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The articles in "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.

The ABSTRACTS are issued at irregular intervals. Their purpose is to bring together a summary of current published information about 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 are appended.

The classification of articles follows the table of contents used for the "Soil and Water Conservation Research Needs" of the Soil Conservation Service. 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 the 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 follow U.S.D.A. Misc. Pub. 765, July 1958.

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R. S. Dyal, Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Plant Industry Station, Beltsville, Md. 20705.

CONTENTS

	PAGE
WATERSHED ENGINEERING	
Watershed development	1
Hydrology	3
Geology	6
Engineering design	7
WATER MANAGEMENT	
Irrigation	9
Drainage	15
Storage and conveyance	17
BASIC SOIL SCIENCE	
Soil physics	19
Soil chemistry and mineralogy	23
Soil biology	31
Soil-plant-animal relationships	33
Soil classification	40
EROSION CONTROL	
Wind and water erosion	46
Critical areas	48
SOIL MANAGEMENT	
Cropping practices	49
Crop residue management	52
Tillage	53
Fertility requirements for conservation farming	54
Salinity and alkali problems	63
Cover crops and green manure crops	64
Climatic influences	65
Mulching	69
PLANT MANAGEMENT	
Pasture and haylands	71
Rangelands	78
Plant materials	82
Woodlands	82
Windbreaks	88
Management of coffee plantations	88
Fruit and nut crops	89
Field crops	90
Vegetable crops	94
ECONOMIC AND SOCIAL ASPECTS OF SOIL AND WATER CONSERVATION	
Costs and returns	97
Institutional, educational, and social factors affecting conservation application	101
BIOLOGY	
Fish	105
Upland wildlife	107
Wetland wildlife	109
SUPPLEMENT	
Problems indirectly affecting the application of Soil and Water Conservation practices	110
Radioactive fallout	112

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WATERSHED ENGINEERING

Watershed Development

Brown, C. B. ROLE OF SMALL WATERSHEDS IN RIVER BASIN PLANNING. J. Soil and Water Conserv. 18: 14-18. 1963.

The role of small watersheds in river basin planning is rapidly becoming a significant national issue. The development of the conflict between the philosophy that calls for monumental dams on the main rivers to control water and the philosophy that runoff should be controlled where it originates in the headwaters was traced. Practical guidelines for river basin planning were given.

[Deceased.] Copies can be secured from Watershed Planning Div., SCS, USDA, Washington, D.C. 20250.

Landgren, N. E., Timmons, J. F., and Andersen, J. C. WATERSHED PROTECTION THROUGH FARM PLANNING. J. Soil and Water Conserv. 18: 3-7. 1963.

Results of an investigation was given that showed that the individual goal of increased profits from resource use was not necessarily incompatible with a watershed community goal of protection from excessive runoff.

Though structural methods of runoff control are often considered essential to watershed protection and development, there are many watersheds in which land management adjustments within individual farm units would provide the simplest and most acceptable way of achieving effective control of runoff.

FERD, ERS, USDA, Washington, D.C. 20250.

Soil Conserv. 28(9): 195-216. Apr. 1963.

This issue of the Soil Conservation Magazine was devoted to conservation of watersheds. The following articles were given:

Williams, D. A. WATERSHED LANDS AND WATER ARE EVERYBODY'S CONCERN. SCS, USDA, Washington, D.C. 20250.

Smith, G. S. WATERSHED PROJECT BRINGS COMMUNITY REWARDS. SCS, USDA, Upper Darby, Pa.

Dellberg, R. RANCH WATERSHED JOB PAYS GOOD DIVIDENDS. SCS, USDA, Ukiah, Calif.

Ridenour, W. J. WATERSHED CONSERVATION INSURES CITY WATER SUPPLY. SCS, USDA, Jackson, Ohio.

Braithwaite, D. L. UTAH IRRIGATORS LICK WATER LOSSES. SCS, USDA, Panguitch, Utah.

White, J. S., Jr. GEORGIA TOWNS REAP WATERSHED BENEFITS. SCS, USDA, Carrollton, Ga.

Hartman, M. A., and Ree, W. O. STUDY DOWNSTREAM EFFECTS OF UPSTREAM WATERSHED IMPROVEMENTS. SWCRD, ARS, USDA, Chickasha, Okla. 73018.

Wavrin, W. D. IRRIGATED LAND LEVELING SAVES WATER AND LABOR. SCS, USDA, Bismarck, N. Dak.

Swenson, E. A., Jr. WATERFOWL MARSH DEVELOPMENTS CATCH ON IN CONNECTICUT. SCS, USDA, Newton, Conn.

Smith, W. L. PAPER MULCH HELPS GRASS GROW ON DAMS. SCS, USDA, Denton, Tex.

Work, R. A. SNOW WATER. SCS, USDA, Portland, Oreg.

Quackenbush, T. H. IRRIGATORS' MANAGEMENT KEY TO WATER SAVING. SCS, USDA, Washington, D.C. 20250.

Wiese, J. BENTONITE POND LINING SOLVES WATER PROBLEM. SCS, USDA, Tensleep, Wyo.

Miller, C. R., and Borland, W. M. STABILIZATION OF FIVEMILE AND MUDDY CREEKS. J. Hydraul. Div., ASCE 89 (HY 1): 67-97. Jan. 1963.

Since the Riverton Project, in arid central Wyoming, began operations in 1925, Five-mile Creek has been used as the principal drainageway for carrying off irrigation wastes. With the extension of the Wyoming Canal in 1950, Muddy Creek also began to carry waste flows. Under natural conditions, both streams were ephemeral and flowed only as a result of storms or snowmelt. By 1952, the annual discharge had increased from less than 5,000 acre-ft. to over 90,000 acre-ft. on Fivemile Creek and over 20,000 acre-ft. on Muddy Creek.

On Fivemile Creek, the combination of seepage, high sustained waste flows, and natural floods resulted in a condition that greatly accelerated the erosion along the channel. The stream lost its natural meander pattern and became generally wide and braided between natural bedrock constrictions. Muddy Creek did not lose its meander pattern because it did not carry as great a volume of water as Fivemile Creek, and because it did not carry waste water until 1950.

By 1952, the deterioration of Fivemile Creek had become so severe that effective erosion control measures were necessary. This stream alone was contributing 49 percent of the sediment flowing into Boysen Reservoir.

Detailed field investigations and office studies were undertaken in 1952. In 1953, a comprehensive plan for the control of erosion on Fivemile Creek was completed. Similar studies were undertaken for Muddy Creek in 1953, and a comprehensive plan for that stream was completed in 1954. Although the structural elements recommended in each plan were similar, the approach on each stream was different. Fivemile Creek, having lost its natural meander pattern, was approached from the standpoint of channel stability. The main object was to keep the flowing water away from the stream banks and to provide continuity of the energy gradient between the wide sections and downstream natural control sections. Placement of the jack lines was determined by application of the relationship

developed by Leopold and Maddock. On Muddy Creek, all control works were developed in order to protect the existing meander pattern. On both streams, extensive planting of willow and Russian olive seedlings behind the jack lines was done in order to provide continued stability of the channel after the jacks had deteriorated.

All of the erosion control measures have met with considerable success. Both channels are now essentially stabilized and will require only maintenance of existing installations and spot control in future years. The success of the program was dramatically illustrated by the fact that the sediment inflow into Boysen Reservoir from Fivemile and Muddy Creeks was, as of 1962, only one-tenth of that which existed prior to the installation of the control measures.

Foothills Hydraul. Lab., SWCRD, ARS, USDA, Colo. State U., Fort Collins, Colo. 80521.

Hedges, R. F., and Garner, M. M. STATUS OF STATE LEGISLATION RELATING TO THE WATERSHED PROTECTION AND FLOOD PREVENTION ACT, AS AMENDED. U.S. Dept. Agr., SCS-TP-142, 28 pp. 1963.

The Watershed Protection and Flood Prevention Act of 1954, as amended, established a new national policy for Federal assistance to State and local agencies in projects for flood prevention and the conservation, development, utilization, and disposal of water. By 1963, 43 States had enacted laws to enable State and local agencies to cooperate with the Secretary of Agriculture in activities authorized by the Act. Summaries of certain provisions of the State laws and some of the reasons for their enactment were given.

SCS, USDA, Inform. Div., Washington, D.C. 20250.

Hydrology

Tomlinson, G. E. IN THE SOUTHEAST RIVER BASINS: LAND AND WATER RESOURCES DEVELOPMENT PLAN. J. Soil and Water Conserv. 18: 109-113. 1963.

A plan for development of land and water resources in southeastern United States was summarized in a proposed report prepared by the United States Study Commission, Southeast River Basins. The report details the Commission's conclusions and recommendations after it took a 40-year look-into-the-future at an 88,000 square mile area in Alabama, Georgia, Florida, South Carolina, and North Carolina.

U.S. Study Comm., Southeast River Basins, Atlanta, Ga.

Hewlett, J. D., and Hibbert, A. R. MOISTURE AND ENERGY CONDITIONS WITHIN A SLOPING SOIL MASS DURING DRAINAGE. J. Geophysical Res. 68: 1081-1087. 1963.

In an effort to explain the source of nonstorm streamflow in deep-soiled areas of the southern Appalachians, a 3 x 3 x 45-foot inclining concrete trough was constructed on a 40 percent slope. The structure was packed with a natural sandy-loam soil to a bulk density of 1.3, and after thorough soaking was covered with plastic to prevent evaporation. Outflow was measured at the base, and soil moisture tension and content were recorded for 145 days. As shown by piezometers, the larger pores were substantially emptied in 1.5 days, during which outflow occurred according to the expression,

$$Q = a_1 T^{-b_1}$$

where T is time in days since day zero and a_1 and b_1 are constants. After a 5-day transition period, the logarithm of drainage for the next 80 days was again linearly related to the logarithm of time, but with new constants, a_2 and b_2 , expressing unsaturated flow from the entire soil mass. An additional 60 days of flow occurred, deviating more and more from the log-log relation as the limits of drainage were approached. Soil moisture content and tension substantiated the theory that the entire unsaturated soil mass was contributing to outflow throughout the experiment. It was concluded that unsaturated flow in the earth mantle of steep watersheds cannot be ignored in hydrograph analysis, since it may well be a primary mechanism for sustaining baseflow.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

Pillsbury, A., Osborn, J. G., and Pelishek, R. E. RESIDUAL SOIL MOISTURE BELOW THE ROOT ZONE IN SOUTHERN CALIFORNIA WATERSHEDS. *J. Geophysical Res.* 68: 1089-1091. 1963.

Previous research indicated that, with conversion of watershed vegetation from chaparral to grasses and forbs, there were water savings at the end of the summer dry season because of residual soil moisture left by the shallow-rooted annuals. Such residual moisture, with subsequent deep percolation, was eventually carried downward to the water table. Two techniques were developed and utilized on chaparral-covered watersheds in San Diego and Riverside Counties of southern California to evaluate this possibility. One of these permitted an evaluation of any residual moisture to depths up to 14 feet and the other to depths up to 20 feet. No residual moisture was found at these depths in the chaparral plots or in the plots that had been converted to grasses and forbs. Rainfall was below normal (about 15 inches per year), and it generally wet the soil to depths of 4 feet or less.

U. Calif., Los Angeles, Calif.

Rauzi, F. WATER INTAKE AND PLANT COMPOSITION AS AFFECTED BY DIFFERENTIAL GRAZING ON RANGELAND. *J. Soil and Water Conserv.* 18: 114-116. 1963.

Studies of water intake on rangeland soils were conducted on the Northern Great Plains Field Station, Mandan, N. Dak., during July 1961. The study areas, native range pasture grazed at three different intensities over a long period of time, afforded an unusual opportunity to determine the effect of livestock use on the rate of water intake. The loss of surface cover and heavy use by livestock decreased the rate of water intake. Total water intake on the moderately grazed pasture was 1.6 times as great as on the heavily grazed pastures during the 1-hour test. Water intake on the ungrazed area was 1.8 times as great as on the moderately grazed pasture.

The composition of vegetation on the sites showed marked differences as a result of different histories of grazing. Blue grama was the dominant grass on the heavily grazed pasture. Western wheatgrass and needle-and-thread were more abundant on the moderately grazed pastures. Sedges were dominant on the area that had not been grazed since 1940 but prior to that time had been heavily grazed.

Management of grazing is a tool that can be used to increase the amount of precipitation available for plant use.

SWCRD, ARS, USDA, Laramie, Wyo. 82071.

Black, P. E. TIMBER AND WATER RESOURCE MANAGEMENT. *Forest Sci.* 9: 137-145. 1963.

A graphical and mathematical procedure for predicting stream yield increases due to forest cutting was developed. Inventory data on streamflow and timber stands on the headwaters of the Fraser River, which supplies water to Denver, Colo., were used in the analysis. The authors concluded that the management intensity indicated by the analysis for the watershed was both realistic and desirable; and that the use of minimum figures throughout the analysis enhanced its practical value in application to the land through good land management practices.

Humboldt State Col., Arcata, Calif.

Rowe, P. B. STREAMFLOW INCREASES AFTER REMOVING WOODLAND-RIPARIAN VEGETATION FROM A SOUTHERN CALIFORNIA WATERSHED. *J. Forestry* 61: 365-370. 1963.

A test of applied watershed management on the San Dimas Experimental Forest in southern California showed that streamflow yields could be appreciably increased. This was accomplished by clearing the deep-rooted woodland-raparian vegetation from selected canyon bottom reaches of Monroe Canyon. The increases in flow were especially important because they occurred primarily in summer and in the initial period of soil wetting during succeeding rainy seasons, when streamflow was lowest and water most needed.

During the one rainy season of heavy precipitation and continuously wet soils, the removal of the woodland-raparian vegetation had no appreciable effect on streamflow, peak discharge, or erosion rates. However, during wetting periods and during the one rainy season of light precipitation, streamflow yields, particularly during storms, were considerably increased.

Streamflow was inadequate to produce sediment movement in either the treated or control watersheds during these wetting periods. Removal of the tree-bush cover shading the stream course resulted in an increase in the algae content of the late spring and summer flows but had no other detectable effect on water quality.

The removal of the canyon bottom vegetation should be limited to carefully selected areas where conditions of climate, vegetation, soil, and water capable of yielding the desired increases are present.

Agr. Expt. Sta., Col. Agr., U. Ariz., Tucson, Ariz.

Eschner, A. R. and Larmoyex, J. LOGGING AND TROUT: FOUR EXPERIMENTAL FOREST PRACTICES AND THEIR EFFECT ON WATER QUALITY. *Prog. Fish-Cult.* 25: 59-67. 1963.

Experimental logging of watersheds caused significant changes in quantity and quality of streamflow.

Poorly located and constructed skidroads resulted in continuous, very high stream turbidities during logging. This effect diminished with time after logging disturbance ended. Carefully planned and constructed skidroads contributed negligible amounts of turbidity.

Clearcutting resulted in significantly higher maximum stream temperatures in the growing season and lower minimum temperatures in the dormant season. Maximum stream

temperatures above those generally tolerated by brook trout were noted often in the summer of 1959. Moderate cutting did not produce water-quality changes that were harmful to trout.

Increases in pH, alkalinity, and specific conductance were noted in the stream flowing from the clearcut watershed.

Streamflow was increased by the treatments in proportion to the amount of timber cut and killed. Most of the increases came late in summer and early in fall, in periods of high evapotranspiration and soil moisture recharge, when flow in many trout streams is dangerously low.

Changes in stream pH, alkalinity, and temperature are persisting; but treatment effects on quantity of flow and turbidity are diminishing as time passes.

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

Geology

Flaxman, E. M. CHANNEL STABILITY IN UNDISTURBED COHESIVE SOILS. J. Hydraul. Div., ASCE 89 (HY 2): 87-96. March 1963.

The erosion resistance of cohesive soils was defined by a comparison of shear strength tests with field observations under specific flow conditions. Samples were obtained by pushing 1.9 in. by 4 in., thin-walled tubes into undisturbed soils along channel boundaries. Coefficients of permeability were obtained. While still saturated, unconfined compression strength tests were made. Field observations and tests showed that the degree of erosion resistance and shear strength were positively related. Dry density, plasticity index, and percentage of soil finer than 5 microns showed a moderate to high correlation with shear strength, individually and in multiple regression analysis, but failed to explain a majority of the variations. Permeability was better related with the coefficient of correlation $r = -0.78$. This variable reflected the condition that slowly permeable cohesive soils that lose strength by saturation were better able to resist erosion from long duration flows. Shear stresses were symbolized by the product of channel slope, hydraulic radius, specific weight of water, and average velocity, and termed "tractive power." This product and the unconfined compressive strength were used to define the boundary between channels that were observed to be stable or eroding.

SCS, USDA, Portland, Oreg.

Zernial, G. A., and Laursen, E. M. SEDIMENT-TRANSPORTING CHARACTERISTICS OF STREAMS. J. Hydraul. Div., ASCE 89 (HY 1): 117-137. Jan. 1963.

Natural streams may have an ill-defined relationship between sediment load and discharge. U.S. Geological Survey data for several western streams include information on temperature, velocity, depth, width, bed material, concentration, and discharge. The variability of the load-discharge characteristics of these streams was assessed by the use of a relationship for the sediment-transporting capacity of streams and the measured variability of the factors determining the load. Although a direct comparison between prediction and observation was not feasible for every set of measurements, the predicted range of variation in sediment load was more than sufficient to explain the observed variation.

Jr. Author., U. Tuscon, Ariz.

Caldwell, L. T. GROUND WATER GEOLOGY OF THE DEKALB AND SYCAMORE QUADRANGLES. Trans. ILL. Acad. Sci. 55: 146-163. 1963.

A bedrock surface map and an areal geology map were formulated from 930 drilled well logs. Two structure cross sections were made from the data given by the deeper well records, one section extends across the study area in an east to west direction and the other from north to south across the central portion of the area. Interpretations were made for the data of the two sections and from the two maps. Glacial drift covers all the study area with thicknesses from 40 to 350 feet. The glacial drift aquifer, which is the most productive, occurs at the base of the drift layer. The buried bedrock surface has an average dip-slope to the south, including one large and two small parallel stream channels with 5 feet per mile channel gradients southward. The areal geology consists of Galena-Platteville surfaces in the DeKalb quadrangle and Maquoketa shale slopes with Niagaran dolomite uplands in the Sycamore quadrangle. The rock strata have an average structural dip to the south-east of about 9 feet per mile. Bedrock aquifers occur in the Ordovician (Galena-Platteville) dolomite, Ordovician (St. Peter) sandstone, Cambrian (Iron-ton-Galesville) sandstone, and Cambrian (Mt. Simon) sandstone. The Iron-Galesville aquifer is the best water-resource for water wells in the area.

Northern Ill. U., DeKalb, Ill.

Klug, M. L. GROUND WATER IN TEXAS. J. Hydraul. Div., ASCE 89 (HY 3): 153-165. May 1963.

Ground water forms an appreciable part of Texas' water resources. Programs of the Texas Water Commission are directed toward overcoming a deficiency of ground water information for statewide water planning. Quantitative methods used for reconnaissance studies being made of the entire State provide generalized evaluations of ground water available for development within large areas. Detailed county studies define current ground water conditions, and continuing studies keep abreast of development in selected areas in which ground water use is large. The various studies, together with a statewide program of basic data collection provide ground water information useful in planning water resources development on a more localized basis. Recommendations concerning the extent of surface casing to be installed in oil wells, the approval of wells that are to be used for subsurface disposal of industrial and municipal wastes, and the coordination of studies related to ground water contamination with the State Water Pollution Control Board are directed toward protecting fresh ground water in the State.

Nearly 80 percent of the communities and municipalities in Texas use ground water for their public supplies. More than 1,000 of these communities and municipalities are entirely dependent on ground water. In addition, ground water furnishes domestic supplies for more than 2 million people living in rural areas of the State. Many hundreds of industries and thousands of irrigators depend on ground water for their supplies.

William F. Guyton and Assoc. Conserv. Ground Water Hydrologists, Austin, Tex.

Engineering Design

Stall, J. B., and Neill, J. C. CALCULATED RISKS OF IMPOUNDING RESERVOIR YIELD. J. Hydraul. Div., ASCE 89 (HY 1): 25-34. Jan. 1963.

A system of drought risks was developed which governs the yield of an impounding reservoir. By using a frequency curve of annual events, the probability that an event (drought) of selected magnitude will not occur in any one year can be determined. The

corresponding probability that this event will not occur during any "design period" of n years is the n th power of the 1-year probability. This is based on the law of multiplication of probabilities. By considering various magnitudes and various design periods, a system of governing probabilities or risks is calculated. This system of risks allows the engineer to exercise his judgment as to the severity of these drought risks as they might affect municipal pumpage or yield.

Ill. State Water Survey, Urbana, Ill.

Beard, L. R. FLOOD CONTROL OPERATION OF RESERVOIRS. J. Hydraul. Div., ASCE 89 (HY 1): 1-23. Jan. 1963.

Dependable flood control operation of multi-purpose reservoirs requires the formulation and strict observance of a set of operating rules designed to provide essential flood control while assuring essential conservation accomplishments. In the Central Valley of California, fully satisfactory protection against unpredictable rain floods requires firm flood control space throughout the rainy season, with varying space requirements at the beginning and end of the season. Where conservation functions warrant, rain space requirement may be governed in part by ground conditions. Protection against snowmelt floods usually can be provided on a forecast basis, with good utilization of the flood control space for conservation purposes. Ungated spillways usually provide an important moderating effect on excessive floods, whereas gated spillways usually do not and must be operated with great care in accordance with prearranged schedules.

U.S. Army Engin. Dist., Sacramento, Calif.

Task Force. FRICTION FACTORS IN OPEN CHANNELS. J. Hydraul. Div., ASCE 89 (HY 2): 97-143. March 1963.

The development of fixed-bed, open-channel flow resistance equations was traced from Chezy to the present (1963). The use of the Darcy-Weisbach f was recommended, and methods of determining f were examined. Manning's n was also useful but has limitations that were explained. It gave good results for fully rough flow and smooth channel flow but was less satisfactory in the transition range. The relationship of boundary layers to open-channel resistance must be studied in order to advance the understanding of frictional resistance in open channels. Movable bed channel resistance and the criteria for determining when bed motion begins were reviewed. Further research was recommended in various areas such as definition of equivalent roughness, transition from smooth to fully rough flows for different types of roughness, large relative roughness, composite channels, and resistance with movable beds. A comprehensive bibliography through 1960 was given.

No address given.

Reigner, I. C. A VINYL-LINED WEIR FOR SMALL-WATERSHED STUDIES. J. Forestry 61: 297-298. 1963.

An inexpensive weir to gage small streams was built of wood and lined with a sheet of vinyl film. The cost was about \$850 and the weir is expected to last 5 to 10 years without repair. Construction details were presented.

New Lisbon Res. Cent., Northeastern Forest Expt. Sta., FS, USDA, New Lisbon, N. J.

Knisel, W. G., Jr. BASEFLOW RECESSION ANALYSIS FOR COMPARISON OF DRAINAGE BASINS AND GEOLOGY. J. Geophysical Res. 68: 3649-3653. 1963.

By means of baseflow recession analysis, a method of comparing drainage basins and geologic formations with the aquifers at maximum performance was developed. With the technique, it is possible to analyze data for perennial and intermittent streams. A minimum of subjective judgements is involved, so that comparable results can be obtained from independent investigations. The baseflow recession curve is assumed to be a decay-type curve. The maximum aquifer capacity can be determined from integration of the maximum recession curve. Baseflow data were analyzed for 61 drainage basins representing 9 geologic formations in the south-central United States, and the relative ground water storage of the formations were evaluated.

SWCRD, ARS, USDA, Riesel, Tex. 76682.

WATER MANAGEMENT

Irrigation

Hansen, V. E. UNIQUE CONSUMPTIVE USE CURVE RELATED TO IRRIGATION PRACTICE. J. Irrig. and Drain Div., ASCE 89 (IR 1): 43-50. March 1963.

By relating consumptive use to a suitable measure of weather conditions, such as evaporation, much of the variation in consumptive use from day to day disappears. The consumptive use-evaporation ratio has a minimum value when emergence occurs, increases to a peak at the beginning of flowering, and then diminishes until harvest occurs or the crop is essentially dead. By relating the consumptive use-evaporation ratio to relative growth, a unique curve results, which represents most agricultural crops.

Three distinct stages of growth exist: Vegetative, flowering, and fruiting, with the fruiting stage being considered in two parts--a wet fruit stage and a dry fruit stage.

Irrigation practice can be related to the stages of growth and thus to the ratio of consumptive use to evaporation. Irrigation should be adjusted while the consumptive use-evaporation ratio is increasing to stimulate vegetative growth and to stimulate flowering near the peak values, followed by wet fruit, and finally by dry fruit during the final stages of maturity when the plant approaches a dormant or dead condition.

Utah State U., Logan, U.

Quackenbush, T. H. THE MANAGEMENT OF IRRIGATION WATER...IT IS THE KEY TO OUR WATER PROBLEM. Irrig., Engin. and Maintenance 13(4): 16-17, 25. 1963.

Water conservation is a subject of growing concern to communities everywhere. Alarmed by the rapidly growing demands on our water resources, government and industry alike are studying ways of making water go farther by making a given amount do more jobs or by reducing waste.

One of the biggest opportunities for water savings is in irrigation agriculture. Eighty-five percent of the water consumed in the United States in 1960 was used by irrigation.

Great improvements are now being made in water conveyance and storage. Line canals and reservoirs, pipe lines, and control of phreatophytes are progressing at a good rate commensurate with the economic limitations that control this type of improvements.

Good irrigation water management includes irrigating at the right time, putting on the right amount, and putting it on at a rate the soil will absorb without excessive runoff or erosion.

Obtaining good irrigation water management on surface irrigated land is a more difficult job than on land irrigated with sprinklers because more of the management factors are "built" into the sprinkler system. Even with sprinklers there is a job to do which is quite often neglected. Good irrigation water management can be obtained by: (1) Creating the desire to practice it; and (2) supplying the proper information to the irrigator concerning such seemingly simple items as when to irrigate and how much to apply at each irrigation. The solution to these problems requires a knowledge of the rooting habits of the plant, the water-holding capacity of the soil, and the rate at which the plants use water.

Efficient water management is not a simple job--it takes effort and know how.

SCS. USDA, Washington, D.C. 20250.

Smerdon, E. T. SUBSURFACE WATER DISTRIBUTION IN SURFACE IRRIGATION.

J. Irrig. and Drain Div., ASCE 89 (IR 1): 1-15. March 1963.

Field data for the distribution of water application along irrigation runs by surface irrigation methods were analyzed for three different soils. These soils had radically different intake rates as pertains to the changes in the rate that occur with time after irrigation begins. In order to determine if some consistent trend existed, all data were reduced to dimensionless form for analysis. From the dimensionless curves of water application distribution, empirical equations were determined that related the depth of application at any point along the run to a dimensionless time parameter. This parameter was the ratio of the time required for the wetting front to traverse the run to the time required for the average water application to infiltrate.

The equations suggested were checked to assure that they were compatible with physical restrictions of the problem.

The uniformity of application along an irrigation run was shown to be dependent of both the infiltration equation of the soil and the speed at which the wetting front traversed the irrigation run. A chart was given relating the uniformity of water application to the infiltration characteristics and the ratio of the time needed for the water to traverse the run to the time needed for the average water application to infiltrate.

Tex. Agr. and Mil. Col., College Station, Tex.

Seginer, I. WATER DISTRIBUTION FROM MEDIUM PRESSURE SPRINKLERS. J. Irrig. and Drain. Div., ASCE 89 (IR 2): 13-29. June 1963.

Better understanding of the interrelationships among sprinkler drop size distribution, drop velocity, and the distribution pattern of the water on the ground is needed to improve sprinklers performance. A set of simple experiments enabled a quantitative analysis of the effect of some factors on these characteristics.

Operating pressure was the most important factor. The higher the pressure, the longer the range of the drops (radius of wetting), the finer the drops and the more even the distribution of the water on the ground. The faster the rotation, the shorter the range. Small differences in sprinkler construction, as in the shape of the sprinkler's body or nozzle, did not cause major differences in sprinkler performance.

The larger the drops and the faster they moved, the less susceptible they were to drifting by wind. However, large drops were produced by low pressures and large diameter nozzles and were associated with poor distribution patterns. In addition, larger and faster drops caused more damage to the soil by breaking of soil aggregates on the surface. A compromise, must, therefore, be sought for each particular purpose.

Analysis of the trajectories of the drops enabled determination of the tangential velocity of the water drops in the air. The tangential velocity reached a minimum before striking the ground. The value of this minimum was less than the terminal velocity of the drops and was practically independent of the operating pressure.

SCD, Ministry of Agr., Tel-Aviv, Israel.

Strong, W. C. CRITERIA FOR THE OPERATION OF SPRINKLERS. Irrig. Engin. and Maintenance 13(3): 11, 24. 1963.

Young cotton grown under sprinkler irrigation emphasized the need to design and to operate sprinklers correctly. The damage to the plants first reported as "summer frost" was not due to sprinkler irrigation per se but was due to improper operation of the sprinklers.

A number of factors are present where the damage usually occurs: (1) The cotton is young and much bare ground is exposed; (2) the weather is windy and often warm; (3) the soil and/or the water may be alkaline or saline; (4) the pressure at the nozzle of the sprinkler is below the recommended amount for optimum breakup of the nozzle stream; and (5) the rate of the rotation of the sprinkler is slow.

The last two items are operational and can be changed by the farmer or the designer of the sprinkler irrigation system.

Adequate water pressure, correct speed of sprinkler rotation, and a rate of application less than the infiltration and percolation rate of the soil involved will correct this "summer frost".

Fresno State Col., Fresno, Calif.

Davis, J. R., and Fry, A. W. WHAT PRICE SPRINKLER UNIFORMITY? Irrig. Engin. and Maintenance 13(4): 10-11. 1963.

At Davis, Calif., in 1962, second year alfalfa on Yoho soil gave the highest net return from the 60 x 60 foot sprinkler spacing that had an efficiency rating that averaged 63 percent when compared with the 20 x 30 and 30 x 50 foot sprinkler spacing when both had an average efficiency rating of 87 percent, and the 80 x 80 foot sprinkler spacing that had an average efficiency rating of 16 percent. In general, hay yields for the four systems were about equal through the cutting of July 25th, but after that time the 80 x 80 foot spacing decreased in yield.

The results tend to prove that a sprinkler system with a relatively poor distribution of water may be the most economic system, particularly when the value of the crop is relatively low. More economic design of sprinkler systems could be affected, or that for this type of crop an existing system could be "stretched" to save labor, without any decrease in crop yield.

Tables and figures.

Stanford Res. Inst., South Pasadena, Calif.

In a study of the effects of the use of saline water for irrigation, it was concluded that:

1. The osmotic pressure of the soil solution will be increased by applying saline irrigation water but not indefinitely. The leaching produced by irrigation tends to prevent excessive osmotic pressure.
2. Natural precipitation may leach out salts that accumulate as a result of applying saline water. If the amount of precipitation is sufficient to penetrate the soil to depths below the root zone, the accumulation of salts may be largely prevented.
3. One of the most important effects of saline irrigation water is that of cation exchange whereby Ca^{++} is replaced by Na^+ , but this exchange will not ordinarily be excessive if the Ca content of the water is 35 or more percent of the total cations of the applied water.
4. As Ca^{++} is replaced by Na^+ , the soil tends to disperse, thereby reducing the rate of water penetration into the soil. On the other hand, dissolved salts flocculate the fine-sized soil particles, and this may overcome the dispersing effect.
5. Leaching is vitally important wherever irrigation is practiced, and, if adequate, moderate salinity of irrigation water may be agriculturally advantageous, provided its Ca content is not unduly low.
6. The availability of Ca in the soil is probably the most important question in connection with the use of saline irrigation water.
7. The concentration of soluble salts in soils irrigated with saline water may vary greatly even in apparently uniform soil.
8. Owing to the multiplicity of the factors involved, hard and fast rules concerning permissible salinity of irrigation water cannot be laid down.
9. Irrigation tends to affect the pH of the soil adversely, but pH can be controlled by the proper choice of nitrogenous fertilizer.

U. Calif., Berkeley, Calif.

Lunin, J., Gallatin, M. H., and Batchelder, A. R. SALINE IRRIGATION OF SEVERAL VEGETABLE CROPS AT VARIOUS GROWTH STAGES: I. EFFECT ON YIELDS. Agron. J. 55: 107-110. 1963.

A greenhouse study was designed to determine the salt tolerance of several vegetable crops where plants were established on soil initially nonsaline and salinized at 3 successive growth stages approximately 2 weeks apart. The effect of different salinity levels on evapotranspiration by the different vegetables was determined. Five levels of salinity were used for each crop of broccoli, tomatoes, spinach, beets, onions, and peppers.

There were considerable variation in the reduction in yields due to salinity when salinized at different growth stages for all crops, with the exception of the broccoli and beet tops. All crops gave significant reductions in yields with increasing salinity, but significant interactions between salinity level and growth stage at which the soil was salinized were obtained only for tomato tops and pepper tops. Even though beet roots, onion bulbs, and pepper fruit did not reach maturity, the immature portions harvested indicated that the relative salt tolerance of these portions of the plant differed from that of the vegetative parts.

SWCRD, ARS, USDA, Norfolk, Va.

Batchelder, A. R., Lunin, J., and Gallatin, M. H. SALINE IRRIGATION OF SEVERAL VEGETABLE CROPS AT VARIOUS GROWTH STAGES: II. EFFECT ON CATION COMPOSITION OF CROPS AND SOILS. *Agron. J.* 55: 111-114. 1963.

Tomatoes, broccoli, onions, and peppers (medium salt tolerant crops), and beets, and spinach (high salt tolerant crops) were grown in a greenhouse to determine the effects on saline irrigations at various growth stages on the growth and cation composition of vegetable crops. The saline treatments were applied at three different growth stages. The treatments consisted of a control receiving only demineralized water and 4 levels of salinity, which consisted of synthetic sea water diluted to give electrical conductivity (EC) values of 5, 10, 20, and 30 mmhos./cm. for the medium salt tolerant crops and 10, 25, 40, and 50 mmhos./cm. for the high salt tolerant crops.

The cation composition of the soil solution (saturation extract), although showing no effects of time of irrigation, was altered by the level of salinity. This, along with differences in the physiological characteristics of each crop, resulted in wide variations in plant composition that made any broad generalizations difficult. The Ca, Mg, and Na contents, generally increased with salinity, with Na being the most consistent. The effect of salinity on the K content varied considerably with the individual crops. The stage of growth at which salinization occurred had a lesser effect on the composition than did the salinity level of the water applied.

SWCRD, ARS, USDA, Blacksburg, Va. 24060

Marani, A., and Horwitz, M. GROWTH AND YIELD OF COTTON AS AFFECTED BY THE TIME OF A SINGLE IRRIGATION. *Agron. J.* 55: 219-222. 1963.

An experiment to determine the effects of the timing of a single irrigation on the growth, yield, and quality of two varieties of cotton under dryland conditions was conducted in 1959.

Plant height and the number of flowers and bolls were strikingly influenced by irrigation treatments. When soil moisture decreased to permanent wilting percentage at 15 to 30 cm. and to 30 percent of available moisture capacity at the 30- to 60-cm. layer, vegetative growth was stopped, and flowering ceased about 3 weeks later.

A single irrigation at the beginning of flowering increased the yield of lint more than the other treatments did. This irrigation increased the number of bolls produced, as well as boll size. Staple length and fiber maturity were satisfactory.

An irrigation applied at the initiation of flower bud formation was less effective in increasing the number of bolls. This was because of an excessive rate of shedding of young bolls during the peak of flowering in July. Bolls were smaller and fibers shorter. There was a higher proportion of immature fibers.

A late irrigation applied at the peak of flowering was the least effective in increasing boll number. It did improve boll size, staple length, and fiber maturity.

Hebrew U. Jerusalem, Jerusalem, Israel.

Thrasher, F. P., Cooper, C. S., and Hodgson, J. M. COMPETITION OF FORAGE SPECIES WITH CANADA THISTLE, AS AFFECTED BY IRRIGATION AND NITROGEN LEVELS. *Weeds* 11: 136-138. 1963.

Of the grasses studied over a 3-year period, Alta tall fescue (Festuca arundinacea) was most competitive and Troy bluegrass (Poa pratensis L.) least competitive with Canada

thistle (Cirsium arvense). Ladino white clover was more competitive than birdsfoot trefoil (Lotus corniculatus) when present in full stands. Winter-killing of Ladino clover (Trifolium repens L.) resulted in an increase in Canada thistle, particularly at low irrigation levels. Irrigation favored an increase in Canada thistle numbers in the year the grass stands were established. In the next 2 years thistle numbers declined more rapidly on irrigated than on non-irrigated plots. High rates of nitrogen increased the competitive ability of the grasses.

CRD, ARS, USDA, Bozeman, Mont. 59715

Carlson, C. W., Grunes, D. L., Haise, H. R., and Alessi, J. EFFECT OF ALFALFA ON THE NITROGEN AND PHOSPHORUS REQUIREMENTS OF CROPS. Soil Sci. Soc. Amer. Proc. 27: 319-323. 1963.

The effect of N and P fertilization on crop yields under irrigation was evaluated in a nonlegume rotation (barley, corn, potatoes), and in a legume rotation (barley, alfalfa, alfalfa, alfalfa, corn, potatoes), on Gardena 1 at Upham, N. Dak.

In the nonlegume rotation, all crops responded to N. Phosphorus alone decreased yields of corn forage. With adequate N, P increased yields of barley, corn, and potatoes.

In the legume rotation, the major effect of alfalfa was to supply available N. Added N fertilizer increased the yields of all nonlegume crops, but P additions increased yields of all crops. Phosphorus was available to potatoes 5 years after it had been added on the barley crop.

Yields of barley and corn tended to be higher in the legume rotation than in the non-legume rotation, regardless of the fertilizer treatment. At the highest N fertilizer rate, yields of potatoes were similar in the two rotations. Higher yields in the legume rotation resulted mainly from the available N contributed by the alfalfa, but other factors also appeared to be involved. Alfalfa, grown only in the establishing year, contributed available N to the succeeding corn crop in an amount comparable to alfalfa grown for a longer time.

SWCRD, ARS, USDA, Beltsville, Md. 20705

Leamer, R. W. RESIDUAL EFFECTS OF PHOSPHORUS FERTILIZER IN AN IRRIGATED ROTATION IN THE SOUTHWEST. Soil Sci. Soc. Amer. Proc. 27: 65-68. 1963.

Phosphorus applied at the beginning of a rotation on an irrigated Springer fsl affected yield, plant composition, and soil tests for several years. Yields were increased for at least 6 years or until an amount of P equal to the application was removed in harvested crops.

Nitrogen fertilizer had no measureable effect on alfalfa or on first-year sorghum following phosphated alfalfa. Second-year sorghum benefited from applied N when ample P was present.

Alfalfa affected the usual measures of P status of soil. Chemical extracting agents did not remove as much P from a soil after alfalfa had been grown, although there was no reduction in the amount available to plants. Second-cycle alfalfa had lower P content than first-cycle alfalfa at equivalent yield levels.

SWCRD, ARS, USDA, University Park, N. Mex. 88070

Musick, J. T., Grimes, D. W., and Herron, G. M. IRRIGATION WATER MANAGEMENT AND NITROGEN FERTILIZATION OF GRAIN SORGHUMS. Agron. J. 55: 295-298. 1963.

Field studies were conducted for a 3-year period, 1958-60, to determine the effects of 4 irrigation treatments combined with 4 nitrogen rates on grain sorghum yields, evapotranspiration (ET), and efficiency of water use for grain production. Experiments were located on Richfield cl, silted phase, at Garden City, Kans.

Grain yields were curvilinearly related to soil moisture availability as controlled by number of irrigations. Maximum yields were approximately 8,500 pounds per acre. Near-maximum yields were obtained from three irrigations applied at preplanting, at 12- to 16-inch plant height, and at late boot stage of growth. Yield data, when combined with results from adjacent irrigation experiments indicated significant decreases in yields occurred when soil moisture during the period of boot to dough stage of grain was depleted below approximately 25 percent available in the top 4 feet.

