributed over almost all of the farming area of the United States and are prevalent in many other parts of the world. They infest a large section of the farming area of Maine, but are relatively less abundant in the potato growing areas of northern Aroostook County than elsewhere.

The length of time wireworms live in the soil varies according to the species present.

A number of alternative methods of control are available today which are of aid in preventing wireworm injury. Cultural practices that destroy grasses and weeds reduce populations to low levels and effectively prevent populations from building up. Crops also vary considerably in their degree of susceptibility to wireworm injury. It is now practical to make use of insecticides for immediate reduction of wireworm populations when necessary.

Heptachlor, aldrin, chlordane, and dieldrin are chlorinated hydrocarbon materials which may be used effectively to control wireworms. Aldrin, chlordane, and heptachlor are readily available, low in cost, and reliable for practical use in wireworm control.

Aldrin or heptachlor is used at a rate of 2.5 or 5 pounds of active material per acre. The amount of chlordane found to be effective in wireworm control varies from 5 to 10 pounds of active material per acre.

Dusts containing chlordane have not generally proven as effective as emulsifiable concentrates or wettable powder formulations used with water. Chlordane, aldrin, or heptachlor when used in combination with fertilizers has not generally proven quite as effective as emulsifiable concentrates or wettable powders used as water sprays.

Prompt coverage of the insecticide with soil is necessary to obtain maximum wireworm control. Dusts or water sprays containing these insecticides may be conveniently covered by harrowing. The insecticide is worked in to a depth of 5 or 6 inches.

Maine Agr. Expt. Sta., U. Maine, Orono, Maine.

Petty, H. B., and Moore, S. III. PROFITABLE CONTROL OF UNDERGROUND CORN INSECTS. U. Ill. Col. Agr. C. 805, 8 pp. 1959.

Underground insects of corn steal profits from Illinois farmers every year. They reduced average yields in the state 5 to 6 bushels an acre each year.

In many fields, their attacks cause poor stands, so fields must be replanted. They prune the roots so severely in many fields that the plants lodge and harvest is slowed down, or at least made more difficult. There is no way to measure the resulting inconvenience to the farmer.

The damage these pests do may begin when the seed is planted and continue until harvest. Not all species are present in any one field in the same year, but many of them, in various combinations, may be.

Ten kinds of insects that attack corn underground are illustrated and described.

Soil insecticides: (1) Provide insurance against replanting because of insect damage; (2) insure easier picking because of less lodging; (3) save an average of 5 to 6 bushels of corn an acre; and (4) return their cost 3 times or more in 25 percent of all fields, 2 to 3 times in 18 percent, and 1 to 2 times in 24 percent.

If all Illinois cornfields were treated, total corn savings would more than pay for the cost of treatment and the farmer would have the added benefits of easier picking and less replanting.

Ill. Nat. Hist. Survey and U. Ill., Col. Agr., Ext. Serv. Agr. and Home Econ., Urbana, Ill.

Bigger, J. H., and Blanchard, R. A. CONTROL OF UNDERGROUND INSECTS OF CORN. Ill. Agr. Expt. Sta. B. 641, 28 pp. 1959.

Cornfields in Illinois, as this 5-year study shows, may be damaged by one or more of these underground insects: wireworms, white grubs, grape colaspis, cornfield ants, corn root aphids, or rootworms. They were present in significant numbers in 38 percent of the fields studied and may do considerable economic damage. The extent of infestation was determined by digging in untreated portions of cornfields throughout the state. Abundance of the insects mentioned above appears to be most likely when corn is grown more than two years in succession in a field or when corn follows a legume-grass mixture.

Cornfields are also damaged by seed-corn maggots, seed-corn beetles, cutworms, billbugs, and possibly other insects. Plant population counts suggest that such damage may occur in an added 30 percent of the fields.

Aldrin and heptachlor at a rate of 1 1/2 pounds of active ingredient to the acre and dieldrin at 1 pound to the acre, all sprayed broadcast and disked in ahead of planting, gave good to excellent control of all insects under study. They also provided the largest increases in plant populations in the treated portions of the fields. Aldrin and heptachlor at 1 pound per acre, broadcast and disked in, gave very good control of corn rootworms. These insecticides at 1 pound per acre applied over the row and covered with soil controlled most, but not all, the insects studied. Insecticide-fertilizer mixtures used at planting time and placed in the row were not always effective, especially if less than 1 pound of insecticide per acre was used.

Insecticides at rates recommended are not detrimental to the plants. They destroy some predators but do not reduce the earthworm population.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

Guyer, E. G., Brown, H. M., and Wells, A. AN EVALUATION OF SYSTEMIC INSECTICIDES FOR CONTROL OF HESSIAN FLY IN MICHIGAN. Mich. Q. B. 40(3): 595-602. 1958.

There is a constant desire on the part of farmers to plant winter wheat early in the late summer planting period to insure better establishment of the stand, and in some cases, to utilize the wheat for pasture.

Seed and in-row treatments with two systemic insecticides were evaluated for control of the Hessian fly. Both spring and winter wheat were included in the investigation. The results indicate that both Thimet and Bayer 19639 appear to be effective materials for systemic control of this pest on winter wheat. Seed treatments were slightly more effective than in-row applications at several treatments. Generally, there was a complete recovery of the retarded plants followed by increased vigor. This was especially evident in the treatments with Thimet. The addition of a fungicide to the seed treatment lessened the phytotoxicity problem and in some instances eliminated the damage. Residues of Thimet decreased from 4.9 p.p.m. 13 days after seeding to below a detectable amount 57 days after planting.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Huffman, C. F., Lassiter, C. A., and Duncan, C. W. SUGAR BEET-TOP SILAGE FOR DAIRY COWS. Mich. Q. B. 41(1): 189-197. 1958.

Michigan farmers grow about 70,000 acres of sugar beets annually. Each acre yields about 12 tons of roots with about 700 to 800 pounds of tops per ton of roots. The newer types of harvesting equipment remove the beet tops before the roots are dug; the tops do not include crowns.

The feeding value of silage made from sugar beet tops harvested with a forage harvester and ensiled with 200 pounds of beet pulp per ton of tops was investigated in two experiments. In Experiment 1, milk production was maintained when 35 pounds of beet-top silage replaced 6.4 pounds of grain in an all-hay ration. This indicated that the T.D.N. in the beet-top silage and grain were about equal for milk production. When 50 pounds of silage replaced 12.4 pounds of good second cutting alfalfa hay, four of six cows increased in F.C.M. (4% fat corrected milk).

The percentage composition of the 1957 beet tops on the dry matter basis were: protein, 20.9; ether extract, 1.7; crude fiber, 13.7; N.F.E., 50.4; and ash, 13.7.

In the second trial, two groups of 8 cows each were fed on a reversal design experiment to determine the effect of replacing 22 pounds of hay with 85 pounds of beet-top silage daily. The first 6 days of each 24-day period were not used in calculating the results. The cows average 22.4 and 29.1 pounds of F.C.M. per day on the basal and beet top rations, respectively. The cows gained 47.4 pounds in body weight on the basal ration and lost 16.2 pounds on the beet-top silage ration. Some of the loss in weight on silage may have been due to less digestive tract fill.

The flavor of the milk produced by cows fed beet-top silage was very good when the silage was fed after milking.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Thomas, H. R., and Kincaid, C. M. PEANUT HULLS FOR GROWING AND FATTENING BEEF CATTLE. Va. Agr. Expt. Sta. B. 501, 12 pp. 1959.

Feeding trials were conducted with growing and fattening beef cattle during a 2-year period to test the value of peanut hulls, peanut vine hay, molasses, and winter pasture.

