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ABSTRACTS

of recent published material on
Soil and Water Conservation

Number 27

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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 Research 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 an entire number of a publication is devoted to reviewing one subject then the entire publication is abstracted as one article giving title and authors of each paper included in the publication. Abbreviations of journals and addresses 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.

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WATERSHED ENGINEERING

Watershed Development

Harrold, L. L., Brakensiek, D. L., McGuinness, J. L., Amerman, C. R., and Dreibelbis, F. R. INFLUENCE OF LAND USE AND TREATMENT ON THE HYDROLOGY OF SMALL WATERSHEDS AT COSHOCTON, OHIO, 1938-1957. U.S. Dept. Agr. Tech. B. 1256, 194 pp. 1962.

Concepts of land management for water production and procedures to test the validity of these concepts with observed streamflow data from treated watersheds were developed. Land treatments evaluated in the study were for several levels of crop production and for timber production. These were: (1) Average crop production and average soil stability (prevailing practice); (2) high crop production and considerable soil stability (improved practice); and (3) management as a farm woodlot and complete soil stability. Concepts were developed from small, singlecover watershed runoff data, lysimeter percolation data, ground-water well elevations, and soil physical data.

Since runoff from single-cover watersheds of an acre or so is essentially surface runoff, a reduced runoff would reflect increased infiltration. Higher management levels increased the infiltration potential when the particular soil type was amenable to change. The infiltration increase was largest on small watersheds converted from idle land to farm woodlots.

Percolation from lysimeters subjected to improved management crop or forage production was markedly less than from prevailing management.

By 1957, the ground-water elevation, from a well in the reforested area of a farm woodlot watershed, showed a marked decline of about 20 inches at the end of the growing season (November 1), whereas the ground-water elevation on each May 1 showed little change.

The evidence suggests a hypothesis of a two-fold effect due to improved land management: (1) An increase in infiltration potential; and (2) an increase in soil-moisture utilization and a subsequent decrease in percolation potential.

The previously described levels of land management were imposed during the 1938-40 period on each of five mixed-cover watersheds, located on the Soil and Water Conservation Research Station near Coshocton, Ohio. One mixed-cover watershed of 303 acres was continued essentially unchanged in management level (prevailing practice). Two mixed-cover watersheds, 29.0 and 75.6 acres, were changed to a higher level of management (improved practice). An area of 43.6 acres, about two-thirds initially in very poor pasture and idle land with the remainder in hardwoods, was completely converted to a farm woodlot. The fifth area, 74.2 acres in mixed cover, was managed under prevailing practice. This constituted a relative improvement in management, as this watershed had been mismanaged before the treatment period.

Amounts of streamflow from the 303-acre prevailing-practice watershed were used as an index of climatic variations. The multiple regression technique was used to evaluate changes in streamflow of the remaining four watersheds.

Annual streamflow volumes for the 43.6-acre wooded watershed, for a May 1 water year, were reduced sharply by the establishment of the farm woodlot. In the 19th year of record, this watershed yielded 5.32 inches less than it would have yielded had it not been reforested. The flow changes were of much less statistical significance for the mixed-cover watersheds than for the wooded watershed. The 29-acre and the 75.6-acre watersheds (improved practice) showed that in the 18th year of record the reductions in annual flow were 1.26 and 1.75 inches, respectively. The reduction on the 74.2-acre watershed (changed from very poor practice to prevailing practice) amounted to 1.60 inches in the 20th year.

Further analyses were made for the growing season (May 1 to October 31) and for the dormant season (November 1 to April 30). For the farm woodlot watershed, almost 70 percent of the reduction was in the dormant season. In the 19th year of record, the reductions amounted to 3.80 inches in the dormant season and 1.71 inches in the growing season. The three mixed-cover watersheds did not show a distinct tendency to have greater reductions in the dormant season than in the growing season.

Analyses of high-flow data indicated that high flows on all the treated watersheds had been reduced.

Peak rates and ground-water recession curves were studied. Only the wooded watershed showed a significant reduction in medium to high peak rates of streamflow.

In general, the reduction of streamflow from the wooded watershed and the trend toward streamflow reduction on the mixed-cover watersheds managed at various levels support the concepts deduced from studies on single-crop watersheds, lysimeters, and ground-water well elevations. The studies also indicated that the changes may persist in these somewhat larger-sized areas.

Basic data pertaining to this study are given.

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

Sewell, J. I., and van Schilfgaarde, J. PREDICTION OF WATER YIELDS FROM AGRICULTURAL WATERSHEDS. *Soil Sci. Soc. Amer. Proc.* 26: 82-85. 1962.

Available runoff data were used in developing a method for predicting the water yields from agricultural watersheds in the Southeast. The watersheds were classified according to size, cover, geographical location, and season of year; and, weighted quadratic relationships of runoff on rainfall were computed by machine techniques. This method can utilize local rainfall data in making runoff predictions on a frequency basis. In developing a simplified and easily used technique, complicated watershed classifications were minimized.

A method was developed which allows more realistic estimation of runoff from small watersheds in the Southeast than by current techniques. This simple technique requires only the substitution of properly chosen rainfall quantities into the prediction equation to obtain monthly or annual runoff predictions.

The monthly runoff relationships suggest that during May, June, July, and August, the period during which most irrigation takes place, the runoff is low and might be ignored without introducing serious error. The annual runoff relationships probably provide more useful information on water available for storage in irrigation ponds than do the monthly relationships.

The technique does yield results that are useful in the design and planning of water storage structures and that on the average will be considerably more reliable than results obtained by present methods. The results are not seriously at variance with those obtained from the tentative proposal of Mockus. The large variation in results obtained from the Mockus chart with different evaluations in cover does not occur in the method proposed here.

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

Gray, D. M. DERIVATION OF HYDROGRAPHS FOR SMALL WATERSHEDS FROM MEASURABLE PHYSICAL CHARACTERISTICS. *Iowa Agr. and Home Econ. Expt. Sta. Res. B.* 560: 517-570. 1962.

The development of a method for synthesizing the unit hydrograph for small watersheds from topographic characteristic was studied. The topographic and hydrologic characteristics

from 42 watersheds located in Illinois, Iowa, Missouri, Nebraska, Ohio, and Wisconsin were investigated. These watersheds varied in size from 0.23 to 33.00 square miles.

Five watershed characteristics were measured on each basin: drainage area size, A ; length of the main stream, L ; length to the center of area, L_{ca} ; slope of the main stream, S_c ; and mean land slope, S_L . An initial attempt to relate these factors with hydrograph properties by employing the principles of dimensional analysis proved unsuccessful. A preliminary analysis of the topographic data was undertaken to ascertain the reason for this failure.

The study indicated that the three length factors-- A , L , and L_{ca} --for the watersheds were highly correlated and could not be used as independent terms. The results showed that the watersheds adopted a relatively consistent shape, intermediary between ovoid and pear-shaped. For all practical purposes, in the watersheds studied, $L_{ca} = 0.50L$.

Tests indicated that the variables, L and S_c , are related if consideration is given to the effect of regional influence.

An empirical relation was found between the mean land slope of a watershed, S_L , and the mean slope of a representative sample of first-order streams taken from the same watershed, S_1 .

The rainfall and runoff characteristics from a number of unit storms occurring over each watershed were analyzed. The results showed that the period of rise, P_R , could be used in place of lag time, t_L , as a time parameter to relate the salient features of rainfall and runoff. For practical work, $P_R = t_L$.

For each watershed, a representative distribution graph was developed and modified to a dimensionless form based on the use of P_R , as the time parameter. Recent hydrologic investigations have shown that the unit hydrograph can be described by a two-parameter equation which is identical in form to the equation describing the two-parameter statistical gamma distribution. This distribution was fitted to each dimensionless graph, and estimators of its parameters, q and γ , were obtained by machine calculation. In most cases, the two-parameter gamma distribution could be employed to describe the dimensionless graph; however, additional work is required in evaluating the goodness of fit in terms of hydrologic acceptance.

A set of relationships was derived to enable evaluation of the three variables, P_R , q , and γ . With these values known, the dimensionless graph, distribution graph, or unit hydrograph of a given area can be described. A successful linkage between hydrograph properties and watershed characteristics was obtained by relating the storage factor P_R/γ , with the watershed factor $L\sqrt{S_c}$.

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

Hydrology

Hendricks, E. L. CURRENT PROBLEMS IN RESEARCH: HYDROLOGY. Sci. 135 (3505): 699-705. 1962.

Hydrology is that branch of the earth sciences which treats of the storage and movement of water on the earth, the physical and chemical reaction of water with its environment, and the relation of water to living organisms. The central concept of hydrology is the hydrologic cycle, which denotes the circulation of water from the oceans, through the atmosphere to the land, and thence, with numerous delays, back to the oceans by overland, subterranean, or aerial routes. Hydrology is concerned mostly, however, with the continental phase of the cycle--that is with water from the time it is precipitated on the land until it returns to the sea or the atmosphere. In broad view it includes, also, meteorology and oceanography insofar as these sciences relate to processes of the hydrologic cycle.

Only a few of the many problems in hydrology are discussed. Several of the more basic ones are chosen to illustrate the scope of the science and the many disciplines that are contributing to a better understanding of hydrological processes.

U.S. Geol. Survey, Dept. Int., Washington, D.C. 20240

Holtan, H. N., Minshall, N. E., and Harrold, L. L. Comm. FIELD MANUAL FOR RESEARCH IN AGRICULTURAL HYDROLOGY. U.S. Dept. Agr., Agr. Res. Serv., Agr. Hbk. 224, 215 pp. 1962.

This manual assembles and supplements material pertinent to research procedures in hydrology. The various techniques and procedures were obtained by soliciting information from experts and adapting material described in the current literature. Data on SWC forms were often copied from old records of the Soil Conservation Service and used as the examples. The SWC forms show that they were issued with a later date than the material transferred from the old records.

The material in the manual is divided into five sections; Section (1) provides an introduction to the manual, including references to symbols commonly used in hydrology and constants to be used in converting data from one set of units to another. Section (2) on the design and installation of measuring devices is written primarily for professional engineers. It sets down the rudiments of acceptable procedures. Section (3) is primarily for guidance of the subprofessional field observer. Step procedures are used wherever possible for field measurements, with a minimum of development or derivation given. Section (4) is intended as a guide for clerical employees or subprofessional aids who annotate and tabulate basic data. Wherever possible, compilation of data is reduced to a series of simple steps; and section (5) is for the professional employee involved in data analyses. This section includes more explanation of concepts and development.

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

Eagleson, P. S. UNIT HYDROGRAPH CHARACTERISTICS FOR SEWERED AREAS. J. Hydraul. Div., ASCE 88 (HY 2): 59-68. May 1962.

Measured storm rainfalls and coincident sewer flows were analyzed for 27 storms and 5 urbanized areas in Louisville, Ky. Characteristics of the resulting unit hydrographs were correlated with significant drainage basin and sewer properties. This technique can be used in hydraulic design problems requiring consideration of the time history of discharge from sewer urban areas. Suggested design procedure is outlined.

It was concluded that volumetric runoff coefficients measured from the beginning of rainfall-excess are a constant for an area of given imperviousness and slope for which evaporation and infiltration losses are negligible; the unit hydrograph technique is well adapted for the prediction of discharge hydrographs from sewer areas; and the synthetic unit hydrograph characteristics presented here are applicable to sewer urban areas larger than 100 acres in Louisville, Ky., and probably in other areas.

Mass. Inst. Technol., Cambridge, Mass.

Lee, F. S. Y. CRITICAL FLOW IN TERMS OF HYDRAULIC EQUIVALENTS. J. Irrig. and Drain, Div., ASCE 88 (IR 2): 1-19. June 1962.

The principle of hydraulic equivalent is presented for the study of the critical flow in open channels. Based on the modification of the equation of specific energy and the introduction of equivalent coefficients, graphs were prepared. These graphs, developed originally in the metric system and used for many years, will assist engineers in the analysis of open channels.

Construction Engin., Forest Hills, N.Y.

Keppel, R. V., and Renard, K. G. TRANSMISSION LOSSES IN EPHEMERAL STREAM BEDS. J. Hydraul. Div., ASCE 88 (HY 3): 59-68. May 1962.

Transmission losses, as measured in two reaches of Walnut Gulch, an ephemeral stream in southeastern Arizona, are large. They are influenced by antecedent moisture of the channel alluvium, peak discharge at the upstream gaging station, duration of flow, width of channel, and the quantity and texture of the channel alluvium. In a very dry channel system, losses of 25 acre-ft per mile were measured in a channel reach where the computed possible maximum, based on quantity and texture of the alluvium, was 30 acre-ft per mile.

A series of intense, convective thunderstorms, close together in space and time, and steep channel gradient give rise to over-riding, translatory waves that, in conjunction with such large channel losses, may result in peak discharge at the lower station nearly equal to that at the upper, even though the volume of runoff measured is much less. This condition is accompanied by a shortened rise time in the hydrograph at the lower station.

SWCRD, ARS, USDA, Tucson, Ariz.

Allis, J. A. COMPARISON OF STORM RUNOFF VOLUMES: FROM SMALL, SINGLE-CROP WATERSHEDS AND FROM A LARGER, MIXED-CROP WATERSHED. Agr. Engin. 43: 220-223. 1962.

Estimating flood runoff from larger, complex watersheds from measured storm runoff from plots and small watersheds is a perplexing problem. Uncertainties are introduced into such estimates by differences in soils, land use, storm precipitation, antecedent soil moisture, valley storage, and other factors. The differences in such estimates and of factors affecting these differences were studied. The author concluded that:

1. Direct area runoff from small watersheds can be expanded to runoff from a larger, complex watershed in the Hastings area, with practical limits.
2. Transmission losses appear to vary seasonally and to increase as the normal seasonal runoff and stream stages increase up until early June. During the remainder of June, the transmission losses decrease as the flood plains soil becomes wet. In the latter part of June and the first part of July, weed growth in flood plains deplete the soil moisture, thus making additional space available for water and causing transmission losses to increase. After late August the runoff is small, stream stages are low, the transmission losses are low until the following spring.
3. The differences in the computed runoff and measured runoff increased as the size of the storms increased up to approximately 0.80 in. of runoff. There was also an indication that for the high runoff producing storms (above 0.80 in.) the trend reversed, and the difference in computed and measured runoff decreased as the magnitude of runoff increased.

4. On the average, considering all storm runoff except that due to snow melt, there was about 13.6 percent less measured flow than computed flow from watershed W-3. These differences are considered due mainly to transmission losses to valley alluvium on the 481-acre watershed.
5. Soil moisture indexes on uplands, antecedent precipitation, duration of flow, and other factors could not materially explain the differences between computed and measured runoff from watershed W-3.

SWCRD, ARS, USDA, Hastings, Nebr.

Willis, W. O., and Carlson, C. W. WINTER PRECIPITATION--TOO MUCH IS LOST. N. Dak. Farm Res. 22(1): 14-15. 1961.

The effect of soil moisture level in the fall on depth of freezing and spring runoff was studied. The results showed that a soil that was dry in the fall froze faster and deeper than a soil that was wet. However, the dry soil tended to thaw from the lower depths toward the surface so that frost was gone from a dry profile by the time all the snow was melted in the spring. A wet soil tended to thaw both from the lower depths toward the surface and from the surface downward, but the rate of thawing was slower than in a dry soil so there was frost remaining after the completion of snow melting and runoff. The thawing from the surface downward in a wet soil did not begin until the snow was almost gone. Runoff from a dry soil is likely to be much less than runoff from a soil which was wet in the fall before freezing. However, a dry soil did not retain enough water from the snow-pack to bring it up to a moisture content equivalent to that of a soil which had been wet in the fall to a depth of 4 feet.

Measurements of spring runoff showed that fall moisture conditions of the surface foot of soil govern the amount of runoff.

Results also showed that after the soil begins to thaw in the spring, the period required for complete thawing of the profile may only be a matter of a few days (longer if the soil was wetter). It is during this short period that most of the accumulated winter precipitation is lost. Since the moisture condition of the top foot of soil is important and the period of complete thawing is not very long, it is possible that some management practice might be developed for control of runoff and for increased moisture conservation.

Almost any means of holding the snow-melt in place until it can infiltrate the soil would be advantageous for soil moisture storage. One such practice is the level or conservation bench terrace.

If a soil is bare (without snow or vegetative cover) and remains that way over winter, it is possible to lose as much as 1.5 inches of soil moisture by evaporation. In addition to the possibility of losing the soil moisture, a bare soil, even if it were wet before freezing, may freeze-dry and become subject to the hazard of wind erosion. Either loss--moisture or soil--can be expensive.

SWCRD, ARS, USDA, Mandan, N. Dak.

England, C. B., and Lesesne, E. H. EFFECTS OF SINGLE CROP COVERS ON RUNOFF. J. Soil and Water Conserv. 17: 11-12. 1962.

The Tennessee Valley Authority and North Carolina State College have set up a long term research project to evaluate the effects of important single crop covers on runoff from soils of western North Carolina and to study the intermediate effects of these cover changes on physical properties relating to water movement in soils.

Preliminary results indicate that cropping treatments do have a definite influence on peak rates of runoff, which increase in this order: Improved pasture, heavily grazed pasture, wheat, and corn. Table 1 shows averages of the highest peaks obtained under the various covers. The total volume of water that flowed from a watershed in a year was not materially affected by the covers under study.

TABLE 1.--Peak Discharge Rates Under Various Covers

Cover	Average of highest three peak discharge rates
	Cubic ft/second/acre
Corn	2.38
Wheat.	1.38
Heavily-grazed pasture	0.78
Improved, moderately grazed pasture	0.43

Soil changes produced by the cover treatments are being correlated with changes in surface runoff rates. It has been observed that the soil surface condition is more important in determining surface runoff than is soil moisture storage capacity. The bulk density, porosity, and structural development of the top increment of soil is most critical in determining how much water will infiltrate into the soil and how much will run off.

The most outstanding changes produced by cover on the soil characteristics and resulting water relations are made on areas where the topsoil is thin or non-existent. Heavy grazing produced definite compaction of the thin east-slope soils on watershed 2, resulting in greatly increased surface runoff from the one-twentieth-acre plot located in this area of the watershed. Soil samples obtained from watershed 2 under improved pasture and heavily grazed pasture showed the changes in soil characteristics given in table 2.

TABLE 2.--Soil Properties Under Improved Versus Heavily Grazed Pasture.

Soil properties	Improved pasture	Heavily grazed pasture
Bulk density (grams per cc.)	1.05	1.21
Large pore space (pct. of total volume)	12.0	2.50
Infiltration rate (in. per hour).	1.24	.35

Overgrazed pasture provides considerable soil protection and permits far less runoff and soil loss than freshly plowed ground. Data (table 3) from adjacent watersheds for the storm of April 8, 1954, illustrate how even closely cropped turf on undisturbed soil holds both soil and water.

TABLE 3.--Rainfall and Runoff Measurements on Adjacent Watersheds
During the Storm of April 8, 1954.

Measurement	Watershed 1	Watershed 2
	Plowed for corn	Heavily grazed pasture
Rainfall (in.)	0.57	0.60
Maximum intensity (in. per hour)	2.70	2.70
Peak discharge (cc. feet per second)	12.0	.429
Storm runoff (inc.)39	.04
Soil loss (tons per acre)	11.0	trace

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

Cannell, G. H., and Stolzy, L. H. HYDRAULIC GRADIENTS ASSOCIATED WITH INFILTRATION IN FIELD STUDIES. Soil Sci. Soc. Amer. Proc. 26: 112-115. 1962.

A field method is described for measuring hydraulic head changes with time during infiltration of water into the soil. Using graphical methods, the hydraulic head and hydraulic gradient relationships for depth with time were established. From the sets of curves developed, soil depths were determined where soil physical properties influenced water flow during infiltration.

U. Calif., Riverside, Calif.

Miller, D. E., and Gardner, W. H. WATER INFILTRATION INTO STRATIFIED SOIL. Soil Sci. Soc. Amer. Proc. 26: 115-119. 1962.

A laboratory investigation was made of the effects of textural and structural stratification within the profile on rate of water infiltration into soil. A recording infiltrometer was devised and method developed for obtaining uniformly packed tubes of soil. Infiltration data were obtained for soil conditioner treated Palouse sil. The data were used to test several infiltration equations found in the literature. It was observed that none of the equations tested adequately described the experimental data.

Effects of strata within soil were related to the pore characteristic differences between the layering material and the surrounding soil. When most of the pores in a layer were larger than those in the surrounding soil, infiltration was temporarily inhibited after the wetting front reached the layer. The degree of inhibition was increased when the pore sizes in the layer were increased. Water must accumulate at a layer-soil interface until it is at a tension low enough to allow it to move into pores in the layer. Water movement into the surface is reduced while the accumulation takes place.

SWCRD, ARS, USDA, Prosser, Wash.

Liacos, L. G. WATER YIELD AS INFLUENCED BY DEGREE OF GRAZING IN THE CALIFORNIA WINTER GRASSLANDS. *J. Range Mangt.* 15: 34-42. 1962.

An experiment was established on the Berkeley hills, California, in 1959-60 to check the effect of the intensity of grazing upon the water balance.

Heavy grazing for more than 35 years had resulted in a shallower soil than where ungrazed during the same time.

Reduction of infiltration and percolation rates and increased shallow rooted plants, caused by heavy grazing, resulted in considerable increase of water yield. Against only 33 mm. produced from the ungrazed plot there were produced 97 mm. and 232 mm. from lightly and heavily grazed plots, respectively.

The net interception losses from dead plant material (litter) were 3, 5, and 9 mm. from heavily, lightly, and ungrazed plots respectively.

Serv. Forest Tech. Works (Y. D. E. M.), Thessalonica, Greece.

Johnston, A. EFFECTS OF GRAZING INTENSITY AND COVER ON THE WATER-INTAKE RATE OF FESCUE GRASSLAND. *J. Range Mangt.* 15: 79-82. 1962.

A study was conducted to determine the effects of grazing intensity and cover on the water intake characteristics of soils of the fescue grassland. A mobile infiltrometer was used to apply artificial rainfall at measured rates to selected study sites. The results showed that, even after 10 years of very heavy grazing, soil erosion by water was not a critical factor in management. The water-intake rate increased with increasing amounts of standing vegetation and natural mulch. Soil loss from artificially bared plots was approximately 2 1/2 tons per acre at a rainfall intensity of 3.23 inches per hour.

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

Branson, F. A., Miller, R. F., and McQueen, I. S. EFFECTS OF CONTOUR FURROWING, GRAZING INTENSITIES AND SOILS ON INFILTRATION RATES, SOIL MOISTURE AND VEGETATION NEAR FORT PECK, MONTANA. *J. Range Mangt.* 15: 151-158. 1962.

An area near Fort Peck, Mont. was contour furrowed and seeded to crested wheatgrass. After 10 years vegetation measurements were made to determine the consequences. Three grazing intensities and two soil conditions were studied.

Before treatment, the area had a sparse stand of nuttall saltbush and pricklypear cactus. After furrowing and seeding, especially on the more favorable soils, there was a satisfactory stand of crested wheatgrass producing 500 to 700 pounds per acre. The yield of nuttall saltbush on treated and untreated land was about 200 pounds per acre. Light and heavy grazing caused some reductions in plant yields.

There were great contrasts in plant yields and wheatgrass presence on the two soil conditions, slick and semi-slick. Slick soils had lower plant yields, poorer establishment of wheatgrass, lower infiltration rates, and lower soil moisture percentages than semi-slick soils. Slick soils were characterized by a sodium-dispersed zone near the soil surface that greatly reduced rates of water entry. It is possible that some soils that would have been classed as slick prior to treatment were improved to semi-slick conditions by contour furrowing. The fact that furrowed and seeded slick areas remained almost barren under protection from grazing shows that slicks cannot be completely eliminated by this treatment.

A different kind of furrowing treatment might have beneficially modified the slick soils. A contour furrowing machine that made small dams within furrows at intervals of about 40 feet was used on similar silty clay soils in the Willow Creek Valley in 1955. Five years after treatment it was apparent that the small dams in furrows had prevented movement of water from the relatively impermeable slicks and provided conditions favorable for plant growth.

U.S. Geol. Serv., Denver, Colo.

Geology

Guy, H. P., and Ferguson, G. E. SEDIMENT IN SMALL RESERVOIRS DUE TO URBANIZATION. J. Hydraul. Div., ASCE 88 (HY 2): 27-37. March 1962.

A study of the problems involved in the deposition of sediment in small reservoirs from urbanization in the Washington, D.C. area leads to the following conclusions:

1. The use of rural land for urban expansion is increasing rapidly. This is the product of increasing rates of population growth, larger house and lot sizes, more commercial parking areas, and other evidences of higher living standards.
2. Many drainage basins with reservoirs used for water supply and recreation are in the path of urbanization. Such urbanization involves a wide range of efforts and facilities ranging from the construction and maintenance of homes retaining little or none of the original vegetative cover to public parks retaining much of their original vegetative cover.
3. Construction exposes large areas of soil and sub-soil which greatly intensifies the processes of erosion, transportation, and deposition of sediment. Residential construction caused approximately 25,000 tons of sediment to deposit in Lake Barcroft for each square mile urbanized. Residential construction, in another area in metropolitan Washington, caused approximately 50,000 tons of sediment movement in streams per square mile.
4. Theory for understanding the nature and complexity of the urbanization-induced sediment problem has not been established. Present knowledge concerning sediment erosion, transportation, and deposition in the "rural basins" must be combined with new knowledge of the nature of urbanization processes.
5. After urbanization, a significant source of sediment deposition in reservoirs would probably be from the natural channel widening caused by increased rate and quantity of water discharge, and caused by an increase in sediment particle sizes lining the stream bed and banks.
6. Deposition in a reservoir probably will be of coarser sediment when associated with urban construction than when associated with rural conditions. This is the result of the exposure of coarser sediments to erosion, the increase in transport capacity of drainage systems, and the high concentrations of fine sediments being carried through the reservoir during the early phases of construction.

Further studies should be made of the cause as well as the effect of reservoir sedimentation from upstream urbanization. Large geographic differences will likely be revealed.

U.S. Geol. Survey, Dept. Int., Washington, D.C. 20240

Bittinger, M. W. GROUND WATER MANAGEMENT VITAL TO COMPREHENSIVE DEVELOPMENT OF RIVER BASIN WATER RESOURCES. Colo. Farm & Home Res. 12(4): 3-5, 7. 1962.

Planned management and operation of ground-water reservoirs in conjunction with surface-water supplies probably should include: (1) Heavy reliance upon ground water during years of deficient runoff. (2) Artificial recharge facilities to replace pumped ground water during years of favorable runoff. (3) Planned long-term storage in ground water aquifers where geologic conditions make it possible. This may involve transfer of water from surface reservoirs to underground reservoirs during fall and winter months to provide catchment capacity in the spring. And (4) because of the storage manipulations, the ground-water reservoirs cannot be kept full and thus will not always provide return flow to the rivers. Many ditches may have to be served by pumps when surface water is not available.

Colo. State U., Fort Collins, Colo.

Jenkins, E. D., and Moulder, E. A. GROUND-WATER TECHNOLOGY AND LITIGATION PROBLEMS. J. Irrig. and Drain. Div., ASCE 88 (IR 2): 21-32. June 1962.

Water in Colorado commonly is adjudicated on the principle of "first in time, first in right." Surface-water rights generally are senior to ground-water rights and the presumption of the courts is that most, if not all, ground water in the State is a part of the the "natural stream." Ground-water development in Colorado is often delayed by tedious and costly litigation. Ground-water technology has played and will continue to play an important role in facilitating better water legislation. A detailed evaluation of local hydrology can materially assist the court in making an equitable decision.

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

Engineering Design

Doubt, P. D. STABILIZED CHANNELS: THEIR DESIGN AND MAINTENANCE BY THE TRACTIVE FORCE THEORY. Agr. Engin. 43: 76-77, 85. 1962.

The methods of permissible velocities, regime theory, and the tractive force theory have been applied with various degrees of intensity for the design and maintenance of stable channels. The first two methods are empirical while the tractive force theory is analytical. Some empiricism has been used in the application of the tractive force theory which has unfortunately led to the questioning of the validity of this theory. This paper will help clarify the logical application of these hydraulic principles and reduce the empiricism used in applying the tractive force theory by the discussion of the following three premises: (1) The tractive force theory is logically a dynamic theory; (2) the water surface profile must be computed to evaluate tractive forces; and (3) the tractive force depends on the actual depth of flow and on the roughness coefficient of the earth material in the wetted perimeter.

SCS, USDA, Beltsville, Md. 20705

Harder, J. A. ANALOG MODELS FOR FLOOD CONTROL SYSTEMS. J. Hydraul. Div., ASCE 88 (HY 2): 63-74. March 1962.

The success of applying analog model techniques to tidal flow channels has led to the extension of the technique to the simulation of flood control systems. The similarity relationships for long period flood waves are derived.

Methods for the simulation of the channel sections are described, with particular attention paid to the non-linear properties of the stage-discharge relation and the stage-storage relation. The introduction of boundary conditions in the form of streamflows and rainfall excesses is programmed for each 6 hours in the prototype, for a total period of 10 days, by special pinboards. Each simulated flood requires 5 milliseconds, after which initial conditions of flow, at the initial instant of the 10-day period, are re-established in preparation for the next flood period. The time history of stage or discharge at any 2 of 50 stations can be displayed simultaneously on an oscilloscope screen. Provision is made for the insertion of up to six reservoirs into the analog, each of which is provided with a programmable output simulating the action of reservoir release gates. It is expected that the analog will be useful both in project planning and during flood emergencies.

Its areas of use may be divided into three categories: (1) The study of historic floods from which to determine the dynamic characteristics of the river sections; (2) project planning, in which the effect of various reservoir configurations on design storms may be rapidly evaluated; and (3) flood fighting during an actual emergency. This last function illustrates some of the advantages of analog operation that are operative in project planning as well. A very important feature is the rapidity with which the results of the perturbation of any input or operational change are displayed to the human operator. It takes only 0.03 sec. for any change to be reflected in the output. As soon as the operator has had a chance to evaluate the results of one perturbation, he can initiate the next, and so on in rapid succession until an optimum plan is derived.

During a flood emergency, some of the information available has been predetermined, as the stream gaging results from upstream points; some information is current, in the form of rainfall excess that has not yet appeared in the stream channels; and some is information predicted from weather forecasts. Some of this information will be continuously changing during the course of a flood emergency. The analog, by working at a speed limited only by the interpretive ability of the operators, will make it possible to work out a newly optimized operational plan several times a day.

The analog's full potential will only be realized in those situations in which some reservoir control is available over upstream flood discharges.