Nitrogen response curves were related to irrigation treatment. The first 40 pounds per acre applied N on the preplanting irrigation treatment significantly increased yield, but additional amounts did not affect yields appreciably. Yields increased steadily in the wetter treatments with increasing N applications up to the maximum application rate of 120 pounds per acre.

Applied nitrogen increased seasonal ET by 1 to 2 inches under conditions of appreciable response. Increased yields were disproportionately greater than the slight increases in seasonal ET; therefore, nitrogen considerably increased water use efficiency.

Stage of plant growth had a major effect on daily ET. The maximum daily ET, 0.31 inch per day, occurred during late boot stage of growth.

SWCRD, ARS, USDA, Bushland, Tex. 79012

Drainage

van Schilfhaarde, J. DESIGN OF TILE DRAINAGE FOR FALLING WATER TABLES. J. Irrig. and Drain Div., ASCE 89 (IR 2): 1-11. June 1963.

An equation was presented for relating spacing and depth of drains to water-table drawdown rate. Although based on the Dupuit-Forchheimer assumptions, it was equally applicable for any depth to an impervious layer. It does not assume a constant thickness of the water-bearing stratum. A method was suggested for correcting for the convergence of flow in the vicinity of the drains. The incorporation of these two features should cause the method to yield more nearly correct results than are obtained from the Glover equation.

SWCRD, ARS, USDA, Raleigh, N.C. 27607

Youngs, E. G., and Towner, G. D. A STUDY OF SOME THREE-DIMENSIONAL FIELD-DRAINAGE PROBLEMS: II. MESH SYSTEMS WITH MAJORS AND MINORS AT DIFFERENT LEVELS. Soil Sci. 95: 369-375. 1963.

The Dupuit-Forchheimer analysis was used to obtain approximate relationships between the water-table height, rainfall rate, soil hydraulic conductivity, and the geometry of rectangular-mesh drainage systems with majors and minors at different levels for the case of the lower drain on an impermeable floor. The results were confirmed by hydraulic

model experiments. Additional experiments indicated that the relationships could also be applied when the lower drain was at some height above an impermeable floor. Anomalous behavior in the drain discharge versus time relationship was reported.

Agr. Res. Council, Cambridge, England.

Bouwer, H., and Rice, R. C. SEEPAGE METERS IN SEEPAGE AND RECHARGE STUDIES. J. Irrig. and Drain Div., ASCE 89 (IR 1): 17-42. March 1963.

Principles of a falling-head seepage meter technique for evaluating seepage and hydraulic conductivity of bottom materials were extended to conditions of seepage affected by pressure head in the canal and to stratified bottom material. The principles were reduced to simple procedures for routine application of the method in the field. The equipment included a vacuum, inverted U-tube manometer for convenient, on the canal bank, measurement of the falling head inside the seepage meter.

Hydraulic conductivity of bottom material was evaluated by means of the balanced-flow differential head which was measured as the pressure difference between the water inside and outside the seepage meter after closing the meter at the top. Procedures for conductivity calculation were presented that apply to uniform bottom materials and to soils underlain by much less permeable, or by much more permeable, materials. For the case of bottom materials overlying much more permeable soil, the slowly permeable top layer may be partially or completely penetrated by the seepage meter. In the latter case, conductivity information is obtained in terms of hydraulic impedance.

The theory of the falling-head technique was tested in various laboratory models, where good agreement was obtained between seepage meter results and measured or calculated values of seepage, hydraulic conductivity, impedance, and pressure below slowly permeable layers.

Seepage meters can be used in seepage investigations, in evaluations of the field performance of artificial soil sealants for reducing seepage, and in investigations of recharge installations. Examples were presented to illustrate the various applications of seepage meters and the type of information that can be obtained with the falling-head technique.

U.S. Water Conserv. Lab., SWCRD, ARS, USDA, Tempe, Ariz. 85281

Stoeckeler, J. H. A REVIEW OF FOREST SWAMP DRAINAGE METHODS IN NORTHERN EUROPE. J. Forestry. 61: 99-104. 1963.

Drainage of peatlands and wet mineral soils were used extensively in northern Europe on more than 4 million acres as a means of increasing growth rate of the forest. In many places this increased growth rate amounted to 15 to 60 cubic feet per acre per year. On very good sites it exceeded 100 cubic feet, and on very poor sites there was virtually no growth response. Since a large proportion of the swamps--in some countries exceeding 50 percent--is not feasible for drainage, careful site selection is imperative. The costs of drainage in recent years were drastically lowered by the use of large winch-drawn ditching plows. These usually weigh from 3 to 6 tons and make ditches at 50- to 80-yard intervals. The ditches were up to 3 feet deep, 3 to 5 feet wide at the top, and around 0.5 foot wide at the bottom with a cross-sectional area of from 3 to 10 square feet, depending on type and setting of the plow. The actual cost of making the ditches was generally from 2 to 4 cents per linear foot, or around \$5 to \$10 per acre.

Lake State Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Spencer, W. F., Patrick, R., and Ford, H. W. THE OCCURRENCE AND CAUSE OF IRON OXIDE DEPOSITS IN TILE DRAINS. Soil Sci. Soc. Amer. Proc. 27: 134-137. 1963.

A red sludge like deposit was found in several tile systems in Florida citrus groves. This deposit prevented the tile from functioning properly by blocking the passageway through which water entered the tile. The deposit was found to be due primarily to "iron bacteria" which oxidize and precipitate reduced iron in the drainage water. Chemical analyses indicated a large proportion of the material was organic--probably bacterial cell bodies and waste products. The inorganic portion was mainly hydrated iron and aluminum oxides. Bacteriological studies of the material indicated the following genera of bacteria were responsible for the formation of the deposits: Gallionella, Leptothrix, Thiothrix, Thiobacillus, Crenothrix, and Cladothrix. The predominating genera within a tile line varied with location. The deposits occurred in both bituminous pipe and clay tile whether installed in sawdust filter or wrapped with fiberglass. The relative amounts of the deposit in tile at various locations were related to the amounts of reduced iron extracted from the soils with an aluminum chloride solution.

SWCRD, ARS, USDA, Riverside, Calif. 92506

Ford, H. W., and Spencer, W. F. COMBATTING IRON OXIDE DEPOSITS IN DRAIN LINES. Fla. State Hort. Soc. Proc. 75: 27-32. 1962.

A sludge like red deposit in several tile lines in Florida, caused principally by various iron bacteria, was controlled by certain alkaline filter materials. Slag gravel was found most effective as a means of precipitating ferrous iron before it entered the tile line, thus eliminating the primary ingredient necessary for the formation of iron oxide deposits.

Copper, either as a wire in the pipe or as copper sulfate in the blackfill, did not appear to be an effective, economical, long-term deterrent to the sludge problem in Florida.

A rapid quantitative spot test procedure developed for ferrous iron was found to be an effective method of evaluating drainage installations for sludge formation.

Fla. Citrus Expt. Sta., Lake Alfred, Fla.

Storage and Conveyance

Leonards, G. A., and Narain, J. FLEXIBILITY OF CLAY AND CRACKING OF EARTH DAMS. J. Soil Mechanics and Found. Div., ASCE 89 (SM 2): 47-98. March 1963.

An approximate theory was formulated to calculate the critical tensile strains in an earth dam as a result of differential settlements (at the base) along the axis of the dam.

Laboratory apparatus and procedures were developed in order to estimate the limiting tensile strain at which a compacted clay will crack.

Comparisons between predicted and observed behavior of four dams and one test embankment indicated that the theory and laboratory tests can be used to predict the cracking potential of an earth dam (if the settlement pattern is known) with an accuracy that was satisfactory for practical purposes.

The tensile strain at cracking is a small fraction of the compressive strain at failure. Their ratio varies from approximately 0.01 to 0.1 with no evidence of any consistent pattern.

An increase in molding water content from 2 to 3 percent dry of optimum to around optimum substantially increased the flexibility of compacted clay; increases in molding

water contents (to 3 percent wet of optimum) may result in little improvement in flexibility, particularly if settlements occur rapidly. At comparable moisture contents with respect to optimum, an increase in compacting effort substantially decreased the flexibility.

In general, highly plastic clays were more flexible than clays of low plasticity, but the relative flexibility of the latter soils could not be distinguished on the basis of plasticity characteristics. The effect of time on the tensile strain at cracking could not be assessed, on this basis.

Rapid settlements, such as those that resulted from collapse of soil structure on wetting, were more conducive to the development of transverse cracks in earth dams than were long-term settlements as a result of consolidation.

Discontinuities such as at abutments and closure sections often result in sharp changes in slope of the settlement curve, and large tensile strains may develop in the dam; however, no direct relationship exists between these latter two factors. Theoretical analysis can serve as a valuable tool for the assessment of the beneficial effects of proposed changes in the profile of the dam, and provide a framework on the basis of which more meaningful field measurements can be undertaken.

Research is needed in two areas: The prediction of the longitudinal settlement pattern of earth embankments, and the erodability of soils in V-shaped cracks.

Purdue U., Lafayette, Ind.

Peterson, H. V., and Heath, V. T. STOCK WATER FACILITIES FOR THE PACIFIC SOUTHWEST. *J. Soil and Water Conserv.* 18: 103. 1963.

Water is an all-important resource to stockmen whose cattle graze the western ranges; the amount of it they use or impound is of great concern to downstream water users who depend on surface flows for their supply. These facts prompted the Pacific Southwest Inter-Agency Committee to appoint a task force to study range water problems, particularly the effect of stock water ponds on water yields and downstream user's rights, in the Great Basin and the Colorado River Basin. The report of this task force was summarized and reviewed.

Geol. Survey, U.S. Dept. Int. Menlo Park, Calif.

Frank, P. A., Hodgson, R. H., and Comes, R. D. EVALUATION OF HERBICIDES APPLIED TO SOIL FOR CONTROL OF AQUATIC WEEDS IN IRRIGATION CANALS. *Weeds* 11: 124-128. 1963.

Ninety-one herbicides and experimental compounds were evaluated for herbicidal activity on submersed aquatic weeds, Sago pondweed (Potamogeton pectinatus L.) and American pondweed (P. nodosus Poir.). Twenty-one of the compounds tested showed some phytotoxicity at 20 lb./A. The other compounds were completely inactive. Fenac and dichlobenil showed outstanding activity with good persistence in water-saturated soil. Fenac and silvex were tested in field trials in an irrigation canal in eastern Wyoming. The sodium salt and amide of fenac did not give adequate weed control at 5 lb./A. Spring applications of herbicides did not perform as well as fall ones. Mechanical incorporation of herbicides improved some results, but was of doubtful value.

CRD, ARS, USDA, Laramie, Wyo.

BASIC SOIL SCIENCE

Soil Physics

SWARTZ, W. E., and Kardos, L. T. EFFECTS OF COMPACTION ON PHYSICAL PROPERTIES OF SAND-SOIL-PEAT MIXTURES AT VARIOUS MOISTURE CONTENTS. *Agron. J.* 55: 7-10. 1963.

Eight soils in sand-soil-peat mixtures reacted differently to compaction as reflected in percolation rates and aeration porosity. Generally, if the mixtures contained 50 percent or less total sand, compaction at high moisture contents resulted in inadequate percolation rates. Mixtures containing 70 percent total sand maintained adequate percolation rates under compaction but the average available moisture content of such mixtures was only 1.2 inches per foot of depth.

Jr. Author, Pa. State U., University Park, Pa.

Ward, R. C., Langin, E. J., Olson, R. A., and Stukenholtz, D. D. FACTORS RESPONSIBLE FOR POOR RESPONSE OF CORN AND GRAIN SORGHUM TO PHOSPHORUS FERTILIZATION; III. EFFECTS OF SOIL COMPACTION, MOISTURE LEVEL AND OTHER PROPERTIES ON P-Zn RELATIONS. *Soil Sci. Soc. Amer. Proc.* 27: 326-330. 1963.

Greenhouse experiments were used to study soil compaction, moisture level, soluble P and Zn, pH, organic matter and clay contents, K saturation, and titratable alkalinity as these soil factors influenced P-Zn relationships in corn. The observations helped to explain why starter fertilizers containing P may on occasions cause depressions in plant growth.

Fertilizer P applied in the row markedly reduced Zn concentration of corn. Increasing soil compaction and soil moisture level caused further depressions of Zn concentration. The combination of irrigation practice on newly graded (and compacted) land, especially when soil P is high, seemed to portend Zn deficiency problems. The problem was accentuated in subsoil materials of high clay and low organic matter contents.

Soil K saturation appeared to have a decided influence on P-Zn relations in the plant. The higher the percent K saturation of the soil, the less applied P reduced plant utilization of Zn.

J. Paper No. 1254, Nebr. Agr. Expt. Sta., Lincoln, Nebr.

Miller, D. E., Bungler, W. C., and Proebsting, E. L., Jr. PROPERTIES OF SOIL IN ORCHARD AS INFLUENCED BY TRAVEL AND COVER CROP MANAGEMENT SYSTEMS. *Agron. J.* 55: 188-191. 1963.

In a peach orchard, the influences of equipment travel and four cover crop management practices were evaluated in terms of the soil properties of bulk density distribution with depth, water stability of the 1- to 2-mm. aggregates, organic matter levels, and water intake characteristics. The physical properties of the soil were maintained in better condition with a cover crop than with a chemically maintained bare surface. Evidences of this were less surface compaction, a tendency for increased aggregate water stability, increased organic matter in the surface soil, and increased intake of irrigation water in soil with continuous

cover cropping compared with bare soil. Continuous cover crops were more favorable than a disked rye treatment with respect to water intake and proportion of the whole soil occurring as 1- to 2-mm. aggregates, but differences among these cover treatments were minor in compaction and organic matter levels.

The bulk density of the surface soil was markedly increased by travel, with the effect decreasing with depth. Travel reduced water intake to approximately one-third that obtained in nontraveled areas. The reduced water intake of the compacted soil should be considered in the design of the irrigation system if adequate water is to be added to the soil. It is important to minimize those practices which contribute to compaction, especially excessive travel, when the soil is wet and most susceptible to packing.

SWCRD, ARS, USDA, Prosser, Wash. 99350

Collis-George, N., and Smiles, D. E. AN EXAMINATION OF CATION BALANCE AND MOISTURE CHARACTERISTIC METHODS OF DETERMINING THE STABILITY OF SOIL AGGREGATES. *J. Soil Sci.* 14: 20-30. 1963.

For artificially reconstituted aggregates of soils low in organic matter, the definitions of the stability of structure in terms either of cation balance and cation concentration of the ambient solution or of the drainage moisture content-suction relationship characteristic after slow wetting are consistent.

Identified factors of organic matter and of heating and drying (or drying alone) confer a structural stability on aggregates which can be detected by the moisture characteristic method. There is circumstantial evidence to suggest that the organic matter must be in equilibrium with vegetation.

Sch. Agr., U. Sydney, Sydney, New South Wales.

Kolaian, J. H., and Low, P. F. CALORIMETRIC DETERMINATION OF UNFROZEN WATER IN MONTMORILLONITE PASTES. *Soil Sci.* 95: 376-384. 1963.

Water adjacent to clay mineral surfaces has many unusual properties. One of these is its resistance to freezing at sub-zero temperatures.

A calorimetric method was used to determine the unfrozen water in pastes of Li-, Na-, and K-montmorillonite at -5° and -15° C. As much as 55 percent of the water remained unfrozen at -5° and as much as 45 percent at -15° C. The unfrozen-water content was greatest in the Na-montmorillonite and least in the K-montmorillonite. Reasons, based on thermodynamic equations, were given for the lack of freezing. It was concluded that forces at the particle surfaces were a significant factor.

Exploration and Production Res. Div., Texaco Inc., Bellaire, Tex.

Kramer, P. J. WATER STRESS AND PLANT GROWTH. *Agron. J.* 55: 31-34. 1963.

Research on the relationship between soil moisture content and plant growth has yielded valuable information, but has left some important problems unsolved, especially the effects of small soil water deficits on plant processes.

Plant growth really is controlled by the internal water balance and the turgidity of the plant, because this is what controls the physiological processes and conditions that determine the quantity and quality of growth.

The internal water balance of plants depends on the relative rates of water loss and water absorption. Although they are somewhat interdependent, absorption is controlled chiefly by soil factors and transpiration chiefly by atmospheric factors, hence they often occur at somewhat different rates. There is a tendency for absorption to lag behind transpiration because of the high resistance to water movement which exists in roots.

It is not safe to assume that a certain level of soil water stress is accompanied by an equivalent degree of plant water stress because plants in moist soil are subjected to water stress when transpiration is rapid and plants in dry soil may be subjected to little water stress if transpiration is very slow.

The only way to know whether a plant is being subjected to water stress is by measuring the plant itself. The best measure of plant water stress probably is the DPD (suction force) although measurement of saturation deficit seems to be useful. In research dealing with plant water relations, the plant water stress itself should be measured as routinely as soil water stress or atmospheric factors.

Duke U., Durham, N.C.

Rubin, J., and Steinhardt, R. SOIL WATER RELATIONS DURING RAIN INFILTRATION: I. THEORY. *Soil Sci. Soc. Amer. Proc.* 27: 246-251. 1963.

Soil moisture content changes and rates of water entry during rain infiltration into a semi-infinite soil column were analyzed mathematically. The model considered involves, principally, the following assumptions: Darcy's and continuity equations are applicable; the soil's hydraulic conductivity and diffusivity are unique, positive, and monotonically increasing functions of soil moisture contents; rainfall entering the soil can be considered as a continuous body of water.

It was shown analytically that an incessant rain eventually results in ponding only if rain intensity, R , exceeds the saturated soil's hydraulic conductivity, $K(w_{sat})$. For $R \leq K(w_{sat})$ it was proven that as infiltration proceeds soil moisture contents at increasing depths tends to approach a constant level. At this level, the soil's hydraulic conductivity equals the rain intensity. For $R > K(w_{sat})$ it was indicated how to estimate the water uptake at incipient ponding.

A difference method for solving approximately the differential equation of the model in question was described. An illustrative numerical example of this method's results was presented.

Dept. Soil and Water, Natl. and U. Inst. Agr., Rehovot, Israel.

Bennett, O. L., and Doss, B. D. EFFECTS OF SOIL MOISTURE REGIME ON YIELD AND EVAPOTRANSPIRATION FROM COOL-SEASON PERENNIAL FORAGE SPECIES. *Agron. J.* 55: 275-278. 1963.

The effect of three soil moisture regimes on yield and water-use of eight cool-season forage species was determined under field conditions during the 1956 and 1957 growing seasons. The three moisture regimes were established by irrigating when 32 percent (M_3), 63 percent (M_2), and 80 percent (M_1) of the available soil moisture had been removed in the root zone of the plants. All species showed an increase in yields up through the intermediate (M_2) moisture regime. In 1956, a dry year, yields of all legume species increased as available soil moisture was increased. These increases were not as great in 1957 when rainfall was distributed better.

Daily evapotranspiration rates and total amounts of water used increased with increased soil moisture. No differences in evapotranspiration rates were found between species growing at the same moisture regime if rates were calculated for the same period. However, total seasonal evapotranspiration was greater for legumes than for grasses. Evapotranspiration rates were always higher before plants were harvested than after.

SWCRD, ARS, USDA, Thorsby, Ala. 35171

Nakayama, F. S., and van Bavel, C. H. M. ROOT ACTIVITY DISTRIBUTION PATTERNS OF SORGHUM AND SOIL MOISTURE CONDITIONS. *Agron. J.* 55: 271-274. 1963.

The relative root activity of sorghum was determined using the radiophosphorus injection technique. Phosphorus-32 solutions were injected in a grid pattern at different depth-distance intervals about the plant row. The plants were analyzed for P-32 through the growing season. Of the root activity, 90 percent occurred in the region 36 inches deep and 15 inches laterally from the plant. Roots grew at a rate of 0.75 to 2 inches per day. The moisture extraction pattern showed that 80 to 90 percent of the water was depleted from the surface 3 feet of a 5-foot soil profile. The results indicate that the sorghum plant absorbed a small fraction of water and the tracer phosphorus below the 3-foot depth.

SWCRD, ARS, USDA, Tempe, Ariz. 85281

England, C. B. WATER USE BY SEVERAL CROPS IN A WEIGHING LYSIMETER. *Agron. J.* 55: 239-241. 1963.

Results of 3½ years' measurements of water use by various crops grown in a weighing lysimeter at Waynesville, N.C., were presented. A partial year's record under pasture, and 1 year's record under corn, oats, and alfalfa were compared.

Annual totals were shown to mask monthly and other short-term differences in water use rates between crops.

Evapotranspiration under pasture exceeded precipitation in summer months, indicating that limited irrigation might be beneficial in this region. Winter rainfall in excess of plant use is sufficient for replenishment of soil moisture and recharge of ground waters.

From planting to harvest, corn used 21.18 inches of water, as opposed to 8.23 inches for oats in the succeeding year. With both crops, the period of peak demand coincided with grain formation.

Samples of hourly and daily rates reflected the influence of meteorological elements measured in the surrounding area.

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

Peters, D. B., and Roberts, W. J. USE OF OCTA-HEXADECANOL AS A TRANSPIRATION SUPPRESSANT. *Agron. J.* 55: 79. 1963.

Data on the use of hexadecanol in a field trial was presented. The field experiment was divided into two parts: (1) A completely plastic-covered plot experiment in which transpiration and drainage were the mechanisms of water loss from the sampled soil volume; and (2) a set of plots which were treated, but not covered with plastic, in which soil evaporation was an added component of water loss. Each experiment was a complete randomized block with

five replications. The experimental variables are given, along with the data, in Table below. The hexadecanol was applied by hand and disked in on the broadcast plots. The banded application was applied in a band approximately 6 inches deep immediately beneath the corn row after the disking operation.

Table--Water use, grain yield, and corn height as influenced by "hexadecanol."

Type of plot	Hexadecanol added		Water use	Yield	Plant height (cm.)		
	Method	Lb./A.	In.	Bu./A.	June 28	July 13	June 26
Open	(Check)	0	9.9	131	75	166	255
	Broadcast	25	9.7	131	75	164	251
		500	9.3	130	75	164	249
	Banded	25	9.6	123	72	160	246
		500	10.1	130	71	154	245
Plastic-covered	-	0	3.5	138	-	-	-
	Broadcast	500	3.8	136	-	-	-

No statistically significant difference in either water use or corn yield occurred as a result of hexadecanol application was found. There was a slight, but statistically significant, reduction in plant height associated with the hexadecanol treatments.

SWCRD, ARS, USDA, Urbana, Ill. 61803

Jones, M. B., McKell, C. M., and Winans, S. S. EFFECT OF SOIL TEMPERATURE AND NITROGEN FERTILIZATION ON THE GROWTH OF SOFT CHESS (Bromus mollis) AT TWO ELEVATIONS. *Agron. J.* 55: 44-46. 1963.

Applied nitrogen increased the growth rate of the grass very little in California when the average soil temperature was below 45° F. Grass fertilized with nitrogen showed the greatest increase in growth compared with unfertilized grass when the average soil temperature was between 47° and 55°. When the temperature went above 55°, the difference between unfertilized and fertilized grass growth rate decreased.

At comparable temperatures, plant growth was more rapid during April and May than during January and February. Several factors were involved: (1) The days were longer, (2) the light intensity was greater because the sun was farther north and less cloudy weather occurred; and (3) plant development was more advanced.

U. Calif., Hopland Field Sta., Hopland, Calif.

Soil Chemistry and Mineralogy

Wit, C. T. De., Dijkshoorn, W., and Noggle, J. C. IONIC BALANCE AND GROWTH OF PLANTS. *Verslagen van Landbouwkundige Onderzoekingen NR. 69.15*, 68 pp. \$1.12. 1963.

Short time experiments with excised roots showed that cations and anions from neutral salts were not necessarily taken up in equivalent amounts. Since electroneutrality must be

maintained, any difference between both uptakes was balanced by exchange of HCO_3^- or H^+ . Because of the concurrent change in the organic anion content, the pH of the plant material remained around 6.

The total cation content (C) equaled $\text{K}^+ + \text{Na}^+ + \text{Ca}^{++} + \text{Mg}^{++}$, and the total inorganic anion content (A) was $\text{NO}_3^- + \text{H}_2\text{PO}_4^- + \text{SO}_4^{--} + \text{Cl}^-$. The N and S in the organic form were present in the reduction stage of NH_3 and H_2S . During reduction of NO_3^- and SO_4^{--} , the negative charge was released as HCO_3^- , which was either transformed into an organic anion or exchanged with an inorganic anion from the medium, or neutralized by H^+ uptake. The ionic state of phosphate was not changed by its utilization.

The difference between the cation and inorganic anion content, the (C--A) content, was numerically equal to the organic anion content.

Ion selectivity and related competitive phenomena were mainly studied for plants growing on nutrient solutions with varying cation or anion composition. For cations, two competitive uptake systems were distinguished: A four-ion system concerning the ions K, Na, Mg, and Ca; and a monovalent-ion system concerning K and Na. Both systems operated in Gramineous species, which differ from each other by their relative uptake of K and Na through the monovalent-ion system. The four-ion system was the only one operating in plantain.

The anions NO_3^- and Cl^- appear to compete during the uptake by Gramineae. The dependence of the (C--A) content on the composition of the nutrient medium was studied in experiments in which the nutrition was varied in such a way that the growth was not affected, but the anion and cation contents varied over a wide range. The plants maintained their (C--A) content at a remarkably constant value.

It was inferred that a constant (C--A) content was not due to the properties of the uptake and utilization mechanisms per se but to a regulation of its value during growth.

In small grains, a stress on the (C--A) content develops when the availability of cations is low, the uptake of inorganic anions which stay as such in the plant is high, and the reduction of nitrates in the shoots proceeds at a low rate. This stress on the (C--A) content is accompanied by a reduction of the growth rate. A reduced growth rate with a normal (C--A) content may also occur, but a low (C--A) content is never accompanied by a normal growth rate.

Normal growth is possible at a wide variation of the C content, the A content, and the contents of the individual ionic species, provided that the (C--A) content is normal. This indicates that the organic anions are essential for good growth. The cations are only necessary in amounts above 250 me./kg. for K and 50 me./kg. for Ca and Mg because they form neutral salts with the inorganic and organic anions. Among these cations, the K ion plays a dominant role as a positive charge because it is readily taken up by most plant species. However, it can be replaced in this respect by Na, Ca, and Mg when these are readily taken up.

An excessive C content or (C--A) content may occur in the case of K shortage in the presence of any other cation which is readily taken up. Although these other ions may function as a positive charge, the K ion seems to be the only one which accompanies the excess organic anions in their downward movement.

With ammonium fertilization, growth often proceeds at a lower rate. This is due to a stress on the (C--A) content because of competition between NH_4^+ and other cations and the release of H^+ ions during the organic N formation.

A flow chart, summarizing the present knowledge with respect to the evaluation of the nutritional status of grass plants was given. This flow chart cannot be used for other species because they may differ in the relative uptake of cations (plantain) or in the normal (C--A) content (buckwheat, beets).

Centrum Voor Landbouwpublikaties en Landbouwdocumentatie, Wageningen, Netherlands.

Bergseth, H., Hageb, F. A., Lien, H., and Steenberg, K. DETERMINATION OF CATION-EXCHANGE CAPACITY IN COLLOIDAL SOIL MATERIAL BY MEANS OF RADIO-STRONTIUM (Sr 89). *Soil Sci.* 95: 97-100. 1963.

An isotope method for the determination of C.E.C.'s in colloid soil material by means of Sr-89 was described. Results were reported on four different types of soil material, and comparisons were made between the isotope method and a flamephotometric determination of absorbed strontium. The effect on the observed C.E.C. values when CaCO₃ was added to the samples was studied with the isotope method.

Agr. Col. Norway, Vollebekk, Norway.

Nielsen, K. F., Carson, R. B., and Hoffman, I. A STUDY OF ION INTERACTIONS IN THE UPTAKE OF NITROGEN, PHOSPHORUS, POTASSIUM, CALCIUM, CHLORINE, AND SULFUR BY CORN. *Soil Sci.* 95: 315-321. 1963.

The uptake of N, P, K, Ca, Cl, and S by corn was studied in the greenhouse, using soil treated with different rates of N, P₂O₅, K₂O, Cl, and SO₄.

Yield increases were obtained as rates of N, P₂O₅ and K₂O were increased, but Cl and SO₄ had no effect. There were reductions in content of some of the nutrients that could be explained by dilution resulting from yield increases. Dilution, did not seem to account adequately for the adverse effects of: N on percent K; P₂O₅ on percent K; K₂O on percent N; percent P and percent Ca; and Cl on percent S. In these instances, specific antagonisms seem to have existed. In some cases the antagonism was not mutual; for example, SO₄ had no effect on percent Cl.

There were evidences of a beneficial effect of one ion in the accumulation of another. Increases in content of both P and Ca resulted from increases in applications of N. The supply of N had a dominating influence in nutrient interactions, and it was suggested that its effect on cation-exchange capacity and on root proliferation were important considerations in this respect. Supplies of N and K₂O affected the cation-anion ratios to the greatest degree.

Expt. Farm, Swift Current, Saskatchewan, Canada.

Chao, T. T., Harward, M. E., and Fang, S. C. CATIONIC EFFECTS ON SULFATE ADSORPTION BY SOILS. *Soil Sci. Soc. Amer. Proc.* 27: 35-38. 1963.

The magnitude of sulfate adsorption from different salt solutions, ranging 5 to 100 p.p.m. S, by soils was in the order CaSO₄ > K₂SO₄ > (NH₄)₂SO₄ > Na₂SO₄. The magnitude of sulfate adsorption by soils saturated with different cations followed the order of chemical valency of the saturating cations (Al³⁺ > Ca²⁺ > K⁺). The influence of different cations on sulfate adsorption was shown to be associated with nature of cations and pH. Resolution of the two factors indicated that pH had greater influence than the type of cations. As neutrality was approached, sulfate adsorption decreased considerably regardless of the type of saturating cation. However, there was still a cation effect in addition to the pH effect over the pH range studied. The influence of different cations was attributed to possible effects of electrokinetic potentials and anion repulsion. The effect of pH on sulfate adsorption was greater in soils containing higher amounts of sesquioxides, exchangeable aluminum, and/or amorphous materials.

Oreg. Agr. Expt. Sta., Oreg. State U., Corvallis, Oreg.

Lamm, C. G., Hansen, E. H., and Jorgensen, J. A. ISOTOPIC EXCHANGE IN SOIL FERTILITY STUDIES. *Soil Sci.* 95: 16-23. 1963.

When properly used, isotopic exchange was a very useful tool in soil fertility evaluations. Under given conditions, the rate of isotopic exchange of a nutrient between the solid and liquid phase of the soil-solution system was correlated with the rate of desorption of the nutrient from the solid phase.

Isotopic exchange reactions depended on the crystal structure and the surface area of the solid compound, on the nature of the chemical bond, on chemical reactions involved in the exchange, and on the experimental conditions, using P-32 and Mn-54. Provided there was no chemical isotopic effect between the labeled and unlabeled atoms, isotopic exchange reactions occurred in systems where chemical equilibrium was already established.

Desorption reactions depended on the above factors as well as on the concentration in the liquid phase, but they only took place in systems where chemical equilibrium was not established.

Tech. U. Denmark, Copenhagen, Denmark.

Passioura, J. B. A MATHEMATICAL MODEL FOR THE UPTAKE OF IONS FROM THE SOIL SOLUTION. *Plant and Soil* 18: 225-238. 1963.

A model was developed in which the uptake of ions that exist wholly in the soil solution was described in terms of their net movement towards the surfaces of roots. The ions were assumed to move either by diffusion, or in the mass flow of water towards the roots. Given these two ways of movement, the model was based on five main assumptions. The validity of these assumptions was discussed together with some of the model's implications, and a few experiments were suggested by which it could be tested.

Sch. Agr., U. Melbourne, Melbourne, Australia.

Benson, D. W., and Toth, S. J. AVAILABILITY OF Ca AND K ADSORBED ON CLAY MINERALS AND SOILS. *Soil Sci.* 95: 196-203. 1963.

Greenhouse tests were conducted to determine the effects of clay minerals and of two soils (Penn and Evesboro) on the uptake of Ca and K by tomato plants. The most important findings were:

1. Highest yields of tomato tops were obtained on montmorillonite-sand mixtures when compared with yields produced on kaolinite or illite-sand mixtures.
2. In montmorillonite-sand mixtures, yields increased as the Ca-K ratios of the substrate decreased. Similar trends were noted in the kaolinite-sand mixtures.
3. Two points of maximum yields of tomato tops were observed to occur on the Evesboro soil.
4. Yields of tomato tops and of fruit were higher on the Penn than on the Evesboro soil.
5. Mean uptake of Ca and K from all treatments on the montmorillonite-sand mixture was higher than that from the other two clays used in the tests.
6. Based on the mineralogical composition of the clay fraction of the two soils used in the test, no differences were expected to occur in the uptake of Ca and K by tomatoes. The results obtained confirmed this contention.

7. The average cation-summation value of tomato tops grown on the Evesboro soil was 62 percent lower than the cation summation value of tops grown on the Penn soil.
8. Mean anion summation values for all treatments were about the same on tomato tops grown on the Evesboro and Penn soils.

N. J. Agr. Expt. Sta., Rutgers--The State U., New Brunswick, N.J.

Van Schouwenburg, J. C., and Schuffelen, A. C. POTASSIUM-EXCHANGE BEHAVIOUR OF AN ILLITE. *Netherlands J. Agr. Sci.* 11: 13-22. 1963.

The specificity of the K-adsorption on illite with respect to divalent cations was explained by accepting the existence of three different types of exchange sites. Each of these types shows a normal exchange process which was described very well with the Gapon exchange equation, each type had its specific exchange constant. The K-exchange on an illite was mathematically described as the sum of these three processes. Proof of the validity of this mathematical expression was presented.

Agr. State U., Wageningen, The Netherlands.

Carter, D. L., Harward, M. E., and Young, J. L. VARIATION IN EXCHANGEABLE K AND RELATION TO INTERGRADE LAYER SILICATE MINERALS. *Soil Sci. Soc. Amer. Proc.* 27: 283-287. 1963

A mica-vermiculite material was treated with $MgCl_2$ and converted to a typical Mg-vermiculite. The same material was treated with $AlCl_3$ and converted to a 14Å mineral concluded to be a vermiculite-chlorite intergrade similar to those recently reported in the literature. $AlCl_3$ treatment of Mg-vermiculite also resulted in intergrade formation. In B₂₂ and C horizon samples of a Dayton soil, added aluminum blocked K fixation and increased K release when samples were cycled through various wetting and drying treatments. The roles of aluminum in release of K and in intergrade mineral formation were shown to be interrelated. It was concluded that Al^{3+} replaces K^+ in mica and Mg^{2+} in vermiculite lattices and then probably forms a sixfold coordination compound with H_2O or $(OH)^-$ which blocks lattice collapse upon subsequent K-saturation. The increase in exchangeable K upon drying of soils appears to be related to the replacement of fixed K^+ by Al^{3+} arising from degradation of minerals.

SWCRD, ARS, USDA, Weslaco, Tex. 78596

Yuan, T. L. SOME RELATIONSHIPS AMONG HYDROGEN, ALUMINUM, AND pH IN SOLUTION AND SOIL SYSTEMS. *Soil Sci.* 95: 155-163. 1963.

The relationships of H and Al ions and pH were studied in HCl and $AlCl_3$ solutions and soil suspensions and in the KCl leachates of soils.

In the study of HCl and $AlCl_3$ solutions, when both the H and Al ions were present, a well defined two-step titration curve was obtained. The curve gave a quite accurate estimation of the H and Al ions in solution. The pH of the solution depended largely on the amount of H ions present. The hydrolysis of Al ions took place only after the H ions were neutralized. The pH at which Al ions started hydrolysis depended both on the amount of H and Al ions and on a usual pH range of 4.25 to 4.75 for the concentrations used. The hydrolysis was essentially complete at pH 5.3 or 5.4.

In soil suspension studies, soil pH was greatly reduced by the addition of H ions. The initial effect of Al ions was considerable but subsequent increases in amount had little effect. When both the H and Al ion species were present, the H ions were the dominant factor that determined the pH, but Al did have an effect on soil pH when the H ion concentration was low.

In soil leachate studies, the two-step H, Al-titration curve was observed in soils treated with HCl and AlCl₃. In addition to the two-step curve, two other types of titration curves were found in the leachate of the untreated soils, one with a barely noticeable two-step curve and one without this characteristic. A soil with a low pH value did not necessarily have a high acidity as a result of a low Al ion content. Soil pH data from 22 virgin Florida sandy soils indicated that the pH of the soils correlated more closely with the H ions in the N KCl leachate than with the Al ions or the combined amount of H and Al ions.

Fla. Agr. Expt. Sta., Gainesville, Fla.

Jansson, S. L. BALANCE SHEET AND RESIDUAL EFFECTS OF FERTILIZER NITROGEN IN A 6-YEAR STUDY WITH N15. Soil Sci. 95: 31-37. 1963.

The balance and the residual effects of tagged fertilizer N were studied in a 6-year pot experiment with oats. The test soil was an acid sandy loam poor in organic N and C. Standard Mitscherlich pots were used. The tagged fertilizer N, amounting to 500 mg. N per pot (90 p.p.m. of the air-dry soil) was given at the start of the experiment as (NH₄)₂SO₄ and NaNO₃. Thereafter, the whole experiment received an annual basic dressing of 150 mg. nontagged N per pot as NaNO₃. In half the experiment the oat crop was harvested at maturity, in the other half at the earing stage.

The N balance showed a small deficit ranging between 8 and 14 percent of the tagged N. Denitrification was the main cause of the N losses. When the oats were harvested at maturity, the N losses were confined to the year of addition. After harvesting at the earing stage, losses also occurred during the second year. No losses were found after the residual N had been transformed into organic substances. The nitrate N suffered somewhat larger losses than did the ammonium N.

Harvesting the oats at maturity increased the N losses with a few percentage units as compared with harvesting at the earing stage.

The first-year crop recovery of the tagged nitrate N was significantly higher than that of the ammonium N. In part this was due to a greater net availability of the nitrate (chemical fixation of the ammonium), in part to the inclusion of the ammonium N in the biological mineralization-immobilization turnover of soil N, in which the nitrate is not normally included. As a result, a considerably higher percentage of the tagged ammonium N than of the nitrate remained in the soil after the first vegetation period.

The plant availability of the true residual N (organically bound and chemically fixed) was small. It ranged about 1 percent per year of the original fertilizer addition. No definite trend with time was revealed.

The removal and net mineralization rates were used as characteristics of the availability of the residual fertilizer N. The former is defined as the percentage of the tagged residual N which is removed by the harvested parts of the crop, the latter the percentage taken up by the entire crop (of which roots and stubble will remain in the soil). The removal rates ranged between 2.6 and 4.0 percent in the nitrate treatments and between 1.4 and 3.7 percent in the ammonium treatments. Approximate mineralization rates were obtained by multiplying the removal rates by 1.35.

The removal or net mineralization of residual fertilizer N may be looked upon as a process obeying the exponential equation of unimolecular reactions. By putting the removal or net mineralization rates, which showed no obvious trend with time, equal to the velocity constant of this equation, the half-life of the residual fertilizer N was calculated. The approximate half-life figures obtained were 20 to 29 years on the basis of the removal rates, and 15 to 22 years on the basis of the calculated net mineralization rates.

Royal Agr. Col. Sweden, Uppsala, Sweden.

Plucknett, D. L., and Sherman, G. D. EXTRACTABLE ALUMINUM IN SOME HAWAIIAN SOILS. *Soil Sci. Soc. Amer. Proc.* 27: 39-41. 1963.