1. Peanut hulls are a satisfactory roughage for beef cattle when properly supplemented, provided they constitute not more than 60% of the total ration.

2. For yearling cattle the addition of molasses to a fattening ration containing 40% peanut hulls increased total feed intake slightly but showed little differences in average daily gains.
3. In the weanling heifer calf test, peanut hulls replaced hay satisfactorily in the ration. Feed consumption was higher in the peanut hull lot than in either of the two hay lots; however, carcass grades were lower. Average daily gains were 2.25, 2.16, and 2.06 for the lots fed rations containing peanut vine hay, peanut hulls, and mixed hay, respectively.
4. In the weanling steer calf test, the peanut hull ration containing 60% peanut hulls was an excellent ration for wintering calves. This ration provided 6 pounds more concentrates per head per day than the two lots fed limited concentrates and peanut vine hay.
5. It appears the winter pasture replaced a considerable amount of the concentrates.
6. Winter pasture from cover crops and permanent pasture may replace about half of the hay needed to winter calves.

Va. Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va.

Walker, H. J., and Box, J. USE OF COTTON BURS TO IMPROVE SOIL PRODUCTIVITY ON IRRIGATED LAND. Tex. Agr. Expt. Sta. MP-394, 6 pp. 1959.

Cotton burs applied annually on an irrigated fine sandy loam soil at Lubbock, Texas during 1953-58 increased the lint yield 36 pounds per ton of burs applied. For the 6-year period covered by this test, the greatest lint yield increases were obtained during the last 4 years. Following three annual applications of burs on the same location increased lint yields were obtained for 3 additional yields without burs.

The addition of 12 to 15 pounds of nitrogen per ton of burs applied during the first 2 years of bur application is recommended. This amount provides sufficient nitrogen for plant growth and for the microorganisms involved in the decomposition of the burs.

Method of land preparation after the burs were applied had little effect on the benefits obtained from the burs. Cotton burs did not significantly affect the soil pH.

Organic matter content of the soil was not increased appreciably with annual applications of 2, 4, or 6 tons of burs per acre during 1953-58.

Phosphorus content of the soil apparently was increased slightly at the 6 to 12-inch depth with bur applications.

Potassium content of the soil was high on untreated and treated land at the beginning and end of the test period.

Tex. Agr. Expt. Sta., College Station, Tex.

## Soil-Plant Relationships

Ehrler, W., and Bernstein, L. EFFECTS OF ROOT TEMPERATURE, MINERAL NUTRITION, AND SALINITY ON THE GROWTH AND COMPOSITION OF RICE. Bot. Gaz. 120: 67-74. 1958.

Salinity and low root temperature are two soil factors that have been noted to injure rice and depress yields. In California the use of cold irrigation water in early spring has been observed to delay flowering and reduce grain production. Experience indicates that water temperatures below 21°C. may lower rice yields.

Two water-culture experiments were conducted with Caloro rice grown at several constant root temperatures and several levels of nutrition or salinity. In the first experiment, growth of shoots, roots, and grain was decidedly better at a high than at a low cation level. Variations in cationic ratio brought about changes in cation content of shoots and roots. This altered cation content did not significantly affect vegetative growth, but grain yields were significantly greater on isoequivalent (Ca=Mg=K) and high-K solutions than on high-Ca or high-Mg solutions. At a constant root temperature of 18°C., shoot growth was twice that at 30°C., and root growth one and a half times as great; however, grain yield was only three-fourths as much at the lower root temperature. There were no statistically significant interactions between root temperature and cationic concentration or cationic ratio.

In the second experiment the nutrient solution which had allowed the most growth (the isoequivalent solution at the high cation level) was used as a base nutrient in a study of root temperature and salinity effects. Rice was grown only to the late-flowering stage, at which time the two lower constant root temperatures, 22° and 14°C., had brought about less top growth than 30°C. Two atmospheres of chloride (NaCl, $CaCl_2$, or mixed NaCl and $CaCl_2$) added to the base nutrient were appreciably more inhibiting than sulfate ($Na_2SO_4$). Shoots accumulated two to three times as much chloride (up to 60 to 90 meq/100 gm. dry wt.) on the chloride solutions as on the non-saline medium. Four atmospheres of NaCl were lethal at all three root temperatures. The interaction between salinity and root temperatures was not statistically significant.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Miller, D. F. COMPOSITION OF CEREAL GRAINS AND FORAGES. Committee on Feed Comp. of the Agr. Board Natl. Acad. Sci.-Natl. Res. Council P. 585, 663 pp. 1958.

The Committee on Feed Composition of the Agricultural Board was established in 1946 for the purpose of providing precise information on the nutrient value of animal and poultry feeding stuffs in a manner which would provide maximum potential benefit to our animal production resources.

The need for reliable information of this nature is well recognized. Methods of quantitative analyses for many nutrients have been greatly improved; changes and improvements have occurred in the processing of numerous feed ingredients, and new products are continually expanding the long list of materials used in the economical feeding of livestock and poultry. The urgent need for precise information has become especially significant in view of the increased efficiency of livestock feeding made possible through the widespread application of the knowledge summarized in the series of Nutrient Requirement Reports of the Committee on Animal Nutrition. Mixed feeds are being more and more widely used, and the achievement of maximum efficiency necessitates more complete knowledge of the composition of available ingredients. This compilation represents an effort by the Committee on Feed Composition to provide this basic information on cereal grains and forages.

These tables represent a compilation of the most reliable data available on the composition of domestic cereal grains and forages. Data in terms of 60 nutrients have been compiled for the various component parts of 325 genera and 700 species of plants, including both cultivated and range type forages. Variations are shown as affected by such factors as class of feeding stuff, method of handling or processing, stages of maturity, federal grade, cutting, and geographical origin, encompassing over 5,000 different designations regarding specific feed identifications.

Natl. Acad. Sci., Natl. Res. Council, Washington 25, D. C.

Fujimoto, G., and Sherman, G. D. THE COPPER CONTENT OF TYPICAL SOILS AND PLANTS OF THE HAWAIIAN ISLANDS. Hawaii Agr. Expt. Sta., Tech. Prog. Rpt. 121, 22 pp. 1959.

The copper content of the representative types of Hawaiian soils has been found to range from 16 to 357 p.p.m., and the average for 87 samples is 124 p.p.m. This is higher than the averages reported in other areas. The copper content is greater in the upper horizons of the soil and decreases with depth. Copper tends to accumulate where iron oxide is high in the old weathered soils. The exchangeable copper ranged from 0.03 to 0.25 p.p.m. in six soils, although they differed widely in texture, pH, and age.

The copper content of plants ranged from 1.2 to 31 p.p.m. The average of copper content of 58 plants which include leaves of trees, beans, vegetables, fruit, and grasses is 11.0 p.p.m. The lowest was in head cabbage grown in cinder soil near the Volcano area and the highest in cultivated sugar cane leaves obtained from Puunene, Maui.

The characteristic differences in the soils or the application of increments of copper did not make much difference in the uptake of copper by lettuce, spinach, and tomato. However, there was a slight increase in the uptake at the 500-pound application in some cases and those that did not take up more at this concentration showed toxic effects.

The copper content of 18 grass samples from pastures and cultivated fields averaged 11.1 p.p.m. Since this is well above the minimum requirement of 5 p.p.m. of copper for the normal health of animals, the prospect of copper deficiency in animal green feed may be very remote.