U. Calif., Berkely, Calif.

Chow, V. T. HYDROLOGIC DESIGN OF CULVERTS. J. Hydraul. Div., ASCE 88 (HY 2): 39-55. March 1962.

The development of a practical procedure for the determination of peak discharges for the design of culverts or other drainage structures on small rural watersheds is presented. Although the procedure illustrated was prepared for design conditions in Illinois, the concept involved is universally applicable to other areas, provided that adequate data are available for similar analysis and development.

The proposed method has the following merits:

1. The method has an analytical basis because it is developed from valid hydrologic principles.

2. The method is based on the available data that are applicable to the local conditions under consideration.
3. The criterion for the determination of a design discharge is clearly defined.
4. Although the result obtained by the method may still require some professional supervision or review for final adoption in a design, the method will provide a unique solution, or produce close answers by different individuals.
5. The procedure of the method is simplified by a design chart so that practicing engineers may follow the steps and use it with great ease.
6. The method may readily be improved by further analyses and tests with the accumulation of rainfall and runoff data and the field experience.

The major disadvantage is that the design discharge is based on a given frequency of rainfall, instead of runoff. This shortcoming is entirely due to the lack of suitable data of runoff frequency for small watersheds. The analysis of a large quantity of suitable runoff data may overcome this problem in the future.

U. Ill., Urbana, Ill.

Neill, C. R. HYDRAULIC ROUGHNESS OF CORRUGATED PIPES. J. Hydraul. Div., ASCE 88 (HY 3): 23-44. May 1962.

Original data on friction losses in two types of corrugated-metal pipes. A comprehensive friction factor-Reynold's number diagram, incorporating all published data on corrugated-metal pipes, is presented and used to develop a relationship between peak friction factors and relative depth of corrugations. A flow formula is developed to replace the Manning formula, but a table of n values, for use with the Manning formula, is also given.

Corrugated-metal pipes produce a different type of friction factor-Reynold's number diagram from other types of commercial pipe. The data available on standard pipe with $\frac{1}{2}$ -in. deep corrugations indicate that peak values of f are proportional to the square root of relative corrugation depth, and that consequently, values of Manning's n decrease as pipe diameter increases. For structural plate pipe with 2-in. deep corrugations, the data are those reported for a 60-in. size only.

Hydraul. Engin., Res. Council Alberta, Edmonton, Canada.

Ground Water Recharge

Clarke, F. E. INDUSTRIAL RE-USE OF WATER. Industrial and Engin. Chem. 54 (2): 18-27. 1962.

Every industry and most individual plants can reduce their primary water needs by process improvement, water conservation, and water re-use. Where cooling is the principal use, substitution of recycle for once-through operation can reduce intake by as much as 90 percent. Re-use alone might counteract the twofold increase in industrial water requirement predicted for 1980. Doubling the present 100 percent re-use figure would make this possible by providing more than 3 gallons of plant water for each gallon withdrawn. Tripling re-use to 300 percent would allow doubling the current production rate without increasing water intake.

The number and variety of return-flow and on-site re-use systems are increasing. Pertinent information from the latest census of manufacturers (1959) show that over-all re-use in industries other than steam-electric generation increased from 82 to 119 percent

between 1954 and 1959, and that re-use among the re-users increased from 106 to 136 percent during the same period.

Industry as a whole consumes only 2 percent of the 140 million gallons per day of water withdrawn and eventually returns the remainder for downstream users. About 80 percent of this return is cooling water contaminated only with heat. The remainder carries a great variety of industrial wastes.

Ground water recharge is increasing in importance as a special type of return flow re-use. Although industry draws about 10 times as much water from surface sources as from aquifers, ground water may supply 75 percent or more of the demand in areas like the Dakotas. Withdrawal at rates exceeding local infiltration has resulted in serious water table decline, particularly in the southwestern states.

Danger of saline water intrusion and the economic burden of going farther or deeper for water has prompted legislators and industries alike to think more seriously about ground water recharge.

Water is returned to aquifers through direct well injection or by surface spreading in ditches, ridge and furrow systems, and basins. Well injection is three to seven times as expensive as surface spreading and involves the risk that waste waters may clog the aquifer or contaminate the supply. At present, well injection is best suited to cooling water return, where heat is the only pollutant involved. Even here, differences in pH, gas content, and oxidation-reduction potential can create serious problems.

In surface spreading, percolation through the soil removes a variety of industrial contaminants.

The next decade will see much more research directed toward conditioning water for safe, effective recharge, both for perpetuating ground water supplies and for safe disposal of waste.

Water Resources Div., U.S. Geol. Survey, Dept. Int., Washington, D.C. 20240

WATER MANAGEMENT

Irrigation

Parks, W. L., and Smith, H. B. HOW MUCH WATER DOES IT TAKE. Tenn. Farm and Home Sci. Prog. Rpt. 43: 8-9. 1962.

Investigations on moisture use by corn, cotton, and soybeans at the West Tennessee Experiment Station show the total and average daily water use for these crops on different soils. The data (Table 1) indicate that crop yields were higher and the average daily moisture use was higher where a high level of soil moisture was maintained by irrigation. One acre inch of water (27,154 gallons) produces approximately 7 bushels of corn, 50 pounds of lint cotton, or 1.7 bushels of soybeans. Based on these figures, it would take about 388,000 gallons of water to produce 100 bushels of corn, 543,000 gallons of water to produce 2 bales of cotton, and 479,000 gallons to produce 30 bushels of soybeans.

The average daily moisture use rates for the three crops are shown in tables. These data indicate that the peak moisture use for corn occurs from tasselling to kernel formation and remains fairly high during the period from kernel formation to maturity.

The peak moisture use period for cotton is during the first 3-week interval immediately after initial boll set. The use rate remains fairly high during the second 3-week interval after boll set, but gradually declines thereafter.

The peak moisture use period for soybeans occurs during the period from 6 to 10 weeks after planting and gradually declines thereafter.

The average daily moisture use rate for corn and cotton was higher under irrigation which maintained a relatively high level of available soil moisture.

The studies indicated that about one-third of the water used to produce the crop yields was stored in the soil at the beginning of the crop year.

Table 1. Yields and Water-Use Efficiency of Corn, Cotton and Soybeans.

Crop	Soil	Irrigation treatment	Average daily water use	Total water use by crop	Crop yield	Water use efficiency
			Acre inches			
Corn	Richland	No irrig.	0.17	18.52	128.0 bu./A	6.9 bu./in.
Corn	Richland	Irrigation	0.18	20.06	145.4 bu./A	7.2 bu./in.
Corn	Lintonia	No irrig.	0.15	16.57	124.4 bu./A	7.5 bu./in.
Corn	Lintonia	Irrigation	0.18	20.02	143.0 bu./A	7.1 bu./in.
Cotton	Lintonia	No irrig.	0.16	17.38	833 lb./A lint	47.9 lb. lint/in.
Cotton	Lintonia	Irrigation	0.22	24.42	1134 lb./A lint	46.4 lb. lint/in.
Cotton	Lintonia	No irrig.	0.16	17.30	1024 lb./A lint	59.2 lb. lint/in.
Cotton	Lintonia	Irrigation	0.20	22.40	1133 lb./A lint	50.6 lb. lint/in.
Soybeans	Richland	No irrig.	0.17	18.43	32.6 bu./A	1.8 bu./in.
Soybeans	Richland	No irrig.	0.17	18.93	32.7 bu./A	1.7 bu./in.
Soybeans	Hymon	No irrig.	0.17	16.89	30.4 bu./A	1.7 bu./in.

Agr. Expt. Sta., U. Tenn., Knoxville Tenn.

Blewitt, R. I. PRESENT DAY IRRIGATION IN HAWAII. J. Soil and Water Conserv. 16: 270-273. 1961.

Since ancient times, irrigation has been a part of rural Oahu. Today, more than 131,000 acres are irrigated. Most of this land is watered by surface methods, but on several thousand acres, large and complicated machines are used for sprinkler irrigation.

Ewa Plantation Company on Oahu has a completely new trailer-mounted giant sprinkler. It delivers 2,700 gallons per minute at a pressure of 115 pounds per square inch. A 250-horsepower engine drives the centrifugal pump. The sprinkler has two interesting features-- a tilting head and an arc control. On windy days the axis of rotation is adjusted so that the nozzle is lowest when shooting into the wind. Point application rates under single sprinkler operation do not exceed 1.5 inches per hour. Reversing stops are set to give arc control, and only 270 to 300 degrees of a full circle are wetted at any one nozzle setting. This counter-rotation device avoids wetting the roads. Engineers indicate that with the nozzle correctly in use a 450-foot road spacing is satisfactory under the wind conditions at that location. Stream break-up is important so that detrimental soil compaction, aggregate breakdown, and puddling can be avoided.

Irrigation of pineapple is relatively new in Hawaii. High water development costs, limited water supplies, low consumptive use, low water requirements, a block field layout pattern, and shallow rooting are factors in equipment design. The pineapple is a miserly water user and produces well on less than a third of the amount of water required by sugar

cane or alfalfa. In low rainfall areas, large increases in yield may be obtained by applying small quantities of water.

To meet this unusual set of conditions special sprinkling machines were designed and constructed. Dole's largest machine is worthy of description. Two spray booms each 132 feet long are attached to the sides of a large truck. One thousand feet of 5-inch diameter hose is rolled up on a huge reel mounted on the truck. This hose delivers 850 gallons of water per minute to the nozzles. As the truck moves along the field road, the hose is unreeled. On the return trip the reel rewinds the hose like a giant winch. About 10 passes are made to apply 1 inch of water to the pineapple plants. The operator adjusts the boom height with a network of cables. Very good water application efficiencies are obtained because an acre can be irrigated in 35 to 40 minutes.

SCS, USDA, Honolulu, Hawaii.

Brown, L. N. IRRIGATION ON STEEP LAND. Calif. Agr. Expt. Sta. C. 509, 26 pp. 1962.

Irrigation on steep land can be a problem on slopes of 2 per cent or more. Proper irrigation methods will save water, conserve soil, and produce better crops. Success will depend not only upon the method of irrigation, but also upon the rate at which water is applied, the cover on the soil, and texture of the soil.

The main irrigation methods discussed in this circular are: (1) Furrows; (2) strip checks or borders; (3) return water systems; (4) contour ditches; (5) sprinklers; and (6) basin irrigation.

California farmers have been ingenious in developing many variations of these methods to meet the State's great variations in water supply, topography, soil, climate, and crops. This circular brings together these methods to help adapt one or more to a given situation.

Calif. Agr. Expt. Sta., U. Calif., Berkeley, Calif.

Jensen, M. C., and King, L. G. DESIGN CAPACITY FOR IRRIGATION SYSTEMS. Agr. Engin. 43: 522-525. 1962.

Procedure for computing design capacity for irrigation systems, as applied to both individual farm systems and project-wide systems is presented.

Design capacity depends on maximum consumptive-use rates for which the system must supply water and on the efficiency of the irrigation system. Efficiency of a system can be controlled and therefore design capacity is referenced to maximum consumptive-use rate requirement.

Procedure for computing maximum consumptive-use rates for different frequencies of occurrence is included. Actual evaporation and the theory of extreme values applied to evaporation data are used to compute consumptive use. Design capacity is then computed by dividing maximum consumptive-use rate of efficiency of the irrigation system.

A near constant relationship in central Washington between consumptive-use rate and evaporation provides an avenue for establishing frequency and magnitude of evaporation extremes from relatively long periods of evaporation records and interpret them into would-be consumptive use occurrences.

Tables and graphs.

Wash. Agr. Expt. Sta., Wash. State U., Pullman, Wash.

Bondurant, J. A., and Humphreys, A. S. SURFACE IRRIGATION THROUGH AUTOMATIC CONTROL. Agr. Engin. 43: 20-21, 35. 1962.

Automatic operation of surface irrigation systems is being accomplished, but on a limited scale. Savings of both labor and water are being made where it is used. The labor associated with surface irrigation can be virtually eliminated. Also by using automatic control, surface irrigation systems can be made to operate close to design efficiency, particularly the flooding methods--borders and checks. Automatic systems will require properly prepared fields, sensing or timing devices to control the gates, and distribution systems equipped with mechanical, self-operating gates.

Mechanical gates which will eliminate the labor involved in surface irrigation have been designed and tested. These gates, actuated by the water itself, will irrigate a bordered field sequentially. When the proper amount of water has been applied to the first border, the check gate is released; this stops flow of water into the first border and starts flow into the second border. The sequence continues until the entire field has been irrigated.

These gates will reset themselves automatically if water is taken out of the ditch between irrigations. In systems where the supply ditch remains full at all times, gates probably will have to be controlled by sensing devices.

SWCRD, ARS, USDA, Boise, Idaho.

Lytle, W. F., and Wimberly, J. E. HEAD LOSS IN IRRIGATION PIPE COUPLERS. La. Agr. Expt. Sta. B. 553, 15 pp. 1962.

Head loss was determined on 16 different types of irrigation pipe quick-couplers, most of which were tested in 3-, 4-, 5-, and 6-inch sizes. Results of the test for each coupler are presented in three forms. One form is by expressing the loss of the coupler as loss of equivalent feet of straight pipe. The other forms are coefficients K_s and K_c , which can be used in empirical formulas for determining the total friction loss of an irrigation system.

The head loss value varies considerably, and depends on the type of coupler, the size of pipe, the alignment of the pipe joined in the coupler, the distance between pipe ends in the coupler, and the velocity of the flow through the coupler.

The known head loss in the different couplers will be valuable in the future design of quick-couplers. The head loss per coupler will also be useful when designing irrigation systems. For maximum efficiency of an irrigation system the design coefficient should be the coefficient of the coupler to be used.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Soil Conservation Service. SCS NATIONAL ENGINEERING HANDBOOK--SECTION 15: IRRIGATION--CHAPTER 9 - MEASUREMENT OF IRRIGATION WATER. U.S. Dept. Agr., National Engin. Hbk. Sec. 15- Chapter 9, 72 pp. \$0.45 1962.

The Soil Conservation Service National Engineering Handbook is intended primarily for Soil Conservation Service (SCS) engineers. Engineers working in related fields will find much of its information useful to them also.

The handbook is being published in sections, each section dealing with one of the many phases of engineering included in the soil and water conservation program. For easy handling, some of the sections are being published by chapters.

As sections or chapters are published, they will be offered for sale by the Superintendent of Documents, Government Printing Office, Washington 25, D.C., at the price shown in the particular handbook.

This chapter on measurement of irrigation water describes the various methods of measuring irrigation water that are commonly used on irrigated farms. Tables and charts giving rates of flow for the various structures and measuring devices are included.

Supt. Doc., U.S. Govt. Printing Off., Washington, D.C. 20250

Erie, L. J. EVALUATION OF INFILTRATION MEASUREMENTS. Trans. ASAE 5: 11-13. 1962.

The important factors related to infiltration rate of water under irrigation conditions are: Surface soil conditions, internal characteristics of the soil mass, soil moisture content, hydrostatic head, season of the year, temperature of soil and water, and duration of application. Because of the unknown relationships of the many factors affecting infiltration, we must appreciate the part they play; then record, measure, or control them.

Irrigation, tillage operations, rainfall, foliage, compaction, temperature, cracking of soils, erosion, and the shading action of plants are surface soil conditions affecting the rate water can enter the soil. Soil texture, sorting of particles, plow soles, bacterial action, root development, earthworms, and chemicals affect the movement of water through the soil mass where continuity must exist. Infiltration rates generally decrease as the soil or water will lower infiltration rates. High infiltration-rate soils are sensitive to changes in hydrostatic head, increasing with an increase in head. Infiltration rates generally decrease as the growing season advances. The temperature of the soil or water is probably unimportant unless it is near the freezing range.

Cylinders used for measuring infiltration rates should be at least 6 in. in diameter. They should be constructed of no thicker than 12-gage metal. Cylinders should be driven straight into the soil with positive blows. The head of water within a cylinder should be similar to that expected under normal irrigation conditions and buffered with a similar head of water. When basins are used to determine infiltration rates, the expected irrigation head should be simulated and the downward movement of water measured.

Furrow infiltration measurements can best be measured by using the system of measuring the inlet and outlet water, making sure consideration is given to differences between the wheel and non-wheel rows. Infiltration rates may be altered by changing the shape of the furrow or the depth of water within the furrow; therefore, normal field operations should be simulated.

Regardless of the method used, it is imperative that equipment be installed and accurately used. Measurements should be made when the soil moisture is near that normally expected when irrigating. The hydrostatic head in the cylinders, irrigation water, buffers, and rows should be what is expected under normal practices. The validity of the results, and their use, are not only dependent upon the foregoing but also upon the supporting data, such as past cropping history, tillage, soil type, soil structure, and season.

SWCRD, ARS, USDA, Tempe, Ariz.

Davis, S., Schumaker, G. A., and Pepper, J. H. CAREFUL IRRIGATION + ADEQUATE FERTILIZER = FEWER MOSQUITOES + INCREASED PRODUCTION. Mont. Agr. Expt. Sta. C. 239, 6 pp. 1962.

Permanent ponds and oxbows have long been blamed for mosquito production. In a Milk River Valley study, the real culprit turned out to be irrigation water standing on fields. Here, over 90 percent of the mosquitoes developed in irrigation water. Irrigation practices which controlled mosquitoes also led to increased corn yields. Results were better still when appropriate fertilizers were added. All this can be expressed in a simple formula: Careful Irrigation + Adequate Fertilizer = Fewer Mosquitoes + Increased Production.

If 5 days were assumed to be the minimum hatching time for mosquitoes, irrigation water should not be allowed to stand in the field for longer than this. The basic solution is soil and water management rather than chemical control. Chemical control is only a temporary measure and involves such limitations and problems as development of resistance, continually recurring costs, and poison residues.

Many mosquito-producing wheatgrass meadows are not level enough to allow even distribution of water. They should be broken out and leveled and a good irrigation system established. The area can then be reseeded.

If careful irrigation and adequate fertilizer are combined, crop yields can be increased and mosquito populations decreased. Bluejoint (western wheat-grass) production can be increased, and good production of alfalfa, grasses, corn, and other crops can be obtained.

SWCRD, ARS, USDA, and Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

Tefertiller, K. R., Hildreth, R. J., Fisher, F. L., Caldwell, A. G., and Prochaska, F. C. PROFITABLE USE OF FERTILIZER ON IRRIGATED COASTAL BERMUDAGRASS. Tex. Agr. Expt. Sta. MP-543, 7 pp. 1961.

The most profitable application of nitrogen to Coastal Bermudagrass under irrigation on Lufkin fls soils are discussed.

Experiments were conducted to determine the response of Coastal Bermudagrass forage and its protein content at various levels of nitrogen application during 1954-56. Evaluation of the data and results of the soil tests for nitrates indicated that each clipping period (the time between mowing) could be considered as a separate production period, and nitrogen response could be evaluated accordingly.

A maximum yield of more than 6,000 pounds of forage was obtained at a level of approximately 400 pounds of nitrogen in May and June. In July a maximum of slightly less than 6,000 pounds of hay was harvested with about 225 pounds of nitrogen. The response to nitrogen diminished as the growing season progressed. August and September harvests reached a maximum response of more than 4,000 pounds of hay with approximately 175 and 150 pounds of nitrogen, respectively. A maximum yield of slightly more than 3,100 pounds of forage was obtained with 200 pounds of nitrogen in October. If enough nitrogen were used in each clipping period to attain maximum yields, the maximum annual yield would be approximately 15 tons of forage.

The cost of nitrogen and the value of forage determine the level of nitrogen application. When prices of fertilizer or forage change, the most profitable rates of fertilizer also may change. The use for which the forage is produced should be considered. Weight is important if it is sold since its protein content does not presently affect the price received. The nutritional value of the forage also would be important, if the forage produced were to be used for feed.

The nitrogen levels to apply for both forage and protein responses were determined by production periods at various prices of nitrogen and forage. If the forage price increases while nitrogen cost remains constant, the most profitable nitrogen level also increases. The most profitable level of nitrogen application would decline, however, if the cost of nitrogen increased while the forage price remained constant.

With nitrogen priced at 10 cents per pound and forage at \$20 per ton, 917 pounds of nitrogen would be the most profitable amount to apply annually if the forage were sold on the market. An annual production of slightly more than 13 tons of forage should be expected from this amount of nitrogen.

The protein content of the forage increases along with substantial increases in forage production as higher levels of nitrogen are applied. It is profitable to apply more nitrogen if the extra protein value in feeding operations is considered. The most profitable amount of nitrogen to apply annually would be 1,220 pounds if the same prices for forage and nitrogen given in the preceding paragraph were used. This amount of nitrogen would result in a yearly yield slightly less than 14.5 tons, only 0.5 tons less than the maximum potential yield.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Lorenz, R. J., and Rogler, G. A. IRRIGATED FORAGE CROPS FOR NORTH DAKOTA.
N. Dak. Agr. Expt. Sta. B. 437, 31 pp. 1962.

Soil and climatic conditions are excellent for the successful production of forage crops under irrigation in North Dakota. Yields of irrigated hay, silage, and pasture can be expected to be four to six times those from dryland.

Smooth brome is the best adapted grass for use under irrigation and should form the base for all mixtures. Either northern or southern bromes can be used. Other hardy, well adapted grasses are reed canarygrass, Kentucky bluegrass, and timothy. Orchardgrass is an excellent pasture grass but is not sufficiently hardy to be used alone. If used, it should be mixed with smooth brome.

Alfalfa is the highest yielding, best adapted legume under irrigation. Many varieties are adapted but Vernal is recommended because of its wilt resistance and exceptional hardiness. Ranger is another hardy, wilt resistant variety.

Birdsfoot trefoil is not known to produce bloat, but establishment is less reliable and yields are only two-thirds those of alfalfa.

A good irrigated pasture mixture (in pounds of seed per acre) is 12 pounds of smooth brome and 2 pounds of alfalfa per acre. An alternative mixture is smooth brome 7, orchardgrass 5, reed canary 2, and alfalfa 2 pounds per acre. Red clover at the rate of 1.5 pounds per acre can also be added if more legume is desired during the first 2 years. If stockmen will not risk the bloat hazard, the legume can be omitted, but about 160 pounds of nitrogen per acre must be applied annually to maintain high production.

A companion crop of oats or barley seeded at the rate of 1 bushel per acre should be seeded immediately prior to spring planting of perennial forage crops, especially if weed infestation may be heavy. Companion crops should not be used with fall seedings, unless there is danger of soil blowing.

Annual forages are a good source of feed. Corn is an excellent irrigated silage crop. Sorghum can be used for silage and sudan would provide summer pasture, hay, or silage. Oats and peas and soybeans produced less forage than did corn and sorghum, but could be grown for emergency feed.

Seed of all the common grasses can be produced successfully under irrigation, with yields up to 700 pounds or more per acre for some species. A row spacing of 36 inches is

convenient and produced good yields at Mandan. The aftermath and regrowth following seed harvest have good feed value and can be used for hay, silage, or pasture. Russian wildrye produces aftermath that is especially leafy, nutritious, and palatable.

Irrigated forage crops must be fertilized to maintain high production. Nitrogen is most important for grasses but phosphorous may also be necessary, especially on areas where topsoil has been removed to level land for irrigation. Phosphorous should be used on legumes.

CRD, ARS, USDA, and N. Dak. Agr. Expt. Sta., N. Dak. State U. and Appl. Sci., Fargo, N. Dak.

Mitchell, W. H. INFLUENCE OF NITROGEN AND IRRIGATION ON THE ROOT AND TOP GROWTH OF FORAGE CROPS. Del. Agr. Expt. Sta. B. 341 (Tech) 32 pp. 1962.

Several forage crops were studied over the 3-year period, 1957-59, to determine the effect of supplemental irrigation and nitrogen applications on their root and top growth. Ladino clover, alfalfa, birdsfoot trefoil, and orchardgrass were each grown alone and each legume in association with orchardgrass. Each mixture was subjected to two nitrogen treatments, consisting of 0 and 150 pounds of nitrogen per acre applied annually in 50 pound increments, and four irrigation treatments.

Yield responses were measured mechanically. By calculation, the adsorption of methylene blue per gram of dry root tissue was determined to provide a relative measure of root activity. It was concluded that:

1. Alfalfa and alfalfa-orchardgrass were the most productive and persistent forages used in this study outyielding, without irrigation, all other forages even when the others received supplemental water.
2. Birdsfoot trefoil yielded equally as well as Ladino clover the first year after establishment and was significantly better during the second year.
3. Ladino clover made luxuriant growth during the first harvest season but the stands deteriorated seriously during the winter months. It was the least productive of all mixtures during the second harvest season.
4. Inclusion of orchardgrass with legumes generally resulted in significant dry matter increases and less weed encroachment.
5. Orchardgrass responded significantly to nitrogen applications with increases of 89, 74, and 107 percent over the no-nitrogen treatments for the 3-year period.
6. The stands of nitrogen treated orchardgrass were seriously reduced following the second and third harvests in 1958 and 1959. This occurred during seasons of normal or above normal rainfall and was most severe where the height of cut was less than 2 inches.
7. Birdsfoot trefoil did not show a positive response to supplemental irrigation.
8. Supplemental irrigation was not highly effective in increasing the yields of orchardgrass and the 4-inch irrigation was less effective than either the 1- or 2-inch treatments.
9. The relatively small seasonal growth response to irrigation by orchardgrass and trefoil may be explained by the vigorous growth each made with the return of normal rainfall after a prolonged drought.
10. The method of applying supplemental water generally resulted in significant yield differences. In 1957, 2 inches of water applied at each irrigation was superior to 1 or 4 inches. In 1959, the 1-inch treatment was superior to the 2- or 4-inch applications.

11. Modification of an existing methylene blue adsorption technique is described and it appears to have potential as a tool for making relative root measurements.
12. Nitrogen fertilization was generally associated with smaller root systems as measured by methylene blue adsorption and to a lesser extent by dry weight measurements. Nitrogen treatments increased the adsorption of methylene blue per gram of root tissue--a value referred to as root activity.
13. Very significant increases in root activity occurred with increasing root depths whereas the dry weight of roots decreased with depth.
14. Supplemental irrigation decreased root growth as measured by methylene blue adsorption and by root weights. Irrigation treatments also influenced the root growth of the perennial species tested during the year following treatment. In this case, the heavier root systems were associated with supplemental water during the previous season.

U. Del., Agr. Expt. Sta., Newark, Del.

Harris, L. TO ESTABLISH ALFALFA ON SLOPING LAND--CORN GOOD COMPANION CROP. Nebr. Expt. Sta. Q. 9(1): 9-10. 1962.

Corn has replaced low profit oat and barley companion crops in establishing alfalfa on level bench terraces at the Scotts Bluff Experiment Station. Corn yields of 100 to 130 bushels per acre were produced during the year alfalfa was established.

The practice also was successful on sloping land in 1960. A good stand of alfalfa was obtained in corn yielding 97 bushels per acre on sloping land. Corn was planted May 6 in rows spaced 42 inches apart (20,000 corn plants per acre). Alfalfa was seeded June 27. Irrigation water was applied in small ditches and short runs. The slope of the field ranged from 2 to 4 percent.

Irrigation management will determine success in establishing alfalfa in irrigated corn on sloping land. The practice involves more work but returns will likely pay large dividends for the extra work and management involved.

Soil erosion and over-irrigation on the upper ends of fields were eliminated by the careful irrigation practices necessary to establish alfalfa in corn on sloping land. Irrigation efficiency was improved.

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

Grimes, D. W., Herron, G. M., and Musick, J. T. IRRIGATING AND FERTILIZING WINTER WHEAT IN SOUTHWESTERN KANSAS. Kans. Agr. Expt. Sta. B. 442, 9 pp. 1962.

In recent years considerable research work has been done at the Garden City Experiment Station in an effort to increase yields of irrigated wheat. The following comments and recommendations are based upon these results:

1. Irrigate in the fall sufficiently to wet the soil to a depth of 6 feet (assuming soil profile is unrestricted to this depth).
2. Avoid applying irrigation water during the period of early spring growth (March and April).
3. During years of normal or below normal rainfall, a second irrigation should be scheduled when plants are in the boot stage. If wheat was seeded early to provide pasture or if the fall irrigation did not wet the soil to a depth of 5 to 6 feet, an irrigation during the winter may be profitable.

4. In extremely dry years with adverse weather conditions such as high winds, and temperatures and low relative humidity, an irrigation during the milk stage of grain will reduce "shriveling."
5. If soils are coarse textured or have restricted profiles, more frequent irrigation may be needed to produce most profitable yields.
6. Adequate fertilization is necessary to produce high yields of wheat. With adequate irrigation 40 to 60 pounds per acre of nitrogen are needed. Slightly higher rates may be profitable on some fields.

SWCRD, ARS, USDA, and Agr. Expt. Sta., Kansas State U., Manhattan, Kans.

Roberts, S., and Nelson, C. E. CULTURAL PRACTICES AFFECTING STAND AND THEIR RELATIONSHIPS WITH TILLERING, LODGING, AND YIELD OF RILL-IRRIGATED WHEAT. Wash. Agr. Expt. Sta. B. 629, 17 pp. 1961.

The effects of certain cultural practices affecting stand, and their relationships with tillering, lodging, and yield of rill irrigated wheat were studied.

Drilling the seed parallel to irrigation rills spaced 24 and 28 inches apart increased the stands 12.0 percent above those drilled at right angles to the rills. The stands from parallel and cross seedling were not significantly different when the rills were 32 or 36 inches apart.

Packing the soil after seedling increased the stands 1.2 percent compared with no soil packing.

Six types of ditchers used in making irrigation rills were studied for their effects on plant emergence in relation to seedling rates. The ditching operations followed seeding. All types of ditchers reduced stands. When 8, 16, 24, 32, and 40 seeds were planted per square foot, ditching decreased plant emergence by 33.7, 36.2, 38.6, 38.8, and 42.1 percent, respectively. As seeding rates increased, the ditchers moved increasing amounts of seed per unit area into unfavorable locations for germination and emergence.

Plant emergence in relation to the number of seeds planted varied greatly with the type of ditcher used. A narrow shovel followed by a smoothing device, or a ditcher with a shank and diamond point with a flaring device to push the soil to the sides, resulted in the highest percentage of plant emergence. Ditchers with a scoop type of shovel gave the lowest percentage of plant emergence.

Given stands of wheat were obtained within close limits by adjusting the seeding rate for direction of drilling in relation to the rills, compacting the soil after seeding, and ditching.