Extractable Al was measured in 5 Hawaiian soils from Kauai at four 3-month intervals. A relationship between extractable Al and rainfall was observed. Highest extractable Al was measured during high rainfall periods (winter) and lowest extractable Al was measured during low rainfall periods (summer). High extractable Al was observed in the poorly drained Koolau soil. Low extractable Al during summer months could be the result of inactivation of Al on cation-exchange sites due to dehydration. The method used for extractable Al probably measured both "exchangeable" and "soluble" Al. Plant Al analysis indicated not all extractable Al measured was available to the plant. In subsoils treated with lime, extractable Al decreased with increased pH. Lower extractable Al due to P treatment was interpreted as inactivation of Al as the latter reacted with the phosphate.

U. Hawaii, Honolulu, Hawaii.

Omori, K., and Kerr, P. F. INFRARED STUDIES OF SALINE SULFATE MINERALS. *Geol. Soc. Amer. B.* 74: 709-734. 1963.

The cations Na, K, NH_4 , Ca, Mg, Mn, and, in certain instances, Ba, Sr, and Pb combine with the anion SO_4 to form 58 mineral species. Slightly more than half are hydrous, and several contain Cl, F, or CO_3 . Infrared absorption spectra of most of the above sulfates were obtained with a split beam infrared spectrophotometer. The identify of each species examined was verified optically and by means of X-ray diffraction. Where infrared curves were previously published, the absorption bands obtained were compared with data in the literature.

Examination of the spectra indicated that the sulfates yielded infrared curves that fall naturally into several groups. These groups were outlined, and the relative ranges in absorption characteristics were given for each.

Tohoku U., Sendai, Japan.

Jackson, M. L. ALUMINUM BONDING IN SOILS: A UNIFYING PRINCIPLE IN SOIL SCIENCE. *Soil Sci. Soc. Amer. Proc.* 27: 1-10. 1963.

The aluminum ion bonds through oxygen to form a variety of functional groups underlying diverse properties of soils. One aluminum-bond functional group provides the cation exchange site of soil layer silicate clays. Pauling's m-rule of acid strength for oxy-acids, $(\text{HO})_n\text{O}_m\text{C}$, applied to the 2:1 layer silicate clay formula of beidellite, considering all

structural cations, yields $m = 1.6$, characteristic of a medium to strong acid strength (on an m -scale: 1 = weak; 2 = strong). The solubility product of $Al(OH)_3$, k_1 of $Al(OH_2)_6^{3+}$, and the Pauling K_1/K_2 ratio of 10^5 are applied to calculate concentrations of aluminohydronium monomeric cation species of valence of 3, 2, and 1. These concentrations relate to cation exchange and interlayer aluminum polymerization reactions in soils during chemical weathering. The latter and mineral colloid composition changes are summarized in the generalized bonding equation: $Al--O = Al--OH$, which provides the ultimate buffer, setting the lower and upper limits of the pH range of soils except in the presence of strong acid-forming compounds such as S and FeS_2 .

Aluminum bonding is central to soil acidity, through not only the acidic aluminohexahydronium monomeric cations, but also through the weakly acid $Al--OH_2 \dots OH$ pair at edges of polymerized ("precipitated") hydroxy aluminum structures. The aluminum toxicity of soil acidity may involve aluminum bonding and solubility product relations at the soil-root interface and in solutions in soil and sap. Retention by soils of anions, such as phosphate and sulfate, is closely related to aluminum bonding of these anions (OH replacement). Some aspects of soil aggregate structure involve hydroxy aluminum bonding; loss of aggregates follows intensive cheluviation in A_2 horizon. Aluminum bonding in a real sense supplies a unifying principle for understanding many properties of the soil system, much as hydrogen bonding has served to unify understanding of many properties of water and of aqueous organic systems including living matter.

U. Wis., Madison, Wis.

Guinn, G., and Joham, H. E. DISPLACEMENT OF IRON FROM FERRIC ETHYLENEDIAMINETETRA-ACETIC ACID AND FERRIC HYDROXYETHYLETHYLENEDIAMINE-TRIACETIC ACID BY COPPER AND ZINC. *Soil Sci.* 95: 101-104. 1963.

Evidence that Cu and Zn can displace Fe from FeEDTA and FeHEEDTA to give the corresponding Cu and Zn chelates was obtained. The extent of the displacement depended upon pH, the divalent metal, and the Fe chelate. The higher the pH, the more nearly complete was the displacement. Cu was more effective than Zn, and more Fe was displaced from FeHEEDTA than from FeEDTA. Calculations were given to show that the very low solubility of $Fe(OH)_3$ makes these displacements possible.

Okla. State U., Stillwater, Okla.

Stewart, I., and Leonard, C. D. EFFECT OF VARIOUS SALTS ON THE AVAILABILITY OF ZINC AND MANGANESE TO CITRUS. *Soil Sci.* 95: 149-154. 1963.

A series of studies were made to determine some of the factors affecting the uptake of Zn and Mn by citrus trees.

ZnEDTA was an excellent source of Zn when mixed with large amounts of either soda ash or zinc sulfate and applied to the soil in small piles under the trees.

Zn from zinc sulfate was readily taken up by the trees, provided it was mixed with calcium chloride and applied in concentrated amounts to small areas under the trees.

A number of salts, when mixed with zinc sulfate, were found to increase the availability of Zn to citrus trees. None of the salts were, however, as effective as calcium chloride.

The availability of Mn in both acid and calcareous soils was greatly enhanced by mixing manganese sulfate with calcium chloride.

Studies in the laboratory with Zn-65 disclosed that calcium chloride did not replace the exchangeable Zn in the soil.

Nutrient solution and soil greenhouse trials with Zn-65 indicated that high concentrations of either zinc sulfate or calcium chloride increased uptake of Zn.

Citrus Expt. Sta., Lake Alfred, Fla.

Soil Biology

Webley, D. M., Henderson, M. E. K., and Taylor, I. F. THE MICROBIOLOGY OF ROCKS AND WEATHERED STONES. *J. Soil Sci.* 14: 102-112. 1963.

A study was made of the microbiology of rock surfaces and weathered stones. Increasing numbers of micro-organisms were found with increasing degree of colonization by lichens, for example, of rock surfaces. The highest numbers were generally found in "raw" soil in rock crevices where the organic-matter content was high. Bacteria, actinomycetes, and fungi were found in the interior of porous weathered stones but not in unweathered stones. A high proportion of the organisms isolated were able to render silicates soluble when tested in pure culture in the laboratory.

Macaulay Inst. Soil Res., Aberdeen, Scotland.

Sørensen, H. STUDIES ON THE DECOMPOSITION OF C¹⁴-LABELED BARLEY STRAW IN SOIL. *Soil Sci.* 95: 45-51. 1963.

C-14-labeled barley straw, or substances prepared from it, including hemicellulose, cellulose, and lignin, were added to soil samples and allowed to decompose. A small stimulation in the decomposition of native soil organic matter was observed.

The specific activity of the CO₂ evolved from the soil during the decomposition was, in some cases, found to be higher than the specific activity of the CO₂ evolved by combustion of the respective substances, which can be explained by a preferential utilization of C¹²O₂ during CO₂ fixation by soil organisms.

Fractionation and analysis of soil organic matter after the period of decomposition showed that the C-14 incorporated was rather uniformly distributed between fulvic acid, humic acid, and humin. Lignin, however, left most activity in humic acid and humin, whereas the water-soluble substance contributed little to the last-mentioned fraction.

The highest specific activity as a whole was observed in the fraction containing the amino acids incorporated in humic acid and liberated by acid hydrolysis. Thirteen protein amino acids were detected on paper chromatograms and were shown by autoradiography to contain C-14.

Atomic Energy Comm. Res. Establishment Risø, Agr. Res. Dept., Risø, Roskilde, Denmark.

Yamane, I., and Sato, K. DECOMPOSITION OF PLANT CONSTITUENTS AND GAS FORMATION IN FLOODED SOIL. *Soil Sci. and Plant Nutr.* 9(1): 28-31. 1963.

The gas formation from plant material in flooded soil, decomposition of sucrose, starch, cellulose, gelatin, pectic acid, and lignin were studied.

Vigorous formation of H_2 occurred at the beginning of sucrose decomposition and CH_4 was formed after reabsorption of H_2 into soil.

Violent formation of CO_2 and CH_4 occurred from these compounds, except lignin.

Decomposition of these compounds depressed the pH increase and NH_4-N formation except lignin and gelatin.

Inst. Agr. Res., Tohoka U., Sendai, Japan.

Yamane, I., and Sato, K. DECOMPOSITION OF ORGANIC ACIDS AND GAS FORMATION IN FLOODED SOIL. *Soil Sci. and Plant Nutr.* 9(1): 32-36. 1963.

The decomposition of various organic acids which were produced under anaerobic fermentation was studied with special reference to the CH_4 gas formation.

When the sodium salts of organic acids were added to the air-dried soil and then incubated in an injector anaerobically, CH_4 formation was not found by the addition of formate.

With pre-incubated soil, formate produced as much CH_4 as lactate, acetate, and butyrate.

CH_4 formation was not remarkable in the case of the addition of propionate which was used by methane bacteria.

With pre-incubated soil, H_2 was formed from lactate.

Inst. Agr. Res., Tohoku U., Sendai, Japan.

Chandra, P., and Bollen, W. B. NITROGEN TRANSFORMATIONS AS INFLUENCED BY RATES OF WHEAT STRAW AND NITROGENOUS FERTILIZERS IN A LOAM SOIL. *Soil Sci. and Plant Nutr.* 9: 59-64. 1963.

Wheat straw and nitrogenous fertilizers were added to Walla Walla sil soil in the laboratory to study the effect of amount of wheat straw and nitrogen sources on the nitrogen transformations and losses. Straw was used at 0, 5, and 10 T/A. Nitrogen sources were NH_4OH , NH_4NO_3 , and $Ca(NO_3)_2$ at 0, 100, 200, and 400 p.p.m. nitrogen.

Ammonium hydroxide was rapidly nitrified, the nitrification being more extensive at lower rates of application. Addition of straw with NH_4OH decreased nitrate accumulation and nitrogen losses; this was attributable to assimilation of available nitrogen by microorganisms active in decomposition. NH_4NO_3 additions were subject to nitrification, denitrification, and assimilation. Denitrification was more extensive than with NH_4OH and losses of nitrogen were greater although these losses were less with added straw. Nitrate disappeared rapidly from $Ca(NO_3)_2$ treatments, especially in the presence of straw, but much of this disappearance seemed due to microbial assimilation. Without added straw, losses of total nitrogen from $Ca(NO_3)_2$ were small; with straw the losses increased but were less than with NH_4NO_3 . Rates of wheat straw, sources of nitrogen, and rates of nitrogen had significant effects on nitrification, denitrification, and total nitrogen losses.

Expt. Farm, Canada Dept. Agr., Swift Current, Saskatchewan, Canada.

No~mik, H., and Nilsson, K. NITRIFICATION AND MOVEMENT OF ANHYDROUS AMMONIA IN SOIL. *Acta Agr. Scandinavica* 8: 205-219. 1963.

In model experiments, the radial distribution and the rate of nitrification of anhydrous ammonia round the line of injection were studied. A procedure for ammonia injection

and for accurate sampling of the soil at different distances from the point of ammonia release was developed. The investigations showed that the ammonia concentration and the pH of the soil were highest on the line of injection and decreased outwards from there. The width of the retention zone was partly dependent on the amount of ammonia applied. When ammonia was injected in quantities of less than 3 g. of nitrogen per meter in a loamy fine sand, all the ammonia supplied was recovered within a retention zone with a radius of 7 cm. The main portion of the ammonia was located in the 0 to 3.0 cm. zone. The ammonia content of the central 0 to 3.0 cm. zone 6 to 24 hours after injection varied between 900 and 2,500 p.p.m., depending on the amount of ammonia applied and the texture of the soil. The pH reached a maximum in center of the retention zone, showing values up to 9.4 to 9.5.

In the earliest incubation stages, nitrification proceeded as a rule most rapidly in the more peripheral parts of the retention zone, where the ammonia concentration was only moderately high. The extremely high ammonia concentration closest to the line of injection inhibited nitrification and especially the oxidation of nitrite to nitrate. This led to a substantial accumulation of nitrite nitrogen in the soil (maximally 27 p.p.m.).

The moisture content of the soil exerted some influence on the ammonia-retention capacity of the soil. The radius of the ammonia-retention zone was decreased by increasing moisture content of the soil.

The distribution pattern of anhydrous ammonia was only slightly affected by the lime status of the soil.

Royal Agr. Col., Uppsala 7, Sweden.

Soil-Plant-Animal Relationships

Boawn, L. C., and Leggett, G. E. ZINC DEFICIENCY OF THE RUSSET BURBANK POTATO. *Soil Sci.* 95: 137-141. 1963.

An experiment was reported which showed that a growth disorder of Russet Burbank potatoes previously referred to as fern leaf was caused by a deficiency of Zn. Development of fern leaf symptoms was associated with application of P fertilizer to the soil, which produced a significant decrease in the level of ZN in stem and leaf tissue.

Plants that were treated with P but no Zn eventually died and produced no marketable tubers, whereas plants that did not receive P fertilization or were treated with Zn in addition to P had normal growth and produced sizeable tonnages of marketable potatoes.

SWCRD, ARS, USDA, Prosser, Wash. 99350

Pumphrey, F. V., Koehler, F. E., Allmaras, R. R., and Roberts, S. METHOD AND RATE OF APPLYING ZINC SULFATE FOR CORN ON ZINC-DEFICIENT SOIL IN WESTERN NEBRASKA. *Agron. J.* 55: 235-238. 1963.

Considerable Zn deficiency of irrigated corn was noted in western Nebraska. Response of corn to method and rate of ZnSO₄ application was observed on soils having a low supply of Zn.

When properly incorporated into the soil, the broadcast application was the most effective method for increasing early growth and yield of grain. Listed in the order of decreasing effectiveness, the other methods of application of ZnSO₄ were: (1) Banding

at planting time with a small amount of N; (2) side-dressing band with a small amount of N when the corn was 6 to 12 inches tall; (3) banding at planting time; (4) side-dressing band when the corn was 6 to 12 inches tall; and (5) spraying when the corn was 6 to 12 inches tall. When the broadcast application was not plowed under it was ineffective.

ZnSO₄ was broadcast at rates of 5, 10, 20, and 40 pounds of Zn per acre and plowed under. Nearly maximum early growth response and yield of grain response to Zn application was attained with the 5-pound application. Further reduction of Zn-deficiency symptoms was attained with the 20- or 40-pound applications relative to the 5- or 10-pound applications. The yield of Zn in the early growth and the Zn concentration in the index leaf were both increased by an increasing amount of Zn application.

In the controls of all the experiments, the Zn concentration in the index leaf was below 15 p.p.m. Yields of grain within about 90 percent of the maximum were attained when the Zn concentration in the index leaf was 15 p.p.m. or more.

Wash. State U., Pullman, Wash.

Smith, P. F. A CASE OF SODIUM TOXICITY IN CITRUS. Fla. State Hort. Soc. Proc. 75: 120-124. 1962.

A decline of Valencia orange trees was associated with the accumulation of excess sodium following the sustained use of fairly high rates of nitrate of soda.

A steady increase in leaf sodium over a 6-year period was accompanied by severe defoliation and loss of vigor during the last 2 years, coinciding with leaf levels of Na above 2,500 p.p.m. in 4- to 5-month-old leaves.

No chlorosis was associated with the toxicity. Immediately prior to defoliation, brown tips or brown lateral spots along the leaf margin developed. These were especially prominent on freshly fallen leaves.

There was some indication that the citrus nematode may have been a contributory factor in the excessive accumulation of sodium.

U.S. Hort. Field Sta., Orlando, Fla.

Hiatt, A. J., and Ragland, J. L. MANGANESE TOXICITY OF BURLEY TOBACCO. Agron. J. 55: 47-49. 1963.

The occurrence of a nutritional disease of tobacco grown on very acid Kentucky soils, commonly called manganese toxicity, has rapidly increased in recent years. Because very acid soils contain appreciable concentrations of soluble Al, as well as Mn, their relative effects on growth of burley tobacco were studied. Solution culture studies indicated that the characteristic chlorosis and necrotic spotting of the leaves was due solely to high concentrations of Mn in the substrate. Aluminum was more injurious to growth than Mn at the same concentration but did not produce any of the discoloring characteristic of Mn toxicity.

Tobacco plants grown in solution cultures began showing Mn toxicity symptoms when the tissue concentrations reached approximately 3,000 p.p.m. Mn; however, concentrations up to at least 5,000 p.p.m. Mn did not materially reduce growth.

Much of the injury from high Mn in the nutrient solution was overcome by increasing the Fe concentration in the nutrient solution, which also reduced absorption of Mn. Injury symptoms due to excess Mn in tobacco were not the same as those due to iron deficiency.

SWCRD, ARS, USDA, Beltsville, Md. 20705.

McEvoy, E. T. VARIETAL DIFFERENCES IN CALCIUM LEVEL IN LEAVES OF FLUE-CURED TOBACCO. *Canad. J. Plant Sci.* 43: 141-145. 1963.

Radioactivity measurement of leaf samples of tobacco plants following a 6-day absorption period in Ca-45-labelled nutrient solution was found to be a rapid test for varietal differences in calcium uptake. Significant differences in the uptake of calcium were found among varieties and strains of flue-cured tobacco and the ranking of the calcium uptake potential of five strains of tobacco agreed with that obtained by chemical assay. The concentration of Ca-45 in the leaf tissue was highest in Delcrest and Hicks, lowest in White Mammoth, and intermediate in Virginia Gold, White Gold, and Jadel. The same ranking of these varieties was obtained when the plants were grown in soil with added Ca-45 for a 7-week absorption period. The importance of these tests was based on the findings of other workers that leaf content of calcium is inversely related to quality.

Plant Res. Inst., Res. Br., Canada Dept. Agr., Ottawa, Ontario, Canada.

Peterson, L. A., and Tibbitts, T. W. CHEMICAL COMPOSITION OF TOBACCO IN RELATION TO LEAF-BURN AND QUALITY. *Agron. J.* 55: 114-117. 1963.

A study was made of the effect of eight constituents on leaf-burn and quality of tobacco. In a set of 103 farm crop samples, a multiple correlation analysis of leaf-burn with the various constituents gave the following order of importance of the 6 significantly related constituents: $K > Cl > SO_4-S > Mg > NO_3-N > \text{total N}$. Of these, only K was directly related to leaf-burn, while the other 5 were inversely related to it. The contents of Ca and P were not significantly related to leaf-burn. A comparison of the simple correlation coefficients gave a much different order of importance, which was probably less reliable because it did not take various interactions into account. Similar results were obtained for a second set of 48 samples taken from individual plants. In the first set, the 8 constituents accounted for 79 percent of the variation in leaf-burn, and in the second set, K, Cl, and SO_4-S accounted for 61 percent.

Of the eight constituents considered, only Mg was significantly related (inversely) to tobacco quality. The contents of the eight constituents accounted for 19 percent of the variation in tobacco quality.

U. Wis., Madison, Wis.

Pal, N. L., Bangarayya, M., and Narasimham, P. INFLUENCE OF VARIOUS NUTRITIONAL DOSES OF CHLORINE ON THE GROWTH OF TOBACCO PLANT AND THE BURNING CAPACITY OF ITS LEAVES. *Soil Sci.* 95: 144-148. 1963.

The influence of different levels of chlorine, when the levels of other nutrients were kept constant, was studied on the growth, quality, and leaf burn of tobacco in pots in sand culture.

With increasing levels of chlorine in the nutrient medium, the plants absorbed larger amounts of chlorine, and a straight-line relationship was found to exist between the two. Chlorine supply did not influence the uptake of other elements, except phosphorus, which seemed to have been taken up in larger quantities at higher doses of chlorine application.

Chlorine did not influence the growth of the plant or yield, as evidenced from the number of curable leaves, cured weight per leaf, total cured weight per plant, or total bright-leaf equivalent. Chlorine supply adversely affected leaf-burn and resulted in decreasing leaf burn with every increase in level of chlorine in the nutrients. A high correlation was obtained between the chlorine content of the middle leaves and the average burn of all leaves taken together.

The leaf burn was poorest in the leaves taken from the bottom position of the plant and best in the top leaves. In the same leaf, the burn was poor at the base, moderate in the middle, and best at the tip.

Central Tob. Res. Inst., Rajahmundry, India.

Timm, H., and Merkle, F. G. THE INFLUENCE OF CHLORIDES ON YIELD AND SPECIFIC GRAVITY OF POTATOES. Amer. Potato J. 40: 1-8. 1963.

Field trials were conducted during 1953-54 at seven locations in the major potato growing areas of Pennsylvania to study the effects of rates and sources of K on potato yields and quality.

Potato yields were not markedly affected by use of either KCl or K₂SO₄. Soil variability, moisture content, and variety differences apparently affected the response of the potato as much as any differences found due to the source of K. However, specific gravity of tubers was lowered by the use of KCl in place of K₂SO₄ at the higher rates of 133 and 199 lb./A. K.

Increases in potato yields were not realized by additions of K in excess of 66 lb./A. when soil analysis of exchangeable K was higher than 200 lb./A. The specific gravity of potatoes was markedly lowered by use of excess amounts of K, even though significant yield differences were not obtained. Potato quality could be enhanced by the use of lower rates of K with the added advantage of actually reducing the cost of production. Should the need for additional K be required at planting, K₂SO₄ could be applied without loss in yield or quality of potatoes.

U. Calif., Davis, Calif.

Timm, H., Bishop, J. C., and Schweers, V. H. GROWTH, YIELD, AND QUALITY OF WHITE ROSE POTATOES AS AFFECTED BY PLANT POPULATION AND LEVELS OF NITROGEN. Amer. Potato J. 40: 182-192. 1963.

The effects of added N and seed spacing on the yield and quality of 'White Rose' potatoes were studied.

Higher total yields were obtained with each increase of N up to 240 lb./A. However, yield of U.S. No. 1 tubers was increased by the addition of N only up to 120 lb./A. The increased yields obtained with N above 120 lb./A. were associated with higher yields of off-grade tubers.

Cultural practices which maintain greater than 14,000 p.p.m. of NO₃-N in plant petiole tissue past a growth period of 70 days were not necessary. Plants with less than 8,000 p.p.m. of NO₃-N showed N deficiency symptoms and produced lower yields. High levels of N prolonged active vegetative growth and delayed accumulation of dry matter in tubers.

The possibility exists that quantities of N may unknowingly be introduced in the irrigation water. The contribution of N from this source needs to be further evaluated.

With the impact of processing, higher dry matter content was a desirable characteristic. A 'White Rose' potato with a higher percent dry matter is possible with closer supervision of N fertilization in relation to plant population.

U. Calif., Davis, Calif.

Morani, V., and Fortini, S. SODIUM IN THE MINERAL NUTRITION OF AVENA SATIVA. Plant and Soil 18: 140-142. 1963.

In pot experiments with oats on sandy soil poor in sodium and potassium, a study was made of the effect of the addition of Na_2SO_4 and K_2SO_4 on the mineral composition of the straw.

The addition of sodium at 200 p.p.m. Na significantly increased the phosphorus content of the straw and there was a slight further increase with 200 p.p.m. Na plus 200 p.p.m. K, but the phosphorus content never exceeded 0.13 percent.

Sodium and potassium caused a highly significant decrease in the silica content of the straw. Decreased lodging in soils inundated with sea water therefore cannot be ascribed to an increase of silica content.

The calcium and the cellulose contents of the straw were both significantly reduced by sodium and potassium.

Expt. Sta. Agr. Chem., Rome, Italy.

MacKenzie, A. J., Spencer, W. F., Stockinger, K. R., and Krantz, B. A. SEASONAL NITRATE-NITROGEN CONTENT OF COTTON PETIOLES AS AFFECTED BY NITROGEN APPLICATION AND ITS RELATIONSHIP TO YIELD. Agron. J. 55: 55-59. 1963.

The nitrate-nitrogen content of cotton petioles was studied for estimating the nitrogen status of cotton plants, and the seasonal levels that would be necessary to insure optimum growth and production were determined. Petioles of the youngest, fully matured leaves on the main stem of the cotton plants were sampled from nitrogen fertility experiments over a period of 7 years. These samples were analyzed in the laboratory for water-soluble nitrate-nitrogen.

The concentration of nitrate in the petioles during the growing season was directly related to the rate of nitrogen applied. Relationships were found to exist between total yield and the petiole nitrate levels during certain bloom stages of growth. Petiole nitrate-nitrogen levels of 16,000, 8,000, and 2,000 p.p.m. during the early-, mid-, and late-bloom stages of growth, respectively, were considered safe or adequate for high production. Yield reductions were related to the length of time petiole nitrate-nitrogen fell below minimum levels of 1,000 and 2,000 p.p.m. The effects of soil moisture, and plant varieties on the seasonal nitrate content of petioles were found to be small compared to the effect of nitrogen application.

Southwestern Irrig. Field Sta., SWCRD, ARS, USDA, Brawley, Calif. 92227

Watterston, K. G., Leaf, A. L., and Engelken, J. H. EFFECT OF N, P, AND K FERTILIZATION ON YIELD AND SUGAR CONTENT OF SAP OF SUGAR MAPLE TREES. Soil Sci. Soc. Amer. Proc. 27: 236-238. 1963.

Sap yield, sap sugar concentration, and sugar yield data from sugar maple trees collected over 3 years revealed great intra- and inter-seasonal variations. The effect

of N, P, and K fertilizers, applied singly and in combination, affected the yield of sugar by affecting sap yield and/or sap sugar concentration. The combination fertilizer depressed sugar yields the first sap flow season after treatment and increased this yield in the second season. The N or K fertilizer resulted in little change in sugar yield over the control trees while P fertilizer produced a significant effect on sap sugar concentration, thus affecting sugar yield.

State U. Col. Forestry, Syracuse U., Syracuse, N.Y.

Walker, W. M., and Pesek, J. CHEMICAL COMPOSITION OF KENTUCKY BLUEGRASS (POA PRATENSIS) AS A FUNCTION OF APPLIED NITROGEN, PHOSPHORUS, AND POTASSIUM. *Agron. J.* 55: 247-250. 1963.

The concentration of N, P, and K in bluegrass, as a second degree function of applied N, P, and K fertilizers and their linear X linear interactions was established for each element. A coefficient of determination (R^2) was computed for each prediction equation to measure the proportion of the treatment sums of squares explained by the regression. An R^2 of 0.974 was found for the percent N prediction equation, 0.988 for the percent P prediction equation, and 0.973 for the percent K prediction equation. These high values of R^2 indicate that the second degree polynomial gave a satisfactory approximation of the relationship between chemical composition of the bluegrass and applied fertilizer.

A table of F-ratios was computed to determine the significance of specified effects upon the percent N, percent P, and percent K in bluegrass. The linear and quadratic effects of applied N were the most significant factors in accounting for variation in the percent N in bluegrass.

Applied P was the most significant element in accounting for variation in the percent P in bluegrass; however, applied N and K also had statistically significant effects upon the percent P in bluegrass.

The linear effect of applied N was the most significant factor in explaining variation in the percent K in bluegrass. Applied P and K also had a significant effect upon the K percentage. The highly significant effect of N upon the K percentage may be due to a specific N-K relationship in the plant or a simple ion balance effect.

Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Peterson, P. J., and Spedding, D. J. THE EXCRETION BY SHEEP OF ⁷⁵SELENIUM INCORPORATED INTO RED CLOVER (TRIFOLIUM PRATENSE L.): THE CHEMICAL NATURE OF THE EXCRETED SELENIUM AND ITS UPTAKE BY THREE PLANT SPECIES. *New Zealand. J. Agr. Res.* 6: 13-23. 1963.

Data on the excretion of radioactive selenium by two sheep fed on red clover grown in nutrient solutions containing Se-75 were given. The clover contained a total of 6.1 μ g of selenium, which was predominantly incorporated in protein. The major part of the radioactivity was excreted in the feces, 53.8 percent and 53.6 percent being recovered within 99 hrs. for two sheep, while the corresponding urinary values were 1.78 percent and 2.29 percent, respectively. The peak of excretion occurred approximately 20 hrs. after feeding, although Se-75 was still being excreted 14 days after commencement of the experiment.

Chemical fractionation of the dung revealed that most of the Se-75 was present in forms insoluble in solvents. The insoluble selenium was predominantly inorganic, although a smaller proportion was incorporated into protein.

In plant nutrition experiments involving growth of 3 pasture species for 75 days in the presence of radioactive dung, less than 0.3 percent of the added radioactivity was recovered in the herbage. The uptake of Se-75 by brown-top (Agrostis tenuis Sibth.) seedlings was significantly higher on a dry weight basis than by perennial ryegrass (Lolium perenne L.) and by red clover (Trifolium pratense L.).

Plant Chem Div., Dept. Sci. and Indus. Res., Palmerston North, New Zealand.

Hiatt, A. J., Amos, D. F., and Massey, H. F. EFFECT OF ALUMINUM ON COPPER SORPTION BY WHEAT. *Agron. J.* 55: 284-287. 1963.

The effect of Al on the uptake of Cu by excised wheat roots was studied. Al at concentrations as low as 0.1 p.p.m. markedly reduced total Cu uptake and this inhibition appeared to be competitive in nature. The inhibition of the adsorption phase of Cu uptake by Al tended to be overcome by higher levels of Cu concentration, suggesting that Al and Cu were competing for common binding sites at or near the root surface. Evidence indicated that Cu and Al were not competing for the same carrier site involved in the active accumulation of Cu. These results lead to the conclusion that the inhibition of Cu uptake by Al is due primarily to competition between these two ions for adsorption sites associated with the roots.

SWCRD, ARS, USDA, Beltsville, Md. 20705.

Bray, R. H. CONFIRMATION OF THE NUTRIENT MOBILITY CONCEPT OF SOIL-PLANT RELATIONSHIPS. *Soil Sci.* 95: 124-130. 1963.

Evidence was presented which confirms the role of the relatively immobile soil forms of the nutrients as forms which follow the Mitscherlich-Baule percentage sufficiency concept. Field studies showed that the available soil forms already present gave yield responses which were independent of size of yield obtained, but depended on the kind of crop, the planting pattern and rate of planting, the form of the nutrient, and the distribution pattern of the nutrient relative to the planting pattern.

The field studies were with phosphorus and potassium and involved different crops, planting patterns and rates of planting, and different distribution patterns of the nutrient forms in the soil in relation to the planting pattern. The c_1 and c values which were obtained remained constant as yields varied with the favorableness of the soil and the season. But the c_1 and c values varied widely with the kind of crop, planting pattern and rate of planting, and with the form of nutrient and distribution pattern of the nutrient in the soil in relation to the planting pattern.

The nitrate form of nitrogen, acting as a relatively mobile nutrient form, was so highly available that the amount required, exclusive of leaching or other losses or gains, was no greater than the crop content at optimum yield. Hence, nitrate nitrogen followed Liebig's law of the limiting nutrient.

This establishment of the validity of the Mitscherlich-Baule percentage sufficiency concept and of Liebig's law of the limiting nutrient confirms the nutrient mobility concept of soil-plant relationships.

U. Ill., Urbana, Ill.

Donovan, L. S., Dimmock, F., and Carson, R. B. SOME EFFECTS OF PLANTING PATTERN ON YIELD, PERCENT OIL AND PERCENT PROTEIN IN MANDARIN (OTTAWA) SOYBEANS. *Canad. J. Plant Sci.* 43: 131-140. 1963.

The performance of Mandarin (Ottawa) soybeans was tested over a 4-year period in 15 planting patterns resulting from 5 row spacings (7, 14, 21, 28, and 35 inches) and 3 plant spacings (1, 2, and 3 inches) within the row. Response of yield and oil percentage to spacing was considerable. The combination of narrowest row and widest plant spacing within the row (7 X 3) gave the highest yield, whereas highest percent oil was obtained from the widest row and the widest plant spacing (35 X 3). One year of testing of 1-, 2-, 3-, 4-, and 5-inch plant spacings in 7-inch rows suggested that the 7 X 4 spacing was advisable when oil and yield were both considered.

Protein showed less response to spacing. It was highest at the closest spacing. The only significant difference occurred between the 1- and 3-inch spacings within the row, over all row spacings. Iodine number of the oil did not respond to spacing.

Genetics and Plant Breeding Inst., Canada Dept. Agr., Ottawa, Ontario, Canada.

Siemens, L. B. THE EFFECT OF VARYING ROW SPACINGS ON THE AGRONOMIC AND QUALITY CHARACTERISTICS OF CEREALS AND FLAX. *Canad. J. Plant Sci.* 43: 119-130. 1963.

During a 3-year study (1957-59) at three Manitoba locations, agronomic and quality characteristics of Selkirk wheat, Garry oats, Swan barley, and Raja flax were studied when crops were seeded in rows spaced 6, 12, 18, 24, and 30 inches apart. Within crops the same seedling rate per row was used for all spacings.

As row spacings increased from 6 to 30 inches, yields of all crops gradually declined whereas tillering and seed return increased. The 1,000-kernel weight of barley increased substantially with wider row spacings, but in wheat and flax the lowest 1,000-kernel weights were recorded at the widest spacing. The kernel weight of oats and the bushel weight of all crops were not affected noticeably by row spacing. Protein content of wheat at 30-inch spacing averaged 3.2 percent higher than wheat at 6-inch spacing. Protein in barley and flax also appeared to increase at wider row spacings, but not as sharply as in wheat.

Average soil moisture content between 30-inch flax rows was higher at the time of boll formation than between 6- and 18-inch rows. A similar trend was found in wheat at time of heading.

Wheat variety by spacing interactions was studied in which Lerma, Lee, Thatcher, and Selkirk wheats were seeded in rows spaced 6, 12, 18, 24, and 30 inches apart. No significant interactions were observed in tillering and protein content, whereas interactions in yield and 1,000-kernel weights were highly significant.

U. Manitoba, Winnipeg, Manitoba, Canada.

Soil Classification

Schlee, J. S. SANDSTONE PIPES OF THE LAGUNA AREA, NEW MEXICO. *J. Sedimentary Petrology* 33: 112-123. 1963.

Strata of Jurassic age contain cylindrical bodies of sandstone called pipes. They cut gently dipping strata in the Summerville Formation, Bluff Sandstone, and Morrison Formation near Laguna, N. Mex.

The pipes range from a few feet to a few hundred feet in height, and from a few inches to 150 feet in width. Petrographic studies of the material in the pipes and of the enclosing strata show that the pipes were composed of reworked subarkosic sandstone derived from the uppermost units cut by the pipes. Some pipes were composed of brecciated sandstone and mudstone in a fine-grained matrix. The wall rocks sag downward around the pipes, and the pipes were bounded by one or more ring faults. The bottoms of the pipes were in sharp contact with the little-deformed underlying beds.

The pipes formed during a period of gentle regional folding, and for the most part were located in belts near synclinal axes. Pipes originated during deposition of the uppermost sandstone units that contain them. They were probably formed by gravitational foundering of sand into the underlying water-saturated mud. Some of the foundering may have been aided by solution and removal of underlying gypsum.

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

Wright, J. R., and Schnitzer, M. METALLO-ORGANIC INTERACTIONS ASSOCIATED WITH PODZOLIZATION. *Soil Sci. Soc. Amer. Proc.* 27: 171-176. 1963.

Leaching a calcareous soil parent material with a chelating agent caused the mobilization, transport, and redeposition of iron and aluminum resulting in the formation of a profile similar to those of certain podzolic soils. Under natural conditions, fulvic acid is considered to be the dominant ligand affecting the translocation of iron and aluminum in the podzolization process. Oxidative degradation studies and infrared and functional group analyses suggested that fulvic acid consists of an aromatic "nucleus" to which carboxyls, hydroxyls, and carbonyls were attached as the main functional groups. There was a strong possibility that on its path down the profile this fulvic acid forms water-soluble multidentate chelates with metals such as iron and aluminum, etc., and that precipitation of these metallo-organic complexes lower in the profile was affected by further reaction with the same metals and by extremely small amounts of ionic Ca^{2+} and/or Mg^{2+} .

Soil Res. Inst., Res. Br., Canada Dept. Agr., Ottawa, Canada.

Ugolini, F. C., Tedrow, J. C. F., and Grant, C. L. SOILS OF THE NORTHERN BROOKS RANGE, ALASKA; II, SOILS DERIVED FROM BLACK SHALE. *Soil Sci.* 95: 115-123. 1963.

Black shale soils of northern Alaska have properties not previously reported in North America. The soil forms in positions where arctic brown soil is usually present. Black, peaty material is present throughout the profile, and the soil is colonized by mesic plant communities. The black color of the soil is due to humus accumulation and a contribution of carbon from the parent rock. The black shale soils in northern Alaska are included with the broad grouping of endodynamorphic soils. Petrographic, X-ray, DTA, and chemical analyses (including trace elements) were presented. Illite and montmorillonite were the dominant clay minerals with clay-size dolomite, calcite, calciumorthophosphate, gypsum, and whewellite were present in small quantities. The pH values increased from 7.2 in the surface to 7.7 in the bedrock. Carbonates and gypsum had been leached from the surface layers. Organic carbon was approximately 22.9 percent in the surface layer and decreases steadily to 5.3 percent in the black shale bedrock. C/N ratios were approximately 13 to 18. Cation-exchange capacity decreased from 184 me. per 100 g. of soil at the surface to 22 me. at depth.

The DTA curves showed that some of the organic compounds were contributed by the biotic system, and that the carbon in the bedrock was in the form of anthracite coal or low-rank graphite. There appeared to be an enrichment of polysaccharides at the surface, with a tendency for the material soluble in 2 percent HCl to decrease with depth. Carbon in the profile was divided into two forms: organic and elementary.

The geochemistry of black shales was discussed with special references to depositional environments.

N.J. Agr. Expt. Sta., Rutgers-The State U., New Brunswick, N.J.

Cline, A. J., and Johnson, D. D. THREADS OF GENESIS IN THE SEVENTH APPROXIMATION. Soil Sci. Soc. Amer. Proc. 27: 220-222. 1963.

A common criticism of the newly proposed system of soil classification as presented by the Seventh Approximation is its apparent departure from the genetic aspects present in the older systems. Since so much of the published text is devoted to discussions of morphology, it is easy to understand why this impression is gained at first reading. However, the impression is faulty, and the relationship between the accepted theories of soil genesis and the Seventh Approximation is more specifically drawn than was this relationship in the older systems. The major difference being that in the Seventh Approximation the relationship to genesis is drawn by specific definitions of the kind of morphology representative of a kind or a degree of genesis rather than by direct reference to a genetic process itself or its degree of activity. In nearly every case, the choice of morphological character selected to be definitive for a category is based on our understanding of how these characteristics represent a specific kind or degree of genetic process.

This constitutes both strength and weakness in the Seventh Approximation. Its strong relationship to genesis imparts a desirable sense of direction to the system. This same strong adherence may lead to faulty criteria or to improper selection of definitive morphological characteristics where our knowledge of genesis is imperfect. This last is inevitable under any conditions, and the advantages strongly outweigh the disadvantages.

SCS, USDA, Fort Collins, Colo.

Westin, F. C. THE USE OF THE SEVENTH APPROXIMATION IN NEW AREAS. Soil Sci. Soc. Amer. Proc. 27: 222-223. 1963.

The Seventh Approximation was found to be very useful for classifying soils in Venezuela. The system was helpful in three ways: (1) In classifying unfamiliar and little-studied soils; (2) in working with people generally unversed in soil classification; and (3) in making agricultural predictions. In working with unfamiliar soils, the Seventh Approximation provided quantitative definitions of most of the known soils of the world and also made provision for soils not included in the old system. The Seventh Approximation was understood by Spanish-speaking botanists and geologists who were relatively untrained in soils, as well as by trained soil scientists. Agricultural predictions were possible at all levels of abstraction used. Making predictions is important in new areas because the great need is to find the locations of the better soils for both dryland and irrigation development. The Seventh Approximation proved to be an effective framework around which to organize the soils information in new areas. Because it does this well, it helps sell the soil surveyor and his science.

S. Dak. State U., Brookings, S. Dak.

Leahey, A. THE CANADIAN SYSTEM OF SOIL CLASSIFICATION AND THE SEVENTH APPROXIMATION. *Soil Sci. Soc. Amer. Proc.* 27: 224-225. 1963.