U. Hawaii, Hawaii Agr. Expt. Sta., Honolulu, Hawaii.

Younge, O. R., and Otagaki, K. K. THE VARIATION IN PROTEIN AND MINERAL COMPOSITION OF HAWAII RANGE GRASSES AND ITS POTENTIAL EFFECT ON CATTLE NUTRITION. Hawaii Agr. Expt. Sta. B. 119, 27 pp. 1958.

Native or naturally established grasses from ten different locations and soils on the island of Hawaii were sampled at two-month intervals over a period of a little over one year and their chemical composition determined. Data are presented on the seasonal trend of crude protein, phosphorus, and calcium, and compared with the nutrient requirements established for different classes of cattle.

The crude protein is shown to be deficient in amount for all classes of cattle during the five-month period April to August. The reduction in protein during the summer period occurs in wet and dry areas alike and is probably induced by the limited availability of soil nitrogen in the wet areas and the hastened maturity of the grasses in droughty areas. Only the Honokaa and Puu Oo soils at the Ahualoa and Ohaikea sites, with hilograss and paspalum, respectively, meet the minimum protein standards for maturing young stock in the 800- to 1000-pound class, the class with the lowest maintenance requirements next to mature cows. For other classes of cattle, the protein content is considerably below minimum standards most of the time for growing young cattle below 600 pounds and for fattening cattle at all weights and ages.

The phosphorus and calcium content of the native grasses follow the trend of protein, being low during several months during the long-day and summer period. Calcium is below the desirable 0.8 percent level for all grasses on all soils. It falls below the minimum standards for young cattle in the 400- and 500-pound categories for various grasses on all soils except the Honokaa and Puu Oo soils. The periods of deficiency range from one month to all year round. Top dressing with one ton of liming material per acre raised the calcium content of the forage in general but at sites of severest deficiency failed to produce satisfactory levels of calcium for all classes of cattle.

In most grasses phosphorus deficiencies existed seasonally during the long-day period, May to September, for young growing and fattening cattle. The minimal level for all cattle, 0.17 percent, occurred for varying periods ranging up to several months for grasses grown at six locations scattered over all vegetation zones. Surface treatment with 500 pounds per acre of superphosphate slightly increased the phosphorus content of the forage but usually the increase failed to correct the nutritional deficiency.

On the basis of the chemical content of the native grasses from ten widely different soils ranging from the dry Reddish Brown soil group through the Reddish Prairie, Brown Forest, and extremely wet Hydrol Humic Latosols, it is apparent that serious widespread nutritional deficiencies exist for various classes of beef cattle. Prevailingly the grasses fail to meet minimum standards of protein and phosphorus, and for extended periods calcium is apparently also deficient.

U. Hawaii, Hawaii Agr. Expt. Sta., Honolulu, Hawaii.

Troelsen, J. E., and Campbell, J. B. NUTRITIONAL QUALITY OF FORAGE CROPS ADAPTED TO SOUTHWESTERN SASKATCHEWAN AS DETERMINED BY THEIR DIGESTIBILITY AND DRY MATTER INTAKE WHEN FED TO SHEEP. Canad. J. Plant Sci. 39: 417-429. 1959.

Hays from stands top-dressed with 150 pounds of ammonium nitrate (33.5 percent nitrogen) per acre and unfertilized stands of crested wheatgrass, (Agropyron cistatum (L.) Gaertn.), intermediate wheatgrass, (A. intermedium (Host.) Beauv.), streambank wheatgrass, (A. riparium Scribn. and Smith), and Russian wild ryegrass, (Elymus junceus Fisch.), as well as hay from unfertilized stands of tall wheatgrass, (A. elongatum (Host.) B. P.), reed canary grass, (Phalaris arundinacea L.), and Ladak alfalfa, (Medicago media Pers.), were fed to 70-pound wethers in digestion stalls in a randomized incomplete-block experiment.

Chemical analyses of the hays indicated differences in percentage organic matter, crude protein, and nitrogen-free extract, while feed-feces ratios showed differences in the percentage digestibility of crude protein, nitrogen-free extract, and crude fiber. Despite these results no differences were established in nutritive values as estimated by digestible dry matter, total digestible nutrients, digestible energy, or starch equivalents.

Calculations demonstrated that the nutrient intake of crested wheatgrass, streambank wheatgrass, Russian wild ryegrass, and Ladak alfalfa were sufficient to provide at least a maintenance ration, but was not sufficient for intermediate wheatgrass, tall wheatgrass, and reed canary grass.

Although some inconsistencies in the results cannot be explained, nevertheless on the basis of chemical analyses, calculated nutritive standards, voluntary consumption, and trends in daily weights, it is apparent that the order of feeding value of the grass hays (when fed alone and irrespective of fertilizer treatment) is as follows: (1) Russian wild ryegrass; (2) crested wheatgrass and streambank wheatgrass (equal); (3) intermediate wheatgrass; (4) tall wheatgrass; and (5) reed canary grass.

Top-dressing did not increase the digestibility nor the apparent palatability of any feed; apparently consumption was determined by species characteristics rather than fertilizer treatment.

Res. Br., Canada Dept. Agr., Ottawa, Ontario, Canada.

Marsh, H., Swingle, K. F., Woodward, R. R., Payne, G. F., Frahm, E. E., Johnson, L. H., and Hide, J. C. NUTRITION OF CATTLE ON AN EASTERN MONTANA RANGE AS RELATED TO WEATHER, SOIL AND FORAGE. Mont. Agr. Expt. Sta. B. 549, 91 pp. 1959.

This report records the results of a 5-year study of the correlation of soil nutrients, forage nutrients, and nutrition of Hereford range cows, on grazing land near Miles City, Montana. The data on which the findings are based include weather records; soil analyses for nitrogen and phosphorus; forage plant analyses for protein, phosphorus, and carotene; analyses of blood plasma of cows for phosphorus, calcium, magnesium, carotene, and vitamin A; and the performance of the cows, as measured by weight, general condition and health, and reproductive efficiency. The experimental cattle were grazed on pastures established on native range at three grazing intensities--heavy, moderate, and light.

It was concluded:

1. That cows grazed at stocking rates of 30.5 and 38.8 acres per cow, with supplemental hay in winter under conditions of heavy snow or severe drought, developed satisfactory weights and reproductive records, under the following conditions: (1) Average available soil phosphorus of 2.5 p.p.m. and total soil nitrogen of 0.09 percent; (2) annual average crude protein in the forage of 8 percent; (3) annual average forage phosphorus of 0.12 percent; (4) annual average forage carotene of 70 $\mu$g/g; and (5) annual average blood phosphorus of 3.7 mg/100 ml. blood calcium of 9.82 mg/109 ml., blood magnesium of 1.59 mg/100 ml., and blood vitamin A of 30 $\mu$g/100 ml.
2. That the lower weights, lower calf crop, and relatively poor condition of the cows in the heavily grazed pastures (23.1 acres per cow) were not associated with deficiencies of specific nutrients in the forage.
3. That, in general, breeding cattle can be run on the range in the Northern Great Plains without protein, vitamin, or mineral supplements with satisfactory productive performance and without developing nutritional deficiencies; provided that the range is not overstocked, and realizing that there may be areas within the plains region in which nutritional deficiencies may occur.

Mont. Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

Robertson, J. H., and Torell, C. PHENOLOGY AS RELATED TO CHEMICAL COMPOSITION OF PLANTS AND TO CATTLE GAINS ON SUMMER RANGES IN NEVADA. Nev. Agr. Expt. Sta. Tech. B. 197, 38 pp. 1958.