Marfed spring wheat tillered less as plant populations increased. In 1958 and 1960, the regressions of culms per plant in relation to plants per square foot were nearly alike. The number of culms per plant for 1959 was much greater than for 1958, and 1960, and the slope of the regression line was much steeper. Seasonal differences and earlier seeding in 1959 may explain this.

Maximum yields for 1958, 1959, and 1960 were 58.3, 75.8, and 73.8 bushels per acre with stands of 23.8, 8.5, and 5.0 plants per square foot, respectively. Yields decreased with increasing plant population only in 1960. In this year there was a linear relationship of these with lodging.

Because lodging occurred extensively 1 out of 3 years, the potential lodging for the 3-year period was determined by using culm breaking measurements. The force required to break the culms decreased as the plant population was increased. The culms in 1959 were much more resistant to mechanical breakage than in 1958, and the culms for the latter, in general, were more resistant than those in 1960. The weather and general growing conditions

are suggested as possible explanations for differences in culm breakage measurements between years.

Wash. Agr. Expt. Sta., Inst. Agr. Sci. Wash. State U., Pullman, Wash.

Strong, D. C. ECONOMIC EVALUATION OF ALTERNATIVE FACILITIES FOR SURFACE AND SPRINKLER IRRIGATION IN UTAH. Utah Agr. Expt. Sta. B. 433, 47 pp. 1962.

The relative feasibility of surface versus sprinkler methods under different physical and economic conditions were studied. An evaluation was made to determine how farm profits and water use were influenced by each basic method and by various conveyance and application facilities available for these methods.

The following conclusions were given:

1. The initial investment for the portable sprinkler system is less than for any of the facilities for surface irrigation when land grading is required for proper irrigation by surface methods but not by sprinkler. Total annual costs are lower for the sprinkler only when runs for surface irrigation are less than 165 feet on fine-textured soil, and 265 feet on coarse-textured soil. Annual costs of irrigation with unlined ditches are lower than for all other surface irrigation facilities except where slope and soil texture are such that extremely short irrigation runs are necessary. In these situations, irrigation with gated-pipe and sprinklers has the advantage.
2. A high proportion of the total annual costs for irrigation using concrete-lined ditches and sprinkling consists of interest and depreciation charges against the initial investment. Annual cash costs for operation and maintenance are actually lower for gated-pipe and concrete-lined ditches than for either unlined ditches or sprinkler methods. Annual costs are higher for sprinklers than for any of the surface facilities of irrigation.
3. Charges against the surface facilities of irrigation for: (1) Value of production "lost" from land used for ditches; (2) crop adaptability; (3) initial reduction in crop yields because of grading; and (4) increased costs of field operations because the presence of ditches significantly decreases the feasibility of these methods compared to use of sprinkler and gated-pipe.
4. When land grading costs are included and cost-sharing with farmers is not authorized by the government all surface irrigation facilities cost less than portable sprinklers except where irrigation runs are less than 250 feet on fine-textured soil, 300 feet on medium-textured soil, and 400 feet on coarse-textured soil. Sprinkling is the least feasible method for irrigating fine-textured soil on slopes less than about 1.5 percent, and for irrigating medium-textured soil on slopes of less than 3.0 percent. Of the surface facilities, unlined ditches have an advantage on fine and medium-textured soils for runs greater than 660 and 440 feet, respectively. For runs less than these, gated-pipe is the most feasible facility.
5. If land grading costs are not included as a charge against irrigation, the feasibility of surface irrigation facilities increases as compared to sprinklers. Only on coarse-textured soils on slopes greater than about 1.5 percent would sprinklers be more feasible than unlined surface ditches.
6. Total investment for sprinklers using permanent steel main lines was \$31 per acre higher than for those using portable aluminum pipe. Total annual costs for the permanent system exceeded those of the portable method by \$2.35 per acre. Although

total annual costs are higher for a permanent system, annual cash costs for operation and maintenance are lower. Annual costs were lower for sprinkler systems using electric motors than for those using gasoline motors.

7. Variation in size of farm had little effect on per acre investment costs of surface systems. Per acre investment costs for a sprinkler system to irrigate a 160-acre farm were 6 percent less than for an 80-acre farm and 25 percent less than for a 40-acre farm.
8. Attainable irrigation efficiencies for sprinkler methods are greater than for surface methods. The "costs" of the additional water required because of lower efficiency of unlined ditches compared to sprinklers varied from \$5.69 per acre on fine soil and slopes of less than 1.5 percent to \$12.41 on coarse soil on slopes of over 6.0 percent. The value of production "lost" when surface irrigation was used because of additional water required compared to sprinkling added to all other costs made sprinklers the most feasible method of irrigation in all physical situations except on fine and medium textured soils with slopes of less than about 1.5 percent.
9. The relative feasibility of a particular method of irrigation is influenced by a wide variety of physical and economic situations.

Tables and graphs.

Agr. Expt. Sta., Utah State U., Logan, Utah.

White, J. H. GRAVITY IRRIGATION ON COTTON AND SOYBEANS IN CENTRAL ARKANSAS: AN ECONOMIC EVALUATION. Ark. Agr. Expt. Sta. Rpt. Ser. 98, 22 pp. 1961.

The practice in Arkansas of irrigating crops other than rice is relatively new. Excluding rice the acreage of crops irrigated increased from 11,067 to 190,688 acres between 1949 and 1954. The majority of the increase occurred in the eastern half of Arkansas but the area of greatest concentration was in Lonoke and Jefferson Counties. In the early fifties 3 years of drought probably was the most important factor encouraging the development of irrigation facilities on cotton farms. Of the systems studied 80 percent were installed between 1953 and 1955.

The area studied includes parts of Arkansas, Jefferson, Lonoke, and Pulaski Counties. The topography was such that little or no surface preparation of the land was necessary. Farms on which irrigation systems were developed were predominantly cotton farms with sizable acreages of soybeans.

Irrigation pumps were powered with both stationary power units and farm tractors. Because of the difference in total investment, fixed cost, and variable cost the total cost of irrigation was developed for each type of power unit.

Irrigation systems powered by stationary power units required a total investment of \$3,800 or about \$44.00 per crop acre irrigated. The total annual fixed cost including depreciation, interest, and taxes was \$397.21, or \$4.62 per crop acre irrigated. Total variable cost, excluding head ditch construction, amounted to \$2.39 per acre irrigated. The total cost of irrigating one-crop acre an average of three times was \$11.90.

Irrigation systems powered by farm tractors required an investment of \$2,700, or \$41 per crop acre irrigated. The total annual fixed cost was \$249, or \$3.77 per crop acre irrigated. Total variable cost, including the cost of the farm tractor, was \$4.01 per acre irrigated. The total cost of irrigating one crop acre an average of three times was \$15.91.

An analysis was made of the costs of and returns from irrigating cotton and soybeans for the years 1955-58. Returns from irrigation were based on the average yield difference between irrigated and nonirrigated acreages of these crops on farms in the irrigation sample. The 4-year average yield of irrigated cotton was 0.31 bale greater than the yield of

nonirrigated cotton, but the increase ranged from 0.15 to 0.71 bale per acre. During the 4-year period average returns above the cost of irrigation, including the cost of harvesting and ginning the increased yield and the cost of additional chopping and insecticide application, amounted to approximately \$22 and \$19 per acre for power unit and tractor-powered pumps, respectively. During 1955 and 1956, returns above these costs were estimated to be between about \$22 and \$74 per acre. However, because of favorable weather conditions during the growing seasons of 1957 and 1958, returns above these costs were less than \$0.85 per acre in 1957 and \$5.07 or less in 1958.

The 4-year weighted average difference in soybean yields experienced by farmers was 8.5 bushels per acre. Average returns above the cost of irrigating soybeans were \$5.60 and \$3.29 for irrigation systems using stationary power units and tractors, respectively, for pump power. Estimated returns above irrigation costs ranged from a loss of \$4.46 to gain of \$21.50 per acre. Returns from irrigation of soybeans were greater than the cost of irrigation in 3 years out of the 4.

U. Ark., Fayetteville, Ark.

Hughes, W. F., and Magee, A. C. AN ECONOMIC ANALYSIS OF IRRIGATED COTTON PRODUCTION MIDDLE BRAZOS RIVER VALLEY, 1955-58. Tex. Agr. Expt. Sta. MP-580, 12 pp. 1962.

Irrigation development in the Middle Brazos River Valley approximated 80,000 acres in 1957, the peak year. A few farmers obtained part of their irrigation water from the Brazos River, but most irrigation water supplies were obtained from shallow wells on the river flood plain.

Cost of developing irrigation ranged from \$56 to \$116 per acre irrigated, depending largely on differences in the amount of land preparation, investment in portable aluminum pipe, and differences in well capacities among farms. In 1958, development costs averaged \$81 per acre irrigated.

Cotton is the principal crop irrigated; on most farms, it is the only crop irrigated. The irrigation season for cotton usually begins in early July and ends in mid-August. The number of irrigations and the total quantity of water applied differed among years and among farms, depending on the amount of rainfall received in July, well capacities, and micro-relief of the irrigated lands.

Irrigation of cotton increases labor and material requirements. Preharvest power use is increased 14 percent, labor 39 percent, fertilizer 82 percent, and the number of insecticide applications 80 percent over normal dryland requirements.

Yields of irrigated cotton for 1955-58 averaged 823 pounds of lint per acre on selected farms. Average yields of irrigated cotton declined each year of the study, averaging 978, 852, 833, and 732 pounds of lint per acre in 1955, 1956, 1957, and 1958, respectively. Much of the decline in average cotton yield was due to heavy and prolonged rainfall during the cotton-harvesting season of the latter years.

Excluding land, management, and general farm overhead expenses, preharvest cotton production costs averaged \$109 per acre, \$54 per acre more than normal costs incurred in nonirrigated cotton production. The 1955-58 return to land, management and farm overhead averaged \$96 per acre of irrigated cotton, compared with a similar return of \$45 per acre with normal production of nonirrigated cotton.

Irrigation can substantially increase cotton yields, but much of the benefit stemming from higher yield levels is absorbed by increased costs and harvest and grade losses in years with heavy rainfall during the harvest season. Cotton produced on dryland is also subject to yield reduction from the same sources, but much of the dryland crop is normally harvested with little weather damage.

Irrigation delays cotton maturity 3 to 5 weeks and exposes the crop to severe yield and grade losses from fall rains. Weather records show that the chance of receiving damaging amounts of rainfall increases with time, ranging from 1 to 10 in September, 1 to 3 in October, and 2 to 5 in November. Analysis of weather records also indicates that there is only 1 chance in 12 that rainfall of damaging proportions will not be received sometime during the 3-month period--September-November.

Avoiding weather damage is a major problem in irrigated cotton production in the Middle Brazos River Valley. This was shown in 1957-58 and 1960. A management program involving a reduced level of water use and fertilizer inputs, as well as a shortened irrigation season, is being adapted on some farms in an attempt to minimize damage from wet fall weather.

Continuing adjustments in water use and plant nutrient levels indicate that the most economic water use program has not yet been determined.

FERD, ERS, USDA, and Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Robinson, J. F. IRRIGATION COSTS FOR SOUTH DAKOTA. S. Dak. Coop. Ext. Serv. F. S. 63, 2 pp. 1961.

This fact sheet gives an idea of the comparative costs of gravity and sprinkler irrigation. It is meant to acquaint farmers with typical considerations which go along with developing irrigation systems in present farm operations. Specifically, these considerations include system efficiency, operating costs, and credit and additional capital needs.

Table 1. Investment and Cost Per Acre for a Gravity Irrigation System for 100 Acres

Investment	
Land Development	
Leveling 100 acres @ \$30/A	\$3,000.00
Well 100' deep--1,000 gal. capacity @ \$15/ft.	1,500.00
Gear head pump and motor (Propane).	3,900.00
Field Equipment	
Leveler 9'3" capacity	950.00
Ditcher 6'	470.00
Dams and siphon tubes	<u>305.00</u>
Total investment	\$10,125.00
Annual Costs	
Interest on average investment @ 6%	\$303.75
Depreciation.	375.00
Taxes 60% of average assessed value--3%	91.13
Repairs 2.5%	178.13
Tractor use @ \$.50/hr.--(114 hrs.--Ditcher and leveling)	57.00
Fuel (tractor 216.6 gal. @ \$.24/gal.)	51.98
(propane engine 900 hrs.--4 gal./hr. @ \$.12/gal.)	432.00
Oil and grease	<u>17.80</u>
Total annual cost	\$1,506.79

Table 1.--Continued

Number of acres irrigated	100
Cost per acre irrigated	\$15.07
Cost per acre, each 4-inch irrigation.	3.36
Cost per acre, each 1-inch irrigation.84
Fixed cost per acre irrigated	8.27
Variable cost per acre irrigated	6.80

Table 2. Investment and Cost Per Acre for a Sprinkler Irrigation System for 100 Acres

Investment

Development Costs

Well 100' deep--1,000 gal. cap. @ \$15/ft.	\$1,500.00
Gear head pump and motor (propane)	3,750.00
Sprinkler--800'--6" main line, 2,600' lateral 4"	<u>4,000.00</u>
Total investment	\$9,250.00

Annual Costs

Interest on average investment @ 6%	\$277.50
Depreciation.	763.46
Taxes 60% of average assessed value--3%.	83.25
Repairs @ 3%.	277.50
Tractor use @ \$.50/hr. (20 hrs.)	10.00
Fuel (tractor--20 gal. @ \$.24/gal.)	4.80
(propane engine 1,120 hrs.--5.5 gal./hr. @ \$.12/gal.)	739.20
Oil and grease--misc.	<u>20.00</u>
Total annual cost.	\$2,175.71

Number of acres irrigated	100
Cost per acre irrigated	\$21.76
Cost per acre, each 4-inch irrigation.	5.44
Cost per acre, each 1-inch irrigation.	1.36
Fixed cost per acre irrigated	11.34
Variable cost per acre irrigated	10.42

These figures give an idea of the comparative investment cost. However, many other factors are involved. Land usually can be more economically used for surface irrigation, rather than with the sprinkler method, whenever levelling will not materially reduce productivity. On the other hand, sprinkler systems provide greater flexibility in permitting farmers to use larger equipment more easily in field preparation.

Coop. Ext. Serv., S. Dak. State Col., Brookings, S. Dak.

Ruttan, V. W. THE IMPACT OF IRRIGATION ON FARM OUTPUT IN CALIFORNIA.
Hilgardia 31(4): 69-111. 1961.

The problem of allocating water among production units, industries, or geographic units, and of planning water resource development, requires information of the relationship between water input, other inputs, and product outputs. The study was undertaken to determine the extent to which differences in the level of farm output in California counties can be accounted for by differences in irrigation or irrigation-associated inputs as compared with total complex of inputs used in agricultural production. A model is developed to identify the historical impact of irrigation on California's farm output, and this is analyzed in order to project impact of future irrigation development on farm output.

U. Calif., Berkeley, Calif.

The economic feasibility of draining lands in Cache County were evaluated to determine if ground water law and other institutional factors inhibited drainage and development of ground water for irrigation.

Utah's ground water law and decisions of court cases relative to rights of ownership and guarantee of artificial artesian pressure were analyzed to determine the extent to which individual initiative in development of ground water in Cache County and other areas of the State is inhibited. Highlights of the study were:

1. There are 23,619 acres of land in the Logan-Hyde Park-Benson area that need drainage.
2. Under present conditions with no drainage, 12,507 acres or 52 percent of the area consists of idle land and of unimproved nonrotation pasture. With drainage, only 3,627 acres or 15 percent of the area would remain idle and in unimproved nonrotation pasture.
3. For the total area of 23,619 acres, gross crop value could be increased by \$574,552 annually or by 63 percent over that obtained at present. This amounts to an average annual weighted increase of about \$24 per acre.
4. Deduction of all expenses and allowances except for land and water leaves an average net return to these resources ranging from \$22.55 per acre for class 1 land to \$2.26 for class 4 land. Net returns to land and water from land classes 5 and 6 were negative.
5. Deduction of annual amortized costs for land development from net returns to land and water leaves annual total net direct agricultural benefits (residual values to water) of \$19.84, \$10.44, and \$5.05 per acre for land classes 1, 2, and 3, respectively. Net direct agricultural benefits to land class 4 were negative. Out of the total 23,619 acres of land in the area, 14,052 acres of classes 1, 2, and 3 land would be all that is capable of supporting additional drainage and pumping costs.
6. Estimated costs for drainage and water development ranged from about \$60 to slightly more than \$100 per acre. The average capitalized value of the increased benefits accruing to class 3 is practically the same as the costs of drainage and development.
7. Annual indirect benefits from increased farm incomes of \$9,446, additional tax revenues of more than \$39,000 per year from increased property valuations, reduced road maintenance, reduction of mosquitoes, and other indirect benefits become significant in determining the feasibility of reclaiming the land.
8. The majority of court decisions have placed restrictions on individual initiative to to develop ground water for beneficial use. Artesian pressure as a means of diversion cannot be guaranteed as this is beyond the control of man. Drilling a well and pumping is many times a better alternative than litigation over infringement of rights because of the costs and the uncertainties of court decisions.
9. There are 471 wells in the Logan-Hyde Park-Benson area and almost all of them are flowing. About 126 of these wells would cease flowing if the land is drained by pumping. Implications of the law are that most of these wells would have to be replaced by installing pumps or by providing water from other sources if the water table was lowered by pumping from underground aquifers.

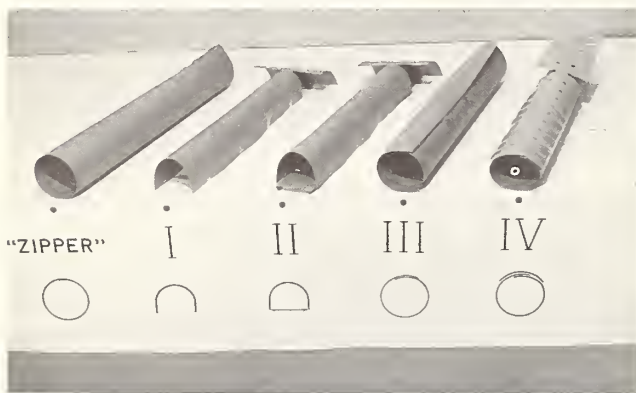
Drainage

Fouss, J. L., and Donnan, W. W. PLASTIC-LINED MOLE DRAINS: PROMISING ANSWER TO LOW-COST SUBSURFACE DRAINAGE. *Agr. Engin.* 43: 512-515. 1962.

In the past 15 years considerable research has been conducted to develop techniques for utilizing new materials to lower the cost of subsurface drainage. A new type of plastic mole drain liner and improved equipment for more accurately installing plastic-lined mold drains have been designed to provide a low-cost method of subsurface drainage particularly in slowly permeable soils and in soils with shallow impermeable strata requiring narrow drain spacings.

A semirigid sheet of polyvinylchloride (PVC) plastic, 15 mil. in thickness, was used in this study for the mole lining material. It is a thermal plastic with high chemical resistance and good dielectric properties. The plastic material will withstand considerable bending, twisting, and tensile pulling.

A method was developed to install within a mole channel a completely closed circular liner formed from a coil of sheet PVC plastic. A 3-in. diameter mole liner was formed from a 10-in. wide sheet of pastic that had interlocking tabs prestamped along both edges. A short section of formed "zipper" type mole liner is shown at the left in Fig. 1. It was



nicknamed zipper mole liner because the interlocking tabs were fastened together with a zipping action by a special die mounted in the installation equipment.

The additional types of plastic mole liners shown in Fig. 1 are being studied also.

Experience with the mole-lining machine during 1960 and 1961 showed that the zipper plastic mole liner could be installed with as much ease and trouble-free performance of the machine as the simpler overlap or arch types of

mole liners. After nine months of field testing, the zipper mole liner had maintained its cross-sectional size and shape better than the overlap types.

This application for plastic may have an extremely important function in future drainage developments. Costs for installing the zipper mole liner 28 in. deep in a heavy clay soil are estimated at 10 to 12 cents per linear foot, 8 cents of which is for the plastic material.

SWCRD, ARS, USDA, Columbus, Ohio.

Hammad, H. Y. DEPTH AND SPACING OF TILE DRAIN SYSTEMS. *J. Irrig. and Drain. Div., ASCE* 88 (IR 1): 15-34. March 1962.

The saturation of agricultural soil may be caused by either or both of the following reasons: (1) Over-irrigation or rain; and (2) seepage from a nearby river, canal, or irrigated field.

The downward seepage flow through porous soil to a system of parallel tile drains was studied. A theory of hydrodynamics was developed with the object of providing a scientific basis for the design of tile drains.

Because seepage flow takes place in planes at right angles to the parallel system of drains, the problem is treated as being two-dimensional. Complex function theory and conformal mapping were used to derive relations among the discharge, head, and spacing of tiles.

The unsteady nature of the seepage flow was taken into account because the water table rises to a maximum height after irrigation or rain, and then falls gradually due to the influence of drainage. A new spacing formula was obtained that was based on the time variation of the water table. This formula gave more economical designs than most of the existing formulas.

The effect of evaporation from the soil surface on the spacing formula was introduced. This effect alone produces an additional economy of approximately 50 percent. An actual drainage problem is solved by applying the present theory and then comparing with solutions derived by use of the theories of other investigators.

Alexandria U., Alexandria, Egypt, U.A.R.

Symposium. EFFECTIVENESS OF BACKFILL MATERIALS FOR TILE DRAINS. Trans. ASAE 5: 54-62, 67. 1962.

Organic and inorganic materials have been used for many years and for many reasons to blind draitile lines. However, few studies have been reported on the effect of the materials on drainage flow, the ability of the materials to retard the movement of unstable soils, or the life of the organic materials.

In recent years the development of fiberglass mats as "filters" has focused attention on the function and use of the organic and inorganic blinding materials. During the 1960 Winter Meeting of the ASAE the Drainage Group of the Soil and Water Division presented a symposium reporting the results of three studies in this area. The papers given, together with a summary statement by Benjamin A. Jones, Jr., are presented below.

Sisson, D. R., and Jones, B. A., Jr. FILTER MATERIALS FOR TILE DRAINS IN A MEDIUM SAND--A LABORATORY COMPARISON. Trans. ASAE 5: 54-58. 1962.

A uniform medium sand known to cause silting of draitile was selected as a base, and seven filter of blinding materials were compared in a laboratory study to determine their relative effects on clogging and flow of water to a draitube. The mechanics of soil moving to the draitube were also studied.

The seven filter materials were: (1) Corncobs; (2) sawdust; (3) straw; (4) topsoil; (5) gravel; (6) fiberglass mat over the top three-fourths of the draitube; and (7) fiberglass over the top three-fourths and vinyl film under the bottom one-fourth of the drain. All of the materials except (7) were placed over only the top and sides of the drain, leaving the bottom one-fourth exposed to base soil.

The drain-tank models consisted of small plywood tanks. Two-inch lucite tubing was used to simulate draitile, and one 1/8 in. circumferential opening was used in all the tests. Each test run lasted 6 hr.--2 hr. of partly saturated profile flow, 2 hr. of ponded-water-profile flow, and 2 hr. of ponded-water-profile flow plus flow through the draitube at half-full state.

Results and conclusions were as follows: (1) With no filter material, sand filled the draitube quickly. In the sizes used, corncobs provided only slightly better protection than no filter material. (2) Fiberglass with plastic, straw, and sawdust, in that order, provided the best protection against soil movement. There was no significant difference between any two of these top three materials. Gravel, 270-deg-wrap fiberglass, and topsoil ranked fourth, fifth, and sixth, respectively. Even topsoil, however, provided protection hundreds of times superior to that of no filter material. (3) No filter or blinding material restricted the flow of water to the draitube. The difference in water discharged when the various filter materials were used were not great. (4) Negative pressures within filter materials during

ponded-water flow tended to favor a low rate of soil movement. And (4) when no filter material was used, soil moved into the draintube along a surface-of-seepage. Soil entered first at the bottom of the tube, but originated almost entirely from above the drain.

Jr. Author, U. Ill., Urbana, Ill.

Palmer, D. B., and Johnson, H. P. FIELD EVALUATION OF FLOW THROUGH BLIND INLETS. Trans. ASAE 5: 58-61. 1962.

Four types of blind inlets were compared in a field experiment over a 5-year period. The inlets were constructed of soil, sand, corncobs, and a combination of materials of varying sizes (gradated). Relative performance was evaluated by the rate of water movement through the inlets with free outlet. Primarily because of the variation in discharge among the four replicates of each inlet type, the statistical analysis did not indicate that there were significant differences among the four inlets. With this limitation in mind, however, certain general trends were noted in regard to the ranking of the four inlet constructions and the effect of time: (1) Corncobs and gradated inlets produced higher average discharge rates than soil and sand inlets; (2) sand inlets consistently gave the lowest discharge rates; and (3) no consistent year-to-year change in discharge rates occurred.

Several observations of the various treatments were made in which the discharge rate for a free outlet was compared with the discharge rate for a submerged outlet. Except for two cases in the soil treatment where piping had apparently occurred, the measurements in the soil treatment and in the sand treatment indicated that saturated flow occurred in these filters when the outlet was not running full, the discharge being approximately proportional to the head applied. In the case of the gradated filter treatment it was apparent that the flow conditions for the free outlet were dissimilar to the submerged outlet; the discharge for the submerged outlet was larger than would ordinarily be predicted from the free outlet discharge. Air apparently had moved into the coarse materials around the drain when the drain did not flow full. Although the data were more erratic, it was apparent that the flow conditions for the corncob treatment were similar to those for the graded filter treatment. Consideration of the submerged outlet observations indicates that: (1) Except for cases where piping is evident, saturated flow may be expected to occur in the vicinity of the drain for soil backfills and for sand backfills covered with soil when the sand is of the particle size distribution used in this study; and (2) if a soil cover is placed over corncobs or a coarse material as is often done in draining potholes, air may move into the filter material and saturated flow will not occur in the vicinity of the tile if the drain is not flowing full.

Iowa State U., Ames, Iowa.

Brownscombe, R. H. FIELD EVALUATION OF TILE DRAINS LAID WITH ORGANIC BLINDING MATERIALS. Trans. ASAE 5: 61-63, 67. 1962.

Visual inspection of the tile with straw as blinding material indicated little or no movement of mineral soil particles into or through the straw. This may be due to the inherent stability of the soil rather than to the excellence of the blinding material acting as a filter. In some cases where straw was used, voids remained under the strawmat due to bridging at the sides of the tile. These voids facilitate water movement but could also cause shifting of tile due to erosion if water velocity was relatively high. In other cases, the straw mat was pressed tightly against the tile and may have reduced water movement.

Sawdust and wood chips probably facilitated the entry of water by providing a porous medium near or connecting with the tile joints. However, the wood chips as placed on the Knutzen tile line would not be effective as a filter because there were no chips on the upper or lower sides of the tile.

Straw that was 11 years old was moderately decayed but still seemed to be fairly effective. Straw that was 6 years old was generally less decayed and nearly as effective as when first placed. It was estimated that straw blinding material would be severely decayed after approximately 15 years. Wood chips were only slightly decayed after 11 years in the soil. If the tile had had good outlets, the rate of deterioration of both the straw and the sawdust might have been significantly faster than observed here.

Tile joint spacing was satisfactory with few exceptions. Most spaces averaged 1/16 to 1/8 in. around the tile circumference. In general tile ends were reasonably even. In one of the exceptions--the Wold farm--some of the tile was chipped or spaced with wide cracks at the joints so that silt and fine sand had been carried into the tile line. In this case no straw or organic blinding material was evident.

SCS, USDA, Portland, Oreg.

Jones, B. A., Jr. SUMMARY. Trans. ASAE 5: 67. 1962.

In the three preceding papers, the duplication of materials studied is limited. However, the results of the studies lead to the following general conclusions:

1. Organic and inorganic blinding materials are effective as protective filters in unstable soils or as blind inlets.
2. In both the laboratory and field studies, graduated material and sawdust or wood chips produced high water discharge rates. In the laboratory, both were effective in limiting soil discharged.
3. In the laboratory, there was no statistically significant difference in soil discharged and the rate of water discharged for straw and sawdust blinding materials. Field observations also indicate that straw and sawdust are similar.
4. Although corncobs were not effective in limiting soil discharged in the laboratory study, they should not be overlooked as an organic blinding material. The potential of corncobs is probably more accurately portrayed by the field study.
5. The life of the organic materials is not known. The straw and wood chips were slightly deteriorated after 9 to 11 years.
6. It is important that organic material be placed around the tile carefully and in sufficient quantity so that the sides and top of the tile are covered.
7. Corncobs or other material that contains large voids after placing, may trap enough air in the pore space so that they will never become saturated by drainage flow unless the tile is flowing full.

Organic blinding materials have been shown to be as effective as inorganic materials. However, since the life of the organic materials has not been determined, it is important that new studies be initiated and existing studies continued so that an economic comparison can be made to determine the true value of the materials.

U. Ill., Urbana, Ill.

Brutsaert, W., Taylor, G. S., and Luthin, J. N. PREDICTED AND EXPERIMENTAL WATER TABLE DRAWDOWN DURING TILE DRAINAGE. *Hilgardia* 31(11): 389-418. 1961.

Comparisons were made between experimental and predicted positions of the water table during drawdown by drains. Experimental positions were obtained from tank drainage data. The predicted water table positions were determined with a modified form of the Kirkham-Gaskell equation for drawdown. An electrical resistance network was used to obtain the components of the potential gradient which are required by this equation. Two modifications were made in the Kirkham-Gaskell equation; The capillary fringe replaced the water table as the upper boundary of the region in which flow occurred. Instead of using a constant drainable porosity, one was used which related drainable pore space to the water table depth.

The agreement between experimental and predicted positions of the water table was good. When either of the modifications was not made, significant discrepancies were noted. There was considerable deviation in both shape and mean position of the water table when a constant porosity was used in the theory.

The proposed equation for drawdown offers a sound basis for studying drawdown by drains. An electrical resistance network is convenient for eliminating the tedious calculations that are required by the equation. Because of extensive calculations, the theory is still not suited for design purposes. It will serve its greatest role in evaluating more practical drawdown equations.

U. Calif., Davis, Calif.

Myers, V. I., Langan, L. N., and Lloyd, R. D. INTERPRETATIVE SOIL GROUPINGS FOR ANALYSIS OF DRAINAGE PROBLEMS IN WESTERN IRRIGATED AREAS. *Trans. ASAE* 5: 103-105. 1962.

With a map delineating drainage units, such as those established for the Newlands Project, and with results of studies described in this paper, it is possible to establish a drainage guide based on sound technical information. A map of a project area can be prepared to show all canals, laterals, and drains and drainage units in which seepage rates are likely to be high. Recommendations can be made for irrigating soils of various drainage units to minimize water-table fluctuations. Recommendations of methods most likely to be successful for each drainage unit and detailed specifications of drain location, depth, spacing, and other design criteria are needed. Economic studies will determine the most economic watertable control plan where alternative methods are available.