Soil classification in Canada has developed on the concept of great soil groups and soil series. The present system, officially adopted in 1960 by the soil survey organizations in this country, introduced the two categories of family and subgroup between the series and great groups and the category of order for combinations of great groups. Though based on soil profile features it has a strong genetic bias, expressed through selection of the differentiating criteria. The Canadian system and the Seventh Approximation are analogous at the series and family categories but differ markedly in the subgroup, great group, and order categories. Differences at these higher classification levels are due to differences in the selection of differentiating criteria, to the more restricted scope of the Canadian system, and to its lack of a suborder. The distinctly different nomenclature accents these differences.

Res. Br., Canada Dept. Agr., Ottawa, Ontario, Canada.

Flach, K. W. SOIL INVESTIGATIONS AND THE SEVENTH APPROXIMATION. *Soil Sci. Soc. Amer. Proc.* 27: 226-228. 1963.

The Seventh Approximation was developed because of the need for precise soil classification for agricultural and other uses. It incorporates recent advances in soil science and allows classification of all soils, whether cultivated, eroded, or virgin. Classes are defined in terms of morphology although the grouping of classes is based on genetic relationships. The Seventh Approximation presents challenges to soil characterization research because classes must be defined by measurable parameters and to soil genesis research because parameters at high categorical levels must reflect important soil-forming processes. Precise definition of classes may, in turn, aid in evaluating the relative importance of soil-forming factors and in the application of the results of research on one soil to similar soils in widely separated areas.

SCS, USDA, Riverside, Calif.

Orvedal, A. C., and Austin, M. E. SOME GEOGRAPHIC ASPECTS OF THE SEVENTH APPROXIMATION. *Soil Sci. Soc. Amer. Proc.* 27: 228-231. 1963.

The Seventh Approximation sharpens the relationship between soil classification and soil geography; and it is likely to lead to more valid geographic correlations between genetic factors and soil morphology. Although the Seventh Approximation is expected to bring about only a few changes on large-scale, detailed soil maps, the opposite is true for small-scale, general soil maps. Even on the general maps, many, perhaps most, soil boundaries will appear where they would have appeared using the current soil classification; but the changes will be drastic in the nomenclature. The fact that substantive names are, or will be, provided for all classes in all categories makes soil classes of all categories available for use on maps. This fact makes possible a better matching of categorical and cartographic levels of generalization. The Seventh Approximation does not alter the need for the concepts of soil phases and soil associations.

SCS, USDA, FCB Bldg., Hyattsville, Md. 20781

Heller, J. L. THE NOMENCLATURE OF SOILS, OR WHAT'S IN A NAME? Soil Sci. Soc. Amer. Proc. 27: 216-220. 1963.

A discussion of the principles to be followed in the assignment of names to any new object or series of objects and of the difficulties experienced by those who devised the nomenclature of the Seventh Approximation was given. The use of elements drawn from the classical languages was defended, and some of the compromises made in their selection and combination were explained.

U. Ill., Urbana, Ill.

Duchaufour, P. SOIL CLASSIFICATION, A COMPARISON OF THE AMERICAN AND THE FRENCH SYSTEMS. J. Soil Sci. 14: 149-155. 1963.

The American classification may perhaps be more 'practical' than the French classification, especially regarding agricultural soils. The French classification, based on the evolution of natural soils and on the entire soil profile, rests without any doubt upon a more solid scientific basis.

In spite of this, a certain fact commands attention. The previous approximations of the American soil classification were yet very foreign to most European classifications, themselves very akin to one another. Now the 1960 approximation stands out as a spectacular rapprochement between the American and the West-European classifications. If one takes into account the fact that the working methods of American cartographers are, to a great extent, opposed to those of their European colleagues, above all because their objective is practical, this rapprochement is a sign of real progress for soil science, in the sense of unifying methods and concepts. This constitutes indeed a very encouraging advance. (Authors conclusions).

Facultes' des Sciences, Nancy, France.

Johnson, W. M. THE PEDON AND THE POLYPEDON. Soil Sci. Soc. Amer. Proc. 27: 212-215. 1963.

One of the great difficulties in soil classification is that soils rarely exist as discrete individuals with clear boundaries. Instead, they grade to other soils across broad transition belts and their boundaries are determined by definition. Two new concepts, the pedon and the soil individual, were proposed to help clarify relations between the soil continuum and soil taxonomic classes.

Pedons are real, natural soil volumes just large enough to show all the soil horizons present and their relationships. Boundaries of pedons do not depend on reference to any taxonomic scheme. A soil individual (polypedon) is also a real soil body; it is a parcel of contiguous pedons all of which have characteristics lying within the defined limits of a single soil series.

Pedons may be considered as building blocks that make up both soil taxonomic classes and soil mapping units. Most pedons are too small to exhibit all the characteristics of a soil individual; for example, usually they do not show shape of the soil nor nature of its boundaries with other soils.

Soil individuals (polypedons) are the subject of soil taxonomy; they are the real objects that are classified. They are comparable to individual pine trees, individual fish, and individual men.

SCS, USDA, Berkeley, Calif.

Lithosols, Regosols, Arctic Brown, Upland Tundra, Meadow Tundra, and Bog soils were recognized as the major genetic soils of northern Alaska. Highly variable soil conditions existed when these soils were associated with patterned ground. Specific patterns of sorted and nonsorted circles, polygons, nets, steps, and stripes often occurred with particular soils. Differences in soil conditions, vegetation, and microrelief existed across these forms of patterned ground in a closely associated complex governed by the kind of patterned ground. It was proposed that arctic soils be classified in terms of both the genetic soil profile and the kind of patterned ground.

Table.--Generalized relationships of patterned ground to the major genetic soils of northern Alaska; classification of patterned ground adapted from Washburn (1956).

Polygon types A, B, C, D, E, E, and F are illustrated in Fig. 5.

Patterned ground	Soils formed under well-drained conditions		Soils formed under conditions of impeded drainage		
	Lithosols and Regosols	Arctic Brown	Upland Tundra	Meadow Tundra	Bog
Sorted circles	Stone rings	Stone rings	Stone rings		
Non-sorted circles			Peat rings Tussock rings Frost boils	Peat rings Tussock rings Frost boils	
Sorted polygons	Stone polygons	Stone polygons			
Non-sorted polygons		Ice-wedge polygons (Types A and B)	Ice-wedge polygons (Types A, B, and F)	Ice-wedge polygons (Types B, C, D, E, and F) Tussock-birch-heath polygons	Ice-wedge polygons (Types C and F)
Sorted nets	Stone nets				
Non-sorted nets	Vegetation nets		Mounds Vegetation nets	Bog ridges Mounds	Bog ridges Ice Mounds
Sorted steps	Steps and stone garlands				
Sorted stripes	Stone stripes				
Non-sorted stripes	Soil stripes	Soil stripes	Soil stripes		

U. Nebr., Lincoln, Nebr.

Wooten, H. H., Gertel, K., and Pendleton, W. C. MAJOR USES OF LAND AND WATER IN THE UNITED STATES WITH SPECIAL REFERENCE TO AGRICULTURE; SUMMARY FOR 1959. U.S. Dept. Agr., Econ. Res. Serv. Agr. Econ. Rpt. 13, 54 pp. 1962.

Total area of the 50 States that comprise the United States is 2,314 million acres, of which 2,271 million acres is land and 43 million water. The addition of Alaska and Hawaii as States greatly enlarged the acreage of the United States. Alaska has increased significantly the land and water areas, forest, rangeland, and waste; Hawaii, the tropical crops and rangeland. The land- and water-use changes within areas previously inventoried for the 48 contiguous States resulted largely from changing technology and growing population.

Of the total land area in the 50 States, 20 percent is cultivated cropland, 28 percent grassland pasture and range, 34 percent forest, and the rest, or about 18 percent, other uses. Drainage has improved 25 percent of the cropland and irrigation 7 percent.

Major changes in use of land have occurred in the last three decades. For example, 30 million acres or more of poorly adapted cropland were shifted to forest and pasture, while an estimated 10 million acres or more of new land were brought into cultivation. Substituting good land for poor was important in increasing production.

Total acreage planted in 1961, including fruits, nuts, and vegetables, was 324 million acres, a reduction of one-eighth from 1930. The biggest reduction since 1930 in acreage was in grains and cotton. The net difference in total cropland acreage in 1930 and 1961 for the country does not fully reflect shifts within States and counties. Farming methods together with improved land- and water-use have increased production per acre, so that a much smaller cropland acreage can meet the 1962 demand for farm products. The shift in farm power since 1930 from horses and mules to tractors and trucks alone has released about 60 million acres of cropland, formerly used for feed, to other purposes.

MOS, USDA, Inform. Div., Washington, D.C. 20250

Thayer, T. P. THE MAGNIFYING SINGLE-PRISM STEREOSCOPE, A NEW FIELD INSTRUMENT. J. Forestry 61: 389-390. 1963.

A folding portable stereoscope that carries standard aerial photographs in stereo position was described. The instrument provides complete coverage of the model with magnifications up to 2X, free surfaces for annotation, and can be set up for use or closed in a few seconds. The instrument is simple, rugged, about 1½ inches thick, and weighs about 3 pounds. Although designed for field use, it is handy for office use and can be stored like a book.

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

EROSION CONTROL

Wind and Water Erosion

Chepil, W. S., Woodruff, N. P., Siddoway, F. H., Fryrear, D. W., and Armbrust, D. V. VEGETATIVE AND NONVEGETATIVE MATERIALS TO CONTROL WIND AND WATER EROSION. Soil Sci. Soc. Amer. Proc. 27: 86-89. 1963.

Fine, medium, and coarse gravel spread uniformly at rates of 20, 50, and 100 tons per acre, respectively, adequately controlled wind erosion of smooth, bare, Sarpy sl where no traffic was involved.

Resin emulsion sprayed at 600 gallons of concentrate per acre and asphalt emulsion and cutback asphalt sprayed at 1,200 gallons of concentrate per acre adequately controlled wind erosion on level Sarpy sl at estimated respective costs of \$213, \$247, and \$335 per acre on a carload basis, in drums, at Manhattan, Kans. Under similar conditions, 4,000 pounds of wheat straw mulch per acre anchored with a rolling disk packer was equally effective at an estimated cost of \$89 per acre.

Quantities of latex emulsion sprayed at rates up to 225 gallons of concentrate per acre were not sufficient to control wind or water erosion on level or sloping ground. Starch treatments were also ineffective to control wind erosion under the conditions of the experiment.

On a 3:1 construction slope, at least 1,200 gallons of asphalt emulsion per acre sprayed uniformly on the surface were needed to control rill erosion. The treatment cost \$335 per acre. In previous experiments on a 3:1 construction slope, prairie hay mulch at 4,000 pounds per acre uniformly spread and anchored with 400 gallons of asphalt emulsion per acre was equally effective at a cost of about \$200 per acre.

N. P. Woodruff, SWCRD, ARS, USDA, Manhattan, Kans. 66504

Schumm, S. A., and Lusby, G. C. SEASONAL VARIATION OF INFILTRATION CAPACITY AND RUNOFF ON HILLSLOPES IN WESTERN COLORADO. *J. Geophysical Res.* 68: 3655-3666. 1963.

Hillslope erosion was studied during 4 years along 25 slope profiles on Mancos shale hillslopes in western Colorado. Erosion was measured by the movement of markers and exposure of stakes. During winter, the soil surface was loosened by frost action, and the stakes showed minimum exposure in the spring. Rain-beat during the spring and summer compacted the soil, and the stakes showed maximum exposure during the fall. Frost action and compaction caused creep to occur in the upper 2 inches of the lithosols. During spring and summer, compaction of the soil by rain-beat decreased infiltration capacity, and runoff increased. Rills formed on the slopes, but these were soon destroyed by winter frost action and creep, and the infiltration capacity of the soil was increased.

Measurement of sediment yield and runoff from small drainage basins on the Mancos shale showed that mean annual runoff was relatively low, but sediment yields were normal for this type of terrain. An analysis of precipitation and runoff data revealed that average runoff and the ratio of runoff to precipitation were less in the spring than in the fall, reflecting the seasonal changes of soil characteristics.

Seasonal changes in the soil, which cause a seasonal change in infiltration capacity, not only control the rate and process of hillslope erosion but also significantly affect the hydrologic characteristics of these small drainage basins.

U.S. Geol. Sur., U.S. Dept. Int., Denver, Colo.

Landgren, N. E., and Andersen, J. C. A METHOD FOR EVALUATING EROSION CONTROL IN FARM PLANNING. *Agr. Econ. Res.* 8(2): 57-65. 1962.

Lineal programming was used in an analysis to determine, for a single farm with a given set of resources and planning horizon of the operator, the economic consequences of formulating the farm plan around specified erosion control goals under different assumptions regarding the availability of operating capital. The analysis was applied to a 173-acre farm in southwest Iowa.

The rates of erosion that resulted from highest profit plans did not differ greatly from the frequently used 5-ton per acre annual limit. An average annual upland soil loss rate of from 5 to 6 tons per acre per year was found to be associated with highest profit plans, though annual soil losses for some soil types were somewhat higher.

Restricting farm plans by an erosion control goal of less than 5 or 6 tons per acre per year would sharply decrease profit. On the other hand, net revenue would be decreased only gradually for farm plans yielding more than five or six tons of soil loss per acre per year. From the point of view of the individual farm operator, income consequences of formulating the farm plan around too low an erosion control goal would be far more serious than erring in the direction of inadequate conservation planning.

Formulating farm plans around an absolute erosion control goal of not more than 5 tons per acre per year for all soil types resulted in slightly decreased net revenue relative to farm plans where soil loss was not considered as a restrictive factor.

Lower erosion rates resulted from increased capital availability as additional livestock entered the plans, forcing a shift from continuous corn to forage-producing rotations. In the highest profit plans, intensive cropping systems, accompanied by contouring and terracing to control erosion, were prevalent on the better soils. Poorer soils were generally devoted to permanent meadow.

ERS, USDA, Washington, D.C. 20250

Krammes, J. S., and Hellmers, H. TESTS OF CHEMICAL TREATMENTS TO REDUCE EROSION FROM BURNED WATERSHED. J. Geophys Res. 68: 3667-3672. 1963.

The results of laboratory and field tests to investigate chemical treatments that might protect a denuded soil surface until a vegetative cover becomes effective were reported. Pure and 'wet' water and several soil-binding chemicals were tested. The chemical soil binders did not reduce surface runoff and debris production. The thin crust of soil formed by the chemical binder increased runoff rates and debris production. A 'wet' (treated with detergents to increase infiltration by reducing surface tension of the rain water) water treatment resulted in added infiltration and less runoff but in higher debris-carrying capacity per unit volume of runoff.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Glendora, Calif.

Critical Areas

Harris, W. S., and Hay, R. C. GULLY CONTROL WITHOUT STRUCTURES--PART I. Trans. ASAE 6(1): 37-39. 1963.

Gully rehabilitation and control normally consists of the construction and maintenance of a grassed waterway. The installation of a structure as a terminating device is often considered to be the essential first step, the very key, to the reclamation of a large gully.

A method of design of vegetated outlet sections for use in terminating grassed waterways was presented. The design method was based on an analysis of causes contributing to the formation of gullies in a specific area. The method of analysis is applicable to any waterway termination problem but design criteria must meet local requirements. A review of the five cases studied illustrated the following basic facts: (1) Structures were an alternate rather than an only solution in waterway termination problems; and (2) benefits from structures were confined to small areas of nonproductive land. A set of three design curves was presented for use in designing "transition sections." These curves may also prove useful in grassed waterway design.

U. Ark., Fayetteville, Ark.

Jones, B. A., Jr. GULLY CONTROL WITHOUT STRUCTURES--PART II. Trans. ASCE 6(1): 39-40, 47. 1963.

Three years after Part I was written, the five areas were inspected in the fields and the results of each inspection were given.

It was concluded that the vegetated outlets sections for use in terminating grassed waterways were feasible provided the assumed conditions were met and routine maintenance was performed.

U. Ill., Urbana, Ill.

Richardson, E. C., Diseker, E. G., and Hendrickson, B. H. CROWNVETCH FOR HIGHWAY BANK STABILIZATION IN THE PIEDMONT UPLANDS OF GEORGIA. Agron. J. 55: 213-215. 1963.

Crownvetch, a deep-rooted perennial legume, appears promising for highway slope stabilization in the Piedmont Upland of Georgia. Stands were successfully established in the fall or spring by transplanting or by seeding. Partial stands soon became full stands as additional growth developed from underground rhizomes and from seed produced. Crownvetch seemed to be free from disease and insect damage after it passed the cotyledon stage. Mulch or nurse crop protection was required on most plantings until seedlings were well established. The vigorous plants produced a thick cover of attractive, prostrate foliage and had a beautiful appearance when in full flower.

SWCRD, ARS, USDA, Cartersville, Ga. 30120

SOIL MANAGEMENT

Cropping Practices

Kilcher, M. R., and Anderson, L. J. WHEAT YIELDS AND SOIL AGGREGATION AFTER PERENNIAL GRASSES IN A SEMI-ARID ENVIRONMENT. Canad. J. Plant Sci. 43: 289-294. 1963.

Spring wheat grown the year following breaking of stands of crested wheatgrass (*Agropyron cristatum* L.) or bromegrass (*Bromus inermis* Leyss) in a semi-arid region of the Canadian prairies yielded 17 percent less than wheat grown on summerfallow in a 2-year wheat-summerfallow rotation. After three successive cycles of the 2-year wheat-summerfallow rotation on the sod breaking, the wheat yields were about equal to those obtained from the check plots. The grasses did not improve soil aggregation any quicker than that which occurred in the wheat-fallow regime under an adopted strip cropping management.

Canada Dept. Agr., Swift Current, Saskatchewan, Canada.

Sander, D. H., Chesnin, L., Rhoades, H. F., McGill, D. P., Coleville, W. L., and Lyness, W. E. MAINTENANCE OF NITROGEN IN A BRUNIZEM SOIL OF EASTERN NEBRASKA. *Agron. J.* 55: 53-55. 1963.

An experiment was initiated in 1946 at Lincoln, Nebr., to study the influence of cropping systems and nitrogen fertilization on the maintenance of nitrogen in a Sharpsburg soil.

The cropping systems from 1946-51 included alfalfa, bromegrass with and without applications of nitrogen, bromegrass-alfalfa mixtures, and sweetclover and grain rotations with and without applications of nitrogen. From 1952-57 the influence of previous cropping systems and annual applications of 40 pounds of nitrogen per acre were evaluated with a corn, oats, wheat cropping system. Soil samples were taken in 1946, 1952, and 1957 to evaluate changes in soil nitrogen levels.

Cropping systems containing legumes maintained soil nitrogen at higher levels than systems with bromegrass. Sweetclover in a grain system was as effective as alfalfa in increasing the soil nitrogen level.

Soil nitrogen levels were maintained by all cropping systems during the 12-year period except a corn, oats, wheat system which did not include fertilization with nitrogen. This system resulted in an 8 percent decrease in soil nitrogen during the 12-year period.

Applications of nitrogen fertilizer resulted in significantly higher soil nitrogen levels in bromegrass and grain cropping systems. However, the increased level of soil nitrogen was subject to accelerated microbial decomposition.

It was concluded that in the Sharpsburg soil, soil nitrogen was in equilibrium with the environment. Practices that tended to increase the production of nitrogenous crop residues also tended to increase the level of soil nitrogen. The production of grain crops tended to deplete soil nitrogen resources unless supplemental applications of nitrogen fertilizers were made.

U. Nebr., Lincoln, Nebr.

Pendleton, J. W., Bolen, C. D., and Seif, R. D. ALTERNATING STRIPS OF CORN AND SOYBEANS vs. SOLID PLANTINGS. *Agron. J.* 55: 293-295. 1963.

Alternating either four, 40-inch rows or six, 24-inch rows of corn and soybeans resulted in approximately a 20 percent increase in corn yields but a 20 percent decrease in soybean yields when compared to yields from a similar area of solid plantings of the two crops. The greater part of this difference was due to the grain production from the border rows immediately adjacent to the other crop.

Twenty-four inch row spacings were superior to 40-inch row spacings in both crops.

Row direction showed no significant effect on yield of either corn or soybeans from strip plantings or solid plantings. However, some interesting differences in yield were noted for individual border rows of the strip planting system in relation to their position.

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

Hedlin, R. A., and Schreiber, K. SUGAR BEET YIELDS ON FALLOWED AND NONFALLOWED LAND ON TWO SOIL TYPES. *Agron. J.* 55: 10-12. 1963.

Sugar beets were grown on fallowed and nonfallowed land on 2 soil types (Altona cl and Altona vfls) in 1958-59. Determinations were made of yield and sugar content of beets and of nitrate nitrogen, extractable phosphorus, and moisture content of the soil.

The main effect of fallowing was to increase nitrate nitrogen by about 55 pounds per acre to a 4-foot depth. This led to a lower response to applied nitrogen on fallowed as compared to nonfallowed land. Application of superphosphate significantly increased beet yields on fallowed land on the Altona vfl.

Nitrogen applications had a tendency to reduce sugar percentage, particularly in 1958 when sugar percentage was high.

There was an inverse relationship between nitrate nitrogen at seeding time and response to applied nitrogen. Response to applied superphosphate was not significantly correlated with sodium bicarbonate extractable phosphorus.

U. Manitoba, Winnipeg, Manitoba, Canada.

Derscheid, L. A., Wicks, G. A., and Wallace, W. H. CROPPING, CULTIVATION, AND HERBICIDES TO ELIMINATE LEAFY SPURGE AND PREVENT REINFESTATION. *Weeds* 11: 105-111. 1963.

Stands of leafy spurge (Euphorbia esula L.) were reduced over 90 percent by 20 combinations of crops, cultivation, and herbicides. Three of the best crop rotations in two 4-year trials were: (1) A short season of intensive cultivation, a mid-August seeding of alfalfa, a crop of alfalfa, spring wheat sprayed with $\frac{1}{2}$ lb./A. of 2,4-D (an ester formulation was always used) three postharvest cultivations, corn sprayed with $\frac{1}{3}$ lb./A. 2,4-D; (2) a short season of intensive cultivation, a mid-August seeding of bromegrass sprayed with 1 lb./A. 2,4-D in early June and mid-August during the second and third years, and a crop of corn the fourth year; (3) spring oats sprayed with $\frac{1}{3}$ lb./A. of 2,4-D ester and three postharvest cultivations, three spring cultivations a close-drilled crop of sudangrass and fall cultivation, spring wheat sprayed with $\frac{1}{2}$ lb./A. of 2,4-D ester and three fall cultivations, a crop of corn sprayed. The best use of non-selective herbicides in four 2-year trials was spring application of 4 to 6 lb./A. of 2,3,6-TBA, plow 10 days later, followed by a corn crop and a spring oats crop, both treated with 2,4-D and 4 to 6 lb./A. of 2,3,6-TBA applied after oats harvest, and the field plowed 10 days later. Reinfestation by seedlings was prevented by an annual spring application of $\frac{1}{3}$ to $\frac{1}{2}$ lb./A. of 2,4-D per acre.

S. Dak. Agr. Expt. Sta, Brookings, S. Dak.

McWhorter, C. G. EFFECTS OF SURFACTANT CONCENTRATION ON JOHNSONGRASS CONTROL WITH DALAPON. *Weeds* 11: 83-86. 1963.

Addition of surfactant (a polyoxyethylene thioether) to solutions of dalapon increased the activity of both technical and formulated grades of dalapon on Johnsongrass (Sorghum halepense (L.)). The increase in activity was influenced by the rate and formulation of herbicide and in some instances by the volume of water in which treatments were applied. Varying the volume of diluent affected control with technical dalapon to a greater extent than that with formulated dalapon probably because of differences in surfactant concentrations. Plants arising from short rhizomes were more readily controlled by dalapon than those from longer rhizomes.

CRD, ARS, USDA, Stoneville, Miss.

Crop Residue Management

Harris, W. W. EFFECTS OF RESIDUE MANAGEMENT, ROTATIONS, AND NITROGEN FERTILIZER ON SMALL GRAIN PRODUCTION IN NORTHWESTERN KANSAS. *Agron. J.* 55: 281-284. 1963.

Soil moisture at seeding time was significantly greater on stubble mulch plots than on no-residue plots 3 out of 6 years in a fallow-crop rotation. It did not differ significantly the other 3 years. Additional moisture was stored under stubble mulch in years when high intensity rainfall occurred (1957) or when 4 to 6 days of consecutive precipitation occurred more frequently than otherwise (1953-55). Soil moisture at seeding time was independent of tillage treatments on continuously cropped plots.

Grain yields were correlated with soil moisture at seeding time plus precipitation from seeding to June 1. Tillage methods which conserved a larger percent of that which fell during the fallow period were instrumental in increasing grain yields. Since stubble mulched plots had more soil moisture than no-residue plots half the time and did not differ significantly the other half, stubble mulch appeared desirable.

Climatic conditions caused large yearly fluctuations in nitrate nitrogen in the soil. Fallowed plots had more nitrate nitrogen in the top 3 feet than continuously cropped plots. Fertilized plots had more than unfertilized, and no-residue plots had more than stubble mulched plots. These differences were unimportant in producing grain as amounts usually present were in excess of plant needs when existing moisture supplies were considered. Additional nitrogen might be desirable when stubble mulching results in more stored moisture in a soil low in nitrate nitrogen. This would occur more frequently where precipitation was greater and continuous cropping was practiced. Nitrate nitrogen fluctuations were greater than could be attributed to plant use.

Kansas State U., Colby Br. Expt. Sta., Colby, Kans.

Behmer, D. E., and McCalla, T. M. THE INHIBITION OF SEEDLING GROWTH BY CROP RESIDUES IN SOIL INOCULATED WITH PENICILLIUM URTICAE BAINER. *Plant and Soil* 18: 199-206. 1963.

Laboratory experiments were conducted to determine the effects of crop residues, without and with Penicillium urticae Bainer inoculation, on growth of wheat seedlings in soil. Fifty grams of Sharpsburg s₁ soil, containing 1 percent by weight of incorporated alfalfa, sorghum, and corn stover residue, were placed in petri dishes, autoclaved, wetted to 40 percent moisture, and incubated at 24^o C. for periods of 2, 3, and 4 weeks. One-half of the petri dishes were inoculated with P. urticae. Germination and seedling-shoot measurements were taken after 7 days of growth.

It was concluded that: (1) The inoculation of soil generally reduced seedling height regardless of the residue treatment; (2) inoculation of soil containing corn and sorghum residues resulted in greater tissue production but reduced height of seedlings as compared to non-inoculated soils; and (3) in the absence of residues, the inoculated control soils were a better growth medium for wheat seedlings than were the non-inoculated control soils. Alfalfa residues, especially in the presence of P. urticae, were strongly inhibitory to the wheat seedlings, causing curling and reduced wheat-seeding root growth.

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Tillage

Khan, A. R. TILLAGE - ITS TRADITIONAL LORE AND RATIONAL PRACTICE. *World Crops* 15: 68-69, 71-72. 1963.

The purposes served by tilling the soil have long been a subject of controversy. The value of tillage is not easily determined since its influence is complex and liable to variation according to soil type, climate, and other factors. The author reviewed historical developments and gave the results of his own research on depth of cultivation.

Indian Agr. Res. Inst., New Delhi, India.

Burrows, W. C. CHARACTERIZATION OF SOIL TEMPERATURE DISTRIBUTION FROM VARIOUS TILLAGE-INDUCED MICRORELIEFS. *Soil Sci. Soc. Amer. Proc.* 27: 350-353. 1963.

The microrelief produced by tillage methods which plant corn on a smooth soil surface, on ridges, or in furrows caused differences in soil temperature during the early part of the growing season. Orientation of the relief features, that is, north-south or east-west, also caused differences in soil temperatures. In general, for germination and the early growth period, the small plant was in the warmest soil if the seed was placed in ridges which run east-west and in the order of decreasing temperature: NS ridges > EW conventional > NS conventional > listing, regardless of row direction.

SWCRD, ARS, USDA, Morris, Minn. 56267

Talati, N. R., and Mehta, B. V. EFFECT OF DEEP AND SHALLOW PLOUGHING ON NUTRIENT RELEASE, MOISTURE CONSERVATION AND YIELD OF PEARL MILLET IN GORADU SOIL OF ANAND. *J. Indian Soc. Soil Sci.* 11: 9-16. 1963.

The effects of deep and shallow plowing on yield of pearl millet were studied at Anand, India, for 14 years to learn the effect of these different cultural practices on nutrient release, moisture conservation, and yield of pearl millet. The authors concluded that:

1. Deep-plowed plots were improved by: (1) Greater retention of moisture; (2) higher mineralization of nitrogen; and (3) higher exchangeable potassium content of the soil than shallow plowed plots. There was no significant difference in the available phosphorus content of the soil.
2. Correlation coefficients between yield of pearl millet grain or straw on the individual factors of nitrate, moisture, and exchangeable potassium contents in soil were significant. No correlation was found between yield of grain or straw and available phosphorus content of soil.
3. Multiple regression equations giving the relation between yield and moisture, nitrate, and exchangeable potassium were made and the contributions of these factors in increasing the yield were calculated. It was concluded that the increase in yield under deep plowing was mainly due to increased nitrate and moisture availability.

Inst. Agr., Anand, Gujarat, India.

Fertility Requirements for Conservation Farming

Welch, L. F., Adams, W. E., and Carmon, J. L. YIELD RESPONSE SURFACES, ISO-QUANTS, AND ECONOMIC FERTILIZER OPTIMA FOR COASTAL BERMUDAGRASS. *Agron. J.* 55: 63-67. 1963.

Coastal bermudagrass yield data, from a 4 by 4 by 4 NPK factorial experiment on Cecil soil, were fitted to the Quadratic Model by multiple regression. The multiple regression yield equation fits the data to the extent that about 98 percent of the variation in yield was explained by different rates of the added nutrients.

Predicted yields of Coastal bermudagrass ranged from 1.96 tons per acre with no nutrients added to 7.48 tons per acre with 400, 88, and 168 pounds per acre of N, P, and K, respectively. The yield response to N was greater than the response to either P or K. Interaction was prevalent, and the greatest yield response to any nutrient occurred at the highest rates of the two nutrients.

Yield isoquants revealed that there are many combinations of rates of nutrients that will result in a specified yield. These many combinations exist because one nutrient may "replace" another nutrient in attaining a specified yield. This "replacement rate" varies and is dependent on the rates of nutrients.

Economic fertilizer optima were given with various assumed prices for Coastal bermudagrass and each of the three nutrients.

SWCRD, ARS, USDA, Southern Piedmont Field Sta., Watkinsville, Ga. 30677

Asher, W. C. SQUIRRELS PREFER CONES FROM FERTILIZED TREES. U.S. Forest Serv. Res. Note SE-3, 1 p. 1963.

Cones from fertilized slash pine trees were more popular food for squirrels than cones from unfertilized trees. This food preference was demonstrated on a seed-production study area near Olustee, Fla.

In May 1960, a factorial experiment involving root-pruning, fertilizing, and untreated checks was installed in a seed-production area containing a stand of 27-year-old slash pines.

The following table summarizes the data:

	<u>Fertilized trees</u> (Number)	<u>Nonfertilized trees</u> (Number)
Cones eaten	354	34
Cones not eaten	560	323
	<hr/>	<hr/>
	914	357

Southeastern Forest Expt. Sta., FS, USDA, Ashville, N.C.

Okigbo, B. N. AN EVALUATION OF LOSSES CAUSED BY HESSIAN FLY IN A WHEAT FERTILIZER EXPERIMENT. *Agron. J.* 55: 117-119. 1963.

Grain losses resulting from hessian fly infestation ranged from 0.8 to 9 bushels per acre, while straw losses were much lower and ranged from 30 to 280 pounds per acre. These were closely related to the percentage of infestation. The highest losses were observed at the highest levels of nitrogen while the lowest ones were observed where no nitrogen was applied. No definite relationship was found between hessian fly infestation and soil reaction and/or drainage.

Losses attributed to incomplete filling of the grain of infested plants amounted to about one-half of the over-all losses while those attributed to lodging accounted for about one-third. The remaining losses (potential lodging losses) may or may not be sustained depending on whether the point of breakage is high on the culm and, if also, a combine fails to pick up the grain during harvesting. On the average, uninfested plants outyielded the infested ones. A wheat variety like Genesee, which is more or less genetically pure with respect to certain agronomic characteristics, may be an admixture of types in relation to tolerance and susceptibility to the hessian fly.

In some locations, what appeared to be lack of response to nitrogen fertilization turned out to be due to differential hessian fly damage--the losses increasing with increases in the level of nitrogen applied.

Cornell U., Ithaca, N.Y.

Taylor, A. W., Lindsay, W. L., Huffman, E. O., and Gurney, E. L. POTASSIUM AND AMMONIUM TARANAKITES, AMORPHOUS ALUMINUM PHOSPHATE, AND VARISCITE AS SOURCES OF PHOSPHATE FOR PLANTS. *Soil Sci. Soc. Amer. Proc.* 27: 148-151. 1963.

The effectiveness of potassium taranakite and amorphous aluminum phosphate as sources of P for three successive crops of corn grown on acid and neutral soils in the greenhouse was found to correspond to their effects on the phosphate status of a similar soil with which they were incubated in the laboratory.

The availability of the phosphate in potassium and ammonium taranakites and amorphous aluminum phosphate appeared to be controlled by their rates of hydrolysis rather than by their equilibrium solubilities. Small but well-formed crystals of variscite were an extremely poor source of P in an acid soil.

In a calcareous soil, amorphous aluminum phosphate, variscite, and potassium and ammonium taranakites were about as good sources of P for three crops of corn as monocalcium phosphate. On this soil, the particle size of the aluminum phosphates was the dominant factor in their availability.

TVA, Wilson Dam, Ala.

Jones, M. B. YIELD, PERCENT NITROGEN, AND TOTAL NITROGEN UPTAKE OF VARIOUS CALIFORNIA ANNUAL GRASSLAND SPECIES FERTILIZED WITH INCREASING RATES OF NITROGEN. *Agron. J.* 55: 254-257. 1963.

Increasing rates of N up to 160 pounds per acre were applied to California's annual grassland on 2 soil types. Yields, nitrogen concentrations, and nitrogen uptake were determined for individual species at four dates during the growing season.

The primary benefit of N fertilization in the grassland areas of north coastal California was the increase in production of forage during the winter season when grass was short and legumes grew very slowly. Not more than 80 pounds N per acre should be applied since very little increase in winter production resulted from the addition of greater amounts of N. An increase in yield above the 80-pounds-per-acre rate came in the spring and was dependent primarily upon the amount and distribution of rainfall during the warm spring months. Generally there was some carryover of N into the second year, but it was measurable only at the 160-pound rate, and most of the increase in growth came during the spring when plentiful supplies of feed were available.

All rates of N increased the N concentration in the plants early in the season. As the plants matured, N applied at the lower rates was utilized in additional growth to the extent that the percent N in the nonleguminous species was usually decreased with the addition of 40 pounds N per acre. Plants fertilized with 80 pounds N per acre generally had concentrations of N equivalent to that of unfertilized plants; 160 pounds N per acre generally increased the percent N of the nonleguminous plants.

The effect of the applied N was reflected in the increased uptake of nitrogen by the grasses and filaree and decreased N uptake by clover with each additional increment of nitrogen applied. The clovers made their largest gains in total N from March to April where no nitrogen was applied. Each increment of N applied reduced the legume contribution of N to the forage.

U. Calif., Hopland Field Sta., Hopland, Calif.

Laughlin, W. M. BROMEGRASS RESPONSE TO RATE AND SOURCE OF NITROGEN APPLIED IN FALL AND SPRING IN ALASKA. *Agron. J.* 55: 60-62. 1963.

Five replicated experiments employing various experimental designs were conducted on established bromegrass stands to compare several nitrogen carriers and rates and time of application of nitrogen from 1952-60. All fertilizer treatments were evaluated in terms of bromegrass dry-matter produced.

Ammonium nitrate, ammonium sulfate, and calcium nitrate were equally effective as suppliers of nitrogen to bromegrass. Anhydrous ammonia and calcium cyanamide were inferior to all other nitrogen carriers. Urea was seldom as effective as ammonium nitrate, ammonium sulfate, or calcium nitrate. This was especially true with high nitrogen levels and with fall applications.

Split nitrogen applications (half in the spring and half in early summer) produced higher second and third-cutting yields, but no more dry matter for the entire season than did the same amount of nitrogen applied only in the spring.

Spring applications of nitrogen were generally superior to equal quantities applied in the fall.

U. Alaska, Alaska Agr. Expt. Sta., Palmer, Alaska.

Stephen, R. C., and Waid, J. S. POT EXPERIMENTS ON UREA AS A FERTILIZER; I. A COMPARISON OF RESPONSES BY VARIOUS PLANTS. *Plant and Soil* pp., 309-316. 1963.

In a series of pot experiments the effect of soil applications of urea on the aerial growth of various crops was compared with that of ammonium nitrate and ammonium sulfate.

When the nitrogen sources were uniformly incorporated in the soil at the time of sowing, the pattern of response was essentially the same for the 12 crops examined. Applications of urea, ammonium nitrate, and ammonium sulfate at the lowest rates gave similar yields. At the intermediate rates, yields from urea were considerably lower than from the other nitrogen sources and were often equal to or less than those of the no-nitrogen controls. At the highest rates of application, urea gave much lower yields than the other sources. In most crops, these smaller yields were associated with urea-induced damage which was followed by the death of established plants.

Topdressing applications of urea and ammonium nitrate caused very slight damage and increased the yields of all five crops. The responses from urea were lower than those from ammonium nitrate, especially at the higher rate of applied nitrogen.

Within each method of nitrogen application, the pattern of response to urea was similar for all the crops tested.

Levington Res. Sta., Ipswich, England.

Ramig, R. E., and Rhoades, H. F. INTERRELATIONSHIPS OF SOIL MOISTURE LEVEL AT PLANTING TIME AND NITROGEN FERTILIZATION ON WINTER WHEAT PRODUCTION. *Agron. J.* 55: 123-127. 1963.

Field fertilizer experiments with winter wheat were conducted for 3 years on Holdrege v. fsl in central Nebraska. Proper balance of nitrogen fertilization with preplanting available soil moisture gave highest grain and straw yields, nitrogen utilization, milling and baking qualities, and most efficient water use. The continuously cropped, low nitrogen soils that received approximately 12 inches of October to June rainfall produced maximum yields of wheat when approximately 20 pounds of fertilizer N per acre was supplied for every 2.5 to 3.0 inches of preplanting available soil moisture in the 6-foot soil profile. One to 2 inches more water was removed from the 6-foot soil profile when N was applied to plots that had 3 or more inches of preplanting soil moisture than when no N was applied. This additional water was extracted at tensions greater than 15 atmospheres.

SWCRD, ARS, USDA, Pendleton, Oreg. 97801.

Sexsmith, J. J., and Pittman, U. J. EFFECT OF NITROGEN FERTILIZERS ON GERMINATION AND STAND OF WILD OATS. *Weeds.* 11: 99-101. 1963.

Early-spring, broadcast, disked-in applications of nitrogen fertilizers caused an increased germination of wild oat (*Avena fatua* L.) seed present in the soil. With adequate moisture, there was increased wild oat infestation in the seeded crop from early-spring application. With dry weather, the effects did not carry over into the crop period. The apparent breaking of seed dormancy by nitrates from fertilizer applications may offer another method for combating wild oats other than by herbicides. Fertilizer treatment might be used to deplete seed reserves in the fallow years and to reduce the amount of seed returned to the soil in the crop years by combining a fertilizer treatment with delayed crop seeding.

Canada Agr. Res. Sta., Lethbridge, Alberta, Canada.

Sexsmith, J. J., and Russell, G. C. EFFECT OF NITROGEN AND PHOSPHORUS FERTILIZATION ON WILD OATS AND SPRING WHEAT. *Canad. J. Plant Sci.* 43: 64-69. 1963.