Forty forage plants of northeastern Nevada were clipped at successive stages of growth for chemical analysis. Grasses, weeds, and shrubs were sampled during four years. Most of the samples were from summer ranges. Those from winter ranges are included for comparison. Crude protein, crude fiber, nitrogen-free extract, and ether extract were determined for all samples. Calcium and phosphorus were determined for a smaller number. Chemical composition was related to stage of plant development in all instances. Over half of the species analyzed were deficient in phosphorus for normal growth of young beef cattle. The deficiency occurred in grasses, weeds, and shrubs.

Ten groups of young beef cattle were weighed at 28-day intervals during eight grazing seasons. Their rates of gain were studied in relation to plant maturity and to abundance of forage. Although declining forage quality accompanied advancing maturity of key grasses, rates of livestock gain showed no consistent corresponding decline. Mid-summer gain slackened in certain years, apparently at the time of lowest moisture content of the grasses and immediately preceding the inclusion of browse in the diet. Much the best gains, over two pounds daily, were made during the boot and heading stages of bluebunch wheatgrass. Average daily gains per head were less than one pound in only the first and last of the six months on summer range.

Actual losses in weight of cattle in the fall occurred only when the range was fully utilized and the herbaceous plants were over-mature.

Max C. Fleishmann Col. of Agr., Agr. Expt. Sta., U. Nev., Reno, Nev.

Baker, M. L., Baker, G. N., and Matsushima, J. K. SAFFLOWER MEAL AS A PROTEIN SUPPLEMENT. Nebr. Agr. Expt. Sta. S. B. 447, 15 pp. 1959.

Three trials on the use of safflower meal as the only source of supplemental protein, at different levels and in combination with other sources of supplemental protein or nitrogen, are reported.

On the basis of these trials and of other work which is reviewed the following seem reasonable tentative conclusions: (1) Safflower meal fed at an equivalent crude protein level should give approximately the same gains for growing and fattening cattle as the more commonly used oil meals and should produce cattle which should perform about equally well on the market and in the carcass. (2) Safflower meal probably is not as palatable for cattle as the more commonly used oil meals but no especially difficult problems are encountered in feeding it. (3) Combinations of safflower meal and urea have proved quite acceptable where fed on an equivalent nitrogen basis with safflower meal or other supplements. (4) Safflower meals may vary widely in protein content. This of course affects their value as a source of protein. (5) Safflower meal is apparently deficient in certain essential amino acids. The nutrient requirements of swine and poultry are more critical than those of cattle, therefore, it is suggested that specific recommendations be obtained where one wishes to include safflower meal in rations for swine or poultry. And (6) safflower meal apparently is lower in phosphorus than the more widely used oil meals.

U. Nebr., Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

McCormick, L. L. EFFECTS OF PAPER MILL WASTE WATER ON CATTLE, CROPS AND SOIL. La. Agr. Expt. Sta. B. 529, 44 pp. 1959.

Studies have been made to determine the effects of paper mill waste water on cattle, crops, and soil including studies to determine whether waste water could be used as a source of irrigation water in the production of various crops.

Flooding the soil, prior to planting, with annual applications of 3, 6, and 12 inches of undiluted paper mill waste water per acre for five consecutive years caused no significant reductions in the yields of corn, cotton, or a meadow mixture of Dallis grass, white clover, and lespedeza. Soil analyses at the conclusion of the experiment showed no build-up of soluble salts in the soil and no marked increase in the pH of the soil from treatments with the various rates of paper mill waste water.

Paper mill waste water was as good as fresh well water when used as a source of drinking water for bred cows and their calves. None of the cows or their calves forced to drink paper mill waste water were harmfully affected. When sold at 6 to 8 months of age, calves that had been on waste water and calves that had been on fresh well water brought equal and good prices.

Yields of the crops irrigated with waste water were in general equal to the yields of the crops irrigated with fresh well water. Corn irrigated with fresh well water produced slightly higher yields than corn irrigated with waste water, but the difference was not statistically significant. No residual effects on vetch and oats from the use of waste water applied as irrigation water to previous crops were noted. Analyses of the soil after three years of irrigation with waste water showed very little build-up of soluble salts in the soil. The soil pH increased about one unit, which had no apparent detrimental effects on the growth of the crops.

A mixture of Dallis grass, common Bermuda grass, and white clover irrigated with waste water applied through a sprinkler system produced a yield of 4.9 tons of hay per acre, an increase of 2.5 tons above the yield from a non-irrigated meadow.

Corn irrigated with waste water applied through a sprinkler system produced highly significant increases in yields as compared to corn receiving equal amounts of fertilizer but no irrigation.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Stamp, L. D. WORLD LAND UTILIZATION THE MEASUREMENT OF POTENTIAL PRODUCTIVITY. Land and Water 9(4): 10-13. 1958.

The author suggests using the Standard Nutrition Unit of 1,000,000 calories a year farm production, 900,000 calories of consumable food as equivalent to 2,460 calories a day (the average requirement for the maintenance of health and vigor for the people of north-western European or of American height and weight and age composition) as a method of measuring world crops.

The advantage of this unit is that it can be calculated independently of the crop grown or the food consumed. The Manual of Nutrition enables the caloric value of a given weight of any foodstuff to be calculated.

Using this method he compares the countries of the world not only in their acreage of actual or potential food-producing land, but also in their ability, given their varied types of diet, and farming to support human beings. If this is called "efficiency" as it is in one sense, the highest efficiency is reached with the intensive hand cultivation of rice and vegetables--with protein derived from beans and fish, and with very little meat or milk--practiced in Japan with an output of six of seven Standard Nutrition Units per cultivated area. This is roughly seven or eight times as "efficient" as the U.S.A.

The following table shows the acreage per capita and food output per acre for 12 selected countries:

| Country | Acreage per head | | | Standard nutrition units per acre |
|---|---|---|---|---|
| | Total | Cultivable | Cultivated | |
| Canada..... | 150.0 | 22.0 | 4.0 | 0.4 |
| Brazil..... | 40.0 | 30.0 | 1.0 | 1.3 |
| U.S.A..... | 12.0 | 6.0 | 3.5 | 0.4 |
| Uganda..... | 10.0 | 9.0 | 1.0 | 1.0 |
| Burma..... | 9.0 | 4.0 | 1.15 | 1.0 |
| France..... | 3.3 | 2.0 | 1.8 | 0.6 |
| Pakistan..... | 3.0 | 1.0 | 0.7 | 1.0 |
| Denmark..... | 2.5 | 2.0 | 1.8 | -- |
| India..... | 2.1 | 1.0 | 0.9 | 0.75 |
| U.K..... | 1.1 | 0.6 | 0.55 | 0.9 |
| Japan..... | 1.1 | 0.2 | 0.15 | 6.5 |
| Holland..... | 0.8 | 0.6 | 0.55 | -- |
| World..... | 13.4 | 4.0 | 1.2 | 0.75 |

No address given.

## Genesis and Morphology

Aronow, S. DRUMLINS AND RELATED STREAMLINE FEATURES IN THE WARWICK-TOKIO AREA, NORTH DAKOTA. Amer. J. Sci. 257: 191-203. 1959.

Northeast-trending drumlins and related streamline features of late Pleistocene age are found in the Warwick-Tokio area of the Devils Lake region of North Dakota. These features range from small drumlins to large ridges or "scorings" in end moraines. Some isolated end moraine patches contain exposures of Pierre shale bedrock of Cretaceous age. These bedrock "highs" seem to have controlled the location of the morainal patches but do not seem significant in the origin of the streamline features. The origin of the streamline features is uncertain but they are probably erosional rather than depositional. Why they are localized in this part of the Devils Lake region and absent elsewhere is not clear. No significant differences of terrain or materials were found among the various parts of the region.