SWCRD, ARS, USDA, Weslaco, Tex.

Hantush, M. S. DRAINAGE WELLS IN LEAKY WATER-TABLE AQUIFERS. *J. Hydraul. Div., ASCE* 88 (HY 2): 123-137. March 1962.

Flow formulas are found for a well draining a water-table aquifer that overlies a semi-pervious layer through which leakage takes place from or into an underlying permeable strata in which the hydraulic head remains uniform. The leaky water-table aquifer is replenished by vertical percolation due to excess irrigation or leaching or both. A function depending on two parameters is tabulated in order to simplify calculations leading to the determination of the appropriate well discharge and spacing. An expression for the time required to lower the water table to a new desirable elevation is obtained.

Col. Engin., U. Baghdad, Baghdad, Iraq.

Bianchi, W. C., and Tovey, R. A FARM DRAINAGE INVESTIGATION ON THE ALLUVIAL FAN OF THE TRUCKEE RIVER. Nev. Agr. Expt. Sta. Tech. B. 218, 27 pp. 1961.

The alluvial fan of the Truckee River was studied for drainage investigations. A network of piezometer clusters indicated that the drainage problem was caused by artesian leakage from a shallow aquifer 7 to 15 ft. below ground surface. Correlation between the river stage and artesian pressures measured by continuous water stage recorders on wells in contact with the aquifer indicated recharge is from the river channel above the study area. The lateral gradients in the piezometric heads in the aquifer indicated leakage into the river below the study area during normal river stage. The shallow aquifer underlies most of the study area and varies in makeup from large cobbles and sand to loose unconsolidated sand.

The contribution of surface water from irrigation and ditch seepage to the drainage problem is localized in that the water-table is observed to fall during the irrigation season. However, upward leakage is general in the area throughout the year.

An attempt to decrease the artesian pressure by pumping a well located in the artesian aquifer failed to have any effect on the water-table. An analysis of the boundary conditions controlling flow into a well using the Thiem equilibrium equation indicated that even under ideal conditions of well penetration and thickness of aquifer, it is doubtful that satisfactory drainage by pumping could be achieved.

Relief of artesian pressure by deep drains was analyzed by application of electrical analog methods to the case of a constrained aquifer.

A system of drains would need an effective depth of 18 ft. on a half mile spacing and a capacity of 440 g.p.m. per 1,000 ft. in order to provide a 6-ft. draw-down in the aquifer. However, a drain which had an effective depth of 12-1/2 ft. on the same spacing and flowing 150 g.p.m. per 1,000 ft. would provide a 4-ft. draw-down if the aquifer were penetrated either directly or by wells in the bottom of the ditch. Maintenance of deep drains in the area may be difficult because of the existence of loose unconsolidated sands in the profile.

Excellent possibilities exist for an interceptor drain along the west boundary of the study area. The effectiveness of this technique would be dependent upon the complete interception of the entire thickness of aquifer.

SWCRD, ARS, USDA, and Agr. Expt. Sta., Max C. Fleischmann Col. Agr., U. Nev., Reno, Nev.

Harris, W., Benedict, R., and Wait, J. USING COMPUTERS AS A TOOL IN LAND GRADING. Ark. Farm. Res. 11(4): 9. 1962.

A program has been developed for IBM 650 Electronic Computer for solving land grading problems. Using this program, the computer solves problems in warped surface design--that is, surfaces with row grades and side slopes varying within prescribed limits.

It is believed that this computer program will result in designs for warped surfaces that will satisfy requirements for drainage and irrigation. These designs will require near minimum volumes of cuts and fills and near minimum haul distances.

U. Ark., Fayetteville, Ark.

Drainage is the disposing of excess irrigation water or rainfall to prevent injury to crops, to prevent salt accumulation in soils, to allow earlier planting of crops, and to reclaim potentially arable low-lying overflow or swamp areas. Drainage systems are expensive to install, but they are practical where the increased value of agricultural production is greater than the cost of the drainage system. Intangible benefits such as improved health conditions and greater operating convenience to the farmer also may be important considerations.

Drainage is necessary to a successful irrigated agriculture. Losses during water conveyance and application, however, create most of the drainage problems in the irrigated areas of the West.

This circular helps to answer many questions that will come up before and during installation of a drainage system.

Calif. Agr. Expt. Sta., U. Calif., Davis, Calif.

Beer, C. E., David, H. T., and Shrader, W. D. RESPONSE OF CORN YIELDS IN A PLANOSOL SOIL TO SURFACE DRAINAGE, CROPPING SYSTEM AND VARIABLE FERTILIZER TREATMENTS. Iowa Agr. and Home Econ. Expt. Sta. Res. B. 499: 327-336. 1961.

Surface drainage (bedding) is not feasible on a planosol soil (claypan soils of flat lands) for conditions comparable to those described in this experiment, which include 100-foot-wide beds, 0.15 percent grade in the channel, and tillage operations performed at right angles to the channel grade. A summary for the years 1954 through 1959 shows that the average corn yield was higher on some of the bedded plots than on the level plots, while, in other cases, there was a yield depression in the bedded plots. The magnitude of the difference between the level and bedded plots is dependent upon the type of cropping system used. The yield on the bedded plots was depressed about 12.5 percent in the continuous corn system, while, in the COM rotation, a slight (2 percent) increase in yield was obtained.

The results also show that within the continuous corn plots the difference in yields between the bedded and level plots is significantly greater for the higher rates of nitrogen application (30, 60, 120, and 240 pounds per acre) than for the lower fertilizer rates (0, 30 pounds per acre nitrogen, and phosphorous factorial). The 6-year period is considered a fair test of the effect of bedding on yields since it contained years with wide differences in precipitation amounts. The amount of precipitation recorded at the experimental plots for the period April through August varied from 12.41 inches in 1956 to 23.6 inches in 1958. The long-term mean for this period is 19.12 inches of precipitation.

Within the bedded plots, the corn yields vary with respect to the position of the sampled area on the bed. Disturbing and removing the topsoil to build up the crown or top of the bed, as well as year-to-year climatic factors, influence the corn yields. When averaged over the 6-year period, the yield was much lower in the lower portion of the bed which is adjacent to and a part of the channel for the bedding system. The average differences in yield between the two positions are 21.5 bushels per acre and 22.9 bushels per acre, respectively, for rotation corn and continuous corn. These differences reflect a 22-percent and 34-percent reduction in yield in the lower position. The data also show that the higher rates of nitrogen are effective in offsetting the detrimental effects of the poorer environment in the lower position of the beds. A statistical test shows that, if yield were plotted as a function of increasing nitrogen application, the differential increase in yield for the higher nitrogen applications is greater in the lower than in the upper position of the bed.

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

Storage and Conveyance

Harding, S. T. EVAPORATION FROM PYRAMID AND WINNEMUCCA LAKES, NEVADA.
J. Irrig. and Drain. Div., ASCE 88 (IR 1): 1-13. March 1962.

The evaporation from lakes can be derived from available records of inflow, rainfall, and change in the lake elevation. The evaporation data from two relatively large adjacent water areas of different depth (the deep Pyramid Lake and the Shallow Winnemucca Lake) were made and compared with each other and with the available records of a Class A USWB (U.S. Weather Bureau) pan at Lahontan Dam.

The mean annual evaporation from Pyramid and Winnemucca Lakes is 4.00 ft. Whereas the total annual evaporation is in agreement, relatively large differences are shown in the monthly evaporation as the result of heat storage in the deeper Pyramid Lake. This accumulated difference exceeds 1 ft. in depth.

The nearest available records for the Class A pan are those at Lahontan Dam. These pan records indicate the need to use different coefficients to reduce Class A pan results to large water area evaporation based on the depth of the large water area where monthly values for the evaporation need to be derived.

Construction Engin., Berkeley, Calif.

BASIC SOIL SCIENCE

Soil Physics

Bertrand, A. R., and Sor, K. THE EFFECTS OF RAINFALL INTENSITY ON SOIL STRUCTURE AND MIGRATION OF COLLOIDAL MATERIALS IN SOILS. Soil Sci. Soc. Amer. Proc. 26: 297-300. 1962.

The effects of rainfall energy on the clay content, specific surface, aggregate stability, and organic matter content of the several layers of three soil types (Fox sl, Russel sil, Chambers sicl) are presented.

After 30 minutes of simulated rainfall at an intensity of 1.6 inches per hour the magnitudes of the above properties of the first layer (0 to 1.5 cm.) decreased considerably, while these properties of the sublayers (1.5 to 12.0 cm.) did not change. After 30 minutes of rainfall to 2.8 and 4.0 inches per hour, the decrease in the magnitudes of these soil properties in the first layer was greater than that occurring under the 1.6 inches per hour rainfall. Thirty minutes of rainfall with intensities of 2.8 and 4.0 inches per hour changed the physical properties of the second layer (1.5 to 3.0 cm.) somewhat, although not of the same magnitude as they were changed in the top layer. The effects of 2.8 and 4.0 inches per hour rainfall were about equal in magnitude, while the effects of 1.6 inches per hour were lower.

Clays labeled with Rb-86 migrated in soil profiles during the application of rainfall. About 1 percent of the clay migrated to a depth of 3 cm. At about 7.5 cm. the radioactivity of the soil was equal to the background.

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

Rosenberg, N. J., and Willits, N. A. YIELD AND PHYSIOLOGICAL RESPONSE OF BARLEY AND BEANS GROWN IN ARTIFICIALLY COMPACTED SOILS. Soil Sci. Soc. Amer. Proc. 26: 78-82. 1962.

Three soils of the Atlantic Coastal Plain were compacted into steel drums with a vibrating probe. The physiological responses of barley and snap beans to changes in soil physical properties due to compaction were measured.

On Galestown s an increase in bulk density from 1.3 to 1.6 g. per cc. resulted in a 50% increase in yield of barley which was linearly and significantly correlated with increased available water. A 37% barley yield decreased with increasing bulk density from 1.3 to 1.65 g. per cc. on Freehold ls was attributed to increased mechanical impedance. Compaction reduced barley yield on Penn sil, the response being correlated with oxygen diffusion.

Density-yield relations were not clear in the case of snap beans, but significant differences in concentration of maturity of the beans were observed on the Penn and Freehold soils.

Hydraulic conductivity and available moisture on the sandy soils and hydraulic conductivity and oxygen diffusion rates on the finer textured soil were found to correlate best with plant response.

Changes in moisture availability due to compaction of these sandy soils are consequential and should not be overlooked.

Jr. Author, Rutgers U.- The State U., New Brunswick, N.J.

Flocker, W. J., and Neilsen, D. R. THE ABSORPTION OF NUTRIENT ELEMENTS BY TOMATOES ASSOCIATED WITH LEVELS OF BULK DENSITY. Soil Sci. Soc. Amer. Proc. 26: 183-186. 1962.

Data are presented to show some of the relationships between soil moisture tension, air space, and soil density and their effect on the total nutrient absorption by tomato plants. Every effort was made to establish clearly defined treatments and evaluate changes in soil moisture during the experiment. The experiment consisted of two parts. In one, integrated mean air space was maintained to 0.15 cm.³ per cm.³, while densities ranged from about 1.2 to 1.6 g. per cm.³, resulting in integrated mean soil moisture tensions from 0.01 to 5 bars. In the other, for the same densities, mean soil moisture tension was 0.7 bar, and consequently mean air space ranged from about 0.32 to 0.09 cm.³ per cm.³. In almost every case there was a significant negative correlation between total nutrient absorbed per plant and increasing soil moisture tension. Total nutrient absorbed by the plant was independent of density as long as soil moisture tension was 0.7 bar, even though density and air spaces were maintained over a wide range. Likewise, except for boron and phosphorus, a positive correlation was found between concentration of nutrient absorbed at time of harvest and soil moisture tension. No significant correlation existed when soil moisture was maintained at 0.7 bar.

U. Calif., Davis, Calif.

Milford, M. H., Kunze, G. W., and Bloodworth, M. E. SOME PHYSICAL, CHEMICAL, AND MINERALOGICAL PROPERTIES OF COMPACTED AND ADJACENT SOIL LAYERS IN COARSE-TEXTURED SOILS. Soil Sci. Soc. Amer. Proc. 25: 511-515. 1961.

Some physical, chemical, and mineralogical properties of compacted and adjacent soil layers from cultivated and virgin Willacy fsl soils in the lower Rio Grande Valley of Texas were studied to attain a better understanding of the compacted zone and its development.

Hydraulic conductivity measurements and field studies substantiated the presence of a hardpan layer, which was first encountered at a depth of 3-1/2 to 7 inches and ranged to a depth of 7-1/2 to 12 inches, at each of the five sites sampled. Clay content increased with depth, while sand content decreased. The fine (0.25 to 0.1 mm.) and very fine sand (0.1 to 0.05 mm.) fractions, for all samples, comprised at least 95% of the total sand and more than 60% of the total soil. Soil reaction (pH), organic matter content, cation-exchange capacity, exchangeable cations, and extractable silica, aluminum, and iron were determined. Extractable cementing materials were not found in important quantities in any of the layers. Mineralogical analyses of the samples showed that quartz and lesser amounts of feldspar composed the sand and silt fractions, while illite and poorly ordered, weathered micaceous materials dominated the clay fraction. No pronounced differences in the chemical and mineralogical properties of the hardpan layers as compared to the layers above and below the hardpan were found.

Jr. Author, Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Rogowski, A. S., and Kirkham, D. MOISTURE, PRESSURE, AND FORMATION OF WATER-STABLE SOIL AGGREGATES. *Soil Sci. Soc. Amer. Proc.* 26: 213-216. 1962.

Moisture and pressure treatments were applied to soil samples consisting of particles of 0 to 0.5 mm. diameter obtained by grinding 2 to 8 mm. aggregates of Webster silt collected at the field moisture capacity and then air dried. The application of the moisture and pressure treatments formed the soil material into cylindrical briquettes and these, while moist, were broken into aggregates; these aggregates were then air-dried and tested for water stability and finally the water-stabilities resulting from the moisture-pressure treatments were compared with the water-stability of 2 to 8 mm. diameter aggregates of untreated soil material. Although pressure and moisture applied to ground soil material did increase water-stability, the water-stability which resulted from the pressure (maximum 1,000 p.s.i.) and moisture (maximum 30.5% referred to oven-dry weight) was much less than was the water-stability found in soil material not ground and not subjected to the pressure and moisture treatments. Since pressures as high as 1,000 p.s.i., which are in excess of pressures exerted by farm machinery, plant roots, and soil fauna, failed to produce water-stability comparable to that of untreated soil material, other forces are more responsible for water-stable aggregate formation. These other forces may be due to chemical, biological, or other natural factors.

Identical moisture and pressure treatments were also applied to 2- to 8-mm. diameter aggregates of this same Webster silt soil material. The moisture and pressure treatments resulted in decreased water-stability of these treated 2- to 8-mm. aggregates in comparison with the untreated 2- to 8-mm. aggregates.

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

Salomon, M. SOIL AGGREGATION--ORGANIC MATTER RELATIONSHIPS IN REDTOP-POTATO ROTATIONS. *Soil Sci. Soc. Amer. Proc.* 26: 51-54. 1962.

Beneficial effects of redtop residues on yields of potatoes grown on a Bridgehampton silt were correlated with increased soil aggregation; particularly with larger aggregates. There was an accumulation of carbon in all aggregates studied. However, the quantity did not appear to be related consistently to degree of aggregation. Analyses of total soil and aggregates (> 1 mm., 1 to 0.25 mm., 0.25 to 1 mm.) for microbial gums, polyuronides, and acid

hydrolyzable polyhexose carbohydrates indicate a similarity in quantities of these constituents as functions of organic carbon. Generally, somewhat wider C/N ratios (13:1) were found in larger aggregates where redtop was included, compared with smaller sizes (11:1). Extraction of organic matter with 0.5N NaOH and neutral 0.1M pyrophosphate indicates similar humic materials loosely held by this silt soil regardless of source. About 6 to 9 percent of the total carbon found in aggregates could be consistently accounted for as acid-hydrolyzable carbohydrate. There was little difference in this fraction due to rotation or size of aggregate.

R. I. Agr. Expt. Sta., Kingston, R. I.

Turelle, J. W., and McCalla, T. M. PHOTOMICROGRAPHIC STUDY OF SOIL AGGREGATES AND MICROORGANISMS AS INFLUENCED BY STUBBLE MULCHING AND PLOWING. *Soil Sic. Soc. Amer. Proc.* 25: 487-490. 1961.

A photomicrographic study was made of the soil at the surface of stubble-mulched and plowed soil plots on July 7, August 28, and October 22, 1959. These soils had been subjected to stubble mulching or plowing for a 20-year period. The plots were in corn in 1959 following wheat in 1958. The surface of the stubble-mulched soil had larger soil aggregates and voids than plowed soil. Contact slides placed in the plots showed more microorganisms on stubble-mulched than on plowed soil.

Water-stable aggregates from each type of tillage were also embedded in plastic compounds. These aggregates were sliced in sections 30 and 0.2μ thick and photomicrographed with light and electron microscopes, respectively. A major problem was the impregnation of soil aggregates for sectioning. The cross-sections of aggregates from stubble-mulched plots seem to be less compact and more porous than from plowed plots in both the 30 and 0.2μ sections of soil aggregates.

Photomicrographs.

Jr. Author, SWCRD, ARS, USDA, Lincoln, Nebr.

Dunn, L. E., and Hanson, R. MODIFICATION OF PHYSICAL AND CHEMICAL CONDITIONS IN SOME WESTERN NEVADA SOILS. *Nev. Agr. Expt. Sta. Tech. B.* 221, 26 pp. 1962.

Practices to improve and maintain a good physical condition are of foremost importance in many Nevada soils. Many of the irrigated and upland soils are comparatively heavy or have heavy subsoils. These layers are difficult to till and restrict the intake and passage of air and water. They do not allow a ready entrance or passage of plant roots. Many salt-affected soils have an adverse physical condition because of being high in clay, or in adsorbed sodium, or in both. The experiments were designed to give pertinent information on methods for the improvement of 12 important Nevada soils known to have adverse physical and chemical conditions. Gypsum, sulfur, manure, and synthetic soil conditioners were used as amendments. Manure and commercial fertilizers were used to increase fertility and possibly plant growth. Leaching and plant growth were studied as a means to improve physical condition of the soils. The use of manure at 10 tons per acre and sulfur or gypsum equivalent to 5 tons had little or only slight effects on soil density and granulation. The soil conditioners, ortho-til and krillium, were found to lower bulk density and increase granulation for surface soils and subsoils with appreciable amounts of clay. These soil conditioners have practical value for use on soils higher in clay on smaller areas such as gardens and flower beds. The amendments and conditioners did not increase crop growth on the surface soils, subsoils, and salt-affected soils used.

None of the soil amendments or conditioners were effective in materially modifying the structural condition of heavy subsoil layers. The most favorable results were obtained by using these soils according to their natural capabilities with soil treatments and cropping practices adapted to the limited conditions of effective depth, water penetration, and permeability. The use of fertilizers in association with increased plant growth was found to be significantly effective in improving the physical condition of these soils.

Five salt-affected soils were used in studies with the use of soil amendments along with leaching and cropping for the modification of soil physical and chemical conditions. The treatments with commercial fertilizer, manure, krilium, sulfur at 1.2 tons per acre, and gypsum at 4 tons per acre were not effective in significantly modifying the chemical and physical conditions of the soils. Higher rates of gypsum varying from 8 to 16 tons per acre along with leaching and cropping were effective in replacing adsorbed sodium and in improving physical condition. The amount of gypsum required for a given salt-affected soil will vary with the exchangeable sodium percentage, texture, structure, and organic matter content. For most salt-affected soils, the exchangeable sodium percentage will need to be reduced to structural condition, crops may be established satisfactorily on soils with exchangeable sodium percentages varying from 15 to about 30 percent. Some soils were materially injured without the use of appropriate soil amendments. Soils low in adsorbed sodium did not require the use of soil amendments for reclamation or improvement. Growing crops and fertilizer practices were found to be of assistance in the reclamation of salt-affected soils.

Agr. Expt. Sta., Max C. Fleischmann Col. Agr., U. Nev. Reno, Nev.

Eagleman, J. R., and Jamison, V. C. THE INFLUENCE OF SOIL TEXTURAL STRATIFICATION AND COMPACTION ON MOISTURE FLOW. Mo. Agr. Expt. Sta. Res. B. 784, 14 pp. 1961.

Knowledge of the water transporting properties from one soil layer to another is important because of the difference of soils in the field. The characteristics of moisture flow at the plane of contact of soil layers differing in texture, structure, and compaction was determined.

Measurements of the velocity of flow and hydraulic gradients were obtained in the suction range of zero to 700 cm. of water by using a laboratory model. Three different textural pairs were used. Two pairs, Salix sil with a fine sandy loam overwash and a Salix sil with an overburden of sandy loam, were sampled from naturally occurring textural breaks in alluvial soil profiles.

Hydraulic conductivity measurements across the textural breaks showed that moisture was readily transferred from the large to small pores, but that a barrier existed for water movement from small to large pores. In the naturally occurring breaks in soil texture, the compaction of the different soil layers determined the degree of expression of the barrier to water movement.

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

Sor, K., and Bertrand, A. R. EFFECTS OF RAINFALL ENERGY ON THE PERMEABILITY OF SOILS. Soil Sci. Soc. Amer. Proc. 26: 293-297. 1962.

The effects of simulated rainfall on the air and water permeabilities of sand and several disturbed soil samples were investigated. Various rainfall intensities were provided

by a rainfall simulator. Soil was packed in a cylindrical infiltrometer, to which was connected eight manometers. Permeability of the soil to water was measured during and after the application of rainfall.

It was found that a rainfall of 30 minutes duration at an intensity of 2.8 inches per hour caused maximum change in water permeability of the soils. Water permeability of quartz sand was not changed by rainfall. Water permeability of soils was changed: (1) Only in top 1.5 cm. by 1.6 inches per hour rainfall; and (2) greatly in top 1.5 cm. and somewhat less in second 1.5 cm. layer by 2.8 and 4.0 inches per hour rainfall. In saturated soil columns, water permeability was not governed entirely by the permeability of the least permeable layer. The thickness of the dispersed and compacted soil layer appeared to be about 1 mm. Below it a less compacted layer, about 3 cm. deep, resulted.

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

Taylor, S. A., Evans, D. D., and Kemper, W. D. EVALUATING SOIL WATER. Utah. Agr. Expt. Sta. B. 426, 67 pp. 1961.

In a study of methods for evaluating soil water, the authors made the following recommendations.

1. Use tensiometers for field and laboratory measurements of matric potential. They give accurate and reproducible measurements provided they are always at the same temperature and are in both thermal and moisture equilibrium with the soil. Do not use tensiometers to estimate the soil water content unless crude estimates are adequate, then each soil must be calibrated separately. Generally, manometer type instruments give better resolutions than dial types; both of these give more precise readings than those that depend upon the expansion of a gas to indicate the pressure in the system.
2. Methods for measuring the vapor pressure of water in equilibrium with soil samples can be used in laboratories that have equipment for accurate and precise temperature control and measurement of micro voltages. The methods show promise for measuring the water potential of plant tissue and soil in the laboratory.
3. Do not use freezing point depression as a routine and reliable laboratory method of measuring the water potential until several problems associated with the method and procedure are resolved.
4. Suitably calibrated plaster resistance blocks may be used to estimate the soil water potential in salt-free soils. The method is subject to many disturbances and should be used only where approximate values are adequate and where tensiometers will not operate. They should not be used to estimate the water content of soil.
5. Air permeability of ceramic units may be calibrated and used to indicate the proper time to irrigate salt-free soil.
6. Conductivity of calibrated ceramic units may be used in field estimates of solute potential that results from soluble salts.
7. Take a sample of known volume to measure water content on a volume basis rather than using an average bulk density or volume weight. Because of inherent soil variability, several samples should be taken for moisture in every plot.
8. The neutron method may be used to measure water content on a volume basis. It is satisfactory for measuring the water in a profile, but is inaccurate for surface soil and for indicating water content in any specific narrow depth interval. It is more advantageous than sampling when repeated estimates of moisture content must be made from a restricted area and when numerous sampling holes in the soil are undesirable.

Agr. Expt. Sta., Utah State U., Logan, Utah.

Liacos, L. G. SOIL MOISTURE DEPLETION IN THE ANNUAL GRASS TYPE. J. Range Mangt. 15: 67-72. 1962.

A study was conducted in annual type grassland in the Berkeley Hills, Calif., to check soil moisture depletion rates.

Soil moisture depletion was found to follow the exponential form ($Q_t = Q_0 \cdot e^{-Kt}$, where Q_t is the amount of water at time t , and Q_0 is the initial water content). This says that the rate of depletion is proportional to the soil moisture available to plants.

The rate of soil moisture depletion varies with the intensity of grazing. The constant rate k was found to be 0.00421, 0.00925, and 0.00683 for heavily, lightly, and ungrazed plots, respectively.

Serv. Forest Tech. Works (Y.D.E.M.) Forest Serv., Tessaloniki, Greece.

Lehane, J. J., and Staple, W. J. EFFECTS OF SOIL MOISTURE TENSIONS ON GROWTH OF WHEAT. Canad. J. Soil Sci. 42: 180-188. 1962.

Greenhouse experiments in which wheat was grown on a limited amount of soil moisture showed that crops subjected to moisture stress at an early stage of growth yielded well on all soils tested, but that crops with moisture stress late in the season yielded poorly on loam soils. Late stress was less damaging on clay because high soil moisture tension in this soil resulted in better distribution of moisture use during the critical period.

Crops grown under early stress used less moisture but were equally as efficient in grain production as those grown under optimum conditions. Crops with moisture shortage during heading and filling were inefficient in moisture use.

Similar variations in moisture efficiency caused by seasonal trends in available moisture supply were observed under field conditions. Good yields of wheat were produced with a minimum of rainfall in Saskatchewan in 1958 when a shortage of moisture in May and June was followed by more favorable conditions in July.

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

Okajima, H. ON THE ABSORPTION OF WATER AND SALT BY THE RICE PLANT ROOT SYSTEM, ESPECIALLY MUTUAL RELATIONSHIP BETWEEN YOUNG AND OLD ROOTS. Soil Sci. and Plant Nutr. 7: 104-114. 1961.

In order to investigate the mechanism of absorption of water and salt by the plant root system, rice plants with the young and the old root groups separated were cultured. The results obtained show that a plant as a whole has a mutual complementary relationship between its old and young roots, concerning water and salt absorption.

1. Generally, water and salt absorption by the old root group is superior to that by the young one in the case where both of them exist.
2. When the demands of tops for water or salt concentrate on either of the root groups owing the removal of one of the root groups, there occurs a very different kind of reaction between them. The young roots absorb much more water and salt. In the case of the old roots, the absorption of water only increases, but that of salt does not.
3. The relationship is maintained under the sufficient supply of nitrogen and disappears in the case of nitrogen deficient state in plants.
4. The nutritional states of the young roots are high-salt, low-sugar and those of the old ones low-salt, high-sugar.

5. The relationship between the development of the root system and its absorption of water and salt or other roles were discussed.

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

Lull, H. W., and Fletcher, P. W. COMPARATIVE INFLUENCE OF HARDWOOD TREES, LITTER, AND BARE AREA ON SOIL-MOISTURE REGIMEN. Mo. Agr. Expt. Sta. Res. B. 800, 15 pp. 1962.

In 1952 a cooperative soil-moisture study was begun at the University Forest of the University of Missouri and the Vicksburg Research Center of the U.S. Forest Service.

Eight 1/2-acre plots were established in a 35-year-old mixed oak and hickory stand having a basal area of 60 square feet. Pairs of plots were treated to obtain conditions denoted as "litter-only," "bare," "trees-and-litter," and "trees-only." Daily soil-moisture and -temperature readings (except Sunday) were taken.

Throughout two growing seasons the litter-only plots were wettest. Profile drying was most rapid on the trees-only plots. Summer rainfalls for both years were stored, for the most part, in the top 20 inches. Rates of moisture loss tended to decrease with increasing depth. The rate of drying at the 0-to-20-inch depth was about the same for the bare plots as for the trees-only and trees-and-litter plots. From 20 to 40 inches, the drying rate for the bare plots was from one-half to one-fourth that of the tree-covered plots. Drying rate for litter-only plots was consistently less than that for the bare and tree-covered plots.

The authors made the following conclusions:

1. During June, July, and August of a very dry summer, an area bare of trees and litter will contain, in the upper 40 inches of soil, about 3 inches more water than a forested area and an area without trees but litter-covered will average about 6 inches more water. During a moderately dry summer these values were reduced to about 2 and 4 inches.
2. Rates of soil-moisture drying for the tree-covered and bare plots were positively related to their profile moisture contents. In this relationship, bare areas had drying rates about 0.5 those of the forested area, and removing only the litter speeded drying to about 1.2 times the trees-and-litter rates.
3. Rates of drying tended to decrease with depth, and field minimum moisture contents were approached at successive depths at successively later dates.
4. When the moisture content is around field capacity: (1) Removing litter alone may increase summer rates of soil drying 5 to 10 percent; (2) removing trees alone will reduce rates about two-thirds; and (3) removing trees and litter will reduce rates about one-third.

Watershed-management implications are fairly obvious. A surface fire that destroys the litter will tend to increase slightly the rate of soil drying, thereby increasing the opportunity for storage of summer rainfalls. This effect would be insignificant because there is commonly more than enough storage available. Litter-burning effects on infiltration and surface runoff may be of much greater import.

Clearcutting but leaving a litter cover will sharply reduce soil drying and conversely increase water yield. However, litter accumulation will no more persist under the clearcut conditions than will the clearcut condition itself. Simultaneous deterioration of litter and growth of herbs and sprouts will soon increase soil-drying rates.

Bare areas are akin to litter-covered areas in that this condition is relatively temporary, depending on the rapidity with which vegetation invades.

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

Hendricks, D. W., and Hansen, V. E. MECHANICS OF EVAPO-TRANSPARATION. J. Irrig. and Drain. Div., ASCE 88 (IR 2): 67-82. June 1962.

The fundamental mechanisms involved in transpiration and evaporation are analyzed. The manner in which the physical factors in these mechanisms act to determine instantaneous transpiration rate are examined by use of concepts of fluid mechanics. These factors are expressed in Darcy's law, the continuity equation, and the power equation. The variables in these equations are functions of soil, plant, and weather factors.