Spring wheat, with fertilizer applied in the drill rows, was grown in wild oat-infested stubble on a Shallow Lethbride 1 soil for 4 years. Phosphorus had no measurable effect on the height, straw weight, seed yield, or number of wild oat plants. Nitrogen increased the number of seed-bearing stems, plant height, straw weight, and seed yield, but did not change the wild oat stand. Wheat yields were increased by nitrogen and further increased by the addition of phosphorus at the rate of 20 pounds of P₂O₅ per acre in 3 of the 4 years. Measured bushel weight of the wheat increased with nitrogen fertilizer additions and was further increased by phosphorus except at the high rate of both materials.

Canada Agr. Res. Sta., Lethbridge, Alberta, Canada.

Curlin, J. W. RESPONSE OF NATURAL STANDS OF SHORTLEAF PINE TO THINNING AND FERTILIZATION WITH NITROGEN AND PHOSPHORUS. *Soil Sci. Soc. Amer. Proc.* 27: 234-236. 1963.

The results of fertilizer experiments conducted with thinned and unthinned natural stands of shortleaf pine were reported. Nitrogen and phosphorus were applied singly and in combination on both thinned and unthinned plots. The plots were located on three soil series (Fullerton, Clarksville, and Dummore) found in close association in the Great Valley Region of eastern Tennessee.

Four-year response in basal area growth per tree was increased as much as 300 percent over the unthinned check by thinning and application of nitrogen. An increase of up to 40 percent over the thinned check was achieved with nitrogen alone. These responses were still evident 4 years after fertilization. Basal area growth response to phosphorus was erratic throughout the study period.

The results indicate that stand density must be low enough at the time of nitrogen application to allow growth to proceed unhindered.

Div. Forestry, TVA, Norris, Tenn.

Herbel, C. H. FERTILIZING TOBOSA ON FLOOD PLAINS IN THE SEMIDESERT GRASSLAND. *J. Range Managt.* 16: 133-138. 1963.

Tobosa (*Hilaria mutica* (Buckl.) Benth.), a drought resistant grass of the arid Southwest, occurs primarily on heavier textured soils, but is not limited to them. It is relatively unpalatable to livestock during the dormant season but is readily grazed during the growing season. Where possible, tobosa flood plains should be fenced separately and grazed during the growing season while the upland pastures are deferred. These flood plains supporting tobosa in high density and receiving additional water as run-in from adjacent mountains can produce several times the herbage of upland sites.

The effects of nitrogen and phosphorus fertilizers on tobosa on a heavy flood plains range site in southern New Mexico were reported for a 5-year period. Under all but the best moisture conditions, fertilization appeared to be generally uneconomical. During 1959, the year having available soil moisture for a continuous 60-day period, fertilization with 90 pounds of nitrogen per acre increased herbage production 4,164 pounds per acre. During one other year (1958) with above-average moisture, yields were somewhat increased. Herbage yields were unaffected by fertilization during 1961, of above-average precipitation, because it followed droughty 1960. Even in 1960, when production as a whole was reduced, plots receiving run-in markedly responded to fertilization. Moisture conditions in 1957 were about average but yields were probably reduced by the droughty conditions in 1956. Protein content of the herbage at the close of the growing season was generally 20 to 35 percent higher with some of the higher levels of fertilization than with checks.

Ranchers with a limited amount of tobosa could profitably fertilize flood plain sites with 60 to 90 pounds of nitrogen plus 0 to 13.1 pounds of phosphorous per acre to give a longer growing season deferment to upland pastures.

Tobosa has the genetic capability of producing over 7,000 pounds of air-dry herbage per acre, under high levels of available soil moisture and with fertilization.

Jornada Expt. Range, Las Cruces, N. Mex.

Walker, W. M., Pesek, J., and Heady, E. O. EFFECT OF NITROGEN, PHOSPHORUS AND POTASSIUM FERTILIZER ON THE ECONOMICS OF PRODUCING BLUEGRASS FOR-AGE. *Agron. J.* 55: 193-196. 1963.

A replicated bluegrass experiment using a 5 X 5 X 5 central composite design with N, P, and K fertilizer variables was conducted on a Fayette sil in northeast Iowa on an old established bluegrass sod in 1958. The fertilizer was applied by topdressing before growth was initiated in the spring, and bluegrass yields were determined from clippings taken at approximately 5-week intervals to simulate grazing.

The data were analyzed, and a quadratic prediction equation containing significant effects was fitted to them. The equation predicted the yield as a function of the linear and quadratic variates of N and P fertilizer, respectively. This prediction equation had a multiple correlation coefficient of 0.9296. This equation could be used to determine isoquants, isoclines, and least cost optimum combinations of N and P for specified price situations. Using this equation, an economic interpretation of this experiment, given various price situations, was illustrated. Interpretation of the experimental results in terms of animal product rather than forage produced was also considered.

A method was derived for determining the minimum price of product at which it becomes profitable to use a specified input. When the cost of N was \$0.14 per pound, it was profitable to use N as a fertilizer when the price of bluegrass exceeded \$11.84 per ton. When the cost of P was \$0.21 per pound, it was profitable to use P as a fertilizer when the price of bluegrass exceeded \$6.34 per ton.

U. Tenn. Ext. Serv., Knoxville, Tenn.

Hortensine, C. C. THE RESPONSE OF SWEET PEPPERS IN EVERGLADES ORGANIC SOILS TO P AND K FERTILIZATION. *Fla. State Hort. Soc. Proc.* 75: 146-152. 1962.

In a fertilizer experiment with sweet peppers on Everglades peaty muck soils, the author concluded that:

1. Heavy rains during early stages of growth of sweet peppers on the organic soils of the Florida Everglades may carry fertilizer out of the root-zone of the pepper plants. Under such conditions, sidedressing of P and K may be beneficial.
2. Phosphorus should be applied to sweet peppers when soil P is below 8 to 10 pounds per acre. Increases in yield were obtained by applying P to organic soil containing 5 pounds of P per acre before fertilization.
3. No increase in yields was obtained from K fertilization, indicating adequate K when the soil contained 60 pounds or more K per acre.
4. In order to increase soil P 1 pound per acre, 10 to 12 pounds of P fertilizer should be applied per acre.
5. In order to increase soil K 1 pound per acre, 4 pounds of K fertilizer should be applied per acre.
6. Phosphorus applied to the soil decreased the uptake of K by pepper plants and decreased the K content of the soil.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Klacan, G. R., and Berger, K. C. EFFECT OF NITROGEN AND MAGNESIUM NUTRITION ON POD AND SEED DEVELOPMENT IN CANNING PEAS. *Agron. J.* 55: 228-231. 1963.

The specific effects of different N and Mg concentrations on pod and seed development in canning peas were studied, using nutrient solution cultures.

At low levels (5 to 15 p.p.m.) of N, plants produced fewer pods and fewer seeds per pod than plants supplied with adequate (45 to 200 p.p.m.) N. There was a wide range of higher N concentrations over which the total number of seeds per plant was not affected, but high concentrations of N increased the size of the seeds. The interval between the flat pod growth stage and canning maturity was shown to be a particularly critical period for N in pea nutrition.

Reducing the N supply from a sufficient (135 p.p.m.) to a deficient (15 p.p.m.) level at any stage prior to the time the first pod swelled greatly reduced the development and N content of the peas. Conversely, high N (135 p.p.m.) concentrations after the swelled pod growth stage were detrimental to seed development.

Initial increases in the Mg supply (20 to 50 p.p.m.) from a deficient level resulted in increases in the number of pods produced per plant and in the number of seeds per pod. Further increases in Mg increased the number of pods more than pod fill. This increase in the number of pods, as the Mg supply was increased above deficient levels, was attributed partly to increased uptake of Mg and partly to increased uptake and translocation of P.

U. Wis., Madison, Wis.

Hunt, O. J., and Wagner, R. E. EFFECTS OF PHOSPHORUS AND POTASSIUM FERTILIZERS ON LEGUME COMPOSITION OF SEVEN GRASS-LEGUME MIXTURES. *Agron. J.* 55: 16-19. 1963.

Potash greatly increased yields of legumes and percent legume in grass-legume mixtures. Legume percentage was increased almost 100-percent in mixtures containing ladino clover by high potash fertilization. Birdsfoot trefoil was the only legume which produced significantly more under low lime levels than under high lime and also increased in legume composition of the forage.

CRD, ARS, USDA, Laramie, Wyo.

Read, D. W., and Beaton, J. D. EFFECT OF FERTILIZER, TEMPERATURE, AND MOISTURE ON GERMINATION OF WHEAT. *Agron. J.* 55: 287-290. 1963.

A laboratory study was conducted to measure the effects of fertilizer, temperature, and moisture, and their interaction on the germination of wheat. The fertilizers used were monoammonium phosphate (MAP), dicalcium phosphate anhydrous (DAP), diammonium phosphate, monocalcium phosphate, phosphoric acid, and ammonium nitrate. These fertilizers were placed in the center of the surface of a jar of soil and wheat seeds placed at 0.5 cm., 1.5 cm., and 2.8 cm. away from the fertilizer. Total germination was reduced more by MAP and DAP than by the other fertilizers. Moisture level and temperature had little effect on total germination. Total germination was reduced more when seed was placed close to the fertilizer than when it was 1.5 or 2.8 cm. distant.

The rate of germination was significantly affected by all factors. Low temperature reduced the speed of germination but to a different extent for different fertilizers. Decreasing soil moisture increased the time required for germination, but the fertilizers reacted differently. The zone of influence for some fertilizers extended to the seeds 2.8 cm. away, while others showed no effect at 1.5 cm. even though they did reduce germination when close to the seed.

Canada Dept. Agr. Res. Br., Expt. Farm, Swift Current, Saskatchewan, Canada.

Jones, M. B. EFFECT OF SULFUR APPLIED AND DATE OF HARVEST ON YIELD, SULFATE SULFUR CONCENTRATION, AND TOTAL SULFUR UPTAKE OF FIVE ANNUAL GRASSLAND SPECIES. *Agron. J.* 55: 251-254. 1963.

Five annual grassland species were grown competitively in the same pots at different levels of available S, and were harvested at 3 stages of maturity. There were differences in yield responses, SO_4 -S concentrations, and total S uptake among the five species at different dates. Yield response of subclover, soft chess, and ripgut to S fertilization increased as the season advanced, but this increase was most outstanding in subclover.

The concentration of total S and SO_4 -S decreased as the season advanced. These decreases were very small where no S was applied and were large at the higher rates of S. The SO_4 -S concentration in each of the species where no S was applied was indicative of S deficiency. However, the SO_4 -S concentration in subclover at flowering appeared to be the best single indicator of S status when all levels of available S were considered.

U. Calif., Hopland Field Sta., Hopland, Calif.

Lavy, T. L., and Barber, S. A. A RELATIONSHIP BETWEEN THE YIELD RESPONSE OF SOYBEANS TO MOLYBDENUM APPLICATIONS AND THE MOLYBDENUM CONTENT OF THE SEED PRODUCED. *Agron. J.* 55: 154-155. 1963.

Molybdenum seed treatment on soybeans gave yield responses ranging from 0.7 to 7.6 bushels per acre. Molybdenum response was related to soil pH on the Chalmers-Odell soils. Yield increases occurred where the soybean seeds produced on the untreated plots contained 1.6 or less p.p.m. molybdenum.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Wolf, B. EVALUATION OF CALCINED MAGNESITE AS A SOURCE OF MAGNESIUM FOR PLANTS. *Agron. J.* 55: 261-262. 1963.

Calcined magnesite was evaluated as a source of Mg for plants by means of pot and plot tests using yield data and Mg analysis of soil and leaves as criteria. The results for sandy soils near pH 7 indicated that: (1) Soil and leaf Mg levels were satisfactory with calcined magnesite, but plant yield was sometimes depressed when the material was applied to soil just prior to planting. (2) Yields were not depressed when calcined magnesite was applied 10 days before seeding or was mixed with the fertilizer. In such cases, calcined magnesite was as good as a better source of Mg than sulfate of potash-magnesia or kierserite. (3) The course grade of calcined magnesite was as effective as the finer material.

Wolf's Agr. Lab., Hollywood, Fla.

Locascio, S. J., and Lundy, H. W. LIME AND MINOR ELEMENT STUDIES WITH WATER-MELONS. Fla. State Hort. Soc. Proc. 75: 131-136. 1962.

Experiments were conducted at Gainesville, Fla., on Ona-Leon fs, Ona fs, and Kanapaha fs soils, and at Live Oak, Fla., on Lakeland fs soils in 1960-62. The effect of lime, nitrogen, and potassium levels on watermelon yield were investigated in 1960. In 1961 and 1962, the variables were lime level and minor element treatments. The authors concluded that:

1. Watermelons did not respond with increased yield to large quantities of lime. Application of lime significantly reduced yields in one experiment and had no significant effect in four experiments. However, a non-significant trend was noted for a slight increase in yield with the addition of small amounts of lime.
2. The reduction in yield caused by liming may have been due to availability of minor elements. This was indicated by a significant response to EDTAOH and Frit 501 applications. Responses to minor elements were not consistent. In one of two experiments, yields tended to be higher with the addition of CuEDTA.
3. Soil pH and calcium levels increased linearly with increased applications of calcium hydroxide. In addition to pH and calcium, soil magnesium was increased by application of dolomite.

Fla. Agr. Expt. Sta., Gainesville, Fla.

Keeney, D. R., and Corey, R. B. FACTORS AFFECTING THE LIME REQUIREMENTS OF WISCONSIN SOILS. Soil Sci. Soc. Amer. Proc. 27: 277-280. 1963.

Soil factors that have been reported to affect lime requirement were measured on 26 Wisconsin soils, and the importance of these factors in predicting lime requirement was determined by use of linear and multiple regression. The lime requirement was taken as the amount of < 200-mesh dolomitic limestone necessary to raise the soil pH to 6.5 after 12 months of equilibration.

Organic matter (percent OM) was found to be significantly related to lime requirement ($r = 0.620$), and a function of a pH-organic matter interaction, (pH 6.5--soil pH) X (percent OM) also correlated well ($r = 0.884$). Clay content, ranging from 5 to 27 percent, did not appear to be an important factor in determining lime requirement. Exchangeable Al contents were too low in these soils to contribute significantly, and pH 4.8 NH_4OAc -extractable Al did not appear to be an important factor. Lime requirement as indicated by the new buffer developed by Shoemaker, McLean, and Pratt was very highly correlated with lime requirement ($r = 0.949$), while the Woodruff buffer did not correlate as well ($r = 0.818$).

U. Wis., Madison, Wis.

Dahnke, W. C., Attoe, O. J., Engelbert, L. E., and Groskopp, M. D. CONTROLLING RELEASE OF FERTILIZER CONSTITUENTS BY MEANS OF COATINGS AND CAPSULES. Agron. J. 55: 242-244. 1963.

The effect of fertilizer coatings was studied on the yield and recovery of the fertilizer constituents by corn and Kentucky bluegrass and on the rate of release of the constituents.

Coating ammonium sulfate grains with paraffin wax, followed by pelleting, significantly increased the recovery of N by corn grown on Miami sil in pots but did not increase the yield. Plowing down capsuled urea or sidedressing capsuled ammonium nitrate for corn on Kellner ls did not significantly increase the yield or recovery of N over similar treatments with noncapsuled fertilizer.

Capsuled 24-5-10 fertilizer gave more uniform growth of Kentucky bluegrass through the season than noncapsuled fertilizer. Total yields of grass and recovery of N and K were not significantly increased by capsuling and recovery of P was significantly lower. Capsuling provided a positive method for controlling the rate of release of the fertilizer constituents for both corn and grass.

Since coating treatments add to the cost of fertilizers, their use is likely to be limited to special situations such as lawns and potted plants where cost is not a major factor. Since relatively large fertilizer capsules can be used for trees and shrubs, this form of coating may prove advantageous for these plants.

U. Wis., Madison, Wis.

Salinity and Alkali Problems

Kanwar, J. S., Sehgal, J. L., and Bhumbla, D. R. RELATIONSHIP BETWEEN SOME INDICES OF SALINE-SODIC SOILS. *J. Indian Soc. Soil Sci.* 11: 39-44. 1963.

An attempt was made to find the relationship between: (1) pH of the saturated soil paste and exchangeable sodium plus potassium percentage (E.S. + E.P.) of the soil; (2) pH and soluble carbonate percentage; (3) electrical conductivity (E.C. $\times 10^3$) and total soluble cations in saturation extracts of the soil; and (4) gypsum requirement (G.R.) and exchangeable sodium and potassium content of the saline-sodic soils of Karnal district (Punjab). Simple regression equations between all the above-mentioned four pairs were found. A significant multiple regression between pH, exchangeable sodium and potassium percentage, and soluble carbonate percentage of the saturation extract of the soil was worked out.

On the basis of these very simple and rapid determinations, namely pH, electrical conductivity and gypsum requirement of the saline-sodic soils, the salinity and alkalinity status of such soils was easily assessed. Even the pH in 1:2 soil water suspension was a good criterion of the degree of alkalinity.

Govt. Agr. Col., Ludhiana, Punjab, India.

Dregne, H. E. EFFECTS OF VARIOUS SALTS ON BARLEY GROWTH. *N. Mex. Agr. Expt. Sta. Res. Rpt.* 62, 6 pp. 1962.

Because excess soluble salt reduces plant growth, soil salinity is one of the principal threats to a permanent irrigated agriculture. Traditionally, controlling the salt problem has consisted of attempts to completely remove the salt from the soil by leaching water. This is the best thing to do when it is economically feasible, but many times it is not economical. The alternatives are to either abandon the land, accept poor yields, or try to adapt soil and water management practices to the salty condition. The latter approach is being studied at the New Mexico Agricultural Experiment Station, and the experiment reported here was designed to throw some light on two phases of the problem: (1) Can fertilizers help reduce the severity of salt effects and (2) how do some of the common salts affect barley growth and soil properties?

A greenhouse experiment was conducted to determine the effect of fertilizer on the response of barley to two levels of sodium chloride and on the specific effects of potassium, magnesium, and sodium carbonates.

The harmful effects of soluble salt on barley were decreased by applying a complete fertilizer, when the salt level of the soil was low to moderate. If the salt level was high, fertilizers intensified the adverse effect of the salt.

Magnesium carbonate reduced yields more than sodium carbonate or potassium carbonate. Potassium and sodium carbonate gave similar barley yields but the effect on the soil was markedly different. The adverse effect of magnesium and potassium carbonates appeared to be due to nutritional imbalance rather than to soil physical conditions.

Agr. Expt. Sta., N. Mex. State U., University Park, N. Mex.

Hobbs, E. H., and Russell, G. C. EFFECT OF METHOD OF IRRIGATION ON THE DISTRIBUTION OF SALTS IN A CHIN LOAM SOIL. *Canad. J. Soil Sci.* 43: 65-69. 1963.

Fields of Chin 1 soil, one irrigated by sprinkler methods and the other by surface methods, were sampled to a depth of 5 feet. Analysis of the samples showed the soluble salt content of the sprinkled field, at all depths sampled, to be consistently higher than that of the surface-irrigated field.

Canada Agr. Res. Sta., Lethbridge, Alberta, Canada.

van Schaik, J. C., and Milne, R. A. SALT ACCUMULATION IN A GLACIAL TILL SOIL IN THE PRESENCE OF SALINE GROUNDWATER AT SHALLOW DEPTHS. *Canad. J. Soil Sci.* 43: 135-140. 1963.

Considerable salt accumulation occurred in a grass-covered soil in southern Alberta where the saline groundwater was maintained at a depth of 3 feet. The SAR values of the saturation extract increased significantly under grass, and indications were that this increase was mainly due to precipitation of calcium. A fallow soil did not show a significant salt accumulation above the water table.

It was suggested that a leaching program was necessary to maintain low salinity where shallow water tables were present and shallow tile drains were used.

Canada. Agr. Res. Sta., Lethbridge, Alberta, Canada.

Cover Crops and Green Manure Crops

Williams, W. A., and Finrock, D. C. VETCH GREEN MANURE INCREASES RICE YIELDS... PROPER DEPTH AND TIMING OF INCORPORATION ALLOWS MAXIMUM RESULTS. *Calif. Agr.* 17 (1): 12-13. 1963.

Purple vetch produces greater rice yields when turned under 4 to 6 inches than when plowed at shallower depths. Shortening the time interval between turning under the vetch and flooding and sowing the rice, also increases yields--when conditions were favorable to nitrification during the preflooding period. When properly incorporated, vetch green manure was equal to mineral sources of ammonium nitrogen in increasing rice yields.

U. Calif., Davis, Calif.

Climatic Influences

Burnside, O. C., Wicks, G. A., and Fenster, C. R. THE EFFECT OF RAINFALL AND SOIL TYPE ON THE DISAPPEARANCE OF 2,3,6-TBA. Weeds 11: 45-47. 1963.

The movement and dissipation of 2,3,6-TBA were studied under different soil and rainfall conditions in Nebraska. This involved growing a bioassay crop on plots in the field as well as bioassays conducted in soil taken from different depths.

Field bioassays of Andrew oats showed marked loss of 2,3,6-TBA from surface soil at North Platte and Alliance as contrasted with little loss at Lincoln. Rainfall during the period studied was almost twice as much at Lincoln as compared to either of the other locations. Reduced volatilization of 2,3,6-TBA as a result of lower soil temperatures due to greater rainfall at Lincoln may account for its greater persistence in Wymore silt soil as contrasted with more rapid loss from Bridgeport and Rosebud at North Platte and Alliance.

Ford soybeans provided a suitable bioassay for 2,3,6-TBA in soil in the range of 1/2 to 2 p.p.m.w.

Soil samples from different depths showed that 2,3,6-TBA readily leached down to the 4- to 5-foot depths when rainfall was sufficient. Greater loss of 2,3,6-TBA occurred from the upper soil profile in central and western Nebraska than in eastern Nebraska. A marked loss of 2,3,6-TBA at 20 lb./A. occurred between May 1960 to September 1961 from the three soil profiles studied.

U. Nebr. Lincoln, Nebr.

Colville, W. L., Chesnin, L., and McGill, D. P. EFFECT OF PRECIPITATION AND LONG TERM NITROGEN FERTILIZATION ON NITROGEN UPTAKE, CRUDE PROTEIN CONTENT AND YIELD OF BROMEGRASS FORAGE. Agron. J. 55: 215-218. 1963.

Bromegrass forage was harvested from plots receiving nitrogen fertilizer applied annually during the period of 1953-1960. Forage yields varied greatly with seasonal differences in precipitation. Forage production was not appreciably increased when fertilizer application exceeded 120 pounds of nitrogen per acre.

Regression analyses showed forage yields of the 0-(check) or 40-pound nitrogen applications failed to respond significantly to changing quantities of precipitation. The addition of 80 or more pounds of nitrogen resulted in yield responses that were linearly related to precipitation. Differences between the straight line regression of 80-, 120-, 160-, and 200-pound applications were not significant. An inch of precipitation was 8.9 times more effective at the 120-pound rate of nitrogen fertilization than were no fertilizer had been applied.

Yield and precipitation data indicated that at the lower level of nitrogen fertilization (0, 40, and 80 lb./A.) production of bromegrass was limited by precipitation when amounts were less than 10 to 11 inches. In the opposite extreme, when moisture levels exceeded 13 to 14 inches, yields were depressed, possibly by insufficient available nitrogen to support luxuriant plant growth. At the higher levels of nitrogen fertilization, moisture deficiency reduced forage production. Nitrogen supplies were apparently ample at the higher precipitation levels.

Crude protein per acre increased by progressively smaller amounts with each 40-pound increment of N. These increases ranged from 270 with the first to 10 pounds with the fifth 40-pound increment of N. This relationship appeared to be linear to the 160-pound application. The nitrogen fertilization rate for maximum forage yield was 80 to 120 lb./A. and for maximum quality return it was 160 lb./A.

Nitrogen recovery was surprisingly uniform and high for the 40-to 160-pound rates of application ranging from 67.4 to 73.9 percent of that applied. Applications of 20 pounds resulted in forage that recovered only 54.7 percent of the applied nitrogen fertilizer.

U. Nebr., Lincoln, Nebr.

Fletcher, P. W., and Lull, H. W. SOIL-MOISTURE DEPLETION BY A HARDWOOD FOREST DURING DROUTH YEARS. *Soil Sci. Soc. Amer. Proc.* 27: 94-98. 1963.

Daily soil-moisture readings were taken during two drouth years with fiberglas units installed on each of 8 plots at 8 depths in the upper 40 inches of soil in a pole-size mixed oak and hickory stand, Butler County, Mo. On two plots the trees were cut and removed and the litter burned (bare); on two the trees were cut and removed and litter was left intact (litter-only); on two the litter was burned (trees-only), and two plots were left undisturbed (trees-and-litter). It was concluded that:

1. Midcontinent sites with subsoil pan formations close to the soil surface tended to be extremely wet in the winter and spring, and extremely dry in the summer and fall.
2. The density of pole-size hardwood stands on fragipan sites tended to become excessive during a period of wet years.
3. Tree mortality during periodic drouths on fragipan sites markedly reduced the basal area of pole-size hardwood stands. A basal area of about 55 square feet was as much as the site could sustain through the 1952-55 drouth.
4. Drouth mortality was most severe for scarlet oak, less for southern red oak and black oak.
5. Drouth mortality was most pronounced among the dominant trees and the understory trees and shrubs.
6. The forested area averaged 2.84 inches less water in 40 inches of soil than the bare area during June, July, and August of a very dry summer.
7. During the same period, the forested area contained 5.76 inches less water than an area without trees but with litter.
8. Rates of soil-moisture drying for the tree-covered and bare plots were positively related to their profile moisture contents. The bare areas had profile drying rates about 0.5 those of the undisturbed forest and about 0.4 those where only the litter was removed.
9. When the profile moisture content was around field capacity, bare areas had drying rates about two-thirds those of the undisturbed forest and about two-thirds those where only the litter was removed.
10. A surface fire that destroyed only the forest litter increased the rate of drying about 7 percent when the moisture conditions were near field capacity and about 13 percent at lesser profile moisture contents.

Pa. State U., University Park, Pa.

Larson, P. R. THE INDIRECT EFFECT OF DROUGHT ON TRACHEID DIAMETER IN RED PINE. *Forest Sci.* 9: 52-62. 1963.

Five-year-old *Pinus resinosa* trees were subjected to artificial drought periods of varying duration during the growing season. A single drought period resulted in a

zone of narrow-diameter latewood tracheids and the formation of a false ring, whereas two drought periods produced two false rings. The formation of these false rings was readily correlated with the decreased needle elongation and auxin synthesis (determined by auxin bioassay) resulting from the drought. The increase in tracheid diameter and the formation of a false ring that normally followed the drought were prevented by inhibiting renewed needle elongation and, consequently, increased auxin synthesis. It was concluded that the influence of drought was directly on the growth of the terminal meristems and only indirectly on tracheid diameter through the intermediate action of auxin.

Lake States Forest Expt. Sta., FS, USDA, Inst. of Forest Genetics, Rhinelander, Wis.

Watt, R. F., and McGregor, W. H. D. GROWTH OF FOUR NORTHERN CONIFERS UNDER LONG AND NATURAL PHOTOPERIODS IN FLORIDA AND WISCONSIN. *Forest Sci.* 9: 115-127. 1963.

Seedlings of *Pinus strobus* L., *Pinus resinosa* Ait., *Picea glauca* (Moench) Voss., and *Picea mariana* (Mill.) B.S.P. were grown under natural and 20-hour photoperiod from seeds collected in Wisconsin and Minnesota.

Long photoperiod permitted growth throughout the 226-day growing season of Florida, producing seedlings that at the end of 2 years were equal to or exceeded the standards for northern-grown transplants 3 to 4 years old; outplantings in the North survived as well as stock from local nurseries. The relatively short natural photoperiod of Florida caused dwarfing of the seedlings. Extended photoperiod in Wisconsin increased the size of 2-year spruces. At both locations, the pines formed precocious secondary needles and the spruce more and longer lateral branches under long photoperiod. Long photoperiod influenced the pattern of growth; the pines grew intermittently the second season but the spruce without interruption both seasons until the end of long-day treatment.

Lakes States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Gerber, J. F., and Busby, J. N. FIELD TRIALS WITH A WIND MACHINE. *Fla. State Hort. Soc. Proc.* 75: 13-18. 1962.

Wind machines in the 100 horsepower class were shown by field trials to provide protection of 2° F. or more for an area of 8 to 10 acres on clear, calm nights in a peach orchard. This protection represents a reduction in the minimum temperature and a reduction in the duration of low temperatures. Successful wind machine operation depended upon proper power input to the fan, and upon the presence of an inversion (i.e. a layer of warm air aloft over the grove.) The protection pattern was roughly circular with the machine near the center. The distortion of the pattern due to wind drift was not pronounced.

Fla. Agr. Expt. Sta., Gainesville, Fla.

Mederski, H. J., and Jones, J. B., Jr. EFFECT OF SOIL TEMPERATURE ON CORN PLANT DEVELOPMENT AND YIELD; I. STUDIES WITH A CORN HYBRID. *Soil Sci. Soc. Amer. Proc.* 27: 186-189. 1963.

The effect of 10° to 15° F. increase in field soil temperature on growth, yield, and ion accumulation by corn was investigated. In Ohio, normal field soil temperatures are below optimum for maximum corn plant development. Increasing soil temperature with heating cables installed beneath the row accelerated the rate of plant development, and produced significant increases in dry matter production and corn yield. Soil heating

significantly increased N, P, K concentrations in plants sampled 30 days after planting. Soil heating did not significantly affect the composition of plants sampled at 60 days or at maturity.

Ohio Agr. Expt. Sta., Ohio State U., Wooster, Ohio.

Jones, J. B., Jr., and Mederski, H. J. EFFECT OF SOIL TEMPERATURE ON CORN PLANT DEVELOPMENT AND YIELD; II. STUDIES WITH SIX INBRED LINES. *Soil Sci. Soc. Amer. Proc.* 27: 189-192. 1963.

Six inbred lines of corn were grown in the field under heated and normal soil conditions. Heating was accomplished using electric heating cables placed under the row. Heating had a marked effect upon the early growth rate and uptake of K, P, and Ca. Heating tended to shorten the period from emergence to silking. All of the inbred lines on the heated rows were shorter than those in the unheated rows at maturity. A differential yield (ear and fodder) response to soil heating was obtained among the inbreds. The differential response among the inbreds may explain why varying yield responses to soil heating which have been obtained in different investigations. Inbred lines may be unique plants to use for determining the factors related to the heat stimulus effect.

Ohio State Agr. Expt. Sta., Ohio State U., Wooster, Ohio.

Lear, B., and Johnson, D. E. INFLUENCE OF TEMPERATURE ON THE NEMATOCIDAL ACTIVITY OF SOIL FUMIGANTS CONTAINING ETHYLENE DIBROMIDE AND DICHLOROPROPENES. *Soil Sci.* 95: 322-325. 1963.

Laboratory and greenhouse experiments showed that the nematocidal activity of ethylene dibromide was greatly reduced at soil temperatures of 55° F. and colder. Diffusion through soils as measured by kill of root-knot nematode larvae was similar in soils ranging in moisture equivalent from 3 to 30 percent. Incorporation of the chemical in infested soil by mechanical agitation or as water solutions did not improve the control at low temperatures over that obtained when the chemical was introduced by injection. Experiments with 1,3-dichloropropene indicated that this chemical was active at temperatures as low as 40° F.

U. Calif., Davis, Calif.

Beaton, J. D., and Read, D. W. L. EFFECTS OF TEMPERATURE AND MOISTURE ON PHOSPHORUS UPTAKE FROM A CALCAREOUS SASKATCHEWAN SOIL TREATED WITH SEVERAL PELLETTED SOURCES OF PHOSPHORUS. *Soil Sci. Soc. Amer. Proc.* 27: 61-65. 1963.

The effects of temperature, moisture, and P source during the initial soil-fertilizer reaction period on subsequent P uptake by oats were investigated in a growth chamber. Phosphorus-treated soil with moisture adjusted to four different tensions was stored at 5°, 16°, and 27° C. for 1 week and for 7 weeks. Following these storage intervals, P uptake by oats was measured using a short-term method.

Uptake of P from soil treated with mono- and diammonium phosphates was greater following reaction of the fertilizer with soil at 5° C. than at either 16° or 27° C. No significant differences between 16° and 27° C. were observed.

Moisture tension during the 1-week reaction period did not influence P uptake. Following the 7-week reaction period, uptake of P was favored by the 2.0 bar moisture tension treatment. It was lowest from soil reacted at 0.4 bar. Water-soluble sources, such as monocalcium phosphate and mono- and diammonium phosphates, were the most sensitive to differences in moisture.

Availability of the sources decreased in the other monommonium phosphate > diammonium phosphate > monocalcium phosphate > dicalcium phosphate dihydrate > anhydrous dicalcium phosphate > check.

Expt. Farm, Res. Br. Canada Dept. Agr., Swift Current, Saskatchewan, Canada.

Stoeckeler, J. H. SPRINGTIME FROST FREQUENCY NEAR LACROSSE, WISCONSIN, AS AFFECTED BY TOPOGRAPHIC POSITION, AND ITS RELATION TO POTENTIAL REFORESTATION PROBLEMS. *J. Forestry* 61: 379-381. 1963.

Records obtained in 1960-61 in hilly terrain in the unglaciated section of LaCrosse, Wisc., showed that the springtime frost frequency between April 26 and July 1 was about twice as high in a cove at 920 feet elevation as on a nearby ridgetop at 1,250 feet elevation. Freezes of 30° F. or less occurred three times as often in the cove. The degree-hours of frost of 30° F. or less in the period were eight times as abundant in the cove as on the ridgetop. For freezes of 28° F. or less, the cove had 67.5 degree-hours compared to none on the ridgetop. In the cove, temperatures reached minima of 1.0° to 10.5° F. colder than on the ridge in eight of nine times on which freezes occurred in this period; these minima on six occasions were at least 3° F. colder for the cove. The temperature inversions were greatest on calm, clear nights. Long-term records over a 89-year period at La Crosse indicated the probability of a freezing temperature on the average of about once every 2-1/2 years in May.

Lake State Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Mulching

Spice, H. R. POLYTHENE FILMS IN AGRICULTURE. *World Crops* 15: 239-245, 249. 1963.

Polythene films were first made in 1938, hence their acceptance and use by agriculturists all over the world during the past quarter of a century has been remarkable. A number of established applications of plastic films in agriculture were reviewed. Some uses of plastic film now in process of development were discussed.

British Visqueen Ltd.

Miller, P. M., and Waggoner, P. E. INTERACTION OF PLASTIC MULCH, PESTICIDES AND FUNGI IN THE CONTROL OF SOIL-BORNE NEMATODES. *Plant and Soil* 18: 45-52. 1963.

Three different mulching materials--hay, black polyethylene film, and translucent polyethylene film--produced different soil temperatures and influenced the microflora of the soil differently. Rhizoctonia solani Kuehn increased in cool or moderate temperatures under hay or black film but not in warmer soil beneath translucent film. Populations of a meadow nematode, Pratylenchus penetrans Cobb were reduced approximately

two-thirds under the black film. Under this film, conditions apparently favor biological control of P. penetrans. Over several months this control was destroyed if a fungicide, pentachloronitrobenzene, and a nematocide, dibromochloropropane, were added. Evidently, the fungicide inhibited organisms predaceous on P. penetrans at the same time it inhibited R. solani.

Conn. Agr. Expt. Sta., New Haven, Conn.

Geraldson, C. M. GROWING TOMATOES AND CUCUMBERS WITH HIGH ANALYSIS FERTILIZER AND PLASTIC MULCH. Fla. State Hort. Soc. Proc. 75: 253-260. 1962.

Increased yields of tomatoes and cucumbers grown in plastic-covered plots and caused by factors other than prevention of ground rot averaged about 20 to 30 percent higher than those without plastic. Maintenance of the established root environment (nutrients and moisture) was believed to be mainly responsible for these yield increases.

Prevention of ground rot of tomatoes and 'belly rot' of cucumbers resulted in a total yield increase of 66 and more than 100 percent, respectively, in these crops.

Plastic mulch was profitably used in conjunction with practices favoring intensive production.

Gulf Coast Expt. Sta., Bradenton, Fla.

Darby, J. F., Scudder, W. T., and Whitner, B. F. EVALUATION OF PETROLEUM AND PLASTIC RESIN SPRAYS AS SOIL SEALANTS AND MULCHES FOR VEGETABLES. Fla. State Hort. Soc. Proc. 75: 240-249. 1962.

Eighteen different formulations of plastic and petroleum emulsions and similar materials were tested over a 2-year period to evaluate their use as soil sealants for fumigants in vegetable seedbeds, as mulches for cantaloupes, and as soil sealants for herbicides. Eight of these materials, sprayed over the surface of the soil, were compared with polyethylene and vinyl plastic films. The first 4 of the 6 seedbed tests were in progress during the hurricane season when rain was recorded on 23 days of the 28-day waiting period. During this rainy weather, plastic seals were little or no better than a water seal alone.

In general, 300 gal./A. diluted to 12.5 percent total solids, sprayed over the wet surface of DMTT and SMDC-drenched seedbeds, permitted 50 and 25 percent reductions, respectively, in dosage of the fumigants, whereas a vinyl plastic cover over SMDC or DMTT-drenched seedbeds permitted a 50 percent reduction in dosage of both fumigants. Since the cost of the plastic sprays was greater than the value of the 25 percent reduction in dosage, the benefits from the use of these materials were not considered to be sufficient to warrant further testing.

In preliminary spring tests, a low cost emulsified petroleum resin product, EAP-2000, at 50 percent concentration, showed more promise than did the liquid plastics. At 600 gal./A., this material, sprayed over cantaloupe beds, increased plant growth, hastened maturity, prevented wind erosion, prevented a high accumulation of soluble salts, and increased yield. The cost-return ratio of this material was 1 to 4.7 for a 5 foot wide band at the 600 gal./A. rate, and 1 to 13.2 for a one foot wide band at the 300 gal./A. rate. It also showed promise as a spray mulch to increase speed of germination, stands, and growth rate of several small seeded vegetables. At the 600 gal./A. rate, a 25 percent concentration of petroleum mulch, when used as a soil sealant on mucky peat, increased the effectiveness of DMTT and SMDC.

Central Fla. Expt. Sta., Sanford, Fla.

Mannering, J. V., and Meyer, L. D. THE EFFECTS OF VARIOUS RATES OF SURFACE MULCH ON INFILTRATION AND EROSION. Soil Sci. Soc. Amer. Proc. 27: 85-86. 1963.

The effects of six rates of applied wheat straw mulch on infiltration and erosion were studied on a highly permeable Wea sil with a 5-percent slope. Series of simulated rainstorms totaling 6.25 inches at an intensity of 2.5 inches per hour were used to evaluate the treatments. Mulch applications of 1, 2, and 4 tons per acre maintained very high infiltration rates resulting in essentially no erosion. The 1/4- and 1/2-ton mulch application lost 3 tons and 1 ton of soil per acre, respectively, whereas the check (no mulch) treatment lost 12 tons per acre. Benefits, indicated from the mulching, were: (1) Reduced soil surface sealing as evidenced by higher infiltration rates; and (2) decreased rainfall and runoff energy for particle detachment and transport as evidenced by reduced soil content in the runoff.

SWCRD, ARS, USDA, Lafayette, Ind. 47907

Kohnke, H., and Werkhoven, C. H. SOIL TEMPERATURE AND SOIL FREEZING AS AFFECTED BY AN ORGANIC MULCH. Soil Sci. Soc. Amer. Proc. 27: 13-17. 1963.

Temperatures and the occurrence of freezing and thawing of mulched and bare soil at 1-, 4-, and 10-inch depths were recorded during a 5-year period. A silt loam of fair drainage with a slight southern slope near Lafayette, Ind., was selected.

Average daily temperatures of mulched and bare soil varied only slightly: in winter the mulched soil was warmer by 1° or 2° F. In spring, the mulched soil was colder by about 1° or 2° F. This difference increased to 3° or 4° F. in the summer. Daily temperature fluctuations at the 1-inch depth were twice as large in the bare soil as in the mulched soil. In the spring, the soil temperature maxima reached favorable corn germination levels about 2 weeks earlier in the bare than in the mulched soil. At the 1-inch depth, the frequency of freezing and thawing was 3.6 times as great in the bare soil as in the mulched soil. At the lower depths these differences were less intense.