Lamar State Col. Tech., Beaumont, Tex.

Smith, K. G. EROSIONAL PROCESSES AND LANDFORMS IN BADLANDS NATIONAL MONUMENT, SOUTH DAKOTA. Geol. Soc. Amer. B. 69: 975-1008. 1958.

Small-scale erosional features in the Big Badlands of South Dakota include miniature mountain ranges and pediments, with morphology resembling that of mature mountainous desert regions of the southwestern United States. Miniature badland pediments have steeper gradients than large-scale pediments of the arid southwest, but angles of mountain fronts average about the same for both--approximately 35°.

There is an abrupt reduction of slope where the miniature mountain front meets its bordering pediment. The miniature mountain drainage is poorly integrated; it consists of closely spaced rill channels having the same gradient as the mountain slope.

At the expense of the retreating miniature mountain front the pediment is extended headward by erosion at the margins of spreading sheetwash. The escarpment retreats by disaggregation through absorption and desiccation and by rill erosion.

Topographic texture varies with underlying bedrock. Topography developed on the Chadron formation is fine-textured; that on the Brule formation is ultra-fine textured. Badlands drainage is typically dendritic with regularly bifurcating finger-tip tributaries.

The mean maximum angle of slope in typical Chadron topography is 26.2°, with estimated standard deviation of 4.2°. For the Brule formation mean maximum slope angles of 56.0°, 49.5°, and 51.0° were obtained in three areas. A test revealed that the differences between means of Brule and Chadron are significant.

Each slope mean represents an equilibrium condition in which the slope has been adjusted to achieve a steady state between the resistivity of the material to erosion and the intensity of erosional processes.

Continental Oil Co., Durango, Colo.

Drewes, H. TURTLEBACK FAULTS OF DEATH VALLEY, CALIFORNIA: A REINTERPRETATION. Geol. Soc. Amer. B. 70: 1497-1508. 1959.

Turtlebacks are smooth, curved surfaces, which form north-northwestward-plunging elongate domes on the east side of Death Valley. These surfaces are roughly parallel to bedding or foliation of anticlines in Precambrain schist, gneiss, and marble. Late Cenozoic fan and playa deposits are faulted over these surfaces along the turtleback faults.

Previously the turtleback faults have been interpreted as part of a thrust fault, perhaps the Amargosa thrust fault, that was arched after thrusting. They are interpreted here as individual normal faults younger than the thrust fault and, contrary to previous interpretations, much younger than the formation of the anticlines in the Precambrian rocks.

The tectonic history of this unusual area is here considered to include the following events: (1) Precambrian folding of the Precambrian rocks; (2) post-Paleozoic and pre-middle(?) Tertiary Amargosa thrusting; (3) uplift and erosion of Paleozoic strata and the Amargosa thrust fault, down to the folded Precambrian rocks in the Black Mountains block; (4) middle(?) Tertiary rhyolite extrusions and the accumulation of later Tertiary fan and playa deposits; (5) Pliocene or Pleistocene uplift of the Black Mountains relative to Death Valley, along the Black Mountains fault system, with consequent removal of support for the Tertiary deposits on the turtleback surfaces, and the development of the turtleback faults by normal faulting or sliding, of the Tertiary sedimentary rocks down the turtleback surfaces toward Death Valley; and (6) Pleistocene to Recent renewal of movement on the Black Mountains fault system.

U. S. Geol. Survey, Fed. Cent., Denver, Colo.

Twenhofel, W. S., and Sainsbury, C. L. FAULT PATTERNS IN SOUTHEASTERN ALASKA. Geol. Soc. Amer. B. 69: 1431-1442. 1958.

Prominent linear features interpreted as faults were plotted from aerial photographs of southeastern Alaska, and the resultant patterns were analyzed with reference to the literature and to the field relations determined by the writers and other geologists of the U. S. Geological Survey. The faults, as interpreted, seem to belong to a well-defined and widespread system that trends northwesterly and to three ill-defined systems that trend northerly, northeasterly, and easterly respectively. The faults are part of a system of fractures subparallelling the Coast Ranges and the North Pacific coast of British Columbia and Alaska.

Movement on the faults in southeastern Alaska took place during late Mesozoic, Tertiary, and possibly recent times. A major lineament, the Denali lineament, can be traced for about 1,600 miles, from southeastern Alaska northwest along the arcuate Alaskan Range and thence southwest to Bristol Bay.

Most of the hot springs of the area are located on conspicuous faults. Some of the carbonated springs are on linears, but some are not. Sulfur springs seem to be unrelated to linears.

The writers suggest that certain mineral deposits in southeastern Alaska are spatially related to certain faults, particularly those of the northwest-trending system. Data support this thesis for the mineral deposits of the Chichagof-Sitka belt and the Juneau gold belt.

U. S. Geol. Survey, Denver, Colo.

Wahrhaftig, C., and Cox, A. ROCK GLACIERS IN THE ALASKA RANGE. Geol. Soc. Amer. B. 70: 383-436. 1959.

Field studies and examination of aerial photographs of approximately 200 rock glaciers in the Healy (1:250,000) quadrangle in the central Alaska Range showed that there are three types of rock glacier in plan: (1) Lobate, in which the length is less than the width (200 to 3,500 feet long and 300 to 10,000 feet wide); (2) tongue-shaped, in which the length is greater than the width (500 to 5,000 feet long and 200 to 2,500 feet wide); and (3) spatulate, tongue-shaped but with an enlargement at the front. Lobate rock glaciers line cliffs and cirque walls and probably represent an initial stage; the other two move down valley axes and represent more mature stages.

The rock glaciers are composed of coarse, blocky debris that is cemented by ice a few feet below the surface. The top quarter of the thickness is coarse rubble, below which is coarse rubble mixed with silt, sand, and fine gravel. Fronts of active (moving) rock glaciers are bare of vegetation, are generally at the angle of repose, and make a sharp angle with the upper surface. Fronts of inactive (stationary) rock glaciers are covered with lichens or other vegetation, have gentle slopes, and are rounded at the top. Active rock glaciers average 150 feet in thickness, inactive rock glaciers, 70 feet.

The upper surface of most rock glaciers is clothed with turf or lichens. Sets of parallel rounded ridges and V-shaped furrows--longitudinal near the heads of some rock glaciers and transverse, bowed downstream, on the lower parts of others--and conical pits, crevasses, and lobes mark the upper surfaces of many rock glaciers.

The upper surface of a rock glacier at the head of Clear Creek moved 2.4 feet per year between 1949 and 1957, and the front advanced 1.6 feet per year.

Heights of the upper edges of the talus aprons along the fronts of rock glaciers average 45 percent of the heights of the fronts.

Rock glaciers occur on blocky fracturing rocks which form talus that has large interconnected voids in which ice can accumulate. They are rare on platy or schistose rocks whose talus moves rapidly by solifluction.

The rock glaciers lie in an altitudinal zone about 2,000 feet thick, centered on the lower limit of existing glaciers. Although the firn lines on glaciers rise 1,200 feet in a distance of 25 miles northward across the Alaska Range, the lower limit of active rock glaciers rises only 800 feet. The firn line on southward-facing glaciers is 2,000 feet higher than that on northward-facing glaciers, yet in any given area southward-facing rock glaciers average only 200 feet higher than northward-facing rock glaciers. Insulation by the debris cover is believed responsible for the difference in altitudinal ranges between rock glaciers and glaciers.

It is concluded that rock glaciers move as a result of the flow of interstitial ice and that they require for their formation steep cliffs, a near-glacial climate cold enough for the ground to be perennially frozen, and bedrock that is broken by frost action into coarse blocky debris with large interconnected voids.