Jr Author, Utah State U., Logan, Utah.

Thomas, G. W., and Moody, J. E. CHEMICAL RELATIONSHIPS AFFECTING THE WATER-HOLDING CAPACITIES OF CLAYS. Soil Sci Soc. Amer. Proc. 26: 153-155. 1962.

The relation between water-holding capacity and clay properties was studied on Wyoming bentonite and four Virginia soil clays ranging in mineralogical type from montmorillonite to kaolinite. The amount of water held at 1/3 atm. pressure was closely related to clay type and cation saturation; the Na-montmorillonites containing much more water than any other clays. At 15-atm. pressure there was little difference in water held between any of the clays regardless of cation saturation or clay type. The only exception was Na-bentonite which held 71% H₂O compared to a mean $48.6 \pm 3.2\%$ among all the other clays. Analyses of displaced solutions from the clay suspensions showed that only in Na-montmorillonites was the predicted double-layer pattern of reduced anion concentration at lower water contents followed. This and the fact that other clays apparently did not imbibe much water between layers support the idea that the double-layer theory is applicable only to freely expandable clay materials.

Va. Agr. Expt. Sta., Blacksburg, Va.

Kassiff, G., and Zeitlen, J. G. BEHAVIOR OF PIPES BURIED IN EXPANSIVE CLAYS. J. Soil Mechanics and Found. Div., ASCE 88 (SM 2): 133-148. April 1962.

Experience in Israel with rupture of piling, buried conduits, and other underground structures in clay has pointed out the need for research on the pressures exerted by such soils. Appreciable pressures are known to result from the swelling of fat clay subjected to moisture changes from irrigation or seasonal variations.

The results of a study of the stresses induced in pipes that were buried in the field in an expansive clay and exposed to seasonal changes, as well as irrigation are reported. Asbestos cement pipes were tested using vibrating wire strain gages to determine the stresses at various sections along both horizontal and vertical planes. Measurements of soil moisture changes and soil movements were made periodically during the investigation.

High stresses resulted in the pipe through inequalities in the lateral and vertical swelling behavior of the clay. Sometimes these stresses were greater than those caused by internal pressure. The swelling forces were strongly influenced by the effect of lateral restraint of the pipe. The bending moments caused by soil pressures were found to be magnified by the rigidity of the pipe connections. The author concluded that:

1. It was essential that the strength of the pipe material in bending should be higher than that required for construction under usual soil conditions. It is desirable to obtain increased strength without increasing the modulus of elasticity.

2. It was important to use a coupling design of maximum flexibility in order to reduce the stresses developing close to the couplings.
3. It was desirable to reduce the stresses caused by the longitudinal soil forces. This may be accomplished by reducing the adhesion of soil to the conduit.
4. It was desirable to place the conduit under initial moistures as high as possible in order to lessen swelling pressures and reduce movements in the clay upon increase of moisture. The best installation procedure was to reduce drying by leaving the trench excavations open the minimum amount of time.
5. Stresses were reduced by placing conduits at depths below the zone affected by moisture variations due to rains or irrigation.

Israel Inst. Tech., Technion City, Israel.

Seed, H. B., Woodward, R. J., and Lundgren, R. PREDICTION OF SWELLING POTENTIAL FOR COMPACTED CLAYS. J. Soil Mechanics and Found. Div., ASCE 88 (SM 3): 53-87. June 1962.

The possibility of damage to structures due to the swelling of clays is complicated by the problem of identifying those soils likely to possess undesirable expansion characteristics. A study to develop a reliable means for predicting the potential expansion characteristics of clays from classification test data is described.

Using test data from soils artificially prepared in the laboratory, it was shown that a well-defined relationship can be established between the percentage of clay sizes present in a soil, the activity of the clay, and the percentage of swell under a 1-p.s.i. surcharge of a sample compacted at optimum water content to maximum density in the Standard AASHTO Compaction Test. The test data were used to establish charts for quantitative or qualitative evaluation of the swelling potential of compacted clays and the proposed procedure was shown to be in good agreement with expansion test data for 28 soils, determined by the Bureau of Reclamation.

The form of the relationship obtained was used to evaluate the usefulness of the plasticity index of a soil as a single factor for predicting swelling potential. This parameter alone can provide an assessment of swelling potential that is probably correct to within ± 35 percent. This method of prediction can be best suited for practical purposes.

The main use of the results is to identify the capability of a soil for swelling either quantitatively or qualitatively. Those soils requiring more detailed study for design purposes can be identified by means of swelling tests.

U. Calif., Berkeley, Calif.

Wu, T. H., Douglas, A. G., and Goughnour, R. D. FRICTION AND COHESION OF SATURATED CLAYS. J. Soil Mechanics and Found. Div., ASCE 88 (SM 3): 1-32. June 1962.

The friction and cohesion of saturated clays were studied experimentally to determine the influence of clay structure and method of loading. Clay specimens in the remolded, laboratory flocculated, and undisurbed states were used. The experimental program consisted of triaxial tests with controlled strain rate, creep, and relaxation.

Both friction and cohesion vary considerably with clay structure and the method of loading. In the remolded clay, the cohesion dissipates with time when the soil is subjected to either a constant stress (creep test) or constant strain (relaxation test). In the case of

the constant-stress test, the progressive reduction in the cohesion is accompanied by an increase in the frictional resistance. The cohesion in the flocculated clay does not dissipate in creep or relaxation tests until stresses close to the ultimate strength are attained.

Mich. State U., East Lansing, Mich.

Soil Chemistry and Mineralogy

Kamprath, E. J., and Welch, C. D. RETENTION AND CATION-EXCHANGE PROPERTIES OF ORGANIC MATTER IN COASTAL PLAIN SOILS. *Soil Sci. Soc. Amer. Proc.* 26: 263-265. 1962.

Soil organic matter is quite important as a source of cation-exchange capacity in Coastal Plain soils. The amount of organic matter in well-drained soils is directly related to the clay content. In the very poorly drained soils this direct relationship was not apparent.

The cation-exchange capacity of soil organic matter varied from 62 to 279 me. per 100 g. The nature of the exchangeable hydrogen of organic matter was measured by the use of several replacing solutions. A portion of the exchangeable hydrogen in soil organic matter was found to come from strong acid groups.

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

Pratt, P. F., Whittig, L. D., and Grover, B. L. EFFECT OF pH ON THE SODIUM-CALCIUM EXCHANGE EQUILIBRIA IN SOILS. *Soil Sci. Soc. amer. Proc.* 26: 227-230. 1962.

The Na-Ca exchange equilibria in 10 acid soils were measured at pH values of 5, 6, 7, and 8 and the results related to a theoretical ion exchange equation based on the Poisson-Boltzmann differential equation of the electrical double-layer. The theoretical equation satisfactorily predicted the relative change in ratios of adsorbed Ca as the pH of the equilibrium solutions decreased. The actual values of ratios of adsorbed Na to adsorbed Ca agreed with the theory when the surface charge densities for each soil were multiplied by an appropriate factor. This factor varied from 1.0 to 2.1 but was the same for all pH values for a given soil.

U. Calif., Riverside, Calif.

Sommerfeldt, T. G. EFFECT OF ANIONS IN THE SYSTEM ON THE AMOUNT OF CATIONS ADSORBED BY SOIL MATERIALS. *Soil Sci. Soc. Amer. Proc.* 26: 141-144. 1962.

Wells fsl and Utah bentonite (noncalcareous) were equilibrated in solutions of NaOH, NaCl, Na₂CO₃ and Na₂SO₄ to determine the effect of the different anions on the amount of cations retained by these materials.

Total exchangeable cations, exchangeable sodium and exchangeable calcium plus magnesium, as extracted by the NH₄OAc method were greatly affected by the anions in the systems.

It was concluded that the adsorption capacity of the materials had not remained constant, but varied with the anion environment, and that this was the most important factor responsible for these results.

J. Art. 19, Dept. Soils, N. Dak. Agr. Expt. Sta., Fargo, N. Dak.

The structure of the clay minerals are reasonably well known, but greater detail and more precision are needed. For example, the selective adsorptive and catalytic properties and the reaction with organic materials vary with the character of the clay mineral, but the structural factors that control such properties are not well understood. Research is urgently needed on the structure of pure clay minerals and on the reactions of pure clay minerals with organic and inorganic materials. Much past research on clay-mineral reactions has little fundamental value because the clay that was used was composed of a mixture of minerals which were not well characterized. To a considerable extent, progress depends on finding such pure minerals or preparing them in the laboratory.

Recent research has shown that the clay minerals found in sediments to some extent reflect the conditions of formation of such sediments. This is a matter of intense interest to the geologist and a field of great promise for future research. Investigations are particularly needed on the composition of recent and ancient sediments where the conditions of deposition and the history of the sediment are well known. Such work requires the utmost in analytical detail. cursory clay-mineral analyses are useless. The clay-mineral composition must be determined in detail, and many samples must be studied.

Clay-mineral research has an unusual fascination because of the wide range of problems that are encountered and because of the combination of fundamental problems of application.

U. Ill., Urbana, Ill.

Higashi, T., and Aomine, S. WEATHERING OF MONTMORILLONITE ON SOILS. *Soil Sci. and Plant Nutr.* 8: 7-12. 1962.

Three soil montmorillonites of varying weathering degree were examined by means of X-ray, differential thermal, dehydration, specific surface, chemical, differential dissolution, and cation-exchange capacity-delta value analyses, and of electron microscope. Results obtained confirmed the conclusions of the previous work which was carried out on montmorillonites separated from weathered and fresh tuffaceous shales. That is, weathering causes montmorillonite: (1) To disorder the arrangement of atoms on c-axis; (2) to increase hydroxyls of low binding energy, which are released by heating below 500° C, and to decrease high energy hydroxyls; (3) to increase Al ions in tetra and octahedral coordinations; and (4) to lessen internal surface area and cation-exchange capacity. These alterations are considered to result from enrichment with Al ions which are activated at a low pH. Enriching the montmorillonite with Al ions develops a halloysite-like structure in the original lattice, which finally grows up into halloysite.

Kyushu U., Fukuoka, Japan.

Barber, S. A. A DIFFUSION AND MASS-FLOW CONCEPT OF SOIL NUTRIENT AVAILABILITY. *Soil Sci.* 93: 39-49. 1962.

A plant-nutrient availability concept was proposed for plants growing in soil. It concerns the movement of nutrients through the soil to the root surface. Two processes are involved: mass-flow in the water absorbed by the plant, and diffusion. The process that has the greatest effect on availability for a particular nutrient depends on the concentration of the nutrients in the water which moves toward the plant root as a result of water uptake by

the plant root, on the amount of water uptake which dictates the flow rate of this water, and on the rate of uptake of the nutrients by the plant root. When more of a nutrient is moved to the root than the root absorbs, the nutrient accumulates at the root interface, and mass-flow becomes the dominant factor in determining availability. Diffusion only enters the picture as it reduces the concentration at the root surface by back diffusion into the soil. Diffusion is the dominant factor controlling availability when mass-flow brings only a small fraction of the nutrients required by the plant root. Absorption by the plant root establishes a concentration gradient along which the nutrients diffuse to the root. Soil factors which influence the size of the concentration gradient and the magnitude of the diffusion coefficient will influence the rate at which the nutrient reaches the plant root and its availability.

J. Paper 1812, Purdue U. Agr. Expt. Sta., Lafayette, Ind.

Tyler, K. B., Lorenz, O. A., and Fullmer, F. S. I. PLANT AND SOIL ANALYSIS AS GUIDE IN POTATO NUTRITION. Calif. Agr. Expt. Sta. B. 781: 4-15. 1961.

and

Lorenz, O. A., Tyler, K. B., Takatori, F. H., Bishop, J. C., and Nelson, P. M. II. FERTILITY EXPERIMENTS WITH POTATOES IN SOUTHERN CALIFORNIA. Calif. Agr. Expt. Sta. B. 781: 15-23. 1961.

In answer to fertilizer needs, plant and soil analyses have been developed. They have proved effective tools to assess potato fertilization practices and to predict fertilizer requirements.

Plant analyses may be used to indicate the adequacy of present and past fertilizer practices for a particular field. As a guide for fertilization of the current season they may be limited, especially for such rapidly growing crops as potatoes; but results can be used effectively as a fertilization guide for subsequent crops in the same field.

Soil analyses can often be used to determine the phosphorus and potassium needs for the next crop where fertilization needs of the crop are unknown and previous plant analyses are lacking. Soil analyses for these two elements are most useful to determine the need for applying either of these nutrients rather than to determine the quantities that should be applied.

This bulletin reports the results of plant and soil analyses carried out in California between 1956 and 1960. The results of fertilizer experiments conducted in potato fields of southern California are summarized for this same period.

Calif. Agr. Expt. Sta., Riverside, Calif.

Lauchbaugh, J. L. SOIL FERTILITY INVESTIGATIONS AND EFFECTS OF COMMERCIAL FERTILIZERS ON RESEEDED VEGETATION IN WEST-CENTRAL KANSAS. J. Range Mangt. 15: 27-34. 1962.

The relationships between a rapid soil-test method and a greenhouse pot-test method to determine major element deficiencies in soils was investigated and yield responses of reseeded grasses fertilized with nitrogen and phosphorus was determined on two soils exhibiting nutrient deficiencies typical of many reseeded areas in west-central Kansas. The authors concluded that:

1. The nitrogen, phosphorus, and potassium levels in the upper 6 inches of eight soils were compared by a rapid soil-test and a pot culture technique and the results were

as follows: (1) Organic matter content used as an index to available nitrogen in the rapid soil-test was a good indicator of the ability of each soil to supply nitrogen in the pot-culture test. (2) Organic matter content was better than soil-test phosphorus determinations in predicting the ability of a soil to supply phosphorus in the pot-culture tests. (3) The rapid soil-test showed a wide range, but high amounts of potassium in all soils. The pot-culture tests indicated no potassium deficiencies in any of the soils used in this experiment. And (4) pot-culture yields of barley were greatest for all soils when both nitrogen and phosphorus were added. Adding potassium was not necessary. Yields were not increased over those from untreated check pots by phosphorus without nitrogen. Nitrogen without the addition of phosphorus increased pot yields to an intermediate level between the check and full treatment in the four soils having the highest amounts of organic matter. Plants grown in the four soils containing the lowest amounts of organic matter did not respond to the addition of nitrogen without phosphorus in the pot culture tests.

2. Field applications of 80 pounds of nitrogen per acre, 60 pounds of phosphorus pentoxide per acre, the two in combination, and no treatment were made on a high organic matter content site and a low organic matter content site in the spring of 1957, and the plots were retreated in the spring of 1959, gave the following results: (1) Forage yields on the high organic matter site were increased significantly by nitrogen. Nitrogen and phosphorus together did not increase yields over nitrogen alone. Phosphorus alone did not increase yields above those of the untreated check plots. Cool-season annual bromes growing with the reseeded grasses responded more to nitrogen fertilization than did the warm-season perennial grasses. Carry-over effects of nitrogen were small each year following fertilizer application. (2) Yields were greatly increased by nitrogen and phosphorus in combination on the low organic matter site over relatively low producing untreated check plots. Nitrogen alone gave an intermediate response. Phosphorus alone produced no increase in yields. Carry-over responses to nitrogen and phosphorus and nitrogen alone were relatively high. And (3) forage crude protein content was increased in plots receiving nitrogen on both soil sites during the early growing season of 1959 only.

Serv. Forest Tech. Works (Y. D. E. M.), Thessalonica, Greece.

Jones, J. B., Jr., Mederski, H. J., and Musgrave, O. L. FERTILITY STATUS OF OHIO SOILS. Ohio Agr. Expt. Sta. Res. B. 894, 41 pp. 1961.

This is the second and most complete summary which has been prepared from the results of soil tests made on Ohio Soils. The data reported summarize 104,041 soil test results for field soil samples submitted by Ohio farmers between July 1, 1956 and July 1, 1959 to the Agricultural Extension Service Soil Testing Laboratory, Columbus, Ohio. The data reported include summaries of pH and lime requirements, "available" phosphorus and potassium, and percent organic matter within 87 Ohio counties, 18 major soil areas, and 52 associated soil types.

The data are presented in map and tabular form. The numbers of samples submitted to the laboratory during the reported period by county are given in Table form. The number of soil samples submitted to the laboratory during the reported period exceeds the total number of farms with cultivated crops (104,041 samples versus 83,025 farms). Each soil sample received by the laboratory represents about 100 acres of cultivated land in Ohio. Although this number is relatively small (from 3 to 44 samples per 1000 acres), the soil test results obtained probably are representative of the county or area from which they were taken.

The methods of soil analysis employed by the Soil Testing Laboratory are given. The soil test results were placed on IBM cards for summarization.

The figures in this bulletin describe the 18 major soil areas in Ohio, the average soil pH by soil type, the average lime need by county and soil type, phosphorus and potassium level by county and soil type, and percent organic matter by county and soil type.

Tables and maps.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Overcash, J. P., Crockett, S. P., and Gholston, L. E. INFLUENCE OF ANNUAL FERTILIZER APPLICATIONS ON A PEACH ORCHARD SOIL. Miss. Agr. Expt. Sta. B. 633, 7 pp. 1961.

Peach orchards are often located on hillsides to provide good air drainage for frost protection. Often these hill soils are either already eroded or subject to erosion.

A long-time fertilizer experiment was set-up to study the effects of fertilizers on a peach orchard set on Grenada sil soil in 1946. The author concluded that:

1. Annual applications of superphosphate at the rate of 6 pounds of 20 percent superphosphate under mature Sullivans Early Elberta peach trees resulted in increases in phosphorous in the soils at a depth of 0 to 6 inches.
2. Under very heavy rates of annual application, the available phosphorous was significantly higher than the check trees to a depth of 12 to 18 inches.
3. Trees which received no phosphate fertilizer had analyses of 5 to 25 pounds of P₂O₅ equivalent per acre. These trees did not grow or yield as well as trees which received phosphate fertilizer and had higher phosphorous analyses in their soils.
4. Annual applications of 1½ pounds of 50 percent muriate of potash to mature trees resulted in a large increase in exchangeable potassium in the soil at 0- to 6-inch depth.
5. Potassium analyses of less than 150 pounds per acre were typical for soils not receiving potash. Analyses of over 400 pounds per acre resulted from annual applications of potash.
6. Four and a half pounds of fifty percent muriate of potash resulted in movement of this element downward to at least 18 to 24 inches.
7. Applications of nitrate of soda caused the pH of the soil to rise and applications of ammonium nitrate caused the pH to drop.

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

Simida, D. E., Haas, H. J., Rogler, G. A., and Lorenz, R. J. CHEMICAL PROPERTIES AND MOISTURE EXTRACTION IN RANGELAND SOILS AS INFLUENCED BY NITROGEN FERTILIZATION. J. Range Mangt. 14: 213-216. 1961.

Ammonium nitrate was applied annually during 9 years at rates of 0, 30, and 90 pounds of nitrogen per acre to native range plots. At the end of this period total soil nitrogen, available phosphorus, and pH determinations were made. During the last 6 years, spring and fall soil moisture determinations were made to evaluate the effect of fertilization on soil moisture withdrawal.

For the overall 6-foot depth there was an increase in total soil nitrogen. Increases occurred in the first 2 depths under both the 30- and 90-pound treatments. Some decrease

occurred, however, in the 24- to 36-inch increment under both treatments. These decreases were possibly the result of increased root activity within these depths.

The increases in total soil nitrogen accounted for 88.9 percent and 69.1 percent of all the nitrogen applied in the 30- and 90- pound treatments, respectively, during the 9-year period. With the addition of the fertilizer nitrogen recovered in harvested herbage, a complete account of the 30-pound applications and 87.9 percent of the 90-pound applications was made.

In the 0- to 6-inch surface increment soil acidity was increased 6.2 and 9.2 percent by the application of 30 and 90 pounds of ammonium nitrate nitrogen, respectively.

Phosphorus availability in the surface soil increased with increasing nitrogen rates. Increase in soil acidity was the determinant of the increased phosphorus availability. Less available phosphorus was present in the lower portion of the profile where nitrogen fertilizer had been applied. This was attributed to increased root activity in the lower depths.

Moisture withdrawal increased in all soil depths with the addition of nitrogen fertilizer. Greater moisture extraction accompanied greater fertilization rates.

SWCRD, ARS, USDA, North Platte, Nebr.

Hanway, J. J., Barber, S. A., Bray, R. H., Caldwell, A. C., Engelbert, L. E., Fox, R. L., Fried, M., Hovland, D., Ketcheson, J. W., Laughlin, W. M., Lawton, D., Lipps, R. C., Olson, R. A., Pesek, J. T., Pretty, K., Smith, F. W., and Stickney, E. M. NORTH CENTRAL REGIONAL POTASSIUM STUDIES: I. FIELD STUDIES WITH ALFALFA. Iowa Agr. and Home Econ. Expt. Sta. Res. B. 494 (North Cent. Region. P. 124): 163-187. 1961.

During 1955 and 1956, 89 field experiments in which K fertilizer was applied at different rates for alfalfa were conducted in seven North Central States, Alaska, and Ontario, Canada. The yield and K content of the alfalfa were determined. Soil samples from each field experiment were used in supplementary greenhouse and laboratory studies.

Regardless of the plant method used for estimating K availability or the depth of soil sampled, the index of plant availability of K was more highly correlated from samples that were air dried at room temperature or oven dried.

Drying different surface soil samples resulted in increases, no change, or decreases in exchangeable K. Fewer soils from the eastern part of the region showed large increases in exchangeable K as a result of drying. Changes in exchangeable K in surface soil samples because of drying seldom exceeded 100 p.p.m., but in some soils this meant that the amount of K extracted was nearly doubled by drying.

Drying of subsoil samples resulted in increased exchangeable K in almost all samples, except some from sandy soils, and with some the increase from drying was almost tenfold. It is imperative that analyses for exchangeable K in subsoils be made on undried samples.

Exchangeable K in field-moist subsoil samples was almost always considerably lower than in corresponding surface soil samples.

Knowledge of exchangeable K in the 6-12 and possibly the 12-18 inch layers in addition to that in the 0-6 inch layer can be used to improve the estimation of K availability to alfalfa plants growing in the field.

Percentages of K in the alfalfa from different cuttings were highly correlated, even though dry matter yields of the different cuttings were not.

Significant yield increases of alfalfa from K fertilization were obtained in only 15 of the 89 experiments, and the increases of the first cutting in these 15 experiments averaged only 1/4 ton of hay per acre with no increases greater than 1/2 ton per acre.

The correlations between percent K, amount of K in the plants, and percent recovery of added K in field alfalfa and greenhouse millet were not high, indicating that environmental conditions in the field have a marked effect on K uptake by plants in the field.

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

Hanway, J. J., Barber, S. A., Bray, R. H., Caldwell, A. C., Fried, M., Kurtz, L. T., Lawton, K., Pesek, J. T., Pretty, K., Reed, M., and Smith, F. W. NORTH CENTRAL REGIONAL POTASSIUM STUDIES: III. FIELD STUDIES WITH CORN. Iowa Agr. and Home Econ. Expt. Sta. Res. B. 503 (North Cent. Region. P. 135): 407-438. 1962.

Uniform field experiments in which K fertilizers were applied at different rates (0, 25, 50, 75, 100, and 125 pounds of K per acre) for corn were established at 51 locations in six North Central states during 1957 and 1958. Laboratory analyses were made on soil samples from each experimental site. Data concerning grain yields and K contents of the corn plants were obtained from 41 of the field experiments.

Exchangeable K in field-moist soil samples from the 0-6 inch layer of soil varied from 64 to 935 p.p.2m. and averaged 210 p.p.2m.

At the time of silking, the corn plants contained 90 percent of the total K taken up during the season, and K uptake appeared to be complete by 10 to 15 days after silking.

The amount of K in plants at silking time from plots that received no K fertilizer varied from 22 to 213 pounds per acre and averaged 78 pounds. The average increase in K content of the plants resulting from K fertilizer application was equal to 23 percent of the amount applied.

Grain yields from plots that received no K fertilizer varied from 33 to 127 bushels per acre and averaged 79 bushels. Grain yields were significantly increased in 11 experiments by application of K fertilizer. Applications of K fertilizer had little or no effect on the shelling percentages. The applications decreased moisture percentages in the grain at harvest in only one experiment, where a large increase in the grain yield also resulted.

The K content of the corn plants was highly correlated with the exchangeable K content of the soil. At a given level of exchangeable K in the soil, plants grown on coarse-textured loams and sands contained more K than plants grown on finer textured silt loam soils.

Uptake of fertilizer K was inversely related to the level of exchangeable K in the soil and to the percent K in corn leaves from plots that received no fertilizer K. Increases in yield of corn grain obtained from K fertilizer applications were more highly correlated with the percent K in corn leaves at silking time than with exchangeable K contents of the soils.

The number of corn plants per acre did not appear to influence the percent K in the plants but did influence total K uptake per acre and yield of grain.

Exchangeable K determined on field-moist samples provided a better estimate of the amount of K in corn plants and increases in grain yields caused by K fertilizer applications than did exchangeable K determined on air-dry or oven-dry soil samples.

Including data for the exchangeable K contents of subsoil layers in multiple regression equations relating K contents of the corn plants and yield of corn grain to exchangeable K contents of the soils generally improved the degree of correlation.

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

MacKay, D. C., and MacEachern, C. R. THE INFLUENCE OF LIMING ON SEVERAL PROPERTIES OF SOIL POTASSIUM IN A LOAM PODZOL. *Soil Sci. Soc. Amer. Proc.* 26: 54-57. 1962.

Both immediate and long-term effects of liming on some soil K properties were determined. Experimental conditions closely simulated field environment but the complicating factor of differential plant removal was avoided. The soil (pH 4.5) was treated with 0, 0.8, 1.6, 3.2, 4.8, and 8 ton per acre of hydrated lime and sampled at intervals during a 6-year period.

Total K, which was high (1.42%) in relation to exchangeable K (66 p.p.m.), did not change after liming. Exchangeable K was significantly reduced by nearly the same extent (17%) with all liming rates above 0.8 ton per acre.

Potassium released by a water-equilibration procedure was influenced by liming, the response pattern being greatly affected by time and rate of lime. The heavier treatments effected first an increase in equilibrated K values, then a progressive decrease over succeeding years to a 50% depression at the end of the experiment. With the lighter rates (0.8 and 1.6 ton per acre) substantial depressions occurred initially, becoming progressively greater with time.

Water-equilibrated K was shown to be closely related to plant content (total %), in a short-term plant growth experiment.

J. Author, Canada Dept. Agr., Kentville, Nova Scotia, Canada.

Pratt, P. F. PHOSPHORUS AND ALUMINUM INTERACTIONS IN THE ACIDIFICATION OF SOILS. *Soil Sci. Soc. Amer. Proc.* 25: 467-469. 1961.

Two soils containing relatively large amounts of basic Ca phosphates were acidified from neutrality to pH 3.5. Acidification produced high P solubility and because of this the Al solubility remained < 1.0 p.p.m. for one soil and < 0.5 p.p.m. for the soil that had the greatest P solubility. Maximum P solubility was obtained at pH 4.2 with both soils. The high P solubility did not prevent accumulation of exchangeable Al when the pH of the soil decreased to pH 3.5. During acidification the Ca phosphate fraction decreased about 50% in one soil and about 80% in the other. This decrease was largely balanced by an increase in NH_4F -extractable P or Al phosphates. Acidification of these types of soils to pH values as low as 4.7 should produce little if any Al toxicity.

Citrus Expt. Sta., U. Calif., Riverside, Calif.

Pearson, R. W., Abruna, F., and Vincente-Chandler, J. EFFECT OF LIME AND NITROGEN APPLICATIONS ON DOWNWARD MOVEMENT OF CALCIUM AND MAGNESIUM IN TWO HUMID TROPICAL SOILS OF PUERTO RICO. *Soil Sci.* 93: 77-82. 1962.

The extent to which the base status of highly acid subsoils can be improved by surface application of limestone used in conjunction with residually acid nitrogen fertilizers was studied in a typical latosolic and red-yellow podzolic soil of Puerto Rico.

The use of high rates of residually acid nitrogen fertilizer caused an appreciable downward transfer of bases in the profile that increased with increasing rates of surface-applied limestone. The amounts of calcium and magnesium moved from the surface into the 6- to 24-inch zone were equivalent to as much as 5.9 tons of CaCO_3 per acre.

While about half the accumulated bases in the 18- to 24-inch layer were in exchangeable form, there were appreciable amounts of calcium and magnesium sulfate present.

The presence of free salts resulted, in part at least, in the persistence of relatively low subsoil pH values.

The rate of downward movement of calcium and magnesium increased with increasing residual acidity of the nitrogen source.

SWCRD, ARS, USDA, Auburn, Ala.

Daniels, R. B., Brasfield, J. F., and Riecken, F. F. DISTRIBUTION OF SODIUM HYDRO-SULFITE EXTRACTABLE MANGANESE IN SOME IOWA SOIL PROFILES. *Soil Sci. Soc. Amer. Proc.* 26: 75-78. 1962.

Manganese, extractable by sodium hydrosulfite and referred to simply as free Mn was determined for 21 Iowa soil profiles. The soil profiles studied included Wiesenbodens, Planosols, Gray-Brown Podzolic soils, and Brunizems.

Brunizems, in general, have either little change in free Mn with depth or a slight decrease in the most acid part of the solum. Free Mn in Gray-Brown Podzolic soils and forest Planosols is at a maximum in the A₂ horizon and at a minimum in the B₂ horizon. In prairie Planosols, minimum values for free Mn occur in the A₂ horizons, and maximum or near maximum values occur in the B₂-B₃ horizons. Free Mn in Wiesenbodens increases from the A₁ to the B₂ horizons.

The distribution of free Mn in Brunizems apparently is a function of pH of the solum, whereas in the prairie Planosols and Wiesenbodens reducing conditions and/or pH may be controlling factors. The distribution of free Mn in Gray-Brown Podzolic soils and forest Planosols may be due in part to pH and reducing conditions, and in part to factors that cannot be determined by data available.

SCS, USDA, Ames, Iowa.

Brown, A. L., Krantz, B. A., and Martin, P. E. PLANT UPTAKE AND FATE OF SOIL-APPLIED ZINC. *Soil Sci. Soc. Amer. Proc.* 26: 167-170. 1962.