Twice as much total heat energy reached the one-inch depth in the bare soil as in the mulched soil but the net heat energy retained was essentially identical in both treatments.

Purdue U., Lafayette, Ind.

PLANT MANAGEMENT

Pasture and Haylands

Maynard, M. L., and Gates, D. H. EFFECTS OF WETTING AND DRYING ON GERMINATION OF CRESTED WHEATGRASS SEED. J. Range Mangt. 16: 119-121. 1963.

During the fall of 1960 and the spring of 1961, the effects of wetting and drying cycles on the germination of crested wheatgrass seed under closely monitored conditions were studied. Temperatures were 86° and 53° F. during the day and night, respectively, and were alternated on a 12-hour basis.

Seeds were subjected to various wetting and drying treatments. The drying periods were for 24 hours, 1 week, and 4 weeks. Most seeds had the treatments continued after the radicle had developed.

Treatment response was determined from total germination and time required for 10 percent of the radicles to reach 22 mm.

Despite extreme variability of the experimental results, some trends were evident. The following conclusions were given:

1. Seeds of crested wheatgrass tolerated extreme moisture fluctuation, remained viable, and produced vigorous seedlings.
2. In many cases, various wetting and drying treatments increased seed germination.
3. When allowed to develop a radicle approximately 2 mm. long and then dried for 1 or 4 weeks, some seeds still developed into vigorous seedlings when water was subsequently applied.
4. Germinating seeds of crested wheatgrass withstood drying temperatures as high as 130° F. and remained viable.
5. Severe and prolonged wetting-drying treatments reduced vigor of germinating seeds.
6. It appeared that critical stages in their physiological processes made seeds of crested wheatgrass readily susceptible to extremes of desiccation. These periods of susceptibility may last for only a few hours.
7. A pre-planting treatment involving some of the cycles used in this study may have promise as a means of increasing germination of crested wheatgrass in range seedings.

U. Ariz., Tuscon, Ariz.

Dahl, B. E. SOIL MOISTURE AS A PREDICTIVE INDEX TO FORAGE YIELD FOR THE SANDHILLS RANGE TYPE. J. Range Managt. 16: 128-132. 1963.

In an attempt to develop a method for predicting forage production on sandhill range, a study was made of the factors that tend to influence yield of forage at the Eastern Colorado Range Station near Akron, Colo.

The authors concluded that:

1. Depth of moist soil and the amount of soil moisture on April 15 were both usable indices and about of equal value for predicting the amount of grass which will be produced by early August. Depth of moist soil was the easier of the two to obtain.
2. Yields of grass from about August 7 to October 1 were found to be largely dependent upon available evapo transpiration water during that period. This was considered to be of minor concern since only 4 percent of the total forage production was made during this period in 5 of the 6 study years.
3. The 2 previous years' total precipitation was found to have a significant influence on the yield of grass during the spring growth period. One previous year's precipitation did not have a significant effect on spring grass yields.
4. The effect of the current seasonal climatic factors seemed to cancel, by mid-season, any effect of prior year's precipitation. However, the prior 2 years' precipitation (in inches) and the depth of moist soil (measured on April 15) when related to grass yields, gave the highest correlation coefficients obtained.
5. Spring drought, which limited the storage of moisture prior to the grazing season, was found to be the most critical factor limiting potential grass yield.

Colo. Agr. Expt. Sta., Colo. State U., Fort Collins, Colo.

Hunt, O. J., and Wagner, R. E. EFFECTS OF MANAGEMENT PRACTICES ON YIELD AND COMPOSITION OF THREE GRASS-LEGUME MIXTURES. *Agron. J.* 55: 13-16. 1963.

Effects of cutting height, frequency of harvest, and date of first cutting on forage yield and botanical composition of 3 grass-legume mixtures were investigated over a 3-year period on Codorus sil at Beltsville, Md. The height to which the forage was cut had the greatest influence on forage yield and botanical composition in all years. Cutting to a height of 2 inches produced significantly more forage with a greater percentage of clover than cutting to 4 inches in all comparable treatments.

Frequency of cutting also had considerable influence on forage yields and botanical composition. During the first 2 years, the less frequent cutting produced more forage than the frequent. As clover content of the less frequently cut plots began to decrease, the yields were reduced to less than that of the frequently cut plots.

Forage yields were increased in most instances as the date of first cut was delayed, especially on frequently harvested plots cut to the 2-inch height. Although smooth brome-grass was very sensitive to management, less frequent cutting at a delayed date of first cutting beyond May 5 maintained yields comparable with tall fescue and orchardgrass. The grasses generally increased in the mixture when cutting was infrequent at the 4-inch height. Smooth brome-grass contributed a much smaller percentage to the forage mixture than did orchardgrass and tall fescue. Tall fescue was the highest producing species.

The ingress of weedy species was not a serious problem in orchardgrass and tall fescue except at the last harvest when weedy grasses made up a high percentage of the forage. Tall fescue appeared to be more compatible with ladino clover than orchard-grass, and it prevented the ingress of weeds to a greater extent. The smooth brome-grass mixture contained a high percentage of weeds throughout the season in all 3 years.

CRD, ARS, USDA, Laramie, Wyo.

Ehrenreich, J. H., and Aikman, J. M. AN ECOLOGICAL STUDY OF THE EFFECT OF CERTAIN MANAGEMENT PRACTICES OF NATIVE PRAIRIE IN IOWA. *Ecol. Monographs* 33: 113-130. 1963.

The immediate and cumulative effects of complete protection, burning, and mowing were studied on the vegetation and soils of the mesic Hayden Prairie in northeastern Iowa. This Prairie was under complete protection from 1945-53. The date of the first burning experiment was in February of 1954.

Plants on recently burned areas began growing 2 to 3 weeks earlier in the spring, developed faster, and matured earlier than plants on unburned areas. However, plants on unburned areas grew faster during the latter part of the growing season so that there was no significant difference in total herbage yield between burned and unburned areas.

Flower stalks of forbs and native grasses were more abundant and taller on burned than on unburned areas until the third growing season after burning.

Soil temperature was influenced by the amount of litter covering the soil surface and seemed to be the chief factor limiting plant growth until June or July. Midday soil temperature was much higher in the burned than in the unburned areas until July or August because on the burned areas litter was absent and the dark surface of the soil was exposed. The difference between maximum and minimum air temperature 1 in. above the ground was also greater on burned than on unburned areas until June.

Because of the higher temperature and the resulting earlier initiation of growth on the burned areas, evaporation and transpiration were greater, causing the soil water supply to be depleted more rapidly.

Available phosphorus was low on all areas but burning increased it. Compared with the unburned areas in 1956, there was 12 times as much available phosphorus on the 1956-burned areas, 6 times as much on the areas burned 2 and 3 years, and 2 times as much on the areas burned only in 1954 and 1955.

An increase of available phosphorus is particularly important for plants of short growth cycle or in areas of short growing seasons. Thus, whereas the higher soil temperatures on burned areas probably account for the earlier start of plant growth, the increased availability of phosphorus during the early part of the growing season could account at least partially for the earlier plant maturity observed on burned areas.

Burning had no apparent effect on soil volume weight, percentage pore space, exchangeable potassium, nitrate production, and total subsurface organic matter. It did cause a slight increase in pH in the upper 0.75 in. of soil.

Clipping four times during the growing season resulted in lower yields than clipping only at the end of the growing season. Frequent clipping for the second consecutive year caused even greater reduction in yields, while clipping at the end of the second growing season resulted only in slight reductions of yields.

Complete protection of the mesic Hayden Prairie for 4 to 6 years after burning would result in accumulation of litter equal to or greater than the annual yield of vegetation and retard plant growth.

The study showed that an occasional spring burning of native prairie in Iowa apparently did not harm the vegetation or soil. When the quantity of litter exceeds the annual yield of vegetation, burning may do some good by increasing seedstalk production of native grasses and decreasing seedstalk production of some introduced grasses. Other than burning, the best method of harvesting the vegetation to prevent excessive injury to the plants may be to mow as required at the end of the growing season after the plants have produced seed.

Central States Forest Expt. Sta., FS, USDA, Columbia, Mo.

Wallace, J. D., Hubbert, F., Jr., and Raleigh, R. J. THE RESPONSE OF YEARLING CATTLE ON CRESTED WHEATGRASS PASTURE TO ENERGY, PROTEIN AND SODIUM SUPPLEMENTATION. *J. Range Mangt.* 16: 1-5. 1963.

Energy (barley), protein (cottonseed meal), and sodium (salt) supplements were fed alone and in all possible combinations to yearling cattle on crested wheatgrass pasture during two grazing seasons.

Both energy and protein supplementation resulted in significant increases in rate of gain each year. Energy supplementation appeared more favorable when forage was somewhat limited or when dry matter content of the forage was relatively low. The primary response to protein supplementation occurred during the latter part of the grazing season.

Supplementation of sodium (salt) resulted in a significant gain response during the early part of 1 year and appeared somewhat detrimental to performance during the other year. When salt was fed in combination with cottonseed meal, yearling gains were reduced compared with those from cottonseed meal alone.

Chemical analyses and *in vitro* cellulose digestibility values of crested wheatgrass samples collected each year during the grazing season were presented.

Oreg. State U., Corvallis, Oreg.

Jackobs, J. A. A MEASUREMENT OF THE CONTRIBUTIONS OF TEN SPECIES TO PASTURE MIXTURES. *Agron. J.* 55: 127-131. 1963.

The influence of 10 species of grasses and legumes on the performance of pasture mixtures was studied in a 4-year experiment on the Agronomy South Farm, Urbana, Ill.

Ladino clover exhibited its usual seedling vigor but was severely winter damaged in 2 to 4 winters. It re-established itself by reseeding. Mixtures with Ladino clover did not produce as much as comparable seedings without Ladino, because the early season yields were greatly reduced while the Ladino was recovering from winter injury or being re-established by seedlings.

Smooth brome was well established but declined rapidly after 1955. It did not influence the performance of mixtures significantly the last 3 years.

Orchardgrass was not as prominent as smooth brome early in the experiment, but it increased rapidly and greatly increased the grass component in the mixtures the last 3 years of the experiment. When it was included in mixtures with short-lived species, it filled in rapidly after they died out and the yield of the mixtures was maintained. Where orchardgrass was not in the mixtures with short-lived species, there was a reduction in yield after they had died out and this reduction lasted through the next 2 years. Orchardgrass was very competitive with alfalfa for when it was added to a mixture with alfalfa there was a reduction of 1.08 pounds of legume in the mixture for each pound of increase in the grass due to adding orchardgrass to the seeding mixture.

The initial stand of alfalfa was very good, and it maintained a good stand and was very productive all 4 years of the experiment. Alfalfa mixtures with orchardgrass had over 40 percent grass in each grazing period after the first year of production. When Alfalfa was added to a mixture with orchardgrass, there was a reduction of 0.32 pound of grass in the mixture for each pound of increase in the legume due to adding alfalfa to the seeding mixture.

The short-lived species, red and alsike clover, and perennial ryegrass increased the legume and grass components, respectively, when they were present in the mixture. When they died out, the yield was maintained if orchardgrass was present.

A fair stand of birdsfoot trefoil was obtained but it nearly all died out in the first year of production due to root-rot.

The initial stand of tall fescue and timothy were not good enough to give an adequate evaluation of these species.

U. Ill., Urbana, Ill.

Campbell, J. B. GRASS-ALFALFA VERSUS GRASS-ALONE PASTURES GRAZED IN A REPEATED-SEASONAL PATTERN. *J. Range Mangt.* 10: 78-81. 1963.

Observations of a repeated-seasonal grazing test that compared grass-alfalfa and grass-alone swards were given for 1956-61, when rainfall was below average.

The yield of dry matter and number of grazing days per acre decreased as the experiment progressed. This was associated largely with progressive drought, but also with physiological age of the plants. Of the three grasses employed, Russian wildrye produced the most consistent yearly yield and maintained the best stand.

Intermediate wheatgrass killed out completely in 4 years. It was replaced by invading crested wheatgrass on Treatment 1 where a nearly complete stand was established. On Treatments 2 and 3 the intermediate wheatgrass was replaced by crested wheatgrass and Russian wildrye, both being components of the seeded mixture.

One pound of alfalfa in the seed mixture provided several benefits over the grass-alone sward. Greater yields of dry matter and higher percentage contents of crude protein were recorded. These increased yields were reflected in higher carrying capacity, increased live-weight gains per ewe and per acre, and greatly reduced consumption per pound of live-weight gain.

Expt. Farm, Res. Br., Canada Dept. Agr., Swift Current, Saskatchewan, Canada.

Carmer, S. G., and Jackobs, J. A. ESTABLISHMENT AND YIELD OF LATE-SUMMER ALFALFA SEEDINGS AS INFLUENCED BY PLACEMENT OF SEED AND PHOSPHATE FERTILIZER, SEEDING RATE, AND ROW SPACING. *Agron. J.* 55:28-30. 1963.

The results of summer seedings of alfalfa, with no companion crop, indicated that yield advantages due to band-placement of seed and phosphate fertilizer depended on the environmental conditions following the seeding. When emergence was delayed by dry weather, there was an increase in yield in the first harvest as compared to broadcast methods. Under more favorable conditions for establishment, there was no yield advantage, although increases in plant size and vigor in the seeding year were obtained.

The level of intra-crop competition was influenced by conditions following the seeding dates. There was less competition among plants within rows when adverse conditions followed the seeding than when the environment was more favorable. Yield increases due to band-placement of seed and fertilizer were obtained only when the level of competition among plants within rows was relatively low. At higher levels, decreases in individual plant size did not allow any increase in yield.

The results at several seeding rates indicated that yield was influenced by the competition among plants. This competition affected plant size and was apparently determined not only by plant number but other factors, such as the environment following seeding.

U. Ill., Urbana, Ill.

Tesar, M. B., and Shepherd, L. N. EVALUATION OF FORAGE SPECIES ON ORGANIC SOIL. *Agron. J.* 55:131-134. 1963.

Hay yields of 8 grasses and 4 legumes were compared for a 4-year period on a Houghton muck soil in Michigan. Grimm alfalfa, Ladino white clover, and Empire birds-foot trefoil were unproductive after the first harvest year and were severely invaded by grasses and weeds in the second harvest year. Big trefoil did not survive the first winter.

Reed canarygrass (4.28 tons), Alta tall fescue (3.89 tons), and orchardgrass (3.43 tons) were the most productive species and the most resistant to weed invasion. Northern type bromegrass (2.80 tons) was more productive in the 4-year period than southern bromegrass (2.42 tons) and maintained its production much better in the fourth year (1.74 vs. 0.06 tons). During the first 2 years, southern type bromegrass produced 3.80 tons compared to 3.30 tons for northern bromegrass.

The high productivity, resistance to invasion by other grasses or weedy species, and persistence of orchardgrass indicated that this species warrants testing in grazing trials on organic soils in order to determine its value in comparison to the less palatable reed canarygrass or the more palatable bromegrass.

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

Rumburg, C. B. PRODUCTION OF REGROWTH FORAGE ON NATIVE FLOOD MEADOWS. Agron. J. 55: 245-247. 1963.

Native meadows were managed to produce 2 crops during the same growing season. Irrigation alone produced regrowth yields of 300 to 600 pounds of dry matter per acre. Nitrogen, in combination with irrigation, added 9 pounds dry matter per pound of N over a wide range of N levels. N also increased hay yields the following year.

Phosphorus had no effect on regrowth yields or on hay yields the following year.

Harvesting hay earlier in the season increased yields of regrowth without decreasing hay yields. Earlier harvesting also conserved soil moisture which would tend to reduce the amount of irrigation water necessary.

The crude-protein content of unfertilized regrowth forage was 8.76 percent in 1959 and 11.3 percent in 1960. Increasing levels of N fertilizer increased the crude-protein content.

Native meadows can be managed, through irrigation and fertilization, to produce two crops during the same growing season. Rush-sedge grass meadows were not particularly well-adapted to a two-crop system of management because of the slow recovery after harvest and low production of the second crop.

CRD, ARS, USDA, Burns, Oreg.

Carder, A. C. CONTROL OF YELLOW TOADFLAX BY GRASS COMPETITION PLUS 2,4-D. Weeds 11: 13-14. 1963.

Smooth bromegrass (*Bromus inermis*) and red fescue (*Festuca rubra*) were sown in 1952 on a fertile soil severely infested with yellow toadflax (*Linaria vulgaris* Mill.) in the Peace River section of Alberta. Annual applications of 2,4-D were made at late flower-bud stage at nil, 1, 2, 3, and 4 lb./A. acid equiv. In 1958, the average percent of toadflax in the brome was 1, 0.5, 0.5, 0, and 0, respectively. Red fescue had 6 to 0.1 percent of toadflax. All rates of 2,4-D prevented seed production. The sods were broken in 1959, and toadflax re-established strongly on all plots from dormant seed and residual plants. In 1961, the brome, rejuvenated by breaking, strongly suppressed toadflax while fescue failed to compete with it.

Expt. Farm, Beaverlodge, Alberta, Canada.

Fink, R. J., and Fletchall, O. H. FORAGE CROPESTABLISHMENT IN SOIL CONTAINING ATRAZINE OR SIMAZINE RESIDUES. Weeds 11: 81-83. 1963.

Four forage grasses and five forage legumes were grown in greenhouse cultures containing 0.12, 0.25, 0.50, and 1.0 p.p.m. of atrazine and of simazine in the soil. They were also planted April 2 and 9 in field plots that had been treated the previous spring with 0, 1, 2, and 4 lb./A. of the same herbicides. In the greenhouse, atrazine produced more injury to the plants than simazine. In the field, residual simazine produced more marked injury. Tall fescue and alfalfa were the most tolerant crops. Timothy was the most susceptible. Red clover, Korean lespedeza, ladino clover, sweetclover, orchardgrass, and bromegrass were intermediate.

Jr. Author U. Mo., Columbia, Mo.

Rangelands

Riegel, D. A., Albertson, F. W., Tomanek, G. W., and Kinsinger, F. E. EFFECTS OF GRAZING AND PROTECTION ON A TWENTY-YEAR-OLD SEEDING. *J. Range Managt.* 10: 60-63. 1963.

Study of a seeded area after 20 years of protection and 17 years of moderate grazing revealed many characteristics of an upland area in west-central Kansas.

Three different grass mixtures were seeded on a clay upland site characterized by a heavy silty clay loam to silty clay soil. The grass mixtures used were: (1) Bluestem mixture containing big and little bluestem, sideoats grama, and switchgrass; (2) blue grama only; and (3) western wheatgrass-grama mixture with western wheatgrass, blue grama, and sideoats grama.

Big bluestem and little bluestem were maintained on the clay upland site under protection. After 20 years of protection, the 2 bluestems formed 90 percent of the total plant population where the bluestem mixture was seeded. Only small amounts of the bluestems occur in an adjacent similar native prairie. The two bluestems and switch grass successfully invaded a stand of blue grama (one of the dominants of the clay upland) when protected from grazing.

Moderate grazing greatly reduced the abundance of the bluestems. Blue grama was the most abundant grass in the grazed area seeded to bluestem mixture, but many of the taller grasses were still present in larger amounts than on native prairie. No significant invasion of blue grama by the taller grasses occurred under moderate grazing.

All three grasses in the wheatgrass-grama mixture seeding were still dominant after 20 years of protection. Moderate grazing reduced the relative amount of western wheatgrass and allowed blue grama and sideoats grama to increase but all three were sufficiently abundant to be considered dominants. Invasion of the blue grama seeding by the two taller grasses occurred to a limited extent and only when protected from grazing.

Areas seeded to pure blue grama were relatively stable after 20 years when subjected to moderate grazing.

Production from the bluestem mixture when protected was over 2- $\frac{1}{2}$ tons in 1961, but 17 years of moderate grazing had reduced it to slightly over 1 ton for the same year. Production on the blue grama seeding was nearly equal on grazed and ungrazed areas but moderate use did reduce the yield on the wheatgrass-grama mixture.

Variation in production of the three mixtures was not as great under moderate use as it was when the areas were protected from grazing. Yields from moderately grazed bluestem mixture and blue grama were nearly equal while the wheatgrass-grama area produced nearly one-third more forage.

Average yields of native and seeded grasslands for the past 17 years were about equal indicating that the site potential under grazing was about the same regardless of species.

The use of dominant, native grasses in a seeding mixture was recommended. The clay upland site was capable of maintaining tall grasses with complete protection but not with moderate use.

Previous history of cultivation may influence the type of grasses the soil will support. Adjoining native grasslands on the same soil type protected for 30 years and close to a seed source of the bluestems did not support big and little bluestem.

Fort Hays Kans. State Col., Hays, Kans.

Houston, W. R. SALT CONSUMPTION BY BREEDING COWS ON NATIVE RANGE IN THE NORTHERN GREAT PLAINS. *J. Range Managt.* 16: 12-16. 1963.

Salt consumption by breeding cows on native range typical of the drier portion of the Northern Great Plains was studied from 1951-57. Six groups of Hereford cows and calves

were grazed each at a different stocking rate on separate summer and winter ranges. Calves were born on the winter range. Average winter feeding was about 3/4 ton of hay per cow.

Ground stock salt was available free-choice to each group throughout the year. No other minerals or additives were furnished. Salt consumption was determined by individual animal groups at 28-day intervals.

Salt consumption apparently was not influenced by stocking rate, but may have been by presence of saline soils or lack of browse forage or both during the summer and by lack of access to browse forage during the winter.

Salt consumption was apparently affected by weather. A high correlation was found between May-June precipitation and salt consumption that year. It is possible that some combination of leaching of dry forage or dilution of salt in plants or both by the higher precipitation is the decisive factor of the weather influence.

Salt consumption was much higher during August, September, and October than during any other time of the year, and it increased rapidly during this time. The increased consumption during this period is probably due to some combination of use by growing calves in addition to the use by cows, and possibly by increased consumption by cows grazing forage leached of part of the mineral and salts.

CRD, ARS, USDA, Miles City, Mont.

Schmutz, E. M., Holt, G. A., and Michaels, C. C. GRAZED-CLASS METHOD OF ESTIMATING FORAGE UTILIZATION. *J. Range Managt.* 10: 54-59. 1963.

A grazed-class method of estimating range utilization combines the advantages of several systems in use. It was proposed for use in both administrative and research phases of range management.

The method is based on a procedure that classifies grazed plants into six grazed-classes--0, 10, 30, 50, 70, and 90 percent use. Photographic guides, developed from height-weight curves of average local plants, are used for each key species to guide the examiner in placing grazed plants into the grazed-classes. Representative samples of 20, 25, 50, or 100 plants, located by toe-pace transects, are estimated for each key species to determine the percentage of grazed plants in each grazed-class. Current utilization is calculated by multiplying the average use factor for each grazed-class by the corresponding percentage of grazed plants in each class and totaling the products. Based on this percentage of current use, plus data on the cow months grazed and proper use of the key species, the cow months remaining and the total proper use can be estimated by simple calculations.

The method was tested against the weight-method and was found to be fast, simple, statistically sound, and reasonably accurate. Estimates were made on two species, sideoats grama and black grama, representing a bunchgrass and sodgrass type growth. After only a few hours use of the method, statistically satisfactory estimates were made by both experienced and inexperienced examiners.

The use of photographic guides makes possible the estimation of utilization based on forage removed (but also shows herbage remaining) and facilitates judgment of irregular grazing on the plant. Errors are compensating and guides can be easily checked against clipped weights.

The method requires reasonably close correlation between the photographic guide and: (1) The height-weight curve of the average plant used to make the guide; and (2) the growth form of the plants estimated in the field, but permits considerable variation in height of plants.

The grazed-class method is easily adapted to use by ranchers, technicians, or research workers. Many problems in utilization remain to be solved and the grazed-class method offers a tool to help solve these problems.

SCS, USDA, and Agr. Expt. Sta., U. Ariz., Tucson, Ariz.

Hadley, E. B., and Kieckhefer, B. J. PRODUCTIVITY OF TWO PRAIRIE GRASSES IN RELATION TO FIRE FREQUENCY. *Ecology* 44: 389-395. 1963.

The effects of fire frequency on living shoot, root, and litter biomass and flowering stalk production in east-central Illinois during the 1961 and 1962 growing seasons were discussed. Three burn conditions in 1961 and four burn conditions in 1962 were studied in communities dominated by big bluestem (*Andropogon furcatus*) and Indian grass (*Sorghastrum nutans*).

Living shoot biomass and flowering stalk production increased after spring burning in both community types. A 1-year period of non-burning resulted in marked decreases in living shoot and flowering stalk production. Significant differences in living shoot caloric values were noted between the burn conditions. These differences, while statistically significant, were of such low magnitude as to be of questionable ecological importance. While root biomass was found to increase as a result of burning frequency, root biomass values remained fairly constant from year to year as long as burning frequency did not change, suggesting an equilibrium. Litter caloric values were not affected by burning frequency. Restoration of litter levels on burned plots to those of the unburned controls required at least a 2- to 3-year period of non-burning.

U. Ill., Urbana, Ill.

Torell, P. J., and Haas, R. H. HERBICIDAL CONTROL OF TALL LARKSPUR. *Weeds* 11: 10-13. 1963.

On the high-altitude western ranges, tall larkspurs are persistent cattle killers, The numerous species of *Delphinium* included in the tall larkspur group are generally regarded as the most dangerous poison weeds affecting cattle.

Herbicidal control of tall larkspur, (*Delphinium occidentale* Wats.) was investigated in the Sawtooth National Forest near Oakley, Idaho. When larkspur was in a prebud stage, 4 and 8 lb./A. of the propylene glycol butyl ether esters of silvex and 2,4,5-T gave good control, with significant increases in yield of native grasses. At the bud and flower stages neither herbicide gave satisfactory control at 12 lb./A. Granular silvex at 400 lb./A. total product (80 lb./A. ae) killed all larkspur with only slight injury to rabbitbrush, sagebrush, and native grasses. A chlorate-borate (25 to 75 percent) mixture gave a complete larkspur kill at 1740 lb./A.

U. Idaho Br. Expt. Sta., Parma, Idaho.

Cotner, M. L. CONTROLLING PINYON-JUNIPER. *Ariz. Agr. Expt. Sta., Rpt. 210*, 28 pp. 1963.

Nearly 75 million acres in the Southwest are classified as pinyon-juniper woodland. In recent decades the existing pinyon-juniper growth has increased in density and open grasslands have been invaded by these uneconomic plants. The competition for range forage

production primarily and water production for irrigation in some instances has prompted considerable investment to convert these areas to native forage production.

Of Arizona's 12.4 million pinyon-juniper woodland acreage, 10 percent has received control treatment mostly in the last decade, representing a total investment of about 4 million dollars. Not all pinyon-juniper sites are susceptible to treatment but, according to estimates, up to 50 percent of the woodland acreage on Federal lands in Arizona could be controlled with present methods.

One of the reasons for a decline in the rate of pinyon-juniper control in view of large acreages remaining to be controlled concerns the economics of the practice. The control work to date represents the more accessible, easier to control sites where cheaper methods were applicable. Future work may be more expensive. Ranchers are concerned that the benefits are insufficient to cover the costs of control.

The leading methods of control are cabling, bulldozing, individual tree burning, and hand-chopping. Per acre costs vary considerably between the different techniques and for each technique depending on tree densities, sizes, terrain features, and many other characteristics. In an analysis of recent project records, cabling costs averaged \$2.06 while bulldozing averaged \$4.53 per acre. The costs ranged from a low of \$0.11 per acre to a high of \$12.39 per acre.

Procedures and basic data were provided to aid ranch managers in predicting costs for their particular pinyon-juniper sites. When the pertinent equipment and labor rates are used, the least-cost control method can be determined and the level of costs for economic decision purposes can be predicted.

U. Ariz., Agr. Expt. Sta., Tucson, Ariz.

Wagle, R. F., and Schmutz, E. M. THE EFFECT OF FENURON ON FOUR SOUTHWESTERN SHRUBS. *Weeds* 11: 149-157. 1963.

The injurious effects of different rates of fenuron on four species of brush were recorded for 2 years in two different types of southwestern brushland, the Oak-chaparral and the Chihuahuan Desert Shrub. Fenuron was more injurious to fire sprouts than to mature plants of turbinella oak (Quercus tubinella Greene) in the Oak-chaparral type especially at 2 to 8 lb./A. The effects of fenuron on mature plants were reduced by burning, suggesting that much of the fenuron absorbed was residual in the stems, twigs, and leaves where it was destroyed by the fire. The effect of fenuron on the fire sprouts changed only slightly between 6 months and 2 years. Gibberellic acid was applied to sprouts and mature oak plants appeared to slightly reduce the injurious effects of some rates of fenuron during the first 6 months but no gibberellin induced differences were observed after 2 years. In the Chihuahuan Desert shrub type, tarbush (Flourenzia cernua DC.) and whitethorn (Acacia constricta Benth.) were about equally susceptible to injury by fenuron with creosotebush (Larrea tridentata (DC.) Cov.) slightly more resistant. Summer applications just before the rainy season were most effective and 4 lb./A. combined high shrub kill with greatest grass growth.

Although 8 and 16 lb./A. killed and injured both grasses and shrubs on the oak plots, grass naturally reseeded into these plots within 6 months after treatment, but on the Chihuahuan Desert area grass had not recovered on the plots treated at 8 lb./A. after 2 years. This difference in grass re-establishment was probably due to rainfall differences which would give differences in leaching of fenuron. Palatability of the grasses in the oak plots increased due to fenuron treatments, particularly on the heavily treated plots. These studies indicate that moderate rates of fenuron, applied just prior to favorable seasonal rains

and repeated at several-year intervals, may be used to control turbinella oak sprouts and mature Chihuahuan Desert shrubs. However, treatments would only be economical where high forage and watershed values would result.

U. Ariz., Tucson, Ariz.

Plant Materials

Pardee, W. D., and Lowe, C. C. SEED PRODUCTION POTENTIAL AND MANAGEMENT REQUIREMENTS OF FIVE IMPROVED FORAGE GRASS VARIETIES IN THE HUMID NORTHEAST. *Agron. J.* 55: 120-123. 1963.

A series of investigations were conducted to determine if any of five improved grass varieties might profitably be grown for seed production under the humid conditions of the Northeast. Studies were conducted to measure the effect on subsequent seed yields of: (1) Various companion crops used in establishment of seedings; (2) the use of row seedings vs. solid stands; (3) planting dates; and (4) various rates and dates of nitrogen fertilization. The level of seed yield obtained from each variety was used to evaluate its potential as a cash seed crop for the area. Climax and Essex timothy, Saratoga bromegrass, and Potomac and N.Y. Syn. E. orchardgrasses were the varieties studied.

Companion-crop studies indicated that orchardgrass and timothy varieties were successfully established in fall plantings seeded either alone or with winter wheat or winter barley as a companion crop. Fall plantings of Saratoga bromegrass were less successful than spring seedings. First-year seed yields for timothy varieties planted in the fall were equal to or higher in value than a winter wheat crop. Orchardgrass varieties did not head out fully during the first season following a fall seeding. Spring plantings seeded alone or with oats were all successfully established. The use of an oat companion crop was advisable with spring seedings to provide a cash crop during the year of establishment.

Performance of row plantings vs. solid stands varied with locations for timothy and bromegrass. Orchardgrass yields varied between years with solid stands outyielding rows in the first harvest year but not in the second. Although the experiments indicated a general advantage for row plantings, field experience showed that the necessary timing of cultivations for row culture was in conflict with other farm operations.

Small spring applications of nitrogen resulted in profitable responses from plantings of Saratoga bromegrass and Essex timothy made the previous fall. On older, established stands of Saratoga bromegrass, 30- to 50-pound rates in the early fall were the most efficient. Fall and early spring applications of 40 pounds of N on timothy were equally effective, but fall applications were found more practical in production fields.

In general, seed yields of the two orchardgrass varieties were too low to be profitable under New York conditions. Saratoga bromegrass seed yields were variable and, because of quackgrass contamination, offered little chance for profitable seed production.

Climax and Essex timothy consistently gave good seed yields and showed promise of being profitable cash crops in the northeast.

Cornell U., Ithaca, N.Y.

Woodlands

Ellerbe, C. M., and SMITH, G. E., Jr. APPARENT INFLUENCE OF PHOSPHATE MARL ON SITE INDEX OF LOBLOLLY PINE IN THE LOWER COASTAL PLAIN OF SOUTH CAROLINA. *J. Forestry* 61: 284-286. 1963.

Soil-site correlation studies in the Lower Coastal Plain of South Carolina showed wide ranges in site index of loblolly pine (*Pinus taeda* L.) with certain soil series. Measured site

indexes were frequently higher than site indexes estimated from prediction charts prepared by Coile and Auten. The variations occurred in localized areas. These areas appeared to correspond to areas where phosphate marl was present or had been mined for phosphate. Detailed studies of phosphate deposits in South Carolina suggested the need for field examinations to determine whether or not phosphate marl influenced site index of loblolly pine. Field data and laboratory analysis of soil samples indicated average site index of loblolly pine on areas influenced by phosphate was 16 points higher than on areas not influenced. It was suggested that phosphatic phases of these soils should be recognized in making soil surveys.

SCS, USDA, Columbia, S.C.

Linnartz, N. E. RELATION OF SOIL AND TOPOGRAPHIC CHARACTERISTICS TO SITE QUALITY FOR SOUTHERN PINES IN THE FLORIDA PARISHES OF LOUISIANA. *J. Forestry* 61: 434-438. 1963.

By regression analyses, certain soil and topographic features were found to be significantly related to the site index of loblolly, longleaf, and slash pines in southeastern Louisiana. Depth to the least permeable layer in the soil profile, percent sand in the subsoil, and the pH of the subsoil were related to the site index of loblolly pine. Site index of slash pine was related to: (1) Depth to the least permeable layer; (2) percent sand in the topsoil and in the subsoil; and (3) degree of internal drainage. Longleaf site index was related to: (1) The sand content of the subsoil; (2) the slope; and (3) the degree of surface drainage. For each species, the regression equation which involves these variables was recommended for use in estimating the site index of the given pine species on sites for which no soil survey maps were available. The field guide based on soil series and mapping units was recommended for determining the site index when a soil survey map was available.

La. Agr. Expt. Sta., Baton Rouge, La.

McGee, C. E., and Hatcher, J. B. DEEP-PLANTING SMALL SLASH PINE ON OLD FIELD SITES IN THE CAROLINA SANDHILLS. *J. Forestry* 61: 382-383. 1963.

The effect of deep-planting on survival and growth of small slash pine seedlings was studied on furrowed old fields in the Savannah River Project near Aiken, S.C. Seedlings were graded on size and root development, and planted at three depths: To the bud; halfway between root collar and bud; and at standard nursery depth. Each treatment was replicated three times on three surface soil types--sand, sandy loam, and loamy sand.

In all cases, deep-planting improved fifth-year survival. Planting to the bud was best, and planting halfway between root collar and bud was better than standard planting. The best 5-year height growth was obtained by planting halfway between root collar and the bud. Large seedlings had over-all better survival and height growth than smaller seedlings, but grade of stock caused no significant difference in survival when seedlings were planted to a bud.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

Gilmore, A. R., and Boggess, W. R. EFFECTS OF PAST AGRICULTURAL PRACTICES ON THE SURVIVAL AND GROWTH OF PLANTED TREES. *Soil Sci. Soc. Amer. Proc.* 27: 98-102. 1963.

Four pine species (loblolly, shortleaf, red, and white) and three hardwood species (sycamore, green ash, and yellow-poplar) were planted on a recently abandoned agronomic

experimental field in southern Illinois that had been used for 40 years to test crop rotations with various soil and fertilizer practices. After 7 growing seasons, pine survival and growth were poorest on the old limed plots (attributed to competition from weeds). After 6 growing seasons, hardwood survival and growth were best on the old limed plots. The effect of the tree species and the past fertilizer practices upon the chemical composition of the soil were given. Five years after plots were planted to pines, soil organic matter remained approximately the same on fertilized plots but nearly doubled on unfertilized plots.

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

Trousdell, K. B. LOBLOLLY PINE REGENERATION FROM SEED--WHAT DO SITE PREPARATION AND CULTURAL MEASURES BUY? *J. Forestry* 61:441-444. 1963.

Logging heavy volumes of mature sawtimber with crawler tractors, plus hardwood control by frilling, were adequate site preparation on heavy-textured soils, and here neither burning nor disking could be justified. The cost of free-to-grow stocking, with seed tree marking as the only cost, was 2 cents per percentage point. If near optimum growth can be expected for 60-percent plus stocking, all stands exceed this level on these soils.

On light-textured soils, logging with hardwood control was less effective and, although costs were low (3 cents per percentage point), additional site preparation was often justified because predicted milacre stocking was less than 60 percent. Stocking below 60 percent is expected to reduce early growth.

Burning and disking improved stocking and were equally effective within a wide range of seeding. Stocking was increased at a cost of \$1.62 per percentage point by disking, and ranged from \$0.26 to \$0.86 for burning. Disking was not justified under the conditions of this experiment. When the proportion of good seedbed expected from logging was low or seed supplies were small, additional site preparation by burning was recommended.

Cost of removing large hardwoods was directly related to square feet of basal area of trees per acre. In regenerated stands that are medium to well-stocked, the removal of 20 square feet increased stocking 13 to 20 percent at a cost of \$0.29 to \$0.19 per percentage point. Improved stocking that resulted from the control of large hardwoods increased pine growth at all levels of stocking.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

Staebler, G. R. GROWTH ALONG THE STEMS OF FULL-CROWNED DOUGLAS-FIR TREES AFTER PRUNING TO SPECIFIED HEIGHTS. *J. Forestry* 61:124-127. 1963.

Twenty trees from 22 to 55 feet tall were pruned to 0, 1/3, 1/2, and 2/3 of their total height. Diameter measurements after 1 and 2 years at several points along the bole showed that 1/3 removal affected growth and form little or not at all. Volume growth was reduced by heavier removals but was so distributed that a more nearly cylindrical bole resulted. Height growth was reduced by the 2/3 pruning, but insignificantly by lesser removals.

Weyerhaeuser Co., Forestry Res. Cent., Centralia, Wash.

Lemmon, P. E., and Schumacher, F. X. THEORETICAL GROWTH AND YIELD OF HYPOTHETICAL PONDEROSA PINE STANDS UNDER DIFFERENT THINNING REGIMES. *Forest Sci.* 9: 33-43. 1963.

A model was presented for computing theoretical results under different thinning management. Statistics for the dominant portion of normal, unmanaged stands on different site classes provide starting data at age 30. A tree-growth equation estimates diameter growth following thinning. Two diameter-based spacing rules to control stocking were studied: (1) Mitchell's $S = (D + X)^2$ and; (2) a new biological spacing rule $S = (D + X)^2 F$. In these, S is the average space provided per tree in square feet, D is the diameter of the dominant and codominant tree of average basal area, X is a value added to the diameter in inches, and F is a factor, specific for each site class, varying with age up to about 50 years, then becoming a constant. F values are read from curves. Suitable combinations of spacing (values for X) and thinning intervals are: Mitchell's rule, X = 6 for all sites using thinning intervals of 20 years for site 60, 12 years for site 80, 9 years for site 100, 7 years for site 120, and 5 years for site 140; for the biological rule, suitable combinations are, $(D + 0.5)^2 F$ every 5 years, $(D + 1.1)^2 F$ every 10 years, $(D + 1.8)^2 F$ every 15 years, or $(D + 2.2)^2 F$ every 20 years. Other combinations may be read from curves. Examples of theoretical growth and yield were computed for site indexes 60, 80, 100, 120, and 140 for both rules. Little difference in average diameter at rotation end resulted from use of the two rules. A range of combinations is suitable where residual trees appear to be held in "free-growing" condition. Diameters at rotation end were greater for thinned than for the dominant portion of normal unthinned stands except for site 80 (essentially equal) and site 60 (much less). Total yields of cubic- and board-foot volumes at rotation end in thinned stands under the biological rule exceeded those under Mitchell's rule, but both were greater than from normal unthinned stands except in two instances.