An average of 30 feet of bedrock was removed from source areas to form the present rock glaciers, indicating an average rate of erosion of 1 to 3 feet per year when they are active.

Alaska Geology Br., U. S. Geological Survey, Menlo Park, Calif.

Thornbury, W. D. THE GEOMORPHIC HISTORY OF THE UPPER WABASH VALLEY. Amer. J. Sci. 256: 449-469. 1958.

Most of the area now drained by the upper Wabash Valley was in Tertiary time part of the Teays Valley drainage. Burial of the Teays Valley and its associated Tertiary topography and diversion of part of its drainage to the Wabash were initiated by the Kansan glaciation and completed by the Illinoian.

The upper Wabash River is superposed across a buried Tertiary topography that the river has hardly more than begun to exhume. Headward, from about Terre Haute, Indiana, the Wabash Valley consists of alternating wide and narrow stretches depending largely upon whether its course crosses a preglacial valley or a buried preglacial bedrock upland. The courses of the Wabash and Teays in Indiana roughly parellel each other but actually intersect at only two places.

The most conspicuous topographic features along the Wabash Valley are largely consequence of its having been a major Wisconsin sluiceway. Most striking are: (1) Minor scabland tracts, where the sluiceway cuts through buried bedrock uplands; (2) partially exhumed bioherms (klintar); where the valley crosses the belt of Silurian rocks; (3) numerous abandoned valley braids above the present valley floor; (4) gravel and bedrock terraces; and (5) dune and loess deposits in or adjacent to the sluiceway.

The surficial loess adjacent to the Wabash Valley is of Tazewell age, but buried loess that has been interpreted as of Farmdale age indicates that during this Wisconsin subage ice extended far enough into Indiana to send outwash down the Wabash Valley. It is questionable whether Iowan loess is present along the Wabash Valley. What has been previously called Iowan loess may be pro-Tazewell loess. No Cary loess has been mapped, but till and outwash of this stadial are present in the uppermost part of the Wabash drainage basin.

Dept. Geology, Ind. U., Bloomington, Ind.

Lovering, T. S. SIGNIFICANCE OF ACCUMULATOR PLANTS IN ROCK WEATHERING. Geol. Soc. Amer. B. 70: 781-800. 1959.

Accumulator plants differ widely in the elements accumulated but have been studied chiefly for their capacity to pick up minor elements deleterious to agriculture. However, the ability of some plants to accumulate certain major elements, such as silicon, aluminum, calcium, manganese, and iron, has geologic implications. Many kinds of vegetation,

especially in the tropics, contain several percent silica dry weight. Some 10 to 20 tons dry weight of new growth per acre is added each year above ground in tropical jungles, and the roots add several tons more. A forest of silica-accumulator plants averaging 2.5 percent silica and 16 tons dry weight new growth per year would extract about 2,000 tons of silica per acre in 5,000 years--equivalent to the silica in 1 acre-foot of basalt. Comparison of lateritic soils with parent rock indicates that a silica-accumulator jungle could convert basalt into lateritic soil rapidly--geologically speaking. The silica in ground water increases with depth and time in contact with the rock, but vadose water seems inadequate to yield the silica required by such a jungle of silica-accumulator plants; biochemical factors must therefore cause much more rapid solution of silica. Under favorable conditions, much soluble organically derived silica may be recycled or added to ground water, but nevertheless, in tropical regions with high rainfall and appreciable runoff, large amounts of siliceous organic debris must be swept off the forest floor into the drainage system. On the other hand, if insoluble silicic phytoliths result from the disintegration of the vegetal litter, the upper soil horizons may become enriched in silica from disintegrating silica-accumulator plants, where erosion does not equal the rate of accumulation, as in many prairie and savannah soils. Plants that accumulate other elements, such as calcium, aluminum, manganese, or iron, may have geologic importance in developing other special soil types and in expediting the selective removal of certain elements.

U. S. Geol. Survey, Denver, Colo.

Nakamura, M., and Sherman, G. D. CHROMIUM DISTRIBUTION IN THE LATOSOLS OF THE HAWAIIAN ISLANDS. Hawaii Agr. Expt. Sta. Tech. B. 37, 12 pp. 1958.

The Hawaiian soils of the latosol groups, rocks representing the parent material of the soils, and concretionary weathering products were analyzed for chromium. The presence of the element was indicated in all of the analyzed samples. The chromium content of the soils ranged from 230 to 9,000 p. p. m. The analyzed parent materials contained from 40 to 1,400 p. p. m. and the concretionary products ranged in content from 380 to 2,140 p. p. m. of chromium.

The chemical analysis table in Grange's soil survey of the Lower Cook Island Group (1953) showed the chromium content to be higher in the more highly weathered soils. The soil samples analyzed in the course of this investigation generally followed the pattern of correlation between chromium concentration and intensity of weathering found by Grange. However, there were several samples with unexpectedly low amounts of chromium in view of the fact that the soils were considered to be intensely weathered. The unusually low concentrations, unaccountable through weathering alone, were in part explained by the extremely small amounts of the element that were present in the parent materials. A definite correlation between the parent material and the concentration of chromium in the soil was noted.

The correlation between weathering and the accumulation of chromium was definitely affirmed by the analyses of the latosols of the Hawaiian Islands. Weathering in itself, however, cannot account for the amount of the element present in the soil since parent material and the physico-chemical properties of the element are responsible to a certain degree for accumulation. Chromium possesses properties which make it a residual weathering element and allow its accumulation in the soil.

U. Hawaii, Hawaii Agr. Expt. Sta., Honolulu, Hawaii.

Sherman, G. D. NATURE AND TYPES OF SECONDARY MINERAL AGGREGATES, CONCRETIONS, NODULES, AND LAYERS OF SOILS. J. Indian Soc. Soil Sci. 7: 193-197. 1959.

The development of secondary mineral aggregates, concretions, nodules, and layers can be considered a soil deterioration process. The loss of specific surface area produces an inertness in soil by markedly decreasing the adsorptive and water holding capacities or by interfering with root penetration, and the infiltration and percolation of water. Lastly the development of these mineral forms are a part of soil aging in that their greatest concentration is associated with senile stage of soil genesis. The greatest development is usually formed in tropical soils.

Table 1

The mineral composition of secondary mineral aggregates, concretions, nodules, and layers

1. Concretion
   - Concretion: gypsum, carbonates, halloysite, pyrolusite, silica, gibbsite, boehmite, iron oxides, anatase
   - Rhyzoconcretion: pyrolusite, carbonates, iron oxides, gibbsite
   - Pisolite: carbonates, gibbsite, iron oxides
   - Amygdules: gibbsite
   - Oolites: carbonates, gibbsite

2. Nodules: gypsum, carbonates, montmorillonite, montronite, beidellite, iddingsite, halloysite, iron oxides, pyrolusite, silica, gibbsite-boehmite

3. Aggregate: salt, gypsum, carbonates, nontronite, halloysite, iron oxides, gibbsite, gibbsite-boehmite

4. Coatings: carbonate, montmorillonite, beidellite, nontronite, pyrolusite, halloysite, iron oxides, alumina, gibbsite, silica

.5. Sheets: carbonate, halloysite, iron oxide, gibbsite-boehmite, pyrolusite, silica

6. Crusts: salt, gypsum, carbonate, silica, iron oxide, pyrolusite, laterite, amatase-iron oxide, gibbsite-boehmite

U. Hawaii, Honolulu, Hawaii.

Smirnov, V. N. NUTRIENT ELEMENT DYNAMICS AND BIOLOGICAL ACTIVITY OF PODZOLS FROM THE SOUTHERN FOREST ZONE. Soviet Soil Sci. 7: 753-758. July 1958.