Greenhouse assays on 53 soils using sweet corn harvested in the vegetative state as an indicator crop showed 84% of the soils containing 0.55 p.p.m. or less dithizone-extractable Zn responded to soil-applied ZnSO₄. Likewise, 76% of those above 0.55 p.p.m. dithizone-extractable Zn did not respond to Zn applications. Generally Zn concentration in plants and total uptake increased with increasing rates of applied Zn. The average recovery of the applied Zn from 5 to 25 pounds per acre was 9.0 and 4.8%, respectively. Approximately 35% of the soil-applied Zn was found as dithizone-extractable after plants were harvested. Soil samples from several fields to which ZnSO₄ had been applied indicated there may be a residual effect for several years. Laboratory studies with soil columns showed there was practically no downward movement of Zn as a result of leaching.

U. Calif., Davis, Calif.

Okruszko, H., Warren, G. F., and Wilcox, G. E. INFLUENCE OF CALCIUM ON PHOSPHORUS AVAILABILITY IN MUCK SOIL. *Soil Sci. Soc. Amer. Proc.* 26: 68-71. 1962.

In laboratory tests, the addition of Ca greatly decreased the solubility of native and applied P in six different muck soils. Reducing the amount of Ca in the soil solution by applying materials having Ca-bonding properties increased the solubility of P in a muck soil. In a greenhouse experiment, tomatoes grown in muck soil limed and fertilized with phosphate in different amounts showed the depressing influence of lime on yield, P content in the plant tissue, and total P uptake by the plants. Liming increased the Ca content in the plant tissue.

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

De, S. K., and Sharma, D. P. EFFECT OF AMMONIUM SALTS ON THE INTAKE OF PHOSPHATE BY INDIAN MONTMORILLONITE (WEST BENGAL BENTONITE). *Soil Sci. and Plant Nutr.* 7: 1-3. 1961.

Phosphate intake capacity of a sample of Indian montmorillonite (West Bengal bentonite) was studied in presence of ammonium chloride, ammonium nitrate, and ammonium sulphate. All of these salts were found to increase phosphate adsorption. In the presence of muriate of ammonia, the intake of phosphate was maximum. Minimum adsorption of phosphate was observed in the presence of ammonium sulfate. Ammonium nitrate was found to take the intermediate position. In all cases, phosphate adsorption was accompanied by an increase in the resultant pH. This is due to the removal of H_2PO_4^- and HPO_4^{2-} ions formed in the solution at suitable pH and their reaction with hydrous iron oxide and hydrous aluminium oxide surface films and corresponding release of hydroxyl ions. The possibility of exchange between OH^- ions present at the edges and corners of the mineral lattice and the two phosphate ions has also been suggested. Variations in the extent of phosphate adsorption in the presence of the three ammonium salts has been ascribed to the difference of H/H value (ratio of $\text{H}_2\text{PO}_4^-/\text{HPO}_4^{2-}$ ions) of the reacting system.

Chem. Lab., U. Allahabad, Allahabad, India.

Lutz, J. A., Jr., and Rich, C. I. THE EFFECT OF SOLUBLE SALTS ON THE AVAILABILITY OF PHOSPHATE FERTILIZERS. *Va. Agr. Expt. Sta. Res. Rpt.* 59, 10 pp. 1961.

The individual effect of 13 salts and urea on the availability of P in monocalcium phosphate, tagged with P-32, was measured with oats in the greenhouse. Oat yields and the percentage fertilizer P in the plant were measured and P removal was calculated.

Further greenhouse experiments were conducted in which four soils adjusted to two pH levels were used. There were five salts and two particle sizes of monocalcium phosphate (tagged with P-32) applied by two methods. Oat yields, the percentage fertilizer P in the oats, and the removal of P by the oats were measured.

In the field experiment, the effect of the five particle sizes of 0-27-0, 10-10-0, and 10-10-10 each tagged with P-32, on the fertilizer P content of bluegrass was measured.

From the data, it was concluded that:

1. The salts did not increase the percentage water soluble P in soil in the laboratory experiments.
2. In general, the salts increased the amount of P removed from the soil by the Bray No. 1 method where lime was applied.

3. In the majority of treatments, the mixture of salt and P increased the fertilizer P content of the oat plant. The most outstanding exception was $(\text{NH}_4)_2\text{SO}_4$ at a soil pH of 5.8.
4. When $(\text{NH}_4)_2\text{SO}_4$ was applied in contact with the phosphate it decreased the percentage fertilizer P in the plant at the lower pH but increased it at the higher pH at the first clipping, $\text{Al}(\text{SO}_4)_3$ had the reverse effect.
5. During the second year, both soil type and kind of salt had highly significant effects on the fertilizer P content of the plant.
6. The recovery of applied P was greatest on Wellston and lowest on Norfolk; Rumford and Davidson soils were intermediate.
7. More fertilizer P was adsorbed when the soil was adjusted to about pH 6.5 than at the lower initial pH's of 5.5, 4.3, 4.5, and 5.6 of the four soils. More P was adsorbed where pulverized material was applied than where tableted material was used.
8. In the field experiment, the presence of N in the granule with the P increased the percentage fertilizer P in the bluegrass at both clippings and with each particle size of fertilizer use.
9. When 0-27-0 was applied in the field experiment, there was a decrease in fertilizer P content of the plant with increase in size of granulation.
10. The inclusion of N and K_2O in the granule with the phosphate caused an increase in the percentage fertilizer P content of the bluegrass.
11. With few exceptions, the salts increased the solubility of applied P as measured by the Bray No. 1 method and increased the availability of applied P to the plant in the greenhouse and field experiments.

Va. Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va.

Olsen, S. R., Kemper, W. D., and Jackson, R. D. PHOSPHATE DIFFUSION TO PLANT ROOTS. Soil Sci. Soc. Amer. Proc. 26: 222-227. 1962.

Diffusion of phosphate appears to account for the observed rates of P uptake by corn roots. A diffusion equation was developed which takes into consideration the effect of plant removal of $\underline{\text{P}}$ on the relationship between solution P and solid phase P, in addition to the tortuosity and ionic interaction factors as the heat flow equation, hence solutions of the latter can be applied to describe phosphate diffusion in soils.

SWCRD, ARS, USDA, Ft. Collins, Colo.

Sanford, J. O., and Lancaster, J. D. BIOLOGICAL AND CHEMICAL EVALUATION OF THE READILY AVAILABLE SULFUR STATUS OF MISSISSIPPI SOILS. Soil Sci. Soc. Amer. Proc. 26: 63-65. 1962.

A quick-cropping technique was adapted to study the immediately available S in soils. Forty Mississippi soils were cropped using this technique. Sulfur uptake by the crop was compared with the sulfate-S content of the soils. Correlation of the two variables proved highly significant ($r = 0.87$). Reduction in soluble sulfate content of soils during the short cropping period agreed rather closely with S absorbed by the crop.

A study of the distribution and availability of sulfate in the profile of soils of the Hill area of Mississippi showed that, in general, sulfate-S in the subsoil of a particular profile tended to exceed that in the corresponding surface soil. Sulfate-S in subsoils was almost as available as that in surface soils under the conditions of the experiment. Ratios of S

uptake by plants to sulfate-S in soils were 1:1.5 for surface soils and 1:1.7 for sub-soils.

SWCRD, ARS, USDA, State College, Miss.

Nakamura, M. T., and Sherman, G. D. THE VANADIUM CONTENT OF HAWAIIAN ISLAND SOILS. Hawaii Agr. Expt. Sta. Tech. B. 45, 20 pp. 1961.

The vanadium contents in the surface horizons of the Hawaiian soils range from 190 p.p.m. to a high of 1520 p.p.m., with an average of 450 p.p.m. The very high concentrations are confined to the Humic Ferruginous Group. The vanadium contents of the Hawaiian soils are higher than those of other arable soils reported in the available literature.

The amount of vanadium in the soil is influenced by the amount found in the parent material but the concentration of the element is more clearly a reflection of the weathering processes. In the Hawaiian Islands, where the major soil-forming process is latosolization, vanadium accumulates in the soil profiles. This characteristic may be used to advantage to find lithologic discontinuities in soil profiles. The concentration ratios derived reflected the weathering state of the soils. When the ratios were plotted against rainfall they fell into the natural soil grouping used by soil classificationists.

A correlation between the concentration of vanadium and titanium was observed in the Humic Ferruginous Latosol Group.

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

Singh, M., Kumazawa, K., and Mitsui, S. FORMATION OF ASPARAGINE FROM ¹⁴C-LABELED ASPARATATE IN DIFFERENT PARTS OF RICE PLANT AT THE PANICLE FORMATION STAGE. Soil Sci. and Plant Nutr. 7: 45-47. 1961.

C-14 aspartate absorption was studied in two different ways through detached leaves and roots.

Highest C-14 asparagine was detected in the case of youngest leaf which indicates that this leaf is the place of accumulation for asparagine at the panicle formation stage of rice crop. However, considerably high C-14 asparagine was found in roots as compared to stem, old and middle leaves. At the same time the content of C-14 aspartate was highest in roots and lowest in youngest leaf. It seems that the velocity of aspartate conversion into asparagine is very fast in a young leaf, not so fast in roots, and rather slow in an old leaf. The conclusions that asparagine formation in an old leaf is the resultant effect of protein breakdown, seems true.

U. Tokyo, Tokyo, Japan.

Singh, M., Kumazawa, K., and Mitsui, S. INCORPORATION OF HEAVY NITROGEN IN DIFFERENT PARTS OF RICE PLANT AT THE PANICLE FORMATION STAGE. Soil Sci. and Plant Nutr. 7: 5-7. 1961.

Asparagine formation and appearance at the panicle formation stage of rice with the use of heavy nitrogen was investigated. The velocities of nonprotein and protein nitrogen formation and turnover ratios between them were studied. The following results were obtained: N-15 easily entered the non-protein nitrogen of all the parts, but the rate of entrance

was faster in the roots than other parts. Turnover ratios between non-protein and protein nitrogen made it clear that NH_4 absorbed by roots is rapidly transported to the younger leaves in the form of ammonium itself or amino acids and only a small part is distributed in old leaves. In old leaves, in which decomposition is in progress, conversion of non-protein nitrogen to protein nitrogen is rather slow. It seems that nitrogenous compounds transported from the roots to the old leaves are retransported to the young leaves before their utilization in the form of amino acids or amides and gradually utilized for the formation of protein.

U. Tokyo, Tokyo, Japan.

Simpson, D. M. H., and Melsted, S. W. GASEOUS AMMONIA LOSSES FROM UREA SOLUTIONS APPLIED AS A FOLIAR SPRAY TO VARIOUS GRASS SODS. Soil Sci. Soc. Amer. Proc. 26: 186-189. 1962.

The gaseous loss of NH_3 from urea applied to plant sods was studied under laboratory conditions, using various grasses which had been grown in pots under greenhouse conditions. Spray applications of N^{15} - and C^{14} -labeled urea solutions equivalent to 50, 100, and 150 pounds of N per acre were made to the potted plant samples which had been transferred to a bell-jar apparatus. Care was taken to spray as much of the solution as possible directly on the plant foliage. The total amount of NH_3 lost through volatilization, as measured over a period of 8 to 10 days, increased with increasing rates of application. Losses ranged from about 0.5 pounds per acre with 50-pound application to about 45 pounds with the 150-pound application. A lag period of 2 to 3 days occurred before any measurable quantity of NH_3 was lost from any of the plants, with the exception of bluegrass. The greatest amount of urea hydrolysis, as measured by C^{14}O_2 evolution, occurred during this 2- to 3-day period. The amount of NH_3 lost and the rate of urea hydrolysis were influenced somewhat by the type of sod to which urea was applied. In most cases, there apparently was little or no direct relationship between C^{14}O_2 evolution and the NH_3 lost.

Jr. Author, U. Ill., Urbana, Ill.

Weir, C. C., and Miller, M. H. THE MANGANESE CYCLE IN SOIL: I. ISOTOPIC-EXCHANGE REACTIONS OF Mn-54 IN AN ALKALINE SOIL. Canad. J. Soil Sci. 42: 105-114. 1962.

The manganese cycle in an alkaline soil was investigated by means of isotopic-exchange studies. Mn-54 was added to the solution in equilibrium with the soil and the rate of disappearance of the Mn-54 from solution was determined. The forms of soil manganese in equilibrium with solution manganese were studied by extracting soil with buffered pyrophosphate and/or ZnSO_4 solution after equilibration with Mn-54 .

The rate studies indicated that there are five or more first-order exchange reactions between soil and solution manganese. These reactions were characterized by a quantity and specific rate constant. Extraction of the soil following equilibration with Mn-54 indicated that a portion of the pyrophosphate extractable and all of the ZnSO_4 extractable manganese was in equilibrium with the solution manganese. These two extractants removed all the soil manganese that had reached equilibrium with the Mn-54 in solution. It was indicated that the pyrophosphate extractable manganese existed in layered surfaces probably of a concretionary nature.

Ontario Agr. Col., Guelph, Ontario, Canada.

Chao, T. T., Harward, M. E., and Fang, S. C. MOVEMENT OF S^{35} TAGGED SULFATE THROUGH SOIL COLUMNS. Soil Sci. Soc. Amer. Proc. 26: 27-32. 1962.

Soil columns were used to study the movement of S-35 tagged sulfate applied as gypsum ($CaSO_4 \cdot 2H_2O$) through soil systems as influenced by different rates of water and sulfur applications, and of fertilizer treatments. With different rates of water, the distribution of the surface-applied sulfate showed a well-defined pattern of gradual downward movement. Increasing the rate of sulfate applied in conjunction with a given amount of water resulted in a greater total amount of sulfate moving through the columns. The distribution of sulfate on a percentage basis was independent of the amount of sulfate applied. The data suggest that the retained sulfate ions were in kinetic equilibrium with those in solution. Both lime and phosphate treatments were shown to increase the movement of sulfate in column studies. The effect of lime was much greater than the effect of phosphate. The results of equilibration studies were in good qualitative agreement with those from column studies. Differences caused by fertilizer treatments with respect to degree of sulfate movement in columns were dependent on the nature of the soils used.

Of the 15 soils examined, one Reddish Brown Lateritic, two Brown Latosols, and an Ando soil showed appreciable ability to hold sulfate ions against leaching. These soils also contained a much higher content of free aluminum and iron oxides, and higher levels of exchangeable aluminum than other soils.

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

Okuda, A., and Yamada, Y. FOLIAR ABSORPTION OF NUTRIENTS: III. COMPARISON OF FOLIAR ABSORPTION WITH ROOT ABSORPTION IN POTASSIUM PHOSPHATE DOUBLE-LABELED WITH ^{42}K AND ^{32}P . Soil Sci. and Plant Nutr. 8: 14-18. 1962.

Okuda et al. (1958) reported that the purity of radioactive potassium, which had been produced by K-41 (d,p) K-42 nuclear reaction and separated from radioactive anions by the use of ion exchange resin, was tested by means of its decay curve. By this test, it is difficult to distinguish K-42 from Na-24 contamination, because of half-life of radioactive sodium (Na-24) is 15.06 hours and it is very similar to that of radioactive potassium (K-42), which is 12.4 hours. When the nuclear reaction Na-23 (d,p) Na-24 occurs, the cross section of this reaction for deuterons is about 100 times that of potassium nuclear reaction. In this case the purity of radioactive potassium (K-42) could be confirmed by its Gamma-ray spectrum. Radioactive potassium of high purity was obtained. Potassium phosphate, which was double-labeled by this radioactive potassium and imported radioactive phosphorous (P-32), was applied to leaves or roots of bean plants. The authors concluded: (1) Radioactive potassium was produced by nuclear reaction K-41 (d,p) K-42 in cyclotron and high purity was proved by its Gamma-ray spectrum. (2) The amounts of phosphorous absorbed through the leaf surface were a little greater than those of potassium in molar ratio under conditions with regard to light. However, the root absorption of potassium was very much greater than that of phosphorous in comparison with the ratio obtained in foliar absorption. And (3) both distributions of potassium and phosphorous in bean plant were made clear. Phosphorous is transported to and accumulated in the growing parts, but potassium accumulates rather in the stem and roots.

Kyoto U., Kyoto, Japan.

Dennis, E. J., and Ellis, R., Jr. POTASSIUM ION FIXATION, EQUILIBRIA, AND LATTICE CHANGES IN VERMICULITE. Soil Sci. Soc. Amer. Proc. 26: 230-233. 1962.

The influence of different levels of added potassium on the equilibrium values of water-soluble, exchangeable, and "fixed" potassium in a vermiculite system was investigated by chemical methods. X-ray diffraction techniques were used to establish the levels of added potassium necessary to result in changes in the basal "d" spacing of the vermiculite lattice. The effects of dehydration and complementary ion were studied.

In general, fixation of potassium by vermiculite against chemical extraction was associated with a change in the basal "d" spacing of the vermiculite lattice as shown by X-ray diffraction. However, some potassium was fixed against chemical extraction which was not detected by the X-ray diffraction method employed. Dehydration increased potassium fixation. Calcium and sodium systems were compared to determine the influence of the complementary ion on the fixation process. For a given level of exchangeable potassium, more fixation of potassium occurred when calcium was the complementary ion.

Jr Author., Kans. State U., Manhattan, Kans.

Chao, T. T., Harward, M. E., and Fang, S. C. ADSORPTION AND DESORPTION PHENOMENA OF SULFATE IONS IN SOILS. Soil Sci. Soc. Amer. Proc. 26: 234-237. 1962.

Four soils, of 15 examined, exhibited much higher adsorption of sulfate than the others. Isotopic exchange studies indicated that sulfate, which is retained by soils, is in kinetic equilibrium with sulfate in solution. Adsorption-desorption studies using retentive soils also indicated that sulfate adsorption is dependent on the concentration of the equilibrium solution. The adsorption phenomena could be described by the Freundlich type equation. The data indicated that the sulfate-retentive soils did not possess adsorption maxima or definite anion exchange capacities, at least up to 500 p.p.m. S. Although certain soils were shown to have marked capacity to retain sulfate, the sulfate could be easily desorbed. As much as 45% of the sulfate initially adsorbed could be recovered in the first water extraction.

The lack of adsorption maxima is in contract to cation-exchange reactions where more definite exchange capacities are observed. These data suggest that either anion exchange is not involved in the retention of sulfate or that other mechanisms in addition to anion exchange are involved with sulfate retention by these soils.

Oreg. Agr. Expt. Sta., Corvallis, Oreg.

Soil Biology

Boswell, F. C., Richer, A. C., and Casida, L. E., Jr. AVAILABLE SOIL NITROGEN MEASUREMENTS BY MICROBIOLOGICAL TECHNIQUES AND CHEMICAL METHODS. Soil Sci. Soc. Amer. Proc. 26: 254-256. 1962.

Microbiological and chemical techniques for assaying available soil nitrogen were evaluated using 30 soils samples selected from Georgia, Iowa, New Jersey, and Pennsylvania. The nitrifying capacity of these soils, as measured by incubation under controlled conditions, was used as the standard for comparison.

A microbiological technique was devised, using a strain of the proteinaceous bacterium Pseudomonas aeruginosa. Production of a pigment, pyocyanin, by this organism during growth in a medium in which soil served as the nitrogen source was used as the criterion

for measuring available soil nitrogen. With this technique, a highly significant negative correlation was obtained between pigment production and nitrifying capacity for the 30 soil samples studied. The method has the advantage that only 4 days are required for the assay, in contrast to 2 to 8 weeks for the determination of nitrifying capacity.

The microbiological technique was compared with the chemical methods of Truog and Purvis. In the Truog procedure, ammonia is distilled from soils in the presence of alkaline permanganate. The Purvis method involves hydrolysis and mild oxidation with dilute H_2SO_4 followed by ammonium ion determination by Nesslerization. Both chemical methods yielded highly significant correlation with nitrifying capacity. The correlation between the two chemical methods also was highly significant. The Truog method and the microbiological technique exhibited a negative correlation of high significance.

Paper 2548, J. Ser., Pa. Agr. Expt. Sta., University Park, Pa.

Okuda, A., Yamaguchi, M., and Kobayashi, M. NITROGEN-FIXING MICROORGANISMS IN PADDY SOILS: VII. PRODUCTS IN MIXED CULTURE OF RHODOPSEUDOMONAS CAPSULATUS WITH AZOTOBACTER VINELANDII. Soil Sci. and Plant Nutr. 7: 115-118. 1961.

It has been reported that the amount of nitrogen fixed was much increased when Rhodopseudomonas capsulatus was cultured with Azotobacter vinelandii, probably due to their symbiotic relationships.

The composition of the products was compared among the separate and mixed cultures of R. capsulatus and the azotobacter by paper chromatography to examine the hypothetical cycle proposed previously.

In cultures of R. capsulatus and the mixed cells with Az. vinelandii after 40 days, the spot of homoserine was found, but not in culture of Az. vinelandii alone. On the other hand, in the culture after 40 days of Az. vinelandii, the spot of γ -amino butyric acid was detected, but in the culture of R. capsulatus the spot was not.

The spot of D-deoxyribose was found in the medium of R. capsulatus (10 days' and 40 days' culture) and the mixed (40 days' culture), not in the medium of Az. vinelandii.

Kyoto U., Kyoto, Japan.

Anonymous. LET BACTERIA "FIX" SUB CLOVER. Oreg. Agr. Prog. 8(3-4): 4-7. 1961.

Once established and managed properly, sub clover is capable of producing 3 tons of dry forage per acre (enough for at least three ewes and their lambs per acre yearly) on western Oregon dryland hill pastures.

Partial failures in establishing this legume have dragged out development for 2 to 3 years for many farmers. There have been many complete failures.

Preliminary experiments at Camp Adair in which strains of commercial inoculant have been tested, along with methods of application disclose:

1. Use only a proved strain of bacteria. Commercial strains are available, but they should state on the container, "For use on subterranean clover."
2. Use enough bacteria--at least several thousand per seed.
3. Dampen seed with water or milk and stir until seeds are slightly damp. Then add inoculum and continue stirring until each seed is well coated. Plant as soon as seed will run through drill openings.

4. Inoculate just before seeding. Cover seeds in moist soil. Direct sunlight, heat, and drying kill bacteria. Wait until after the first autumn rain for seeding, even if it is until early October. Late seeding may reduce yields the first year, but soil moisture at planting time will help insure uniform effective nodulation, essential for a good seed crop in future years.
5. Highly acid fertilizers in contact with inoculated seed kill bacteria. Such fertilizers should be bandseeded.
6. If inoculation fails, reseed. Surface inoculation with pure culture or soil usually is not successful.

Getting sub clover properly nodulated may be the key so far but after the legume is established, first year management also determines how much forage your sub clover pasture will yield in the years ahead.

Here are some suggestions: (1) Fertilize on the basis of a soil test. (2) Graze early in the spring to hold back grasses and weeds. Begin grazing with first spring growth or as soon as soil is firm enough to support animals. In May and early June, remove animals and let sub clover produce as much seed as possible. It's important that large amounts of hard seed get into the soil. This insures sub clover survival in the years ahead. Do not cut sub clover the first year, especially when grass is seeded with sub clover. And (3) remove as much vegetation as possible during the summer, preferably by grazing, after seeds are mature. Sub clover will not germinate and establish the following autumn where vegetation covers the soil surface. Soil surface should be bare.

Whether sub clover thrives in succeeding years depends on two things: (1) Maintenance applications of fertilizer in the fall; and (2) removal of all vegetation during the summer to permit reseeding the next year. Sub clover is an annual pasture plant. It develops best under hard grazing and full use. After the establishment year, hay and silage can be cut early so enough seed is produced from regrowth, or cut late so some mature seed is left on the ground.

Sub clover is proving to be one of the most useful legumes for improved hill pastures in western Oregon. Growth patterns coincide with feed requirements of sheep better than other legumes. Adding cattle keeps the pasture in better condition for sheep.

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

Harper, H. J. A PRELIMINARY STUDY OF LEGUME INOCULATION IN OKLAHOMA.
Okla. Expt. Sta. Processed Ser. P-415, 19 pp. 1962.

Twenty-four soils collected from 14 Oklahoma counties did not contain rhizobium capable of producing nodules on soybeans in a greenhouse experiment. Only 7 of the soils produced nodules on Crimson clover; 10 soils produced nodules on alfalfa; and 20 soils produced nodules on lespedeza.

A field study of alfalfa, red clover, and Austrian winter peas revealed that abundant nodule development on red clover occurred on only 2 of 61 Oklahoma soils. Approximately 15 of the soils produced good nodulation on Austrian winter peas and 12 of the soils produced nodules on alfalfa plants.

One of eight soils taken from six Oklahoma counties contained natural inoculation for alfalfa. A high percentage of the plants were nodulated when inoculated seed was planted. The average number of nodules per plant was high on only three of the eight soils. Inoculating Austrian winter pea seed greatly increased the percentage of nodulated plants and increased the average number of nodules per plant on seven of the eight soils.

More natural inoculation occurred from the sand than from Norge 1, when the Norge 1 and Stidham fs had an application of 8 tons of barnyard manure per acre.

Nodulation percentage on soybeans was higher where a liquid culture was mixed with an organic carrier and applied to the seed before planting as compared with an equivalent quantity of the liquid culture applied directly to the seed.

Natural inoculation was high on four soils where cowpea seed was treated with a liquid culture before planting and with the same quantity of culture in an organic carrier. Neither method of inoculating the seed had any appreciable influence on the percent of nodulated plants nor on average number of nodules per plant.

Uniform nodulation was not obtained when rhizobium strains, isolated from nodules on three soybean varieties, were used to inoculate seed of five other varieties. Manchu soybeans were well nodulated with a culture from Tokio, while only 47 percent of Virginia soybean plants were nodulated when Tokio culture was used. Better nodule development occurred on Virginia soybeans than on Manchu from a culture isolated from Haberlandt. Both Manchu and Virginia were well nodulated from a culture isolated from Laredo soybeans. None of the three rhizobium cultures produced good nodulation on Peking, Hollybrook, or Chiquita varieties.

Inoculated cowpea seed on three soils increased nodulation and the average number of nodules per plant on two of the soils.

Nodulation on mungbean plants was poor and the average number of nodules per plant was low from both inoculated and uninoculated seed. Planting inoculated soybean seed resulted in a higher percent of nodulated plants on two upland soils (Kirkland sl and Norge 1), but did not increase nodule development appreciably on a bottomland soil (Yahola cl).

No increase in nodule development occurred when four times the normal culture application was applied to cowpea, mungbean, and soybean seed.

Tables.

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

Klemmedson, J. O., Schultz, A. M., Jenny J., and Biswell, H. H. EFFECT OF PRESCRIBED BURNING OF FOREST LITTER ON TOTAL SOIL NITROGEN. *Soil Sci. Soc. Amer. Proc.* 26: 200-202. 1962.

The effect of prescribed burning of ponderosa pine forest floor on soil nitrogen was investigated. Standardized soil columns were placed under the forest floor and subjected to three burning treatments: No burn, light-burn, and intense burn. One-third of the columns were removed immediately after burning, one-third 4 months later, and remainder 16 months later.

All burning and post-burning treatments showed net gains of nitrogen, those of no-burn and light-burn being greater than that for intense burning. The gain of nitrogen in the first inch of soil for the no-burn and light burn treatments was 11.1 pounds per acre per year. This gain is attributed to leaching of the decomposing forest floor remaining after treatment and indicates a decomposition rate of 3 percent. The combined effects of light and intense burning reduced the nitrogen in the forest floor by 124 pounds per acre.

Jr. Author, U. Calif, Berkeley, Calif.

Young, J. L., and Cattani, R. A. MINERAL FIXATION OF ANHYDROUS NH_3 BY AIR-DRY SOILS. Soil Sci. Soc. Amer. Proc. 26: 147-152. 1962.

Fixation of anhydrous NH_3 by the mineral fraction of air-dry samples from 65 horizons in 17 Pacific Northwest soils was investigated. Soils represented a wide variety of great soil groups. Nitrogen fixed from anhydrous NH_3 was compared to: (1) Nitrogen fixed from aqua- NH_3 ; (2) indigenous fixed NH_4^+ , and (3) NH_3 retention of the whole soil (organic and mineral fraction).

Mineral fixation of anhydrous NH_3 varied greatly between soils and between horizons within individual profiles. Values ranged from 6 to 1015 p.p.m. N and appeared large enough to have possible practical significance in some soils. Though small in comparison to NH_3 retention, mineral fixation of NH_3 caused lattice collapse from $14\frac{0}{A}$ to $10\frac{0}{A}$ in some samples. Mineral fixation of anhydrous NH_3 by air-dry samples generally exceeded by severalfold the wet fixation of nitrogen from aqua ammonia.

Ammonia retention ranged from 820 to 9190 p.p.m. N. Of the NH_3 retained, from 1 to 8% in the surface and from 2 to 31% in the subsurface horizons was fixed by the mineral fraction.

Indigenous fixed NH_4^+ , found in all horizons, ranged from 17 to 125 p.p.m. N and comprised from 1 to 7.5% and from 2 to 42% of the total N in surface and subsurface horizons, respectively. From 11 to 89% and from 6 to 63% of the total mineral-fixed NH_3 in the surface and subsurface horizons, respectively, was previously satisfied by indigenous fixed NH_4^+ .

SWCRD, ARS, USDA, Corvallis, Oreg.

Justice, J. K., and Smith, R. L. NITRIFICATION OF AMMONIUM SULFATE IN A CALCAREOUS SOIL AS INFLUENCED BY COMBINATIONS OF MOISTURE, TEMPERATURE, AND LEVELS OF ADDED NITROGEN. Soil Sci. Soc. Amer. Proc. 26: 246-250. 1962.

$(\text{NH}_4)_2\text{SO}_4$ at levels of 0, 150, and 450 p.p.m. N was incubated in a calcareous soil at 2° , 10° , and 22° C. at 10, 1, and 0.3 bars moisture tension using periodic aeration. A second incubation study included 4 other moisture levels (7, 15, 115 and 415 bars moisture tension) and continuous aeration. Good control of the moisture was attained with the continuous aeration by humidifying the incoming air over saturated salt solutions known to give the required relative humidity. The soil used, Millville 1, is a highly calcareous (47% CaCO_3 equivalent) fertile soil with a saturated paste pH of 7.8, and moisture contents at field capacity (0.3 bar tension), permanent wilting percentage (15 bars tension), and air dry was 18.0, 6.9, and 1.6%, respectively.