SCS, USDA, Washington, D.C. 20250

Trousdell, K. B., and Wenger, K. F. SOME FACTORS OF CLIMATE AND SOIL AFFECTING ESTABLISHMENT OF LOBLOLLY PINE STANDS. *Forest Sci.* 9: 130-136. 1963.

In the coastal plain of North Carolina, data collected over 10 years from burned, disked, or untreated logged tracts showed that the number of 1-year-old seedlings from natural seeding of *Pinus taeda* L. was directly related to the seed available and inversely related to April-through-June rainfall. With a given amount of seed, more seedlings were established on mineral soil than on burned seedbeds, and more on heavy-textured than on light-textured soils. Milacre stocking of free-to-grow seedlings 3 years after treatment depended on total milacre stocking in the first year, was reduced in proportion to basal area of residual hardwoods larger than 4.5 inches d.b.h. and was greater on heavy-textured than on light-textured soils.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

Cook, D. B. SPACING AND LAYOUT FOR CONIFEROUS PLANTATIONS IN THE NORTHEAST. *J. Forestry* 61: 273-277. 1963.

In the Northeast, the traditional and widely recommended planting pattern of 6 x 6 foot squares arranged in straight lines has proved expensive. It involves both high establishment costs and high subsequent cultural expense. Trees are planted that serve no better purpose

than as space fillers and as insurance against catastrophic losses. Only rarely are conscious provisions made for easy, safe, and efficient extraction of forest products. Plantations made at a spacing of 6 x 10 feet, in equidistant rows laid out with due regard for subsequent skidding requirements, not only provide adequate growing space and ample working room and save 40 percent in the cost of establishment, but also eliminate the need for at least one noncommercial thinning--an operation hard to perform and even harder to persuade the forest landowner to perform.

Cooxrox Forest, Albany, N.Y.

Alexander, R. R. HARVEST CUTTING OLD-GROWTH MOUNTAIN SPRUCE-FIR IN COLORADO. *J. Forestry* 61: 115-119. 1963.

In the Fraser Experimental Forest, a study was started in 1944 to test harvesting methods in overmature mountain spruce-fir stands. Treatments were: (1) Alternate clear-strip where 50 percent of the merchantable volume was removed by clearcutting one-half of the area in alternate strips 66 feet wide and an additional 10 percent of the volume by improvement cutting in the leave strips; (2) circular patch clear-cutting where 50 percent of the merchantable volume was harvested by clearcutting one-third of the area in circular groups 66 feet in diameter, and an additional 10 percent of the volume by improvement cutting in the between-group stand; (3) individual tree selection where 60 percent of the volume was cut by selecting individual trees over the entire area; and (4) uncut.

Reproduction surveys were made before logging, in 1949, and in 1959. Growth and mortality measurements were made in 1955.

Enough advanced reproduction survived logging in 1944 to provide a well-stocked replacement stand under all harvesting methods, but the composition was largely fir. Good stocking of abundant reproduction followed all methods of cutting. Composition of reproduction insured abundant spruce in the overstory of the new stands.

The rate of growth in residual stands was not stimulated by any of the cutting methods tested. Mean annual net increment on all plots was related to reserve volume. Mortality was not reduced by any of the cutting methods because of heavy windfall losses in the cut-over stands.

Alternate strip cutting was recommended as the best method tested for harvesting old-growth spruce-fir. More abundant and better distributed reproduction was established under the cutting system. Windfall losses were reduced by: (1) Increasing the width of cut and leave strips; and (2) eliminating improvement cutting in the leave strips.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

McCormack, M. L., and Korstian, C. F. CONVERSION OF POST OAK-BLACKJACK OAK TYPE TO PINE IN THE NORTH CAROLINA PIEDMONT. *J. Forestry* 61: 445-446. 1963.

Conversion by both natural reproduction and clearcutting and planting was found to be satisfactory for replacing low value stands of the post oak-blackjack oak type with faster growing, desirable species of higher value. The treatments described could be applied in similar stands where merchantable hardwoods and cedars would contribute toward the cost of the treatment. The treatments resulted in freeing a sufficient number of desirable pine and cedar to form the major components of the stands. The untreated area has undergone relatively little change, with most of the growth occurring on poor quality oaks, and with the pines still minor components of the stand.

Southern Ill. U., Carbondale, Ill.

Shipman, R. D. SCRUB OAK CONTROL WITH FENURON PELLETS IN THE SOUTH CAROLINA SANDHILLS. *J. Forestry* 61: 217-220. 1963.

Satisfactory first year results on the control of scrub oaks--principally Turkey oaks (*Quercus laevis* Walt.)--were obtained after a broadcast application of fenuron pellets on Sandhill sites. One-year old longleaf and slash pine seedlings were interplanted among the scrub oaks, and pellets were applied 1 month after planting. At rates of 30, 40, and 60 pounds per acre (by weight) applied to light sandy soils, no significant differences in the number of scrub oaks killed was observed. First year survival of longleaf and slash pines was 68 and 76 percent, respectively, and both species exhibited good vigor with virtually no discoloration or after-treatment effects. The use of these dry, pelletized herbicides for area-wise and selective control of unwanted hardwoods appears promising. Additional studies on soil and site effects, minimum rates of application, prospects for aerial distribution, and climatic influences preceding and following pelletizing are currently under way.

Clemson Col., Clemson, S.C.

Kozlowski, T. T., and Kuntz, J. E. EFFECTS OF SIMAZINE, ATRAZINE, PROPАЗINE, AND EPTAM ON GROWTH AND DEVELOPMENT OF PINE SEEDLINGS. *Soil Sci.* 95: 164-174. 1963.

Effects of herbicide dosage and time of application of simazine, atrazine, propazine, and eptam on growth and development of red pine (*Pinus resinosa* Ait.) and white pine (*Pinus strobus* L.) seedlings were studied.

Applying simazine, atrazine, or propazine as a pre-emergence spray or directly to young seedlings caused severe damage. Although seeds germinated and seedlings emerged uniformly, cotyledons of young seedlings became twisted and incurled, especially following atrazine treatment. Many seedlings showed severe distortion and eventually died. Injury and mortality increased as herbicide dosage increased. Atrazine as a post-emergence spray caused formative effects even on older seedlings, in contrast to no visible effects following simazine treatment.

More seedlings, greater total dry weight of seedlings, and less injury resulted as application of the herbicides was delayed.

Red pine seedlings were much more susceptible to injury than were white pine seedlings. Early injury was greater to red pine seedlings growing in composted silt-loam greenhouse soil than in Plainfield s.

With eptam, time of application was less critical than with the triazines, and little injury occurred at the rates used.

Simazine, atrazine, and propazine did not leach readily from the surface inch of Plainfield s when 2, 4, or 8 surface inches of water were applied.

No injury occurred to 2-0 red pine when simazine was applied to the soil surface at 4 or 8 pounds per acre or when simazine was applied to the foliage only. When, however, amounts of simazine equivalent to 4 or 8 pounds per acre (soil surface basis) were incorporated into the soil, especially in the root zone, severe injury resulted and seedlings eventually were killed.

Young seedlings were killed by triazine herbicides, but older seedlings were not, because the roots of the older seedlings normally were below the layers of soil which contained phytotoxic amounts of these chemicals.

U. Wis., Madison, Wis.

Carlson, G. W. IN THE INTERMOUNTAIN REGION; MULTIPLE USE MANAGEMENT OF NATIONAL FORESTS. J. Soil and Water Conserv. 18: 117-120. 1963.

Information about the national forests in the Intermountain Region was given along with the planning guidelines and techniques used by the Forest Service to achieve multiple use of national forest lands.

Div. of Watershed and Multiple Use, Intermountain Region, FS, USDA, Ogden, Utah.

Windbreaks

George, E. J., Broberg, D., and Worthington, E. L. INFLUENCE OF VARIOUS TYPES OF FIELD WINDBREAKS ON REDUCING WIND VELOCITIES AND DEPOSITING SNOW. J. Forestry 61: 345-349. 1963.

Comparisons were made of wind velocities and snowdrift patterns on the windward and leeward sides of windbreaks and slat barriers of varying numbers of rows, designs, and densities. Density was determined by placing a dotted grid over a picture enlargement and then computing the space occupied. Windbreaks and barriers, which were permeable in the lower half of the structure, caused snowdrifts to form over a wider area than the less permeable ones. Such permeable structures also reduced most erosive wind velocities to a non-erosive rate. Between a series of windbreaks spaced 400 feet apart wind, velocities and snowdrift deposits indicated the series had no cumulative effect on wind reduction. Proper tillage practices must still be used in conjunction with windbreaks or other structures to control wind erosion of fields.

A windbreak or barrier that would reduce wind to about threshold velocity appears to be the most satisfactory. The cottonwood windbreak and slat barriers gave the best snow distribution and reduced most wind velocities to below an erosive rate.

Further study is needed to determine the best type of windbreak for protection of fields against soil blowing and for distributing drifting snow to build up soil moisture. As the barrier became more open in the lower part, the greatest velocity wind reduction, within certain limitations, moved further away from the barrier. Present data indicate the more open barriers combined with proper tillage practices will give better results than the denser type of windbreaks now commonly planted. The open single-row belts require less valuable farm land and give a better snow distribution over the crop area. The dense-type multiple-row windbreak is still recommended for protection of farm buildings, livestock, and feedlots where immediate trapping of drifting snow is important.

CRD, ARS, USDA, Mandan, N. Dak.

Management of Coffee Plantations

Abruna, F., and Vicente-Chandler, J. EFFECTS OF SIX SOURCES OF NITROGEN ON YIELDS, SOIL ACIDITY, AND LEAF COMPOSITION OF COFFEE. J. Agr. U. Puerto Rico 47(1): 41-46. 1963.

The effects of heavy applications of nitrogen from six different sources on yields and leaf composition of intensively managed coffee and on acidity of a Los Guineos soil were determined under typical conditions in the coffee region of Puerto Rico.

Lowest yields were obtained when nitrogen was applied as sodium nitrate. Applications of ammonium sulfate, ammonium nitrate, potassium nitrate, ammonium nitrate-lime, and urea resulted in high yields of coffee.

Coffee leaves from plots on which the different sources of nitrogen were used were similar in nitrogen, calcium, potassium, magnesium, and phosphorus contents. Leaves from the sodium nitrate plots were highest in sodium content and those from the ammonium sulfate plots were highest in manganese content.

Soil pH was lowest in the ammonium sulfate, urea, and ammonium nitrate plots, and highest in the sodium nitrate, potassium nitrate, and ammonium nitrate-lime plots. Soil from the sodium nitrate plots was highest in exchangeable sodium.

Sodium nitrate should not be used as a source of nitrogen for coffee. The desirability of using nitrogen sources other than ammonium sulfate on soils with a high content of manganese was discussed.

U. Puerto Rico Agr. Expt. Sta., Rio Piedras, Puerto Rico.

Fruit and Nut Crops

Shoemaker, J. S., and Young, H. W. INFLUENCE OF PRUNING ON YIELD AND SIZE OF PEACHES. Fla. State Hort. Soc. 1961. Proc. 74: 353-356. 1962.

Moderate pruning resulted in production of more fruits than heavy or very heavy pruning in each of the first 3 crops.

The first crop naturally was light, but moderate pruning resulted in comparatively large well-formed trees for higher yields in the succeeding years.

In the second crop, the increase in yield of moderately over heavily pruned trees was 29.7 bushels per acre. Removing 50 percent of the young fruits by thinning increased the average fruit size 1 grade (1/8 inch) in moderately and heavily pruned trees compared with unthinned, very heavily pruned trees, or from 1-7/8-2 inches to 2-2-1/8 inches. However, yield was reduced in relation to the number of fruits removed in thinning.

The 50 percent thinned, moderately and heavily pruned trees each produced a higher percent of the largest fruit in the first 3 pickings than did the unthinned, very heavily pruned trees. Roughly half the total crop from unthinned, very heavily pruned trees was comparatively late (last 2 pickings) in maturing and small in fruit size.

Weather had a major influence on fruit size. Rain plus a 4-day instead of a 2-day interval between pickings resulted in markedly increased fruit size in the next picking in the second crop.

In the third crop, in a year characterized by marginal chilling in early winter and by a 7-week drought preceding and during harvest, yield was considerably lower than in the previous year. Fruit size was the same (1-1/2 to 1-5/8 inches) for all pruning and thinning treatments, but averaged 4 sizes smaller than in the previous year. Increase in yield from moderate pruning was 22.6 and 37.2 per acre, respectively, over heavy and very heavy pruning.

Fla. Agr. Expt. Sta., Gainesville, Fla.

Cooper, W. C. TOXICITY AND ACCUMULATION OF SALTS IN CITRUS TREES ON VARIOUS ROOTSTOCKS IN TEXAS. Fla. State Hort. Soc. 1961 Proc. 74: 95-104. 1962.

Salt-tolerance studies on citrus conducted in Texas were reviewed. The artificially salinized-soil-plot technique developed by the U.S. Salinity Laboratory was used to screen

the salt tolerance of Ruby Red grapefruit on various rootstocks. Saline water with the Cl anion predominating was used. The specificity of rootstock variety in conditioning the accumulation of chloride was outstanding. The manifestations of toxicity symptoms were closely related to the Cl content of the leaves. Rangpur lime, Cleopatra mandarin, and Severinia buxifolia were among the most Cl-tolerant rootstocks. The citranges and trifoliate orange were among the least Cl-tolerant.

In tests with various concentrations and proportions of Na in relation to other cations, Na accumulations were generally less than the Cl accumulations observed in the previous tests. Na concentration in foliage was conditioned by the rootstock variety. Na accumulation was higher in trees on mandarin rootstock than in trees on trifoliate orange hybrid rootstocks. Manifestations of salt injury were always associated with high concentrations of Cl in the leaves and not with Na accumulations.

SO₄ accumulation appeared to parallel Na accumulation, but there was no evidence of SO₄ toxicity even when the SO₄ anion predominated in the irrigation water.

In the B-tolerance tests, B content of the leaves of Ruby Red grapefruit varied from 64 p.p.m. for trees on Severinia buxifolia to nearly 507 p.p.m. for trees on sweet lemon and Cleopatra mandarin.

When trees on various rootstocks were irrigated with saline water contaminated with B, trees on certain rootstocks accumulated Cl but not B, and vice versa. Only Severinia buxifolia appeared to exclude both Cl and B.

Ca-salt amendments to a saline Na water and a non-saline HCO₃ water caused an appreciable beneficial influence on citrus.

Salt tolerance of virus-free young-line and old-line citrus varieties carrying xyloporosis and exocortis viruses did not differ substantially.

U.S. Hort. Sta., Orlando, Fla.

Saidak, W. J., and Rutherford, W. M. THE TOLERANCE OF YOUNG APPLE TREES TO AMITROLE, DIURON AND SIMAZINE, *Canad. J. Plant Sci.* 43: 113-118. 1963.

The growth of young apple trees was reduced by application of 24 pounds per acre of either simazine or diuron in a 2-year period. Application of 30 pounds per acre amitrole in the same period had no effect on tree growth, although some slight leaf chlorosis was observed. Adequate weed control for the growing season was obtained with a spring application of amitrole 5 pounds per acre and diuron or simazine 4 pounds per acre. Annual application rates of diuron or simazine should not exceed 6 pounds per acre, in order to avoid injury to young trees.

Res. Br., Canada Dept. Agr., Plant Res. Inst., Ottawa, Ontario, Canada.

Field Crops

Broadhead, D. M., Stokes, I. E., and Freeman, K. C. SORGO SPACING EXPERIMENTS IN MISSISSIPPI. *Agron. J.* 55: 164-166. 1963.

Spacings, plant arrangements, and plant arrangement X fertilizer interactions were studied with several sorgo varieties from 1943-59 at Meridian, State College, and Holly Springs, Miss. Spacings included plants in the drill from 1 to 20 inches apart, 2 plants in hills 16 inches apart, and 3 and 4 plants in hills 24 inches apart. Fertilizer treatments included complete fertilizers with 18, 36, and 54 pounds of nitrogen per acre and a fourth treatment of 36 pounds of nitrogen alone.

Yields of stalks and sirup per acre usually decreased rapidly when the space between single sorgo plants was more than 6 to 8 inches. Juice extraction and stalk weight decreased when plants were spaced closer than 6 to 8 inches in the drill. Two plants in hills 16 inches apart and 4 plants in hills 24 inches apart gave about the same Brix and yield of stalks as single plants drilled 8 inches apart. There was no interaction between spacing and fertilizer treatments for Brix or yield of stalks. Lodging increased with decreased spacing. Hill treatments required less seed for planting and less labor for thinning, cultivating, and harvesting. The slight increase in sirup yield per acre usually associated with the very close spacing (3 inches) was not considered sufficient to justify the increased cost of sirup or sugar production.

CRD, ARS, USDA, Miss. Agr. Expt. Sta. State College, Miss.

Garren, K. H., and Bailey, W. K. COMPARATIVE RESPONSES OF A VIRGINIA RUNNER AND A VIRGINIA BUNCH PEANUT TO CULTURAL CONTROL OF STEM ROT. *Agron. J.* 55: 290-293. 1963.

In Virginia, deep covering of organic trash and non-dirting cultivation were highly effective control measures for stem rot (caused by Sclerotium rolfsii) of Virginia Bunch 46-2, a typical Virginia bunch peanut, and for Virginia 56R, a typical Virginia runner peanut.

Slight differences in infection were recorded for the two varieties but the differences were not great enough to justify an assertion that the runner peanut was less susceptible to S. rolfsii infection than the bunch peanut.

Conventional cultivation caused tufting of laterals in bunch peanuts and made S. rolfsii infection easier to detect in bunch peanuts than in the low growing runner type. Greater ease of detecting stem rot in bunch peanuts might be the reason for the persistence of the concept of stem rot resistance in runner peanuts.

Cultural control measures were essentially as beneficial in reducing infection by S. rolfsii and increasing yield with Virginia 56R as with Virginia Bunch 46-2.

CRD, ARS, USDA, Holland, Va.

Phillips, S. H., and Loeffel, F. A. GROWING CORN IN KENTUCKY. *Ky. Ext. Serv. Agr. and Home Econ.* 588, 14 pp. 1963.

A "culture and care" publication of corn production in Kentucky was given.

U. Ky., Coop. Ext. Serv. Agr. and Home Econ., Lexington, Ky.

Mader, E. L., Peterson, V., and Hertz, L. PRODUCING SOYBEANS IN KANSAS. *Kans. Agr. Ext. Sta. B.* 458, 16 pp. 1963.

A "culture and care" publication on the production of soybeans in Kansas was given.

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

Crops and Soils. A PROGRESS REPORT...FLAME CULTIVATION FOR CORN? *Crops and Soils* 15(6): 7-9. 1963.

Flame cultivation is getting a lot of attention in the Midwest these days. Several farmers are using it on corn--but with varying results.

Flame cultivation is considered an economical and practical means of controlling mid- and late-season annual broadleaved weeds and grasses in the cotton row. It has been adapted by some Southern farmers for use on corn, sorghum, soybeans, and tobacco. It is even being tested on vegetables.

The following authors reported on flame cultivation in their respective states:

Liljedahl, J. B., Williams, J. L., and Albrecht, K. L., Purdue U., Lafayette, Ind.
Reece, F. N., Larson, G. H., and Fitzgerald, L. W., Kansas State U., Manhattan, Kans.
Knake, E. L., U. Ill., Urbana, Ill.

Knake, E. L., and Slife, F. W. WEED CONTROL IN FIELD CROPS. Ill. Agr. Expt. Sta. C. 856, 23 pp. 1963.

A combination of good cultural practices and chemical control is most effective for weed control. Good cultural practices include using clean seed, preparing the seedbed properly, making timely cultivations, following a good fertility program, and rotating crops. If weeds are not controlled by these normal cultural practices, chemical weed killers (herbicides) can often be used, more than repaying their cost by increasing yields. Chemical control should not replace cultural practices, but should be used in addition to them. Recommended chemical control practices were given for the various field crops in Illinois.

U. Ill., Col. Agr., Coop. Ext. Serv., Urbana, Ill.

Foy, C. L., and Miller, J. H. INFLUENCE OF DALAPON ON MATURITY, YIELD, AND SEED AND FIBER PROPERTIES OF COTTON. Weeds 11: 31-36. 1963.

Dalapon was applied as basally directed sprays to the field-grown cotton varieties Acala 4-42. Herbicidal rates of dalapon applied after heavy boll development (approximately 105 days after planting) were noninjurious; earlier applications appeared hazardous. Three or six pounds of dalapon per acre applied during early square or full flowering caused no noticeable injury symptoms but delayed maturity and reduced cotton yields in proportion to dosage. Analysis of eight seed and fiber properties showed no significant differences among treatments except for minor shifts attributed to dalapon-induced changes in maturity. Germination of seed from treated cotton was measurably retarded but final viability was not reduced. The retarding influence persisted for more than 2 years in storage. Accumulation of 8 to 21 p.p.m. dalapon in the seeds was demonstrated by colorimetric and isotope dilution methods of analysis.

U. Calif., Davis, Calif.

Wiese, A. F., and Martin, A. G. TOXICITY OF BENZOIC ACID HERBICIDES TO COTTON AND SOYBEANS. Weeds 11: 7-10. 1963.

Polychlorobenzoic acids (PBA), 2,3,6-trichlorobenzoic acid (2,3,6-TBA), and 2,3,6-trichlorophenylacetic acid (fenac) sprays were applied safely for the eradication of perennial

weeds at pressures of not over 20 pounds per square inch in winds less than 11 miles per hour in and near cotton. Use of these herbicides near soybeans was hazardous because very small quantities of them caused leaf deformities and some loss in seed yield.

Tex. Agr. Expt. Sta., Bushland, Tex.

Staniforth, D. W., Lovely, W. G., and Weber, C. R. ROLE OF HERBICIDES IN SOYBEAN PRODUCTION. Weeds 11: 96-98. 1963.

Band applications of the best residual preemergence herbicides were equal to timely shallow cultivations for weed control in soybeans and were superior when wet weather delayed the early shallow cultivations. The 10-year average soybean yield reduction of 3.8 bushels per acre from weed competition despite normal control methods suggests that, under normal conditions. The net cost of herbicide treatment would not exceed the value of the soybeans lost through failure to control weeds. Coarse broadleaved annuals were a minor part of the weed populations and there was no giant foxtail, so the benefits of herbicides would probably be greater with those weeds present.

Iowa State U., Ames, Iowa.

Grant, W. R., and Mullins, T. ENTERPRISE COSTS AND RETURNS ON RICE FARMS IN THE GRAND PRAIRIE, ARKANSAS. Ark. Agr. Expt. Sta. Ser. 119, 35 pp. 1963.

Several factors have caused major changes in the use of resources on rice farms. Increased supplies of rice during the early 1950's resulted in a return of rice acreage allotments in 1955. The resultant decrease in the acreage of rice released considerable land, irrigation facilities, farm equipment, labor, and capital for other uses. In addition, advances in technology have brought about improvements in production methods. Yields have been increased because of the use of new varieties, heavier rates of fertilization, and the development of effective chemicals for combating pests such as weeds and insects. These rapid technological changes make it advisable for rice producers to continuously re-evaluate their enterprise organization and production methods.

The choice of the combination of enterprises to use is influenced by the farm operator's knowledge of the input requirements and yields of crops adapted to his farm. Budgets were developed to show the annual labor, power, and machinery requirements, monthly labor distribution, and costs and returns for rice, soybeans, and oats. The table should be useful to farmers in evaluating their enterprise organization and in making decisions on the most profitable use of resources.

Costs and returns estimates for the various crop enterprises were presented for small farms and for medium and large farms for the different slope and level of technology situations.

Table.--Summary of Estimated Costs and Returns per Acre, by Farm Size and Level of Technology, Grand Prairie, Arkansas

Crop and Farm Size	Present technology				Advanced technology			
	Gross return	Specified expenses ¹	Labor	Net return ²	Gross return	Specified expenses ¹	Labor	Net return ²
Rice								
Small farm,	\$ 191.25	\$ 69.26	\$ 13.27	\$ 108.72	\$ 258.75	\$ 85.32	\$ 13.92	\$ 159.51
Medium and large farms,	191.25	71.28	13.27	106.70	258.75	87.80	13.92	157.03
Soybeans, nonirrigated, 0 to 1 percent slope								
Small farm,	56.40	23.59	5.49	27.32	72.85	26.44	5.40	41.01
Medium and large farms,	56.40	25.28	5.49	25.63	72.85	28.26	5.40	39.19
Soybeans, irrigated, 0 to 1 percent slope								
Small farm,	70.50	29.94	8.41	32.15	86.95	33.12	8.48	45.35
Medium and large farms,	70.50	31.76	8.41	30.33	86.95	35.19	8.48	43.28
Soybeans, nonirrigated, over 1 percent slope								
Small farm,	47.00	23.04	5.33	18.63	63.45	26.05	5.31	32.09
Medium and large farms,	47.00	24.58	5.33	17.09	63.45	27.77	5.31	30.37
Oats, 0 to 1 percent slope								
Small farm,	31.50	28.02	3.84	-0.36	49.00	36.38	4.25	8.37
Medium and large farms,	31.50	29.61	3.84	-1.95	49.00	38.34	4.25	6.41
Oats over 1 percent slope								
Small farm,	35.00	28.41	3.94	2.65	52.50	36.70	4.31	11.49
Medium and large farms,	35.00	30.20	3.94	0.86	52.50	38.83	4.31	9.36

¹For an explanation of the differences in costs between small farms and medium and large farms see text under "Resources."

²Returns to land and management.

Tables.

Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

Vegetable Crops

Guzman, V. L., and Hayslip, N. C. EFFECT OF TIME OF SEEDING AND VARIETIES ON ONION PRODUCTION AND QUALITY WHEN GROWN IN TWO SOIL TYPES. Fla. State Hort. Soc. Proc. 75: 156-162. 1962.

Two trials were conducted in muck and sand with various seeding dates and different varieties of onions. It was found that yields increased from the first planting (September) to mid-October and then progressively decreased to the last (December). Varieties differed in their yielding ability. When stand was reasonably satisfactory, Texas Early Grano 502 and Yellow Granex produced high yields and bulbs of good quality. White Granex, Early Crystal 281, and Eclipse were outstanding among the white varieties. Yield and appearance of the white onions were inferior to the yellow. Discoloration was severe in white onions grown in muck.

Texas Early Grano 502, grown in muck, field cured in windrows, and supplemented by additional curing with forced air at 118° to 120° F. for 24 hours, produced a loss of 13 percent in 3 weeks' storage at 40° F. When no heat was used, a 69.3 percent loss occurred in 3 weeks and 98.3 in 7 weeks at room temperatures. The same variety grown in sand resulted in a loss of 15 percent in 3 weeks and 20 percent in 6 weeks at room temperature storage.

Texas Early Grano 502 and Yellow Granex grown in muck and cured 4 days with forced air at 110° F. resulted in a loss of 20 percent in 64 days' storage at 40° F., while those stored at room temperature were a complete loss. The same varieties grown in sand, field cured in windrows and kept 83 days at room temperature lost 4 percent.

Sand grown onions had better keeping quality than those grown in muck. The general appearance of onion bulbs grown in sand was better than those produced in muck.

Everglades Expt. Sta., Belle Glade, Fla.

Kelbert, D. G. A., and Burgis, D. S. ADAPTABLE VARIETIES, HERBICIDES AND PLANT SPACING FOR BULB ONIONS ON SANDY LAND. Fla. State Hort. Soc. Proc. 75: 153-156. 1962.

Different varieties, herbicides, and plant spacings of bulb onions were tested on Leon fs in Florida.

Although a number of early maturing varieties (short day types) can be grown on the sandy soil of Florida, the varieties Texas Grano 502, Yellow Granex, and Burmex 5 (Asgrow Y5) were the best adapted yellow varieties, and Early Crystal 281, White Grano, and Eclipse (L303) were the best adapted white varieties.

Onions spaced at 2 inches produced more No. 1 bulbs, which were more uniform in size than those spaced 4 inches apart. Bulb size was not increased to the extent anticipated in the wider plant spacing. The varieties Burmex 5, Yellow Granex, and Texas Grano 502 produced slightly larger average size bulbs at the 4-inch spacing, but the wider spacing did not materially increase the average of bulb size of the other entries.

Split applications of 4-8-8 fertilizer totaling about 2,000 lbs. per acre provided ample nutrition for the crop under the prevailing conditions.

Because of heavy losses through decay, Florida-grown onions, especially white varieties, should be disposed of as soon after harvest as possible.

The herbicide Chloro IPC was shown to be safe and effective when used as either a preemergence or post-setting weed control treatment for bulb type onions.

Gulf Coast Expt. Sta., Bradenton, Fla.

Rhoades, H. L., Holmes, E. S., and Scudder, W. T. A COMPARISON OF IN-THE-ROW AND OVER-ALL SOIL FUMIGATION FOR THE CONTROL OF PLANT NEMATODES. Fla. State Hort. Soc. Proc. 75: 125-129. 1962.

Investigations were conducted to determine the comparative efficiency of in-the-row and overall fumigation for the control of plant nematodes. In three separate experiments, in-the-row fumigation gave good nematode control and comparable yield increases with over-all fumigation.

On cabbage, D-D applied at 30 gal./A. overall and 12 gal./A. in-the-row, DBCP at 2.5 gal./A. overall and 1 gal./A. in-the-row, and Vorlex at 5 and 10 gal./A. in-the-row increased yields significantly over that of the untreated check in an area infested with sting and stubby-root nematodes.

Sweet corn yields, in an area infested with the stubby-root nematode, were increased significantly by D-D at 25 gal./A. overall and 10 gal.A. in-the-row, by EDB (W-85) at 6 gal./A. overall and 2.5 gal./A in-the-row, by Vorlex at 5 and 10 gal./A. in-the-row, and by SMDC at 15 and 30 gal./A. in-the-row. DECP appeared to be phytotoxic to sweet corn and failed to increase yields.

Snap bean yields were lower on untreated plots than where D-D and DBCP were applied overall and in-the-row, but the difference was not significant.

Central Fla. Expt. Sta., Sanford, Fla.

Peterson, A. G. INCREASES OF THE GREEN PEACH APHID FOLLOWING THE USE OF SOME INSECTICIDES ON POTATOES. Amer. Potato J. 40: 121-129. 1963.

Results of experiments at St. Paul, Minn., indicate that applications of insecticides may result in considerably higher populations of the green peach aphid, Myzus persicae (Sulzer), than occur in untreated plots. Potatoes treated with Sevin at 1 and 2 lb. actual toxicant per acre averaged 28 times as many aphids as in the untreated checks. Less spectacular, but still significant, increases occurred following the use of DDT, Guthion, Bayer 24493, and Di-Syston.

U. Minn., St. Paul, Minn.

Mortvedt, J. J., Berger, K. C., and Darling, H. M. EFFECT OF MANGANESE AND COPPER ON THE GROWTH OF STREPTOMYCES SCABIES AND THE INCIDENCE OF POTATO SCAB. Amer. Potato J. 40: 96-102. 1963.

The incidence of scab was significantly reduced by the application of high rates of manganese sulfate (150 and 450 pounds per acre) in two field experiments. Manganese sulfate broadcast in a 12-inch band in the tuber zone caused a greater decrease in the incidence of scab than a comparable rate placed in the fertilizer band.

The results of two greenhouse nutrient culture experiments showed that high levels of manganese in the tuber periderm tissue had no significant effect on the amount of scab development when the level of manganese in the nutrient solution was varied and the environment around the development tubers was kept constant. This indicates that the amount of manganese absorbed by the plants was not the factor in the control of the disease as much as in the direct effect of the water soluble soil manganese on the organism itself. In no instances has scab been reported in fields where manganese toxicity symptoms exist on potato plants.

The results of a serial transfer of the causal organism on synthetic agar media containing various levels of manganese indicated that high levels of manganese inhibited the vegetative growth of the organism. Spores were formed soon after inoculation of media containing high levels of manganese and remained viable. Normal vegetative growth resulted when these spores were transferred to media containing low levels of manganese.

The application of copper sulfate at rates of 20 and 50 pounds per acre caused a significant decrease in the incidence of scab in one field experiment. The results of a greenhouse experiment showed that high levels of copper in the nutrient solution caused poor root development, slow enlargement of the tubers, and a decreased incidence of scab.

Jr. Author, U. Wis., Madison, Wis.

ECONOMIC AND SOCIAL ASPECTS OF SOIL AND WATER CONSERVATION

Costs and Returns

- Rosenberry, P. E. COSTS AND RETURNS, COMMERCIAL CORN BELT FARMS, 1962. U.S. Dept. Agr., Econ. Res. Serv. FCR-9, 5 pp. 1963.
- Stoddard, E. O. COSTS AND RETURNS, COMMERCIAL EGG-PRODUCING FARMS, NEW JERSEY, 1962. U.S. Dept. Agr., Econ. Res. Serv. FCR-10, 9 pp. 1963.
- Shugars, O. K. COSTS AND RETURNS, COMMERCIAL TOBACCO FARMS COASTAL PLAIN, NORTH CAROLINA, 1962. U.S. Dept. Agr., Econ. Res. Serv. FCR-11, 8 pp. 1963.
- Brown, W. H., Lee, J. E., Jr., and Hole, E. COSTS AND RETURNS, COMMERCIAL COTTON FARMS, 1962. U.S. Dept. Agr., Econ. Res. Serv. FCR-12, 11 pp. 1963.
- Stoddard, E. O. COSTS AND RETURNS, COMMERCIAL BROILER FARMS DELMARVA AND MAINE, 1962. U.S. Dept. Agr., Econ. Res. Serv. FCR-13, 17 pp. 1963.
- Shugars, O. K., and Bondurant, J. H. COSTS AND RETURNS, COMMERCIAL TOBACCO-LIVESTOCK FARMS, BLUEGRASS AREA, KENTUCKY, 1962. U.S. Dept. Agr., Econ. Res. Serv. FCR-14, 10 pp. 1963.
- Goodsell, W. D., and Gray, J. R. COSTS AND RETURNS, WESTERN LIVESTOCK RANCHES, 1962. U.S. Dept. Agr., Econ. Res. Serv. FCR-15, 9 pp. 1963.
- Cummins, D. E. COSTS AND RETURNS, COMMERCIAL DAIRY FARMS NORTHEAST AND MIDWEST, 1962. U.S. Dept. Agr., Econ. Res. Serv. FCR-16, 12 pp. 1962.
- Hurd, E. B. COSTS AND RETURNS, COMMERCIAL WHEAT FARMS, PACIFIC NORTHWEST, NORTHERN PLAINS, AND SOUTHERN PLAINS, 1962. U.S. Dept. Agr., Econ. Res. Serv. FCR-17, 9 pp. 1963.

These nine publications give the costs and returns for the crop and areas listed for 1962.

Maps, tables, and graphs.

MOS, USDA, Inform. Div., Washington, D.C. 20250

Taylor, M. M. PUBLICATIONS CONTAINING RECENT FARM ENTERPRISE INPUT-OUTPUT DATA. U.S. Dept. Agr., Econ. Res. Serv. Unnumbered Rpt., 42 pp. 1963.

A current list of publications which include recent farm enterprise input-output data was given.

Reports containing recent data were defined as those for which the year of data was 1956 or later. If the year of data was not identified, the year of publication was used. Tables were presented designed to facilitate use of the reference list.

MOS, USDA, Inform. Div., Washington, D.C. 20250.

Shaudys, E. T., and Sitterley, J. H. COSTS, RETURNS, AND PROFITABILITY OF THE BEEF COW-CALF ENTERPRISE IN SOUTHEASTERN OHIO BY SYSTEMS OF MANAGEMENT. Ohio Agr. Expt. Sta. Res. B. 937, 35 pp. 1963.

Land capability in southeastern Ohio makes it necessary to devote a high proportion of the area to forage crop production if the soil is to be maintained. Typically a farm in this

area has one-third of the total acreage in crops, one-half in permanent pasture, and one-fifth in woods, farmstead, and roads. Most farm operators have more labor available than can be fully utilized.

Four systems of managing the beef cow-calf enterprise, feeder calf, fattening, dual purpose and combination, were found on the 126 farms studied. The system of management tended to be related to land capability. Farm operators handled the beef enterprise to advantageously market the feeds produced on their farms.

About 15 percent of the farmers had a profit above all costs and practically all had a return above cash costs of operation. Some operators in each of the management systems made a profit.

Harvested feeds and cash costs of production accounted for about 70 percent of total production costs. Grain, hay, and silage comprised 45 to 65 percent of total costs depending on the system of production used. Pasture, labor, and buildings represented 25 to 30 percent of total costs.

Sales and slaughter of beef comprised 90 percent of the beef enterprise income. Manure and milk credits accounted for the rest of the income.

The ability to utilize effectively the resources available was more important than the system of handling the enterprise. Farm operators achieving a high production of beef per cow, and a good calf crop while holding feed, labor, and overhead cost down earned a profit. Feeder calf system farmers could earn more profit by using more farm produced or purchased feeds to permit more cows to be carried during the winter and to make more complete use of available pasture and labor. Fattening system operators could increase profit by adding cows to consume the existing feed, pasture, and labor already available on the farm.

Maps, tables, and photographs.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Trock, W. L. CATTLE FEEDING IN THE NORTHERN GREAT PLAINS. Mont. Agr. Expt. Sta. B. 576, 59 pp. 1963.

In a study of the future of cattle feeding in the Northern Great Plains (Montana, North Dakota, and South Dakota) the following conclusions were given:

1. Data concerning costs of cattle feeding indicated some cost advantages. Feed grains were relatively low priced in Montana, North Dakota, and South Dakota; feeder cattle were no more costly than in other cattle feeding areas.
2. Feeder cattle prices might rise if exports to other regions were reduced, but this would be a temporary effect if cattle production in the Midwest and South developed rapidly as a consequence of higher prices.
3. Other costs for feedlot operations appeared similar to those in other regions when similar enterprises were compared.
4. There are real opportunities for cost reductions in existing feedlots in this region. Increases in size and better utilization of plants and facilities would reduce per-head costs and make cattle feeders in the region even more competitive.
5. The opportunity for marketing fed cattle is greatest in the growing western markets. These markets are increasing in size as population grows, and more fed cattle are needed to meet consumer demands for beef. Feeders in the western part of this region should be able to compete in these markets.
6. A condition which limits competitiveness of cattle feeders is the seasonality of feeder and fat cattle production and marketing which is now typical. The solution to

this problem depends on better organization of cattle production and feeding activities, with much more year-around feeding in farm and commercial feedlots. Most existing feedlots will have to expand operations, and some new large scale enterprises are needed.

7. While an opportunity to participate in the western market is foreseen, outlets for fed cattle may still prove problematic in development of cattle feeding in this region. East of the region is the Corn Belt, where large numbers of fed cattle are annually produced; to the south are the grain sorghum producing states, where a cattle feeding industry is rapidly developing. Cattle feeders in these areas will offer stiff competition in markets where they sell slaughter stock. Northern Great Plains feeders will have to compete rigorously in outlets for cattle open to them.
8. An unknown factor in the Northern Great Plains cattle industry is the extent to which the packing industry will develop. If existing packers should expand, or if the major companies should open new facilities, outlets not now available to cattle feeders would be created.
9. Estimates of production of feed and feeder cattle in this region by 1975 indicate that an output of fed cattle amounting to more than 3 million head would be possible with 100 percent utilization of those feeder cattle. Only 30 percent of the feed grains produced would be required to feed this number of cattle. The potential for expansion is thus about 440 percent of the average production of fed cattle for the 1956-60 period.
10. With a rapidly expanding population and moderate increases in per capita consumption of beef, demand for fed cattle and beef will be significantly increased by 1975. Opportunities for increased marketing of fed cattle will exist, and expansion of feeding activities will certainly take place in many areas as feeders attempt to exploit these opportunities. There is a distinct possibility that cattle feeders in the Northern Great Plains can claim a share of these expanded markets.