Variations in biological activity and contents of nitrate, nitrite, ammonia, soluble phosphorus, and potassium were studied simultaneously in podzols under dry pine forest and mixed spruce in the southern forest zone. Soils under pine-lichen forest, open and cut-over areas from such forest, and soils under mixed spruce forest, nurseries, and clover from such forest were chosen for observation.

The contents of ammonia, soluble phosphorus, and potassium, and also the production of soil carbon dioxide, and their variations, were significantly higher in sod medium clay loam podzols under mixed spruce than in sandy podzols under dry pine forest.

Nitrates and nitrites were almost never observed, except for traces in May and June, on both sandy and clay loam podzols.

The greatest peculiarities were found in the production of soil carbon dioxide. Thus, differences in vegetation and soils were shown first of all in the biological activity of the soil. It appears to be the most sensitive indicator of current changes in properties of soil formation and forest vegetation.

The forest litter of podzols stands out as the richest in nutrient elements and the most variable.

The humus horizon is biologically less active and lower in available nutrients. But because of the greater thickness of the $A_1$ horizon and its greater bulk density, the nutrient supply here may be greater than in the $A_0$ horizon. These properties of forest litter require economic interpretation and action to intensifying the biological cycle and increase productivity.

Measures are recommended for improving the biological activity and physical-chemical properties of forest podzols.

Amer. Inst. Biol. Sci., 2000 P St. N. W., Washington 6, D. C.

Davis, J. F., and Lucas, R. E. ORGANIC SOILS, THEIR FORMATION, DISTRIBUTION, UTILIZATION AND MANAGEMENT. Mich. Agr. Expt. Sta. Spec. B. 425, 156 pp. 1959.

This manual on organic soils is divided in the following main parts: (1) Organic soils, their formation, distribution, utilization, and management; (2) water control; (3) nutrient requirements of crops; (4) fertilizer placement on muck soils; (5) soil testing; (6) adapted crops; (7) commercial uses of peat; and (8) selected list of references for organic soils.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

## Mapping and Interpretation

Robinson, G. H., Porter, H. C., and Orenshain, S. S. THE USE OF SOIL SURVEY INFORMATION IN AN AREA OF RAPID URBAN DEVELOPMENT. Soil Sci. Soc. Amer. Proc. 19: 502-504. 1955.

Urban as well as rural planning, are necessarily influenced by certain soil properties such as drainage, permeability, type of parent material, soil texture, and depth to bed rock, water table, or an indurated horizon. These properties affect both sanitary measures and development costs. Information concerning soil characteristics of an area is contained in, or can be interpreted from, a soil survey map and report.

The Fairfax County (Virginia) soil survey is being made largely because of requests from the Fairfax County Planning Commission, a commercial planning firm, and a real estate agent. Local funds are made available to the Virginia Agricultural Experiment Station to defray a part of the costs. The Planning Commission and the commercial planning firm consider soil survey information vital for preparing an overall or master plan for Fairfax County. They feel that it is especially useful in zoning, planning septic tank sewage disposal systems, and agricultural planning, and that the same information is also useful in planning highways, recreational areas, and in arriving at equitable tax adjustments.

It is desirable that persons trained in soil classification, management, and interpretation assist the various users of soil surveys. This assistance can be provided by personal consultation and carefully prepared descriptive legends and reports to accompany the map. The reports should include examples of how soils can be grouped for special purposes.

The expanding use of soil surveys presents a challenge to the soil scientist. It emphasizes the need for adequate classification of soil, closer field observations, improved field techniques, basic research, and careful interpretation of data.

SCS, USDA, Blacksburg, Va.

Fairfax County SOILS OF FAIRFAX COUNTY. 2nd Ed. Rev. 1958. Fairfax Co. Va. in cooperation with Va. Polytech. Inst. and U.S.D.A., S.C.S. Series No. 3, 167 pp. 1958.

The general welfare of the country depends largely on the land to supply the necessities of daily living. It is important to know what the land consists of, its suitability, and proper use. This requires a knowledge of the various types of soil, and amount of each type, where each is located, and its most suitable use.

This report contains important information concerning the soils of Fairfax County which will assist the landowners in wise use of the land, whether it be for farms, urban developments, home sites, gardens, lawns, or recreational areas.

An inventory of the soils of Fairfax County has been prepared through a soil survey made jointly by the Virginia Agricultural Experiment Station, the Soil Survey Division of the Soil Conservation Service and the local county officials. This survey was completed in January 1956. This is a second revised edition of the report.

C. S. Coleman, Soil Survey Off., Box 194, Fairfax, Va.

Obenshain, S. S., and Henry, E. F. CHEMICAL CHARACTERISTICS OF PROFILE SAMPLES OF SOILS IN NORFOLK COUNTY, VIRGINIA. Va. Agr. Expt. Sta. Res. Rpt. 25, 12 pp. 1959.

Obenshain, S. S., and Porter, H. C. CHEMICAL CHARACTERISTICS OF PROFILE SAMPLES OF SOILS OF FLUVANNA COUNTY, VIRGINIA. Va. Agr. Expt. Sta. Res. Rpt. 26, 15 pp. 1959.

Obenshain, S. S., and Porter, H. C. CHEMICAL CHARACTERISTICS OF IMPORTANT TAZEWELL COUNTY SOILS. Va. Agr. Expt. Sta. Res. Rpt. 29, 10 pp. 1959.

Obenshain, S. S., and Porter, H. C. CHEMICAL CHARACTERISTICS OF IMPORTANT PRINCE EDWARD COUNTY SOILS. Va. Agr. Expt. Sta. Res. Rpt. 30, 11 pp. 1959.

Obenshain, S. S., and Porter, H. C. CHEMICAL CHARACTERISTICS OF IMPORTANT LONDOUN COUNTY SOILS. Va. Agr. Expt. Sta. Res. Rpt. 31, 29 pp. 1959.

Obenshain, S. S., and Henry, E. F. CHEMICAL CHARACTERISTICS OF WASHINGTON COUNTY SOILS. Va. Agr. Expt. Sta. Res. Rpt. 39, 6 pp. 1960.

Obenshain, S. S., and Petro, J. H. CHEMICAL CHARACTERISTICS OF FAUQUIER COUNTY SOILS. Va. Agr. Expt. Sta. Res. Rpt. 40, 15 pp. 1960.

Obenshain, S. S., and Porter, H. C. CHEMICAL AND PHYSICAL PROPERTIES OF FAIRFAX COUNTY SOILS. Va. Agr. Expt. Sta. Res. Rpt. 41, 35 pp. 1960.

All of these counties have a published Soil Survey Report. In conjunction with these surveys, studies were made of the physical and chemical properties of the soils. The chemical studies are given in the above reports, while the report for Fairfax County Soil also includes the physical properties of the soils for that county.

Va. Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va.

Bruce, R. R., Raney, W. A., Broadfoot, W. M., and Vanderford, H. B. PHYSICAL CHEMICAL, AND MINERALOGICAL CHARACTERISTICS OF IMPORTANT MISSISSIPPI SOILS. Miss. Agr. Expt. Sta. Tech. B. 45, 36 pp. 1958.