The only evidence of nitrification of 2° C. was the production of $\text{NO}_2\text{-N}$ which was not converted to $\text{NO}_3\text{-N}$ in 10 weeks. At 10° C. there was nitrification at 1/3, 1, and 10 bars tension where the lowest moisture (10 bars tension) apparently only delayed the initiation of nitrification and did increase the period of $\text{NO}_2\text{-N}$ accumulation. At 25° C., nitrification was completely inhibited at 415 and 115 bars tension. At 15 bars tension, 50% of the 150 p.p.m. N was oxidized to $\text{NO}_3\text{-N}$ in 28 days; while at 10, 7, and 1 bars tension, the nitrification was complete in about 28, 20, and 12 days. In this soil, 35° C. was less favorable for nitrification than 25° C. $\text{NO}_2\text{-N}$ accumulated at this temperature and persisted throughout the 8 weeks. Temperature (both high and low) and lowered moisture had a greater inhibiting effect on $\text{NO}_2\text{-N}$ oxidizers than on $\text{NH}_4\text{-N}$ oxidizers.

There was a decrease in the total inorganic N recovered when unfavorable nitrification conditions were encountered. This loss of inorganic N was apparently from the $\text{NH}_4\text{-N}$ pool.

Utah State Agr. Expt. Sta., Logan, Utah.

Burger, K., MacRae, I. C., and Alexander, M. DECOMPOSITION OF PHENOXYALKYL CARBOXYLIC ACIDS. Soil Sci. Soc. Amer. Proc. 26: 243-246. 1962.

The persistence of phenoxyalkyl carboxylic acids in soil was measured by a bioassay technique using alfalfa seedlings. Acetic, alpha-propionic, and alpha- and gamma-butyric acid derivatives were toxic when applied to soil planted to alfalfa whereas the beta-propionic acid derivatives showed no inhibition of the test plant. All 3,4-dichloro- and 2,4,5-trichlorophenoxyalkyl carboxylic acids exhibited prolonged persistence in soil. The duration of phytotoxicity in soil receiving 4-chloro-, 2,4-dichloro-, and 2-methyl-4-chlorophenoxyalkyl carboxylic acids was governed by the type and linkage of the aliphatic side chain.

A Flavobacterium sp. active in the degradation of phenoxybutyric acids was isolated. The bacterium metabolized only phenoxybutyric acids having no meta chlorine on the aromatic ring. In the decomposition, the organic chlorine was liberated and the aromatic ring cleaved.

The results demonstrate that specific structural characteristics of these herbicide molecules govern persistence of the compounds in soil.

N.Y. State Col. Agr., Cornell U., Ithaca, N.Y.

Parker, D. T., and Larson, W. E. NITRIFICATION AS AFFECTED BY TEMPERATURE AND MOISTURE CONTENT OF MULCHED SOILS. Soil Sci. Soc. Amer. Proc. 26: 238-242. 1962.

In the temperature range of 16° to 20° C., a 2° C. differential in soil temperature had a measurable effect on the rate of conversion of NH₄-N to NO₃-N. However, as soil temperature increased to the range of 25° to 30° C. or as the supply of NH₄ -N became limiting, differences in NO₃-N production resulting from small differences in soil temperature were not observed. In field soil, very early in the season when soil temperature was in the range of 16° to 20° C., mulched soil was 1° to 2° C. cooler than bare soil. During this period greater accumulation of NO₃-N could occur in bare than in mulched soil as a result of the temperature difference.

As measured in the laboratory, NO₃-N production was retarded at soil moisture tensions below 50 cm. of water. At still higher moisture levels, considerable mineral N was lost from the soil. Measurements in the field showed that the soil moisture content of mulched soil exceeded that of bare soil. For short periods of time the moisture level of mulched soil was high enough to cause retarded nitrification and loss of N.

SWCRD, ARS, USDA, Ames, Iowa.

Soil-Plant-Animal Relationships

Cibes, H., and Samuels, G. MINERAL-DEFICIENCY SYMPTOMS DISPLAYED BY SMOOTH CAYENNE PINEAPPLE PLANTS GROWN UNDER CONTROLLED CONDITIONS. Puerto Rico Agr. Expt. Sta. Tech. Paper 31, 30 pp. 1961.

Smooth Cayenne pineapples grown in sand cultures in the greenhouse were allowed to develop deficiency symptoms caused by lack of nitrogen, phosphorus, potassium, magnesium, sulfur, iron, manganese, and boron. The most important results were:

1. The absence nitrogen had the greatest influence in retarding plant growth at 11 months.
2. The complete, minus-boron, and minus-sulfur treatments gave the highest yields of fruit at harvest. The minus-nitrogen and minus-phosphorus treatments failed to produce any fruit. The smallest fruit was produced in the absence of potassium.
3. The fruit-to-crown ratio was 1.6 for the minus-potassium as compared to 7.2 for the complete treatment.
4. Plants matured earliest under the minus-iron and latest under the minus-potassium treatment.
5. Total acidity and pH were lowest in the fruit when iron was withheld.
6. The absence of potassium was reflected by a sharp lowering of the degree-brix and total sugar values of the juice which produce a fruit of flat insipid flavor.
7. There was no production of slips under any of the deficiency treatments, and sucker production was highest for the minus-sulfur treatment. There was no sucker production under the minus-nitrogen, -phosphorus, and -potassium treatments.
8. Nitrogen, phosphorus, and potassium deficiencies, in that order, caused the most severe decreases in total plant material produced.
9. The nutrient content of the pineapple leaf is not constant for the various plant materials produced.
10. There was a great decrease in the nutrient elements in the leaf for the respective elements under the deficiency treatments.
11. The nitrogen content of the plant was lowest when nitrogen was omitted, and the new leaf showed large accumulations of phosphorus, potassium, iron, and manganese.
12. Plants under the minus-phosphorus treatment accumulated potassium in the old and intermediate leaves, and had much lower calcium magnesium, sulfur, and manganese contents than those under the complete treatment.
13. Exceedingly low leaf-potassium were found in the old and intermediate leaves when potassium was omitted from the nutrient solution. The omission of nitrogen, phosphorus, calcium, and iron all caused accumulations of leaf potassium.
14. Calcium tended to decrease from the old to the new leaves. Leaf values in general were higher for calcium with Smooth Cayenne than for Red Spanish.
15. There was little change in the magnesium content of the leaf attributable to treatment except in the absence of magnesium.
16. Leaf-sulfur values dropped with transition from old to new leaves. The minus-sulfur treatment did not produce the lowest leaf-sulfur values, except in the intermediate-leaf tissue, and fruit yields were higher than for the complete treatment. It was supposed that a true sulfur deficiency was not achieved in this study.
17. The minus-iron treatment produced the lowest leaf iron in the intermediate leaves. Leaf iron was lowest in old leaves under the minus-calcium, and in the new leaves under minus-magnesium treatment. Leaf-manganese values increased sharply in all leaves when iron was absent from the nutrient solution.
18. Leaf manganese was lowest under the minus-manganese treatment in the new and intermediate leaves, but the old leaves had slightly lower manganese under the minus-phosphorus treatment.
19. Leaf-boron values tended to show little variation with treatment.
20. First to appear was the nitrogen deficiency, characterized by a lighter green color in the young leaves. The older leaves dried up in the latter stages, where the deficiency was severe.
21. In the early stages there were no signs of chlorosis in the leaves in the phosphorus-deficient treatment; however, in the later stages, the older leaves began to dry up and the younger ones to display a lemon-yellow color.

22. The leaves remained green under a potassium deficiency, but there was a drying up of the tip, and necrotic spots and blistered areas appeared on the surface.
23. Calcium deficiency produced a pale-green leaf with some yellow mottling along the center line, and blistering on the underside.
24. A yellow mottling appeared on the leaf as magnesium deficiency became severe.
25. The symptoms caused by a sulfur deficiency were a light-green color with some blistering in the older leaves.
26. Iron-deficiency visual symptoms appeared as a yellow mottling along the leaf margin while the center of the leaf had a pronounced reddish cast.
27. No clear-cut visual symptoms of deficiency were obtained when manganese or boron were omitted from the nutrient solution.

U. Puerto Rico. Agr. Expt. Sta., Rio Piedras, Puerto Rico.

Cairns, R. R., Milne, R. A., and Bowser, W. E. A NUTRITIONAL DISORDER IN BARLEY SEEDLINGS GROWN ON AN ALKALI SOLONETZ SOIL. *Canad. J. Soil Sci.* 42: 1-6. 1962.

Surface samples of an Alkali Solonetz and a Solod soil that occur in intimate association in the field were compared in the greenhouse from a productivity standpoint.

A nutritional disorder developed in the crops grown on the Alkali Solonetz and the disorder was diagnosed as a nitrogen deficiency. This deficiency was so severe that the Alkali Solonetz soil was incapable of sustaining the growth of barley seedlings. The application of nitrate to the soil allowed for the production of repeated seedlings crops at a level comparable with that of the untreated Solod. During 4 weeks' incubation the Alkali Solonetz released only 13 p.p.m. $\text{NO}_3\text{-N}$ as compared with 46 p.p.m. in the Solod.

Canada Dept. Agr., Vegreville, Alberta, Canada.

Miller, J. K., and Miller, W. J. EXPERIMENTAL ZINC DEFICIENCY AND RECOVERY OF CALVES. *J. Nutr.* 76: 467-473. 1962.

Zinc deficiency symptoms observed included; anorexia; dull and listless appearance; low weight gains, breaks in the skin with deep fissure formation around the hoofs; alopecia, especially on the rear legs with edematous soft swelling of the feet in front of the fetlocks with accumulation of fluid; extensive dermatitis between the legs and behind the elbows; hard dehydrated skin on the body and head with that on the legs being tender and easily injured; red, scabby and shrunken skin on the scrotum; undersized testicles; inflammation of the nose and mouth with submucous hemorrhages; horny overgrowth of the mucosa on the lips and dental pad; and reduced blood zinc content and carbonic anhydrase activity. Addition of 260 p.p.m. of zinc to the ration of three deficient calves in the second experiment beginning at 15 weeks of age resulted in rapid and dramatic recovery. All of the conditions listed above with the exception of the undersized testicles were corrected by zinc supplementation of the diet.

Dairy Dept., U. Ga., Athens, Ga.

Adams, F., and Henderson, J. B. MAGNESIUM AVAILABILITY AS AFFECTED BY DEFICIENT AND ADEQUATE LEVELS OF POTASSIUM AND LIME. *Soil Sci. Soc. Amer. Proc.* 26: 65-68. 1962.

The availability of soil Mg was measured on 7 major soil types of Alabama by growing Sudangrass and ladino clover in the greenhouse. The plants were grown at deficient and

adequate levels of available K and lime. Plant growth and plant content of Ca, Mg, and K were measured. Total uptake of Mg was used as a measure of its availability. Growth response to Mg by the two crops occurred on the same soils. Soils that had < 4% of the cation-exchange capacity as Mg were Mg-deficient. Mg-deficient plants contained 0.25 me. or less of Mg per g. of dry material. On Mg-deficient soils, the availability of Mg to both crops tended to be greater at the higher K level. However, the availability of Mg on the same soils was less at the higher soil pH. Mg availability on soils not deficient in Mg in general was affected in the reverse.

Agr. Expt. Sta., Auburn U., Auburn, Ala.

Williams, M. C., Binns, W., and James, L. F. OCCURRENCE AND TOXICOLOGY OF SELENIUM IN HALOGETON AND ASSOCIATED SPECIES. J. Range Mangt. 15: 17-22. 1962.

The selenium content of halogeton collected from seleniferous soils in eastern Utah ranged from 0 to 95 p.p.m. Maximum selenium concentration was usually less than 10 p.p.m.

Halogeton grown in nutrient cultures containing 8 p.p.m. selenium as sodium selenate accumulated 500 p.p.m. selenium in the leaves. Both dry weight and soluble oxalate content were reduced at this concentration. Growth and oxalate content were not affected by selenium accumulation in the field.

Sublethal doses of selenium and soluble oxalates administered daily to sheep were more toxic than when each was fed separately. The increased toxicity resulted from a more rapid and severe injury of the liver, lungs, and kidneys. Necropsy of sheep, which died during the feeding trials, indicated pathology characteristic of both selenium and oxalate poisoning. Death was attributed directly to acute hypocalcemia in only one case. No symptoms of poisoning occurred in sheep fed only soluble oxalates or only selenium for 90 days at comparable dosages.

Except under unusual circumstances, halogeton is unlikely to contain enough selenium to increase its toxicity. Where range condition is so poor that halogeton and seleniferous species constitute an unusually high proportion of the diet, losses among sheep may be more severe when both types of plants are eaten together.

CRD, ARS, USDA, Logan, Utah.

Jensen, E. H., Lesperance, A. J., and Gregory, E. J. MOLYBDENUM IN FORAGE PLANTS. Nev. Ranch & Home Rev. 2(3): 10-12. 1961.

Molybdenum is essential for plant growth. It is also believed to be needed by animals. In certain areas of the United States plants will respond favorably to small quantities of molybdenum fertilizer. There are areas where forages contain relatively high concentrations of molybdenum. When the concentration in the forage exceeds 5 to 20 parts per million (p.p.m.), molybdenum becomes toxic to cattle. The degree of toxicity is related to copper content of forage.

To better understand the problem of molybdenum toxicity, a number of experiments are being conducted by the Agricultural Experiment Station of the University of Nevada. These include studies on the uptake of molybdenum by plants and the effects of molybdenum on cattle.

Results of a greenhouse experiment show that most legumes accumulate significantly more molybdenum than grasses. Birdsfoot trefoil and sweet clover were the worst offenders

and contained a greater concentration of molybdenum than other legumes such as alfalfa, strawberry clover, and Ladino clover.

Where excessive molybdenum in the soil is a problem, farmers have observed that legumes are more toxic than grasses to animals. Experiments conducted at the University Main Station field laboratory indicate that the greater toxicity of the legumes to cattle is due to the greater ability of legumes to accumulate molybdenum.

Toxic levels of molybdenum in forage plants have been observed frequently in areas where the water table is high. The effects of water table on molybdenum accumulation by birdsfoot trefoil and alfalfa were studied in field phytometers at Reno (figure 1). Chemical analysis of the first harvest of the 1960 crop did not show any significant differences in molybdenum accumulation due to water table. However, analyses of the third crop indicated that water table was associated with uptake of molybdenum by the plants.

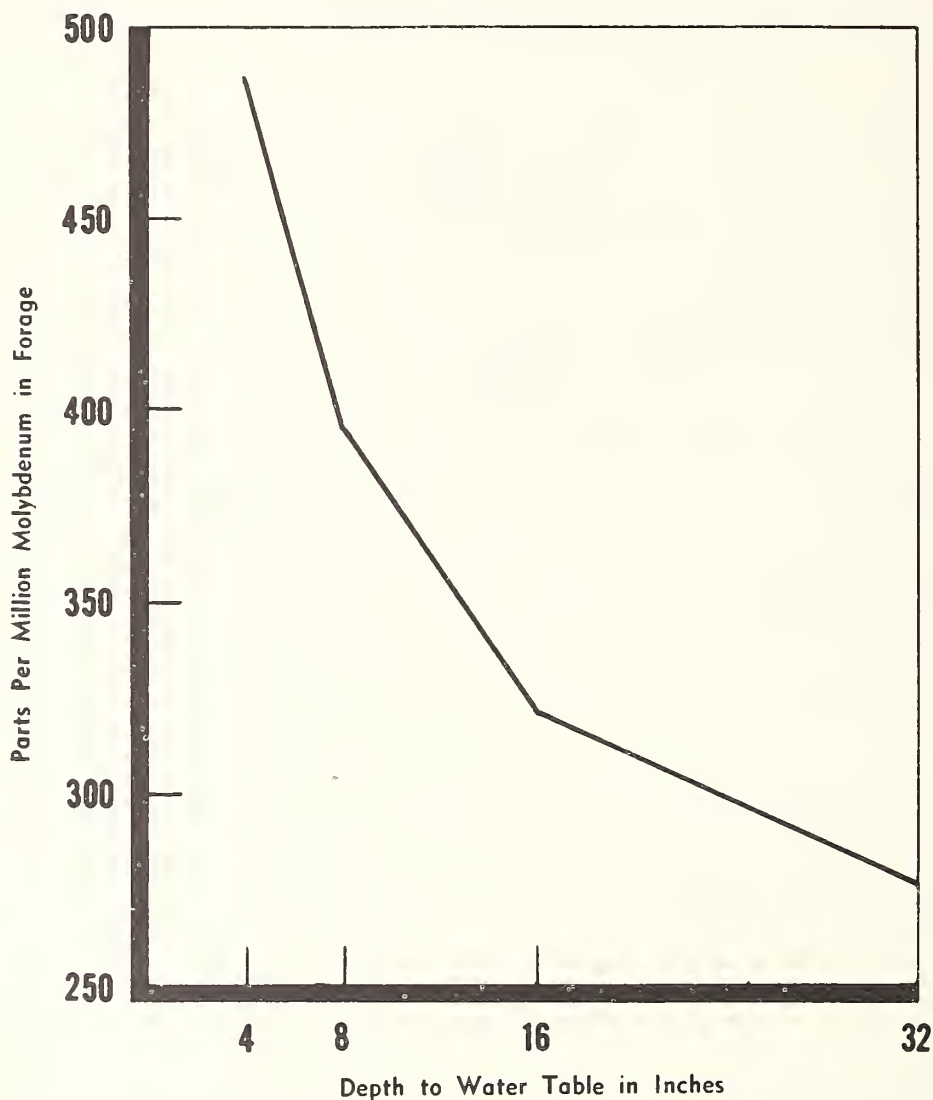


Figure 1. Effect of water table on average molybdenum accumulation by birdsfoot trefoil and alfalfa.

Roberts, S., and Nelson, C. E. HOP NUTRIENT UPTAKE AND THE RELATIONSHIP BETWEEN QUALITY AND NUTRIENT CONTENT OF HOP CONES. Wash. Agr. Expt. Sta. B. 630, 16 pp. 1961.

Use of nitrogen, phosphorus, potassium, calcium, and magnesium for the entire hop plant, and dry matter production during weekly intervals of the growing season were studied using the Late Cluster variety.

The seasonal growth of the hop plant has a linear relationship to time of weekly harvesting. The greatest dry matter production for any one week occurred from July 13 to July 20. During this week, air temperatures were the highest for the season, and the solar and sky radiation lower than that for several preceding weekly intervals. In general, dry matter production increased rapidly in the 3-week period preceding cone formation (June 29 to July 20) and in the 3-week periods, 27 and 33 percent, respectively, of the total seasonal dry matter was produced, a total of 60 percent.

The percentages of N, P_2O_5 , and K_2O in the hop plant decreased in a linear relationship with weekly harvests from June 15 to September 21. The calcium and magnesium percentages remained fairly constant for the season.

The yield of harvested cones of the Late Cluster variety for the experiment was 2,060 lbs. per acre at 8 percent moisture (10 bales).

The total uptake by both the vines and cones was: N, 242 pounds; P_2O_5 , 66 pounds; and K_2O , 229 pounds per acre. The harvested cones contained 65 pounds N, 19 pounds P_2O_5 , and 58 pounds K_2O per acre. The common practice is to chop and return all vines and leaves to the soil.

The application of N, P_2O_5 , and K_2O after the first part of July gave little or no increased plant growth.

The alpha acid and total brewing value in relation to the total nitrogen in the cones was studied from 37 hop yards. These yards were at various locations representing the entire area where hops are grown in the Yakima Valley.

A negative correlation was found between both alpha acid and total brewing value with total nitrogen in the Late Cluster variety of hop cones. No correlation was found between total nitrogen content of the cones of Early Cluster hops and alpha acid or total brewing value.

The linear regression data of alpha acid or total brewing value of Late Clusters on total nitrogen content imply that the alpha acid or total brewing value decreases with increasing amounts of total nitrogen in the cones.

Wash. Agr. Expt. Sta., Inst. Agr. Sci. Wash. State U., Pullman, Wash.

Laughlin, W. M. SPRAY CONCENTRATIONS OF POTASSIUM CHLORIDE AND POTASSIUM SULFATE AFFECT POTATO GROWTH, YIELDS, AND CHEMICAL COMPOSITION. Amer. Potato J. 39: 100-106. 1962.

Nine weekly sprays of solutions of 0, 1.2, 2.4, 3.6, and 4.8% K_2O as KCl and K_2SO_4 supplying 0, 12, 24, 36, and 48 pounds K_2O per acre during the season were applied to Arctic Seedling potato foliage in a 5^2 factorial in 1959 and 1960.

Both potassium sprays increased US No. 1 tuber yields and decreased the weight of tubers showing brown sunken lesions.

At high concentrations potassium sulfate sprays produced greater US No. 1 tuber yields than did similar potassium chloride sprays. Concentrations of potassium chloride exceeding 2.4% K_2O significantly reduced yields.

Rapid reduction in tuber specific gravity occurred with increasing concentrations of potassium chloride sprays. Increasing concentrations of potassium sulfate slowly reduced the specific gravity. This reduction became significant only at the highest concentration.

Leaf margins and tips burned when sprays of potassium chloride exceeding 1.2% K_2O were used. No leaf injury resulted from any spray concentration of potassium sulfate.

Tubers from plants receiving potassium chloride contained more potassium and magnesium than did those receiving potassium sulfate.

Each increasing concentration of potassium spray increased the tuber potassium content.

Potassium spray concentrations exceeding 1.2% K_2O significantly increased tuber magnesium content.

Alaska Agr. Expt. Sta., Palmer, Ala.

Rusoff, L. L., Achacoso, A. S., Mondart, C. L., Jr., and Bonner, F. L. RELATIONSHIP OF LIGNIN TO OTHER CHEMICAL CONSTITUENTS IN SUDAN AND MILLET FORAGES. La. Agr. Expt. Sta. B. 542, 36 pp. 1961.

The lignin content and other chemical constituents of two summer pasture grasses as well as the relationship among lignin, crude protein, crude fiber, and dry matter as affected by stage of maturity and rates of nitrogen fertilization were studied. The yield of forage as affected by rate of nitrogen fertilization was also studied. Sudan and millet forages, fertilized with 0, 30, 60, 120, and 240 pounds of nitrogen per acre, in two applications, were cut at 10-day intervals. First cuttings on all treatments were made when the plants were 30-35 inches high. The plants were cut back to a 6-inch stubble. The forages were harvested for yield when they reached the silage stage, or approximately at the stage between boot and full bloom.

Results on both forages showed that lignin progressively increased with plant maturity, with values ranging from 3.23 percent to 6.72 percent on the first and fifth cuttings, respectively. The percentages of crude protein decreased significantly from 13.1 percent to 5.9, with a relatively small decline between the first two cuttings. Crude fiber increased significantly, with a decline at the fifth cutting which was apparently due to seed formation, particularly in the millets. Gahi-1 millet produced a significantly higher silage yield than Tift Sudan and common millet at all levels of nitrogen application with the exception of 0-level.

No significant increases in lignin up to 120 pounds of nitrogen application per acre were obtained. Crude protein increased significantly from 7.4 to 13.5 percent, while crude fiber decreased from 32.0 to 30.1 percent at the 0- and 240-pound levels, respectively. However, there were no significant differences in the crude fiber content at the 30-, 60-, and 120-pound levels. Dry matter, nitrogen-free extract and ash also increased.

Highly significant negative correlation coefficients were obtained between lignin and crude protein, crude protein and crude fiber, and crude protein and dry matter. Positive correlations were obtained between lignin, crude fiber, and dry matter at the 1-percent level of probability.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Dunn, L. E. PLANT CHEMICAL COMPOSITION AND SOIL FERTILITY. Nev. Agr. Expt. Sta. Tech. B. 211, 28 pp. 1961.

The chemical composition of plants is dependent upon the kind of plant and the environmental conditions present for its growth. Climatic and soil conditions are of great importance in influencing the composition and quality of crops. Soils which are low in one or more of the plant nutrient elements are frequently associated with lower crop yields and with crops or crop products which are deficient in elements needed in feeds for livestock or foods for human consumption. Cultural practices may be adjusted to improve the yield, nutrient content, and quality of crops: Fertilizers are commonly used for these purposes.

A number of experiments were conducted with the use of fertilizers on Nevada soils for crops which are most commonly grown in Nevada. Yields and chemical composition were obtained. Nitrogen fertilizers commonly increased the yields and protein content of grains and grasses. High rates of application were either uneconomical or tended to discourage the growth of legumes in pasture or meadow mixtures. Phosphate fertilizers did not have much effect upon yields for the soils and conditions involved in the experiments. In nearly all cases, phosphate fertilizer increased the phosphorus content of grains, grasses, and legumes. In most cases, the increases were such as to materially increase the quality of the crops produced. Potash fertilizers increased the potassium content of the crops. Most Nevada soils are relatively high in potash and the crops produced on untreated soils had adequate amounts of potassium.

Fertilizers should be used on Nevada soils to improve both the yield and quality of crops. Kinds and amounts of fertilizers to use will need to vary appreciably for different soils, crops and growing conditions.

Tables, graphs, and photographs.

Agr. Expt. Sta., Max C. Fleischmann, Col. Agr. U. Nev. Reno, Nev.

Laughlin, W. M. SOIL AND FOLIAR APPLICATIONS OF NUTRIENTS AFFECT POTATO YIELDS, DRY MATTER, AND FOLIAR NECROSIS. Amer. Potato J. 39: 225-234. 1962.

A series of field experiments from 1958 through 1960 was conducted to determine the effect upon potato leaf breakdown and tuber yields of nitrogen, lime, and soil and spray applications of KCl , K_2SO_4 , and other sprays.

Lime had no significant influence on foliar breakdown or tuber yields.

Increasing nitrogen levels increased foliar breakdown and US No. 1 tuber yields.

Soil and spray potassium applications, irrespective of potassium source, decreased foliar breakdown and increased US No. 1 tuber yields. Spray application of K was not as effective as soil application in reducing foliage breakdown.

Tuber dry matter content was reduced consistently by KCl applied to the soil or as a spray. In 1958, K_2SO_4 increased the dry matter content, but did not influence it significantly in other years. Sodium phosphate sprays increased tuber dry matter content in 1958.

Soil applications of potassium in 1960 increased the potassium content of the tubers. Soil application of KCl tended to decrease the phosphorus content. Spray applications of potassium had no significant influence on the phosphorus content.

Ala. Agr. Expt. Sta., Palmer, Ala.

Anderson, O. E., Dempsey, A. H., and Wentworth, J. SWEET POTATO YIELD AND QUALITY AS AFFECTED BY FIELD APPLICATIONS OF MANGANESE SULFATE. Ga. Agr. Expt. Sta. Mimeo. Ser. N.S. 132, 12 pp. 1962.

Manganese sulfate was applied at the rates of 10, 20, 30, and 60 pounds per acre to field plots of sweet potatoes on Lynchburg, Ruston, Marlboro, Red Bay, Norfolk loamy sands, and Greenville and Colfax sandy loams. Where the soil pH was 5.5 or above, the average yield for most of these soils was increased by approximately 45 bushels per acre where 30 and 60 pounds of $MnSO_4$ were applied.

Grade, taste, sugar, carotene, and dry matter content were not affected by treatment.

The cost of incorporating 30 pounds of $MnSO_4$ per 1,000 pounds of fertilizer ranges from \$2.00 to \$3.00 depending on the quantity ordered.

Ga. Expt. Sta., Experiment, Ga.

Beaton, J. D., and Gough, N. A. THE INFLUENCE OF SOIL MOISTURE REGIME AND PHOSPHORUS SOURCE ON THE RESPONSE OF ALFALFA TO PHOSPHORUS. Soil Sci. Soc. Amer. Proc. 26: 265-270. 1962.

The influence of soil moisture regimes and P sources on the response of alfalfa to P was studied in the growth chamber. Surface samples of two calcareous British Columbia soils, Machete stony sl and the Nisconlith cl, were used. Alfalfa yield and P uptake were highest when soil moisture tension was allowed to reach a maximum of 2.0 bars and subsequently reduced to 0.2 bars. The P sources were almost equally available with this regime.

Calcium metaphosphate and anhydrous dicalcium phosphate produced the highest yields. P content of alfalfa was highest with monoammonium phosphate on the Machete soil. Monocalcium phosphate resulted in the highest tissue P with the Nisconlith soil. Amount of P removed from the soil, with the exception of hydroxyapatite, was not markedly influenced by P source. Hydroxyapatite treated soil released the lowest amount of $NaHCO_3$ -extractable P.

U. British Columbia, Vancouver 8, British Columbia, Canada.

Bourget, S. J., and Carson, R. B. EFFECT OF SOIL MOISTURE STRESS OF YIELD, WATER-USE EFFICIENCY AND MINERAL COMPOSITION OF OATS AND ALFALFA GROWN AT TWO FERTILITY LEVELS. Canad. J. Soil Sci. 42: 7-12. 1962.

Yields of oats and alfalfa grown in two soils in the greenhouse, with and without fertilizer, usually decreased with increasing moisture stress obtained by depleting the available moisture to 75, 50, 25, and nearly 0 per acre.

An application of 6-20-20 fertilizer for oats and of 0-20-20-for alfalfa at the rate of 1,000 pounds per acre gave a marked increase in crops yield and it resulted in a more efficient use of water by the crops than was obtained without fertilizer, although the total amount of water used was greater with than without fertilizer. The water-use efficiency values for oats usually increased with decreasing available water whereas those for alfalfa were less consistent.

The composition in nitrogen, phosphorus, potassium, calcium, and magnesium of the plant tissues did not vary greatly. The phosphorus content of oats grain decreased with increasing soil moisture stress unless fertilizer was added, indicating that soil phosphorus became less available for oats at high moisture stress.

Analytical Chem. Res. Serv. Res. Br., Ottawa, Ontario, Canada.

Harper, H. J. YIELD AND CHEMICAL COMPOSITION OF SERICEA LESPEDEZA, ALFALFA, AND PRAIRIE GRASSES ON NORGE LOAM IN CENTRAL OKLAHOMA. Okla. Expt. Sta. Processed Ser. P-397, 7 pp. 1961.

Sericea lespedeza planted in 14-inch rows on Norge 1 at Perkins in 1937 produced more than 20 hay crops without replanting. Average hay production from one cutting, usually in June or July, was 3,976 pounds per acre. The stand of lespedeza plants in 7-inch rows gradually disappeared over a 10-year period. No fertilizer or lime was applied.

The average annual yield of alfalfa on untreated and on limed soil on adjacent plots was about one-fourth and one-half as much hay, respectively, as was obtained from the lespedeza plot. Alfalfa production on limed soil fertilized annually with 200 pounds of 0-20-0 per acre was 34 percent higher than the average yield of lespedeza.

Prairie grasses planted on adjacent unfertilized land produced an average annual yield of 2,928 pounds of hay per acre as compared with 3,767 pounds of sericea lespedeza hay for the same period.

The lespedeza hay was much lower in nitrogen, phosphorus, calcium, and potassium than the alfalfa. The lespedeza also contained less nitrogen, phosphorus, and calcium than was present in similar forage produced in other states. The lespedeza hay was higher in nitrogen, phosphorus, and calcium than prairie hay from a meadow on similar soil near Stillwater.