Mont. Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

Hunter, E. C. CHANGES IN THE CATTLE-FEEDING INDUSTRY ALONG THE NORTH AND SOUTH PLATTE RIVERS, 1953-1959. U.S. Dept. Agr. Econ. Res. Serv. ERS 98, 15 pp. 1963.

Approximately 6 percent of the cattle that are fattened in the United States are fed in the irrigated valleys of the North and South Platte Rivers. The importance of cattle feeding in the area has been increasing, and the cattle-feeding industry directly or indirectly produces more than half of the area's agricultural income.

During the 1950's, significant changes occurred in the structure of the cattle-feeding industry in the area. The number of feeders classified as farmer-feeders (feeding less than 500 head of cattle annually) declined from 3,755 in 1953 to 3,131 in 1959. This was relatively greater than the decline in the number of all farm operators from 6,531 in 1953 to 5,676 in 1959. During the same period the number of commercial feeders (feeding more than 500 head annually) increased from 83 to 182.

During the period 1953-59, the number of cattle fed within the area increased from 536,500 to 797,055 head. The number of cattle fed by farmer-feeders actually declined during this period from about 341,000 to 335,000 head. The number fed by commercial feeders more than doubled.

About 63 percent of the 800,000 head of cattle fed in 1959 were owned by 171 commercial feeders, who fed 58 percent of all cattle in 182 commercial-sized feedlots.

Counties in the South Platte River Valley that had the greatest relative increase in cattle feeding during the period 1953-1959 had: (1) A relatively high percentage (65 percent or more) of the cattle fed, fattened in commercial feedlots in 1959; (2) transportation favorably located for access to surplus grain-producing areas (either the irrigated corn areas of Kansas and Nebraska or the dryland feed-grain areas of Colorado and Kansas); and (3) an increase in the proportion of the irrigated cropland used to produce sugar beets and feeds crops.

Although each of these factors influence the number of cattle fed, they are not necessarily independent variables. Favorable location relative to surplus feed-grain undoubtedly helps to account for the concentration of commercial feeders in some areas.

The Denver Terminal Market declined in importance as a marketing channel for slaughter cattle during the 1950's.

There were indications that the area will continue to increase its cattle feeding; by 1970 it might be fattening as many as 1,500,000 head of cattle. Cattle feeding will continue to become more concentrated in fewer establishments. The number of commercial-sized feedlots might double in the next 8 years. Many of these new commercial feedlots will have expanded from operations at present classified as farmer-feeders. Others will develop as an appendage of firms that have complementary relationships with cattle feeding. By 1970, farmer-feeders probably will be feeding not more than 20 percent of all cattle fed in this area, and likely about half of this percentage will be owned by operators in the commercial-feeder group.

MOS, USDA, Inform. Div., Washington, D.C. 20250.

Russell, J. R., and Elrod, J. C. COST AND UTILIZATION OF TRACTOR POWER AND EQUIPMENT IN THE COASTAL PLAIN OF GEORGIA. Ga. Agr. Expt. Sta. B. N. S. 104, 43 pp. 1963.

Information on the costs of operating farm tractors and tractor-drawn equipment in the Coastal Plain of Georgia was presented.

Schedules were obtained from 149 farmers in 23 counties. Data were collected from farmers on their 1960 operations by personal interview. The use of each item of equipment was recorded by type of operation.

Tractors rated from 7 to 14 horsepower were classified as small; 15 to 25 horsepower, medium; 26 to 31 horsepower, large; and 32 horsepower and over, extra large.

The average annual use varied with size. Small tractors were used 517 hours annually, medium 608 hours, large 726 hours, extra large 529 hours, and all tractors 596 hours.

Total tractor hours were distributed according to kind of farm operations as follows: Land preparation, 34.7 percent; cultivating, 24.0 percent; miscellaneous (mowing, hauling, etc.) 12.3 percent; harvesting, 8.4 percent; and planting, seeding, and fertilizing, 9.7 percent. These major operations accounted for 89.1 percent of the hours of tractor use.

The 149 farmers owned 322 tractors of a wide range of sizes, and 66 percent of the farmers owned two or more tractors. The total average annual cost of operation was \$10.17 per 10-hour day, of which \$5.76 was operating costs and \$4.41 fixed costs. Cost of tractor operation increased as the size of tractor increased--small tractors averaged \$9.37 per 10-hour day, medium \$9.71, large \$10.72, and extra large \$14.86.

Fuel accounted for approximately 61 percent of total operating costs and gasoline was the most common-type fuel used. Depreciation accounted for approximately 66 percent of total fixed costs.

Hourly cost of operating farm implements was as follows: Two-row front mounted cultivator, \$0.34; two-plow bottom plow, \$0.54; light tandem harrow (20-22 disc), \$0.57; two-row front mounted planter and distributor, \$0.32; and two-row peanut digger and shaker, \$2.70 per hour. Many items of farm implements other than tractors showed a high annual cost due to low annual use.

Farmers owning only one tractor used them 690.8 hours annually. Farmers owning four or more tractors used them 599.1 hours annually.

Farmers owning less than 75 acres of cultivated land owned an average of 1.7 tractors per 100 acres, or 58.8 acres per tractor. Farmers owning 375 acres or more of cultivated land owned an average of 0.7 tractors per 100 acres, or 143 acres per tractor. The number of acres of cultivated land per tractor increased as the size of farm increased.

The type of operation performed affected annual cost of tractor operations. Heavy tractor loads increased fuel consumption in all size tractors using gasoline. Small tractors used 4.6 and extra large tractors used 11.1 less gallons of gasoline per 10-hour day in performing light operations than heavy operations.

Small tractors using less than 150 hours had an average cost of \$2.75 per hour, while those using an average of 400 hours or more had an average cost of \$0.82 per hour. Extra large tractors using less than 300 hours had an average cost of \$3.60 per hour compared with those using 700 hours or more at an average cost of \$0.81 per hour.

Annual use and type of operation performed were the most important factors affecting costs of operating equipment. In a number of cases, farmers owned more tractors than seemed necessary to efficiently operate the cultivated land they owned. Several farmers owned a large tractor for land preparation and other heavy work and a small tractor to do the cultivating. Frequently, this combination of tractor sizes resulted in low annual use of both tractors and a high hourly cost of operation.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Experiment, Ga.

Institutional, Educational, and Social Factors Affecting Conservation Application

Goldschmidt, A. THE DEVELOPMENT OF THE U.S. SOUTH. *Sci. American* 209 (3): 225-230, 232. 1963.

Not so long ago the 13 Southern States were an underdeveloped "country" within the U.S. An account of the process by which a quasi-colonial region was integrated into the national economy was given.

No address given.

Jensen, C. W., and Nash, D. A. FARM UNIT DISPERSION: A MANAGERIAL TECHNIQUE TO REDUCE THE VARIABILITY OF CROP YIELDS. *Mont. Agr. Expt. Sta. Tech. B.* 575, 19 pp. 1963.

The extreme fluctuations in crop yields experienced by farmers in the Great Plains region were studied. A proposal was made and analyzed for reducing yield variability. The proposal was to farm tracts of land dispersed over an area, as opposed to "block" farming. The reason for such a proposal is that hail and rain tend to travel in strips in an easterly direction, with hail covering a narrower path than the accompanying rainfall.

It is reasoned that a dispersed farm has less chance of losing the entire crop from any one hail storm passing through the area. If true, yield variability from year to year will be less on a farm that is dispersed than on a farm with all its tracts connected. The operator may be able to work some part of a dispersed farm not hit by either hail or rain, while a block farm operator may experience delays as a result of storm activity.

Farm dispersion is not considered as a method of avoiding hail storms, but is an attempt only to reduce the impact of these storms in any one year. In total, dispersion may be looked upon as an adjustment to the aggregate affects of all climatic factors influencing yields not just hail alone. It is expected that over a period of years, the dispersed farm will lose the same total acres of grain to hail as the nondispersed farm, but, at the same time reduce the fluctuations from year to year.

Farms were classified according to size and to the distance between tracts making up the farm. Comparisons of the yield variability for individual years, and over the series of years were made among farms which are dispersed varying distances.

A general conclusion from this analysis was that in some years farm dispersion did not influence yield variability. In other years, variability decreased significantly for those farms with less than 1,000 acres in wheat as the dispersion distance was increased, until a distance of up to 15 miles was reached.

When analyzed over time, dispersion was concluded to be an effective technique in reducing yield variability except on those farms which had 1,000 acres of wheat or more.

Mont. Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

Barkley, P. W., and Pine, W. H. EFFECTS OF TENURE ON FARM IMPROVEMENTS.
Kans. Agr. Expt. Sta. B. 454, 31 pp. 1963.

How tenure arrangements affect farm improvements in areas of northeast Kansas, northwest Missouri, southeast Nebraska, and southwest Iowa were given.

During 5 years ending in 1957, more was spent on each kind of improvement on owner-operated farms than on crop-share-cash tenant farms or livestock-share tenant farms (on most items). Differences were not statistically significant for all items.

Operators of crop-share-cash farms reported more improvements needed on their farms than owner operators and live stock-share tenants.

Expenditures increased as size of farm increased for owner operators. Income and debt of owners who operated farms had no significant effect on their expenditures for improvements.

Farm leases usually do not have specific provisions for sharing costs, compensation, removal, or maintenance of improvements.

More money was spent for drainage, terraces, and waterways on rented farms with leases that provided for sharing of original costs and maintenance than other rented farms. Somewhat more (but not significantly) was spent on rented farms with lease provisions for removal of improvements than on rented farms without the provisions.

Where leases had compensation clauses, slightly more was spent for improvements than on other farms, but differences were not statistically significant. Many tenants said they would spend much more on improvements, particularly buildings, if compensated for improvements that would remain if their leases expired.

More was spent on improvements on farms with longer term leases and continuation clauses than on other farms, but differences were significant only for fences.

Having a written lease had no significant effect on money spent for improvements.

Tenants reported that "refusal of the landlord to provide necessary funds" was the most serious obstacle to making improvements.

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

Following a 9-year buildup in feed grain stocks, the 1961 Feed Grain Program was enacted by Congress to enable farmers to maintain their incomes while reducing production of corn and grain sorghums. The program offered farmers incentive payments to divert at least 20 percent of their corn and grain sorghum acreage to conservation uses. It also offered them support prices on their normal yield on the reduced acreage at a national average price of \$1.20 a bushel for corn and \$1.93 a hundredweight for grain sorghum.

About 1,200 farmers in 8 areas were selected for study. The sample in each area included about 75 participants in the 1961 Feed Grain Program and 75 nonparticipants.

In the areas studied, participation in the program ranged from 39 percent of the farms in west-central Ohio to 81 percent in southwestern Kansas.

Participation in the program was highest among the large farms that were cropped intensively. Farms of participants were larger than those of nonparticipants in all areas; in west-central Ohio they were 45 percent larger. Participants had a larger proportion of their land in crops and prior to the feed grain program more of the cropland was used for such high value crops as corn, grain sorghum, soybeans, and wheat. The number of livestock raised per farm averaged as high or higher on the nonparticipants' farms as those of participants. Tenure of the operator appeared to have little effect on participation.

Compared with nonparticipants, participants were younger, had occupied their 1961 farms for a shorter period of years, and more of them had off-farm incomes.

Participation in the Soil Bank, the Agricultural Conservation Program, and other farm programs was closely correlated with participation in the feed grain program.

There was little difference in the "production index" of participating and nonparticipating farms in the Corn Belt. In the Southern Plains area, productivity indexes were higher on farms of participants, but they were not higher relative to yields obtained in 1961.

Participants' estimates of cash costs per acre for producing corn and grain sorghum were higher than estimates made by nonparticipants.

Participants tended to keep their better land in production. A comparison of normal yields for 1960 and 1961 indicated that 1961 yields on participants' farms probably were 2 to 4 percent higher than they would have been without the program.

Because of the reduced acreages of feed grains in 1961, the total quantity of fertilizer applied on these crops was less in 1961 than in 1960. Nonparticipants, however, maintained their acreages of feed grains and used more fertilizer in 1961 than a year earlier. The percentage of the acreage fertilized rose sharply. The amount of plant food applied per fertilized acre in 1961 was higher in most areas than in 1960. The increase was about the same for participants and nonparticipants.

The reasons given most frequently by farmers for participating in the feed grain program were: (1) Because it was more profitable; (2) to improve the land; (3) to help reduce the surplus of feed grains; (4) to reduce risk; or (5) to reduce costs.

Reasons given most frequently for not participating in the program were: (1) Nonparticipants thought their 1961 incomes would be higher if they stayed out of the program; (2) nonparticipants were opposed to all Government programs; (3) nonparticipants didn't understand the program; or (4) nonparticipants thought that they were not treated fairly in the administration of the program.

Both participants and nonparticipants agreed that some of the advantages of the program were: (1) That it reduced surpluses; (2) that it helped to improve or conserve the soil; and (3) that it supported the prices of feed grains and livestock. A large proportion of the farmers surveyed, even among participants, said the program offered no advantages.

Generally farmers in all the areas agreed that the program was less advantageous to livestock farmers and operators of small farms than to operators of large cash-grain

farms. The program was said to be ineffective because participants tended to farm the reduced acreage more intensively. In the Southern Plains, farmers criticized the program because it caused an increase in acreage fallowed and the attendant problem and cost of controlling soil-blowing on the exposed fields.

MOS, USDA, Inform. Div., Washington, D.C. 20250

Timmons, J. F., and Fischer, L. K. APPRAISING YOUR SOIL CONSERVATION DISTRICT: WITH THE HELP OF PROCEDURES DEVELOPED IN THE JASPER DISTRICT. Iowa Agr. Expt. Sta. Sp. Rpt. 31, 22 pp. 1963.

The following findings from a study of cooperating and noncooperating farms in the Jasper Soil Conservation District of Iowa were reported as important to the continued success of the district program.

1. Cooperation in the Jasper Soil Conservation District Program was limited mainly to operators of larger than average farms, owner-operators, and livestock-share tenants. Operators of smaller farms and tenant-operators, particularly crop-share tenants, were not cooperating to a significant degree.

Implication: Special efforts must be made either: (1) To adapt the program to operators of smaller farms, crop-share tenants, part-time farmers, and other groups of operators and owners; and/or (2) to help bring about changes such as farm enlargement and improved leasing arrangements.

2. Many cooperators either drop out of the program or fall behind in carrying out their conservation farm plans. Insufficient time was devoted to servicing and follow-up work after the farm plans were developed. This was due in part to insufficient resources available in the soil conservation district for follow-up assistance. Farm plans tend to be fixed; yet the forces affecting the execution of the plan are exceedingly dynamic. These forces include; Natural forces such as weather, insects and diseases; technological developments; cost and price changes; changes in farm ownership; and changes in operators of farms.

Implication: To keep farm cooperators in the program and on schedule in their progress on farm plans, more time and effort must be devoted to keeping the plans adjusted to the dynamic agricultural environment within which the plans must be carried out. This may be accomplished through: (1) Expanded educational programs emphasizing basic principles, interrelationships, changing conditions, and alternative approaches from which the cooperator may make the necessary adjustments from his original plan; and (2) expanded technical assistance, which farmers need to revise their plans and carry out the adjustments caused by external changes.

3. A wide variety of reasons peculiar to an individual farmer's situation and attitudes prevents or obstructs his entering the program and his carrying out particular conservation practices once he has entered the program.

Implication: Unless these reasons are identified within the district and removed through educational programs, technical assistance, and other means, further progress toward district objectives will be hampered.

4. Many farm operators and owners remain unconvinced of the profitableness of particular conservation practices in the farm plans. Farm plans are designed largely for soil erosion control and soil productivity maintenance and enhancement. As such, some farmers may view the plans as incomplete until they are further developed to reveal expected costs and net income.

Implication: More consideration should be given to providing cooperators and potential cooperators with an economic analysis of the farm plans--in terms of alternative systems of practices, preferences of farmers and restrictions implicit in the farmers situation.

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

Journal of Soil and Water Conservation. SPECIAL FEATURE: OUTDOOR RECREATION, J. Soil and Water Conserv. 18: 43-76. 1963.

This issue of the Journal was devoted to outdoor recreation and the following papers were presented:

Kyle, G. M. OUTDOOR RECREATION: TODAY'S CHALLENGE U.S. Dept., Washington, D.C. 20250.

Johnson, H. A. OUTDOOR RECREATION AND RESOURCE CONSERVATION. RDED, ERS, USDA, Washington, D.C. 20250

Kimball, T. L. FOR PUBLIC RECREATION; PRIVATE DEVELOPMENT OF HUNTING AND FISHING. National Wildlife Assn., Washington, D.C. 20240

Crafts, E. C. LAUNCHED: THE BUREAU OF OUTDOOR RECREATION. U.S. Dept. Int., Washington, D.C. 20240

Shanklin, J. F. FEDERAL ASSISTANCE IN OUTDOOR RECREATION. U.S. Dept. Int., Washington, D.C. 20240

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BIOLOGY

Fish

Fessler, F. R. and Oncale, T. A. WATER QUALITY AFFECTS FISH PRODUCTION. J. Soil and Water Conserv. 17: 157-162. 1962.

The effects of water temperature and the amount of oxygen in ponds, reservoirs, and streams on fish production were studied along with methods to change the water temperature and the amount of oxygen in these impoundments. It was concluded that:

1. Largemouth bass and bluegill are generally managed for warm-water ponds. They do best when water temperatures are 55° F. and above. The oxygen content of the water should be no less than 0.3 p.p.m; a level of 1.0 p.p.m. and above is preferred.

2. Rainbow trout are suited to cold-water ponds. They need at least 5 p.p.m. of dissolved oxygen in the water, and the water temperature should seldom exceed 70° F.
3. Some factors that affect water temperature in an impoundment are solar heat, source of water supply, and routing of the waterflow through the pond.
4. Some factors that affect dissolved oxygen content in an impoundment are oxidation of organic matter, physical disturbances, photosynthesis, and thermal stratification.
5. Water temperature and dissolved oxygen in ponds and reservoirs can be influenced by the type of spillway installed.
6. Submersed-inlet spillways on impoundments on trout (and smallmouth bass) streams minimize changes in stream characteristics in and below the impoundment.
7. Submersed-inlet spillways on warm-water reservoirs supplied with flowing water improve the conditions for warm-water fish management by permitting the development of higher water temperatures in early spring, by allowing early efficient fertilization, and by removing oxygen-depleted water.
8. Artificial circulation of impounded water is one way to oxygenate the lower strata of water in ponds that do not overflow continuously and that are supplied only by runoff.

SCS, USDA, Nashville, Tenn.

Morris, R. C., and Orr, L. W. CATERPILLARS--FISH--TREES. Soc. Amer. Foresters, Atlanta, Georgia, 1962 Proc.: 172-173. 1962.

Since 1952, the forest tent caterpillar (*Malacosoma disstria*) has repeatedly defoliated gum forests in southwest Alabama. Privately owned tupelo, sweetgum, and blackgum timber in the lower Alabama-Tombigbee River and the Mobile-Tensaw River bottoms were affected. Tree growth was severely reduced, very little seed was produced, and mortality and dieback were substantial.

These forests are excellent habitat for fish and wildlife. Many watercourses and lakes in the large river bottoms provide sport and commercial fishing. Deer, turkeys, squirrels, and other game assure good hunting in the forests. Repeated defoliation is changing this habitat and affecting the wildlife dependent on it. Game has less browse and mast where trees cannot produce seed. In some years, fish have been injured in ponds contaminated by large quantities of caterpillar droppings.

In mid-April 1960, aerial spraying of a 40-acre block of heavily infested timber with DDT at the rate of 1 pound per acre resulted in complete control of the caterpillars. It was recognized that application of DDT at this rate over large areas of flooded timberland might result in loss of fish and other aquatic life.

An aerial spray study to test available insecticides was made to find a treatment that would control the tent caterpillar without causing undesirable side effects.

Tent caterpillars were controlled on all plots sprayed with 1/4 or 1/2 pound of DDT per acre, while adjacent unsprayed stands became severely defoliated.

Dibrom or malathion at 1 pound per acre quickly killed most of the caterpillars feeding on the leaves at spraying time. Many that were resting on the trunks moulting, or moving about were not contacted by the spray or did not eat sprayed foliage during the short residual life of these insecticides. These caterpillars survived to partially defoliate the trees and complete their development. In contrast DDT remained effective on the foliage for a week or more and few if any larvae survived.

Sevin suspensions were not satisfactory, though a heavy thunderstorm a few hours after spraying may have reduced their effect. Defoliation on the 1- and 1/2-pound-per-acre plots was estimated to be about 50 and 100 percent.

Only a few parasitic flies and wasps were killed. The experimental DDT treatment of mid-April 1960 had killed large numbers of such parasites but the 1961 spraying was done earlier, before many parasites had emerged.

Biologists found some evidence of fish and bird kill in plots sprayed with $\frac{1}{2}$ pound of DDT per acre but little or none in all other plots.

Southern Forest Expt. Sta. FS, USDA, Stoneville, Miss.

Upland Wildlife

Madson, J. THE RING-NECKED PHEASANT. Olin Mathieson Chem. Corp. Conserv. Div., (Unnumbered) 104 pp. 1962.

A game management publication on the ringneck pheasant was given.

The following general chapters were presented: (1) Life history; (2) ringneck management; (3) pheasant hunting; (4) the pheasant frontier; and (5) bibliography.

Conserv. Dept., Olin Mathieson Chem. Corp., East Alton, Ill.

Madson, J., and Kozicky, E. PRINCIPLES OF GAME MANAGEMENT. Olin Mathieson Chem. Corp. Conserv. Div. (Unnumbered) 25 pp. 1962.

A publication on the principles of game management was given. The following six articles were presented: (1) Hunting regulations; (2) predator control; (3) game refuges; (4) stocking; (5) habitat restoration; and (6) game and habitat analysis.

Conserv. Dept., Olin Mathieson Chem. Corp., East Alton, Ill.

Dasman, W. P., and Dasman, R. F. ABUNDANCE AND SCARCITY IN CALIFORNIA DEER. Calif. Fish and Game. 49: 4-15. 1963.

The periodicity of high and low deer kills in the five counties of California did not appear to have been a product of hunting pressure, length or time of hunting season, or kind of weather that prevailed during the opening month of the season. The relationship of the highs and lows with weather cycles was more possibly a result of concomitant increases and decreases in habitat carrying capacity than of animal distribution. It was concluded that the fluctuating kills reflect animal abundance. Such fluctuations in numbers may be expected of an unmanaged population which has expanded to the maximum carrying capacity of its habitat. With legal hunting usually limited to buck deer, forked-horn or better, and with at least half of the bucks escaping the gun for two or more years, hunting removals cannot prevent deer population increases. It can be safely assumed that throughout the five counties (and the State), deer numbers have long since expanded to the population ceilings imposed by their habitat. Where habitat conditions are improved by logging, fire, or other causes, there is room for increases to a higher ceiling. Where extensive timber harvest is carried on in areas of low deer population, these population increases may be sustained for a considerable period. In other instances they may be of short duration and, in some cases, are offset by habitat declines on other parts of the range.

Deer can multiply rapidly, up to 50 percent or more per year under favorable conditions. But once a deer population is extended to a level where habitat shortages of one kind or another occur, it becomes subject to decimating factors that work against further expansion, and eventually cause a decline in animal numbers.

Periodic deer population buildups and subsequent declines result in waste. If the deer populations were managed by annual (or at least occasional) removals of enough animals of either sex to hold them at an optimum level, some of the waste could be averted. Since an optimum population level is one at which the animals have all they need in order to flourish in average years, declines would occur only during the most adverse periods and never to the degree inflicted on uncontrolled populations. Under management, much of the surplus deer would be used, rather than lost, and the resource would be conserved rather than wasted.

Recognition of natural population fluctuations will allow predictions and sensible explanations of declines. This may help prevent unwarranted actions by governmental bodies resulting from public misunderstanding of such phenomena.

FS, USDA, San Francisco, Calif.

Gibbens, R. P., and Schultz, A. M. BRUSH MANIPULATION ON A DEER WINTER RANGE. Calif. Fish and Game 49: 95-118. 1963.

Effect of manipulation on production and utilization of browse plants was studied on the San Joaquin winter deer range in Madera County, Calif., from 1955-60. Areas of mature brush mashed during winter months were treated by: (1) Burning in early spring; (2) burning in late spring; (3) burning in fall; and (4) leaving unburned.

Production of available browse in unmanaged brush stands ranged from 13 to 106 pounds per acre. Yields of browse were increased by all treatments. The magnitude of increase depended largely on kinds and density of plants; yields ranged from 80 to 2,765 pounds of browse per acre on manipulated areas.

Western mountain mahogany sprouted vigorously on all treatments. Burning did not increase sprouting appreciably so mashing was adequate. Debris created by mashing protected seedlings which were destroyed on burned areas. It was highly palatable to deer and from 35 to 85 percent of current growth was utilized each winter.

Flannel bush was a very vigorous sprouter. Increase of sprouts over original number of plants was elevenfold on burned areas and fourfold on mashed areas. The sprouts grow very rapidly, and delaying burning until after a season's growth increased the period of availability. Leaves are relished by deer and 50 to 80 percent of the current growth was utilized.

Redberry was not abundant but sprouted well on all treatments. It is well-liked by deer and utilization ranged from 40 to 70 percent.

Honeysuckle was a vigorous sprouter on all treatments and was very heavily utilized, with 60 to 85 percent of current growth removed each winter.

Cherry sprouted well when either mashed or burned. Only twigs were available as winter browse and utilization ranged from 5 to 25 percent.

Interior live oak was an extremely vigorous sprouter on all treatments. It was the most abundant plant on several areas but was browsed by deer only in spring when new growth appeared.

Wedgeleaf ceanothus was an abundant and very palatable non-sprouting species. Seedling establishment was greatly favored by fall burning. Spring burns resulted in two seedling crops and greater mortality. Yields were still increasing at the end of 5 years. Deer utilized 50 to 70 percent of current growth each winter.

Chaparral whitethorn sprouted to some extent but the principal means of reproduction was by seed. Like wedgeleaf ceanothus, seedling establishment was favored by fall burning. It grows more rapidly than wedgeleaf ceanothus and its stiff, spiny twigs deter browsing animals to some extent. Utilization ranged from 10 to 60 percent.

Yerba santa appeared in greatest numbers on the fall burn treatment. During their third growing season, seedling produced numerous root sprouts. The rapidly growing plants overtopped and increased mortality of ceanothus seedlings. Although not well-liked by deer, use was heavy in 4 out of 5 years. Up to 80 percent of current growth was eaten.

Mariposa manzanita was greatly reduced in area occupied by both mashing and spring burns. Since only seedlings of this species are readily eaten by deer, treatments which do not favor its establishment are best.

Grasses and herbaceous plants under mature brush stands yielded from 400 to 895 pounds per acre. Grasses were sown on burned areas and yields increased to about 1,500 pounds per acre. Death of perennial grasses after the fourth season caused a sharp reduction in yield. Perennial grasses were heavily utilized by deer and cattle.

To obtain maximum returns from manipulation, treatments should be selected on the basis of species present in a particular stand.

U. Calif., Berkeley, Calif.

Wetland Wildlife

Arner, D. H. PRODUCTION OF DUCK FOOD IN BEAVER PONDS. J. Wildlife Mangt. 27: 76-81. 1963.

Field trials in central Alabama demonstrated that beaver (Castor canadensis) ponds could be economically managed for high yields of Japanese millet (Echinochloa crusgalli var. frumentacea). The methods used over a 3-year period, beginning in 1958, for 30 field trials consisted of: (1) Breaking beaver dams late in spring or early summer, sowing Japanese millet, and maintaining drainage until millet matured, by repeated breaking, if needed; and (2) breaking beaver dams, using log drains to maintain drainage, sowing Japanese millet, and removing drains after millet matured. Log drains proved to be the more economical method, \$4.15 per acre. Yields of Japanese millet seed were 6 to 10 times greater than seed yields of the native plants of value for duck food that became established in drained beaver ponds. Landowners had no difficulty in leasing duck-shooting rights on the managed beaver ponds. The low cost per acre of establishing duck food plants indicates that this type of development is practical for beaver ponds in central Alabama.

SCS, USDA, Selma, Ark.

Uhlig, H. G. USE OF MINNESOTA PONDS AND PITS BY WATERFOWL. The Wilson B. 75: 78-82. Apr. 1963.

In recent years, there has been a significant increase in the construction of ponds and pits for livestock water in Minnesota. This increase was brought about by a need for water to better effect distribution of grazing, by the availability of funds for cost-sharing through the Agricultural Conservation Program, and by the availability of technical assistance through the Soil Conservation Service.

In Minnesota, stock-water pits (dugouts) are less than one-fourth acre in area and about 10 feet deep. Farm ponds in Minnesota average 1 acre in area and are 12 feet or more deep. They are found in more rolling land where a fill can be constructed that will back up water to flood a draw, gully, or ravine.

Minnesota farmers and ranchers constructed 1,902 ponds and pits during the 1962 fiscal year. These brought the total built with technical assistance from the Soil Conservation Service to 6,785.

Many species of wildlife make use of ponds and pits. Ducks in particular utilize them during the migration period, and to some extent for courting, breeding, and brood rearing.

Apparently good grass shore-line vegetation has the most influence on degree of utilization of ponds and pits by ducks. Stable water levels and age of the area appear to be important secondary influences.

Ducks use ponds more frequently than pits, apparently due to the larger size and the irregular and shallow shore lines of the ponds. Waterfowl utilization of pits was substantially improved by installing loafing sites

SCS, USDA, 517 Federal Courts Bldg., St. Paul, Minn. 55102

Uhlig, H. G. SURVEY OF LEASED WATERFOWL HUNTING RIGHTS IN MINNESOTA. *J. Wildlife Managt.* 25: 204. 1961.

Farmers who own wetlands have been requesting information on wetland values from soil conservationists. The information is important because it indicates the potential value of potholes or marshes as an economic part of the farm.

During 1959, information on leased waterfowl hunting rights were obtained from landowners, lessees, sheriffs, and the head of a Production Credit Association. A total of 49 leasing involving 3,919 acres were checked. The total income from this source was \$20,050, or an average of \$409 per lease (\$5.10 per acre).

Twenty of the 49 landowners received \$100 or less. The average for this group was \$80 per lease on an average area of 55 acres (\$1.45 per acre). Seven of the remaining 29 received \$101 to \$200; six, \$201 to \$300; five, \$301 to \$400; and eleven, over \$401. The highest priced leases (over \$401) averaged 118 acres or \$13 per acre. Thirty hunters were involved in one lease for a total of \$3,750. No leases were found for pheasant hunting only. The primary purpose of the lease was always waterfowl hunting.

Size of the area leased had little to do with the cost of the lease. Three-fifths of the leases were for 50 acre or less, and over four-fifths were for areas of 100 acres or less. In only four cases was any type of management involved and these were attempts at establishing desirable duck foods.

Farmers should be informed of the potential economic as well as the aesthetic value of potholes, marshes, and other wetlands. With such information farmers may make clearer decisions regarding the "saving" of wetland areas. At present the highest priced leases (\$13 per acre) give the farmer approximately the same net profit as an acre of cropland. Farmers in many counties are willing to put their cropland under the Conservation Reserve Program at the same price.

Farmers who are leasing their wetland areas for the average price of \$5 per acre may find it profitable to intensify the management for waterfowl to obtain better leases.

SCS, USDA, 517 Federal Courts Bldg., St. Paul, Minn. 55102

SUPPLEMENT

Problems Indirectly Affecting the Application of Soil and Water Conservation Practices

National Agricultural Chemical Association. OFFICIAL FDA TOLERANCES. *Natl. Agr. Chem. Assoc. News and Pesticide Rev.* 21(3): 1-23. 1963.

The 9th annual revision of the official FDA tolerances for pesticides, listed by crop categories was presented. This special issue incorporates all of the changes, additions, or

deletions that have been officially announced from the time the Miller Pesticide Residue Amendment was enacted into law in 1954, up to and including December 31, 1962.

Natl. Agr. Chem. Assoc., Washington, D.C.

Colovos, N. F., and Davis, H. A. NUTRITIVE VALUE OF DRIED BEET PULP. N. H. Agr. Expt. Sta., Sta. B. 477, 7 pp. 1962.

Sixteen digestion and utilization experiments with four Holstein steers were carried out to determine the nutritive value of dried beet pulp fed alone, in a 50-50 ratio with hay, and with hay and a concentrate mixture. The dried beet pulp was a highly digestible concentrate ingredient that contained 4.24 percent digestible protein, 70.93 percent total digestible nutrients, and 78.3 therms net energy per 100 lbs. The protein content of the dried beet pulp was in the range of that of corn and it was well utilized.

The results showed that dried beet pulp was an excellent source of energy for dairy cattle when fed with hay or as part of the concentrate mixture.
Agr. Expt. Sta. U.N.H., Durham, N.H.

Stroehlein, J. L., and Berger, K. C. THE USE OF FERROSUL, A STEEL INDUSTRY BY-PRODUCT, AS A SOIL AMENDMENT. Soil Sci. Soc. Amer. Proc. 27: 51-53. 1963.

The disposal of spent pickle liquor (largely spent sulfuric acid and sulfate of iron) has long been a problem of the steel industry. Ferrosul, a neutralized and precipitated pickling material, was applied to field plots at rates of 200,000 and 400,000 pounds per acre. Corn was grown with and without starter phosphorus fertilizer treatments to determine if phosphorus was fixed by the iron in ferrosul. The ferrosul and phosphorus treatments had little effect on corn grain yield when compared to check plots.

Corn and alfalfa were grown in the greenhouse on Plainfield s and Miami sil soils treated with 1, 10, 20, and 40 percent Ferrosul on the weight basis, as well as an untreated check. Corn yields were best on the 1 percent treatment with the Plainfield s as a result of a sulfur deficiency of the check. Corn yields were decreased at the 40 percent level with both soils. Alfalfa yields were generally best with the Ferrosul treatments. The highest total yield of alfalfa for eight harvests was with the 20 and 40 percent treatments with the Miami and Plainfield soils, respectively. Phosphorus fixation was not found to be a problem when additions of phosphorus fertilizer were made.

It was concluded that large amounts of Ferrosul can be applied to agricultural land without detrimental effects on crops and soils.

U. Wis., Madison, Wis.

Baumann, E. R., Willrich, T. L., and Ludwig, D. D. FOR A PURER WATER SUPPLY CONSIDER. . . PRECHLORINATION. Agr. Engin. 44: 138. 1963.

Adding chlorine to the water supply before its passage through the primary filter rather than after the water reaches the pressure system at the pump results in an intimate mixing of chlorine and water, improving bacterial removal while reducing chlorinous odor and taste.

Prechlorination caused an intimate mixing of chlorine and water, increased contact time, and eliminated the need for special detention vessels to provide contact time for adequate disinfection. The table gives the results of bacterial reduction from the standard control filter and the perchlorinated test filter.

Table. Bacterial reduction
(Run 11 of 25 Days)

Filter	Bacterial reduction, percent		Total bacteria, average no./mi.	
	Coliform bacteria	Total bacteria	Filter influent	Filter effluent
Standard control	84.60	90.38	1725	166
Prechlorinated test	100	99.54	1725	8

Iowa State U., Ames, Iowa.

Radioactive Fallout

Walton, A. THE DISTRIBUTION IN SOILS OF RADIOACTIVITY FROM WEAPONS TESTS. J. Geophysical Res. 68: 1485-1496. 1963.

Results of vertical profiles of radioactivity from weapons tests in several soils from New Jersey were presented. Four radionuclides—strontium-90, ruthenium-106, cesium-137, and cerium-144—were examined, and in general the cumulative activities agreed with the quantities estimated from the observed concentrations of the nuclides in precipitation. Vertical distributions of radioactivity within soils varied considerably, and in many instances they were correlated with certain physical parameters. Permeability and drainage characteristics of the soil and underlying strata were important factors in this respect. Strontium-90 was distributed on the average with 55 percent of the total deposit in the top 2 inches, 79 percent in the top 4 inches, and about 96 percent in the top 9 inches in 1960. Strontium-90 penetrated to greater depths than cesium-137.

The combined γ activities of the three nuclides yielded a dose rate in 1960 of less than 3 percent of the maximum external dose rate recommended by the National Committee on Radiation Protection for the general populace.

Isotopes Inc., Westwood, N.J.

Eno, C. F., and Popenoe, H. THE EFFECT OF GAMMA RADIATION ON THE AVAILABILITY OF NITROGEN AND PHOSPHOROUS IN SOIL. Soil Sci. Soc. Amer. Proc. 27: 299-301. 1963.

The effects of several levels of gamma radiation ranging from 0 to 2,048 kiloroentgens on the availability of N and P from three fine sands and one peat soil were investigated. Nutrient release was measured chemically and by plant uptake. Irradiation increased the availability of N and P in soils evaluated immediately following irradiation, and after 2 weeks of incubation. This was shown by both chemical and plant uptake measurements. The release of N and P was closely related to soil type and more particularly to its organic matter content. The soil containing the largest amount of organic matter showed the largest increase in extractable N and P after irradiation. An evaluation of the ammonium acetate (pH 4.8) extractable Ca, Mg, and K data indicated that there were no measureable changes in the availability of these elements that could be directly related to irradiation of the soil. The release of N and P, in many soils, will be a significant nutritional factor when plants are grown on irradiated soil.

Fla. Agr. Expt. Sta., Gainesville, Fla.

Andersen, A. J. INFLUENCE OF LIMING AND MINERAL FERTILIZATION ON PLANT UPTAKE OF RADIOSTRONTIUM FROM DANISH SOILS. *Soil Sci.* 95: 52-59. 1963.

The uptake of radioactive strontium by ryegrass and red clover was studied in pot experiments, using 20 typical Danish agricultural soils. Comparisons were made between the effects of adding Ca in the form of carbonate, sulfate, and chloride, and the respective Mg compounds on Sr uptake by plants grown on three different soils. The influence of nitrogen and potassium application on uptake of Sr-90 by oats was studied for two different soils.

In red clover the uptake of radioactive strontium was much greater than in ryegrass. The uptake from the different soils decreased with increasing amounts of exchangeable Ca. Adding CaCO₃, at 5 and 10 tons/ha., (2.02 to 4.05 tons/A.) reduced Sr-89 concentration of the plants by 15 to 30 percent, depending on the type of soil. CaSO₄ application showed little effect, and CaCl₂ increased Sr-89 concentration of plants. The Sr-89/Ca ratio in plants could be reduced by the three different Ca compounds, the reduction being most effective when the carbonate was used. Mg as carbonate or sulfate proved more effective in reducing Sr-89 concentration than did the corresponding Ca compounds. An increase in Sr-89 concentration of plants followed the application of MgCl₂. Nitrogen fertilization increased yield and Sr-90 concentration of straw, but lowered Sr-90 concentration in grain. The concentration of Sr-90 and Ca decreased with increasing amounts of added K, leaving the Sr-90/Ca ratio of the crops unaffected.

Atomic Energy Comm. Res. Establishment Risø, Agr. Res. Dept., Risø, Roskilde, Denmark.

Frere, M. H., and Roberts, H., Jr. THE LOSS OF STRONTIUM 90 FROM SMALL CULTIVATED WATERSHEDS. *Soil Sci. Soc. Amer. Proc.* 27: 82-83. 1963.

Soil samples were taken from the plow layer of eight small watersheds and analyzed for strontium-90. Two watersheds in permanent pasture, with no recorded loss of soil, contained about 90 mc. per square mile, which is slightly higher than an estimated total deposit at the time of sampling.

The plow layer of six watersheds under cultivation was sampled by compositing soil cores taken on contours of each watershed. The Sr-90 concentration of these samples was from one-third to two-thirds of that in the permanent pastures.

The loss of Sr-90 appeared to be influenced by length of slope and cropping history. No areas of Sr-90 accumulation were found within these watersheds.

Since no part of the cultivated watershed had a higher concentration of Sr-90 than the uncultivated permanent pastures, it was concluded that the Sr-90 lost must have been carried completely off the watersheds.

SWCRD, ARS, USDA, Beltsville, Md. 20705.