To realize the crop production potential of soils it is necessary to first have a knowledge of their chemical, physical, and biological properties and reactions and then to so alter these properties and reactions to effect a medium optimum for plant growth. In the past, soils have been classified primarily on the basis of physical characteristics observable in the field. Although the soil survey reports resulting from field studies of observable soil physical characteristics provide valuable information, several physical and chemical measurements on soils provide information useful in the intelligent establishment of soil management practices such as irrigation, tillage, drainage, liming, and fertilization. The measurements made on the soils discussed herein include mechanical composition, aggregate stability, bulk density, moisture content at 1/3 and 15 atmosphere tensions, pH, organic matter content, cation exchange capacity phosphorus, and

mineralogical composition. The data obtained from these measurements may assist in resolving certain soil classification problems and in establishing suitable soil management practices.

Twenty of the more common Mississippi soils were investigated.

Charts, tables, and maps.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Lugo-Lopez, M. A., Perez-Escolar, R., Acevado, G., and Juarez, J. Jr. NATURE AND PROPERTIES OF MAJOR SOILS OF LAJAS VALLEY. Puerto Rico Agr. Expt. Sta. B. 149, 60 pp. 1959.

Morphological, physical, and chemical data are presented here for 23 soil profiles from Lajas Valley, comprising the major soils of the area. Mineralogical data for selected profiles are also reported. The studies include soils of the Aguirre, Guánica, San Antón, Santa Isable, Fraternidad, Fe, and Jácana series. These major soils of Lajas Valley exhibit certain characteristics in common that make the Valley unique among irrigation project-development areas. They are very deep with a high, almost uniform, clay content of the expanding-lattice type; predominantly small pores; very slow hydraulic conductivity in the subsoil; very low aggregate stability below the surface layer; but with a topsoil of about 1 foot, in some cases almost 2 feet, that conducts water rather well. They are relatively low in organic matter and nitrogen and generally high in soluble salts and exchangeable sodium, which increases with depth. The topography favors a highly mechanized, intensive type of agriculture which is furthered by the irrigation facilities in progress of installation. Adequate drainage, proper utilization of irrigation waters, and careful cropping systems can be the key to the successful operation of the Lajas Valley, development project.

U. Puerto Rico, Agr. Expt. Sta., Rio Piedras, Puerto Rico.

Arneman, H. F., Khan, A. D., and McMiller, P. R. PHYSICAL, CHEMICAL AND MINERALOGICAL PROPERTIES OF RELATED MINNESOTA PRAIRIE SOILS. Minn. Agr. Expt. Sta. Tech. B. 227, 47 pp. 1958.

This investigation of three prominent upland soil types in Nicollet, Brown, and McLeod Counties in the prairie region of southern Minnesota was undertaken to determine the influence that the slope and drainage of the land had on the mineralogical, physical, and chemical characteristics.

The parent materials from which these soils have developed are relatively young. Calcium carbonate, which originally was abundant in these soils, is removed rather easily by leaching as it comes in contact with the $CO_2$-charged water of the soil. Carbonates are now found well within 42 inches of the surface in all the profiles. In the better drained Clarion and Nicollet soils the lime is deeper than in the poorly drained Webster. The Clarion and Nicollet soils apparently are more permeable, thus facilitating the movement of water through them. The difference in drainage conditions has subjected the Clarion to rather extensive leaching and some erosion; Nicollet to extensive leaching with little or no erosion; and Webster to limited leaching with no apparent erosion.

From the reported laboratory data the following conclusions are drawn:

1. The color of the surface soils is related to the drainage conditions, the darker soils being more poorly drained.
2. The parent material of all three soils series is more uniform in particle size distribution than is ordinarily expected from glacial till of the same age.
3. There is little or no indication of a concentration of clay particles in the B horizons of any of the soils.
4. The surface soil of the Clarion clay loam is regarded to be the most highly weathered horizon of all the soils studied.
5. There is considerable difference in the occurrence of some heavy minerals in the different sizes and fractions.
6. There are no pronounced physical and mineralogical differences in these closely related young soils.

7. The surface soils of the three series are all rich in organic matter the amount decreasing with depth. The Webster series has the highest amount of organic matter, but it is a more carbonaceous type than that in the Clarion and Nicollet series, as shown by the wider carbon: nitrogen ratio.
8. The high total exchange capacity of these soils can be attributed to the preponderance of montmorillonite in the mineral clay fraction and to the presence of a high organic matter content.
9. The exchangeable calcium and magnesium are lower with increasing depth in each of the profiles.
10. The distinguishing properties of these soils are mainly morphological rather than physical, chemical, or mineralogical.

U. Minn., Agr. Expt. Sta., St. Paul, Minn.

Godfrey, C. L., Oakes, H., and Smith, R. M. SOILS OF THE BLACKLAND EXPERIMENT STATION--SUBSTATION NO. 5, TEMPLE, TEXAS. Tex. Agr. Expt. Sta. MP-419, 11 pp. 1960.

The soil types of the Blackland Experiment Station are Houston Black, Austin, and Trinity clays. Results of research on these soils are, in general, applicable to the similar and related series, Houston, Hunt, Bell, and Lewisville. The soils on the substation and related series throughout the Blackland Prairies represent well over 50 percent of the total area of the Blackland Prairies (11,500,000 acres).

The soils of the substation, as well as of the Blackland Prairies in general, have developed largely from highly calcareous Upper Cretaceous marls and chalks, resulting in profiles with a high base status and usually calcareous throughout.

The highly calcareous, generally soft or weakly consolidated parent material, the subhumid climate, and the resulting prairie grass vegetation have imparted distinctive properties to the soils of the Blackland Prairies. The soils are dark-colored in the surface and are of a nearly uniform clay texture throughout the profile. The dominant clay type is montmorillonite, a clay with high exchange capacity and which shows strong shrinkage and swelling with moisture changes. Soils high in this clay are easily puddled when worked too wet, but alternate wetting and drying causes major shrinkage and swelling which tends to restore a desirable granular structure. Repeated soil movement downward into shrinkage cracks is a dominant factor preventing the development of well-defined soil horizons. The action of earthworms on the clay and organic matter produce a strong granulating effect on the soil except under intensive cultivation.

Land use problems are related closely to climatic factors, soil physical properties, and the susceptibility of the soils of the Blackland Prairies to erosion on sloping areas. Acute problems are encountered from the cotton root-rot fungus in relation to climatic conditions. The fertility status of these soils is generally good and microbial activity is relatively high, but moderate nitrogen and phosphorus deficiencies are common on most crops and often iron is deficient or unbalanced on ornamental shrubs and lawns.

SWCRD, ARS, USDA and Tex. Agr. Expt. Sta., College Station, Tex.

Whiteside, E. P., Schneider, I. F., and Cook, R. L. SOILS OF MICHIGAN. Mich. Agr. Expt. Sta. Spec. B. 402, 52 pp. 1959.

A generalized soil bulletin that describes and illustrates the different soil properties of Michigan. The 43 major Michigan soil associations have been grouped into 26 divisions. These divisions are described and a map is presented showing where the division occurs in Michigan.

Agr. Expt. Sta., Mich. State U., East Lansing, Mich.

Gray, F., and Galloway, H. M. SOILS OF OKLAHOMA. Okla. State U. Misc. P. 56, 65 pp. illus. and maps. 1959.

A soil association map is given that shows what soils occur in Oklahoma, where they are located, how they are related to each other, and how and why they differ. This information is useful in the following ways: (1) It serves as an educational tool for teaching

people about the soils of Oklahoma and for showing what uses are and can be made of the land; (2) aids research workers in planning and orienting their research; (3) gives fertilizer industries and highway engineers a basis for evaluating or promoting their programs; and (4) helps readers to better understand the more technical county survey publications and consequently, encourages broader utilization of these reports.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

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