Tables.

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

Conrad, H. R., Pratt, A. D., Hibbs, J. W., and Davis, R. R. RELATIONSHIPS BETWEEN FORAGE GROWTH STAGE, DIGESTIBILITY, NUTRIENT INTAKE, AND MILK PRODUCTION IN DAIRY COWS. Ohio Agr. Expt. Sta. Res. B. 914, 24 pp. 1962.

Digestibility, feed intake, milk production, and nitrogen, calcium, and phosphorus balances were determined in conjunction with forage utilization studies in an attempt to evaluate the effects on nutritive value of advancing maturity and length of growing period. Eighty-three digestion trials were carried out over a 5-year period. The forages used were primarily alfalfa-brome mixture.

Using results of 23 digestion trials obtained with cows fed legumegrass forages, dry matter digestibility was found to decrease by approximately two percentage units per week and was expressed by the regression formula, Y (digestibility) = $71.4 - 0.286X$ where X is equal to the number of days after April 30. The regression formula for decline in daily digestible dry matter intake from first growth legumegrass forages among cows fed all roughage rations was Y (digestible dry matter) = $25.4 - 0.212X$. These formulae provide a basis for predicting the nutritive value of first-cutting forages in central Ohio. The daily digestible dry matter intake per unit body weight was highly correlated with milk production indicating that these formulae are highly useful for making on-the-farm estimations of the value of forages.

When second and third-cutting yields were included, maximum yield of milk per acre was calculated to result from the earliest cut forages (May 17 and May 24 in this study). Digestibility of second growth alfalfa declined markedly after a 42-day growing period.

The *in vitro* cellulose digestibility was highly correlated with dry matter digestibility, digestible dry matter intake, and milk production. *In vitro* propionic acid production was correlated with dry matter digestibility. These results indicate that the artificial rumen procedure also will be useful for predicting the nutritive value on various mixed forages.

It was concluded that the maturing of plants, represented by advancing cutting dates of first growth, induced or increased the severity of deficiencies of carbohydrates (for energy), protein, calcium, and phosphorus and this combination of deficiencies was found to markedly reduce milk production.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Suman, R. F., Woods, S. G., Peele, T. C., and Godbey, E. G. BEEF GAINS FROM DIFFERENTIALLY FERTILIZED SUMMER GRASSES IN THE COASTAL PLAIN. *Agron. J.* 54: 26-28. 1962.

In the Coastal Plains of North Carolina, 3 years' data from a grazing experiment with Coastal bermudagrass, common bermudagrass and Pensacola bahiagrass using 3 rates of nitrogen--100, 200, and 400 pounds per acre--show that beef gains per acre from Coastal bermudagrass were much higher than from the other grasses. With 400 pounds per acre of nitrogen the Coastal bermudagrass produced nearly one-half ton of beef in 1958 and 1959 and approximately 800 pounds per acre in 1960. The relationship between beef gains per acre and the nitrogen used on the Coastal bermudagrass was approximately the same at both the 100- and 200-pound nitrogen rates. Beef gain increases were less favorable, however, using 400 pounds of nitrogen.

Rotation of the Coastal bermudagrass pastures tended to increase beef gains at the 100-pound-per-acre rate of nitrogen. There were no differences at the 200- and 400-pound nitrogen rates. Common bermudagrass and Pensacola bahiagrass beef gain responses were similar.

Average daily gains were 1.39, 1.36, and 1.19 pounds for common bermudagrass, Coastal bermudagrass, and Pensacola bahiagrass, respectively. The difference did not materially affect the stocking rates or the individual animal finishes.

The crude protein percentage in the forage samples varied from over 20% in the spring to less than 10% in the fall. During the rapid growth period in May and June, Coastal bermudagrass responded most to the increasing increments of nitrogen but common bermudagrass had a higher crude protein content during the summer and fall in most cases.

S.C. Agr. Expt. Sta., Clemson Agr. Col., Clemson, S.C.

Tucker, J. M., Cordy, D. R., Berry, L. J., Harvey, W. A., and Fuller, T. C. NITRATE POISONING IN LIVESTOCK. *Calif. Agr. Expt. Sta. C.* 506, 11 pp. 1961.

Nitrates, absorbed from the soil by most plants, serve as a source of nitrogen which plants convert into proteins and other nitrogen-containing compounds. Normally functioning plants usually contain relatively small amounts of nitrate because the nitrate is converted into other nitrogenous compounds almost as soon as it is absorbed. Under certain conditions, some plants may accumulate fairly high concentrations of nitrate. While these concentrations are not toxic to the plant itself, animals feeding on such plants may sometimes suffer fatal poisoning.

Nitrate itself is not very toxic, but is readily converted into nitrite. Probably most of the conversion of nitrate to nitrite takes place in the animal digestive tract, although some field studies indicate that nitrate may already be present in the plants before they are eaten. Nitrite converts the hemoglobin in red blood cells to methemoglobin, which cannot transport

needed oxygen from the lungs to the body tissues. Animals affected with nitrate poisoning show general symptoms of oxygen deficiency.

Ruminants, particularly cattle, are the principal victims of nitrate poisoning because of the large amounts of plant material they eat and the action of microorganisms in the rumen. Sheep and swine are less susceptible.

There appear to be few recorded cases of horses dying from nitrate poisoning under pasture or range conditions. It has been demonstrated experimentally that horses can be fatally poisoned by nitrate and that the mode of action of the poison is the same as in cattle.

The symptoms most frequently observed in nitrate poisoning are depression, weakness (often appearing suddenly), rapid pulse, and respiration which is often very noisy and labored as though the animal were in great pain. Mucous membranes become dark in color. The recumbent animal may show convulsive movements of the legs. Death is due to asphyxia and in acute cases may occur within a few hours after the plant is eaten. The animals' blood is often dark and sometimes chocolate brown. The fourth stomach and the intestine are sometimes congested due to the direct irritating action of high levels of nitrate.

Cows not fatally poisoned may abort dead calves.

This circular discusses the factors that affect the accumulation of nitrates, lists plants known to accumulate nitrates, and suggests approaches to the control of losses from nitrate poisoning.

Calif. U., Davis, Calif.

Seath, D. M., Templeton, W. C., Jr., Jacobson, D. R., Miller, W. M., and Taylor, T. H.
GRAZING COMPARISONS OF TWO ALFALFA-GRASS-LADINO CLOVER MIXTURES
FOR DAIRY COWS. Ky. Agr. Expt. Sta. B. 676, 14 pp. 1962.

Four areas were used to provide two replications each of orchard-grass-alfalfa-Ladino clover and smooth brome-grass-alfalfa-Ladino clover pastures. Comparative grazing tests, using milking cows, were conducted on these plots during the 5-year period 1955-59. The results were summarized as follows:

1. Under the controlled grazing procedures followed, where the pastures were rested for 4 weeks between grazing periods, difficulty was experienced in maintaining satisfactory stands of alfalfa and Ladino clover.
2. Throughout most of the 5-year period a higher percentage of both legumes and weeds but less grass was present in the brome-grass mixture than in the orchard-grass mixture. Difficulty was experienced in securing a satisfactory initial stand of brome-grass.
3. Average yields of calculated TDN per acre were approximately equal for the two types of pasture--2,853 pounds for the orchard-grass mixture, and 2,657 pounds for the brome-grass mixture.
4. On a 4-week basis, persistency of milk production of cows not fed grain was similar for the two mixtures, cows on the brome-grass mixture averaged 89.7 percent and those on the orchard-grass mixture 86.7 percent.
5. The crude protein content of the forage dry matter averaged 21.4 percent and 20.0 percent, respectively, for the brome-grass and orchard-grass mixtures. In the same order the protein digestibility averaged 67.4 and 66.3 percent. In neither case was the difference statistically significant.
6. Almost identical forage dry matter digestibility values were found for the two mixtures--65.6 percent for the brome-grass mixture and 65.0 percent for the orchard-grass mixture.

7. Estimates of the dry matter intake per 1,000 pounds body weight averaged slightly less than 29 pounds daily for each mixture. Approximately 65 percent of the dry matter of each mixture was digestible.
8. A 2-year trial (1958-59) showed that supplemental grain feeding to cows at either the 5- or 10-pound daily level reduced intake of dry matter intake. There were, however, some increases of irregular amounts shown in persistency of milk production due to grain feeding.

U. Ky., Agr. Expt. Sta., Lexington, Ky.

Embry, L. B., Luther, R. M., and Whetzal, F. W. STUDY COMPARES DUAL SORGHUM SILAGE AND CORN SILAGE. S. Dak. Farm and Home Res. 12(3): 4-7. 1961.

Cattle and sheep feeding experiments have generally shown a higher nutritive value for corn silage than for sorghum silage. Values varying from around 65 percent to about equal that of corn silage have been reported for different varieties of sorghum silage. The type of sorghum (forage, dual purpose, or grain type) appears to be an important factor in the value of sorghum silage in comparison to corn silage. The type of sorghum is also important in the yield of silage per acre.

The influence of the proportion of grain to forage on the feeding value of sorghum silage was studied. Dual, and early grain and forage sorghum, was selected for comparisons with corn in these studies.

The authors concluded:

1. Dual grown in the same fields as corn in 1959 yielded 2,576 pounds of air-dry grain (12 percent moisture) per acre in comparison to only 1,269 pounds of grain for the corn. Total yield of air-dry forage was greater for the corn even though it yielded much less grain.
2. When the Dual silage and the corn silage were fed to steer and heifer calves on an equal dry-matter basis with equal amounts of corn grain and protein supplement, the rate of gain was 4.9 percent more for the calves fed the corn silage. Feed efficiency was slightly better when feeding corn silage, 10.3 pounds less feed per 100 pounds of grain.
3. The greater amount of grain in the sorghum silage (51.5 percent on an air-dry basis) did not result in a greater feeding value than the corn silage with a much lower amount of grain (22.5 percent on an air-dry basis). The chemical composition of the silages as fed did not indicate major differences in feeding value, but the sorghum silage was slightly higher in protein and nitrogen-free extract and lower in crude fiber. Much of the sorghum grain may have passed through the digestive tract undigested.
4. Steers gained 13.0 percent faster on 9.8 percent less feed than heifers when fed about the same amount of feed and when both were fed diethylstilbestrol.

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

Johnson, J. C., Jr., Knox, F. E., and Southwell, B. L. COASTAL BERMUDAGRASS SILAGE FOR LACTATING DAIRY COWS. Ga. Agr. Expt. Sta. Mimeo. Ser. N.S. 125, 12 pp. 1961.

A relative evaluation of corn silage and Coastal Bermuda (CB) grass silage as roughages was obtained from two double reversal feeding trials and two digestion trials using the lignin

ratio technique. Silages used in trials 1 and 2 were made in different years. For both trials liberally fertilized CB grass was ensiled when almost 6 weeks old and about 18 inches tall with 8 pounds of sodium bisulfite added per ton. Comparably fertilized corn was ensiled in the early dent stage; however, drought severely damaged the corn used in trial 1. Estimated grain yield of the corn used in trials 1 and 2 was 25 and 50 bushels per acre, respectively.

Seven Jersey cows were used in trial 1; 10 in trial 2. Digestion trials 1 and 2 included eight and four animals each, respectively.

In trial 1, daily dry matter consumption per hundred pounds body weight was 1.73 pounds with corn silage and 1.71 pounds with CB silage. Feeding corn silage resulted in a significant increase of 1.54 pounds (6.0%) in average actual daily milk production per cow over that obtained with CB silage. There was a tendency for cows fed CB silage to gain more weight than cows fed corn silage (1.9 vs. -0.1 pounds per cow per day).

In trial 2, daily dry matter consumption per cwt. was 14.5 percent greater with corn silage (2.05 vs. 1.79 pounds). Feeding corn silage as compared to CB silage resulted in a highly significant increase of 3.80 pounds (14.1%) in average actual daily milk production per cow and a highly significant increase in average daily weight gains (0.73 vs. -0.61 pounds).

On a dry matter basis the TDN content of corn silages, and CB silages, respectively, were 55.3 and 46.9 percent for trial 1 and 57.3 and 44.7 percent for trial 2. Relative differences in estimated TDN content of the silages conforms rather well with differences observed in the feeding trials.

Ga. Coastal Plain Expt. Sta., Tifton, Ga.

Mays, D. A., and Washko, J. B. CUTTING AND GRAZING MANAGEMENT FOR SUDAN-GRASS AND PEARL MILLET. Pa. Agr. Expt. Sta. B. 682, 14 pp. 1961.

Field experiments conducted in 1959 and 1960 at University Park, Pa., investigated the effect of differential cutting heights on the growth, development, and yield of sudangrass and pearl millet. Piper and Greenleaf sudangrass and Gahi 1 and Common pearl millet were planted in early June each year with zero and 200 pounds of fertilizer nitrogen per acre.

Each time the forage reached a height of 18 to 20 inches, it was cut back to 2, 4, 6, or 8 inches above the soil surface and sampled to determine dry matter yields per acre. The dried forage from the first three harvests of Piper sudangrass and Gahi 1 millet was analyzed chemically for crude protein and crude fiber content. The results of these experiments were:

1. The highest total yields of dry matter were removed from those plots harvested at heights of 2 or 4 inches throughout the season. Greenleaf sudangrass yielded slightly better when cut at 2 inches.
2. A greater number of harvests per season resulted when these species were cut at 6- and 8-inch heights, but the amount of forage removed per harvest was too small for adoption as a management practice.
3. Differential nitrogen fertilization did not change the response of sudangrass and pearl millet to different cutting treatments; however, the addition of 200 pounds per acre of nitrogen increased average forage yields by 50 to 60 percent.
4. Raising the cutting height from 2 to 8 inches decreased the crude fiber content and increased the percentages of protein and TDN in forage; however, the nutritive value of forage removed at 6 to 8 inches was not high enough to offset the yield disadvantage of these treatments.

5. The protein and TDN contents of sudangrass and pearl millet were higher at first cutting than at later cuttings.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Clegg, M. D., and Chapman, H. W. POST HARVEST DISCOLORATION OF CHIPS FROM EARLY SUMMER POTATOES. *Amer. Potato J.* 39: 176-184. 1962.

Three plots (high fertility, low fertility, and low fertility plus 120 lb. of nitrogen) were planted to potatoes using the variety Cobbler. These plots were located in the Gilcrest, Colo., summer potato producing area. Potatoes were harvested July 7, 11, 18, 25, August 1 and 8, a sample was chipped, and other tubers were placed into 50^o, 70^o, and 90^o F. storage. An injury treatment was included with July 25 harvest. At 3-day intervals over a period of 21 days, respiration, chip color, and reducing sugars were determined.

Results showed that early harvested (immature) potatoes can be held for less than 3 days before going out of condition for chipping purposes. Delaying the harvest of potatoes lengthened the period during which potatoes could be stored and still make acceptable chips.

Storage at near the soil temperature from which the potatoes were harvested seemed best. Storage at 50^o F. was detrimental for summer chipping potatoes.

Potatoes from fields with low fertility and low yields usually produced the lightest colored chips. However, this may have been due to early dying of vines and greater maturity at any given harvest date.

Mechanical injury to tubers increased reducing sugar accumulation and resulted in darker chips.

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

Anderson, R. N., Linck, A. J., and Behrens, R. ABSORPTION, TRANSLOCATION, AND FATE OF DALAPON IN SUGAR BEETS AND YELLOW FOXTAIL. *Weeds* 10: 1-3. 1962.

Radioactive dalapon (labeled with carbon- 14 in the number 2 position) was used in studies on absorption, translocation, and fate in sugar beets (tolerant) and yellow foxtail (susceptible).

Dalapon entered through the leaves and roots of both species. Dalapon moved throughout all portions of the plants of both species within 48 hours. Accumulation of dalapon was greatest in the younger tissues of both species.

No evidence of any metabolic derivative of dalapon was found in aqueous extracts of plants of either species following treatment with a tracer amount of radioactive dalapon or a tracer amount supplemented by a field rate of non-radioactive dalapon.

Jr. Author, U. Minn., St. Paul, Minn.

Anderson, R. N., Behrens, R., and Linck, A. J. EFFECTS OF DALAPON ON SOME CHEMICAL CONSTITUENTS IN SUGAR BEETS AND YELLOW FOXTAIL. *Weeds* 10: 4-9. 1962.

Dalapon was applied to sugar beets (tolerant) and yellow foxtail (susceptible). Shoots of treated and untreated plants were collected periodically for a period of 3 weeks following treatment and assayed.

Dalapon appeared to cause protein degradation in the shoots of both species. Proteins were broken down to amino acids. Further breakdown of the free amino acids with the liberation of ammonia was indicated in both species.

The amides (primarily glutamine in sugar beets and asparagine in yellow foxtail) appeared to act in ammonia detoxification by serving as storage sites for the released ammonia in both species.

The free pantothenic acid concentration in the shoots of sugar beets was decreased one day after treatment with dalapon. The free pantothenic acid concentration in the shoots of both species rose after one day following treatment with dalapon.

In sugar beets, observed recovery of dalapon-treated plants was accompanied by a general return of the concentrations of the various constituents studied to levels near those found in untreated plants. Yellow foxtail plants did not recover after treatment and the concentrations of the constituents studied generally remained at a high level compared to the untreated plants.

The similarity in initial biochemical response of the two species and the fact that sugar beets recovered may indicate that some mechanism capable of inactivating dalapon was operating in sugar beets.

Jr. Author, U. Minn., St. Paul, Minn.

Soil Classification

Wright, H. E., Jr. ROLE OF THE WADENA LOBE IN THE WISCONSIN GLACIATION OF MINNESOTA. Geol. Soc. Amer. B. 73: 73-100. 1962.

The Wadena ice lobe deposited drumlins and other glacial drift in Wadena County and adjacent parts of west-central Minnesota. The area is in the contact zone between drifts of eastern and western provenance.

The Wadena drumlin field has a fanlike form with its long axis trending southwest and a fan margin of 70 miles along 130° of arc. The fan pattern suggests ice movement from the northeast rather than from the southwest as Leverett suggested. Studies of pebble lithology and carbonate content suggest that initially the Wadena lobe moved southeastward into northern Minnesota from the limestone belt of the Winnipeg lowland, thence was diverted southwestward by the contemporaneous Brainerd lobe advancing from the east. Incorporation of Brainerd ice and debris diluted the carbonate content of the Wadena drift in the northeastern part of the drumlin field, accounting for anomalous leaching depths and pebble counts in this area.

Stone-orientation studies at 22 localities show that elongated stones have a preferential plunge in the up-glacier direction (to the northeast) at moderate angles (15° - 25°), and the writer suggests that the drumlin till was deposited by basal ice characterized by shear planes dipping up-glacier. Fabric of stones in the northeastern part of the drumlin area does not support the hypothesis that an overburden of Brainerd till covers the Wadena till.

The Wadena drumlin field, formed during the Cary subage of the Wisconsin glacial age, is truncated and buried on the east by the slightly younger St. Croix moraine (Cary?) and its outwash aprons, on the north by the Itasca moraine and its outwash (also Cary?), and on the west and south by overlap of the Des Moines-lobe (Mankato?) till and associated outwash. At its maximum the Wadena lobe may have extended south beyond Minneapolis, east almost to Wisconsin, and west to the Alexandria moraine complex (Altamont-Gary moraine of Leverett). It may have contributed a major share of ice to Minnesota during the Cary phase of glaciation but was crowded and eventually overlapped on the east by the Brainerd and Superior lobes and on the west and south by the Des Moines lobe.

U. Minn., Minneapolis, Minn.

Devereux, R. E., Robinson, G. H., and Obsenshain, S. S. GENESIS AND MORPHOLOGY OF VIRGINIA SOILS. Va. Agr. Expt. Sta. B 540, 40 pp. 1962.

General information relative to soil formation and the higher categories in classification of soils in Virginia are presented.

The approximately 300 soil series in Virginia are placed in 13 Great Soil Groups.

The Red-Yellow Podzolic soils are the most extensive and agriculturally important great group of soils in Virginia. Gray-Brown Podzolic soils, Humic Gley, and Low Humic Gley Soils, Regosols, and Lithosols are also extensive and there are lesser acreages of Reddish-Brown Lateritic soils, Alluvial soils, Organic soils, Planosols, Podzols, Rendzinas, and Brown Forest soils (acid). Alluvial soils are limited in extent but, because of their favorable surface relief and inherent fertility, are important to agriculture.

A table is presented that lists some of the more important series in the State by Great Soil Groups.

Tables, photographs, and maps.

Va. Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va.

Bowser, W. E., Milne, R. A., and Cairns, R. R. CHARACTERISTICS OF THE MAJOR SOIL GROUPS IN AN AREA DOMINATED BY SOLONETZIC SOILS. *Canad. J. Soil Sci.* 42: 165-169. 1962.

The profiles studied were from an area in which Solonetzic soils and Chernozemic soils were, geographically, closely associated. The chemical and physical characteristics of the Solonetz and Solodized Solonetz profiles clearly distinguished them from the Orthic Chernozemic soils. The B horizon of the Solonetz and Solodized Solonetz soils contained over 15 percent exchangeable sodium and had a pronounced accumulation of illuvial clay. The C horizons were quite saline, the principal salt being sodium sulphate. The geographically associated Orthic Chernozemic soils exhibited none of these characteristics. The A horizons of these Solonetzic soils were more acid than the A horizons of the Orthic Chernozemic soils. The more strongly leached profiles had morphological and chemical characteristics that were intermediate between the above two groups; some were classed as Solods and some as Eluviated Chernozemic soils.

Canada Dept. Agr., U. Alberta, Edmonton, Alberta, Canada.

Cunningham, R. L., and Drew, J. V. CHARACTERIZATION AND GENESIS OF A MOODY-NORA-CROFTON SOIL SEQUENCE IN NORTHEASTERN NEBRASKA. *Soil Sci. Soc. Amer. Proc.* 26: 191-195. 1962.

Soils of the Moody, Nora, and Crofton series are derived from loess in northeastern Nebraska. Morphologically, these soils exhibit a decreasing degree of horizon differentiation and depth to line concretions in the order Moody-Nora-Crofton. Particle size and chemical data substantiate these differences in soil development. The Moody and Nora series have been classed as Chernozems and the Crofton series as a Regosol.

The distribution of these soils on the landscape does not correspond entirely with an idealized soil-relief sequence in which the degree of soil development varies with erosion

and land surface age. Irregularities in depth to lime concretions occur in these soils, particularly in the Moody soils. Petrographic studies show marked variations in amounts of hornblende, epidote, biotite, and muscovite in these soils reflecting parent material non-uniformity. Montmorillonite and illite minerals dominate the clay fraction of these soils with some kaolinite and mixed-layer minerals, and a vermiculite-like mineral in the Moody and Nora soils developed in a loess mantle of irregular thickness overlying a highly calcareous and concretionary older loess. Crofton soil is formed in places where outcrops of the older loess occur.

Jr. Author, U. Nebr., Lincoln, Nebr.

Foss, J. E., and Rust, R. H. SOIL DEVELOPMENT IN RELATION TO LOESSIAL DEPOSITION IN SOUTHEASTERN MINNESOTA. Soil Sci. Soc. Amer. Proc. 26: 270-274. 1962.

The soils of southeastern Minnesota and adjacent areas are found to be developed mainly on loessial parent material of Wisconsin age. The origin, distribution, and some properties of the loess were studied. Loess deposition in southeastern Minnesota was found to have a general relationship to distribution of the major river valleys of the area. Measurements of loess thickness, determination of particle size analysis, and of calcium carbonate distribution provided evidence for this conclusion.

The characteristics of two loess-derived developed under forest cover were studied. The profiles were selected to represent a range in degree of horizon development. The differences in profile development appear to be largely the result of weathering time.

Jr. Author, U. Minn., St. Paul, Minn.

Tyler, L. E., Riecken, F. F., and Allen, J. S. PROPERTIES AND GENESIS OF SOILS DEVELOPED IN VERY FIRM TILL IN NORTHEASTERN IOWA. Soil Sci. Soc. Amer. Proc. 26: 275-281. 1962.

The Cresco and closely associated soil series in northeastern Iowa are known to be less productive than soils formed from similar but less firm parent materials. Lack of information on the properties and genesis of these soils has been an obstacle to assessment of production potential and formulation of management recommendations. Principal soil genesis questions are the nature, origin, and age of the components of a two-storied parent material and the degree to which each of two kinds of vegetation--trees and grass--have influenced morphology.

Basic morphological, physical, and chemical data on these soils are presented as an aid to a better understanding of the soils themselves. Two profiles each of five soil series were studied, representing a moderately well-drained biosequence, part of a prairie toposquence, and part of a transition forest-prairie toposquence. In the prairie toposquence increasing wetness is associated with increasing base saturation. Base saturation relationships suggest that trees probably have occupied all but the poorly drained sites at some time during soil formation. The degree of textural B horizon development increased with increasing evidence of tree occupancy.

SCS, USDA, Champaign, Ill.

Pomeroy, J. A., and Knox, E. G. A TEST FOR NATURAL SOIL GROUPS WITHIN THE WILLAMETTE CATENA POPULATION. *Soil Sci. Soc. Amer. Proc.* 26: 282-287. 1962.

A sample of 114 soils individuals, from Marion County, Oreg., representing the five soil series of the Willamette catena, was tested for the existence of natural soil groups. Natural soil groups are those separated by minima in frequency distributions of single or combined soil characteristics.

Eighty-five morphological, chemical, and physical properties were quantitatively measured on each individual. Frequency distributions were tabulated for each property and examined for the presence of minima. Frequency distributions for depth to evidence of impeded drainage, cation-exchange capacity of the B₂ horizon, and exchangeable magnesium of the B₃ horizon showed minima.

Discriminant function analysis was used to test the combined differentiating abilities of several selected characteristics. Minima were observed in frequency distributions for those combined functions which included a differentiating characteristic. The natural groups separated by these minima corresponded to the recognized soil series.

Jr. Author, Oreg. Agr. Expt. Sta., Corvallis, Oreg.

Finney, H. R., Holowaychuk, N., and Heddleson, M. R. THE INFLUENCE OF MICROCLIMATE ON THE MORPHOLOGY OF CERTAIN SOILS OF THE ALLEGHENY PLATEAU OF OHIO. *Soil Sci. Soc. Amer. Proc.* 26: 287-292. 1962.

Transect studies of soil sequences have been made across four northwest-southeast oriented valleys in southeastern Ohio. In general, soils occurring on southwest-facing slopes have an appreciably thinner A₁ and more strongly developed A₂ and B horizons than in the soils on the northeast-facing slopes. The upper solum of the soils on the southwest-facing slopes was more acid and had wider C/N ratios. The differences noted in the soils appear to be closely related to the different microclimatic regimes and associated differences in vegetation. Physical and chemical data on soils are included.

Jr. Author, Ohio Agr. Expt. Sta., Wooster, Ohio.

Lotspeich, F. B., and Everhart, M. E. CLIMATE AND VEGETATION AS SOIL FORMING FACTORS ON THE LLANO ESTACADO. *J. Range Mant.* 15: 134-141. 1962.

The climate of the Llano Estacado is characterized by low rainfall with a summer maximum, high wind velocities, moderately high summer temperatures, and moderate to low relative humidities. Winters may have frequent short periods of near zero temperature, but total snowfall is small and winters are open. An important feature of winter is the rapid change in temperature with the passage of cold fronts; variations of 50° from one day to another are not unusual. Precipitation effectiveness is low because of the high evapotranspiration stress and the convectional type rainfall. The soil seldom is wetted below 3 feet during years of normal rainfall.

Under pristine conditions, the area was covered by grassland communities of simple floristic composition. Evidence suggests the possibility of a coniferous forest during pluvial intervals which, in the past, have alternated with periods of aridity. Local conditions caused by soil texture and topographic control of precipitation effectiveness result in several variations of the climax vegetation. Roots penetrate to a shallower depth on the Pullman soil but

to a greater depth on the sandier soils of the Amarillo series, reaching a maximum on the dune sands of the Tivoli series.

Although the aerial portions of the climax grass species seldom exceed 1-1/2 feet in height, the roots are extensive and extract moisture from large volumes of soil. The extensive ramification of the root system tends to dry the soil to permanent wilting percentage rapidly after a rain and to improve the structure and permeability of the soil. This through permeation by grass roots contributes to the deeper distribution of organic matter of the soil without actual movement of the organic matter after mineralization. Since water is lacking, the intensity of soil forming processes is reduced because of the low precipitation which falls during the time of year when climax vegetation is removing moisture at a maximum rate.

SWCRD, ARS, USDA, Bushland, Tex.

Heerwagen, A., and Aandahl, A. R. UTILITY OF SOIL CLASSIFICATION UNITS IN CHARACTERIZING NATIVE GRASSLAND PLANT COMMUNITIES IN THE SOUTHERN PINES. *J. Range Mangt.* 14: 207-213. 1961.

The nature of the relationship between kinds of soil and kinds of native plant communities is becoming more apparent as a result of joint field evaluations by soil scientists and range conservationists in connection with the National Cooperative Soil Survey.

Higher soil classification categories aid in making broad generalizations about extensive native plant communities. They lack the specificity needed to identify specific local areas of rangeland having potentials for producing essentially similar native plant communities.

The most meaningful correlation between kind of soil and kind of native plant community occurs at the soil type and soil phase level of differentiation.

Variations in plant communities associated with climatic gradients are best determined by comparisons of characteristic plant communities on similar soil types of closely related soil series.

Recent soil survey reports of areas including privately owned rangelands list the soils included in range sites and identify the range sites delineated by individual soil mapping units.

SCS, USDA, Denver, Colo.

Schlots, F. SOIL SURVEYS SHOW TREES' FUTURE. *Western Conserv. J.* 18(2): 36-37. 1961.

A thorough knowledge of the soils is basic to important land use decisions. Once this decision is made, the soils help determine the conservation practices needed.

A great deal of valuable soil information has been obtained for cultivated crops from the studies of soil on which they grow. Since trees live longer and sample many different climatic cycles and seasons they may furnish even more reliable information.

Today, our understanding of soil technology provides us with information which may be used to predict rates of tree growth for adapted species on land logged many years ago. The progress of applying soil technology in planning woodland use has made rapid strides in the past decade particularly in the Douglas fir-ponderosa pine areas of Washington.

Tables are now available for more than 190 different kinds of soil in the State of Washington. These are extremely useful guides to planning land-use and woodland conservation especially when soil maps are available that show the location of the different kinds of soil.

SCS, USDA, Chehalis, Wash.

Passey, H. B., and Hugie, V. K. APPLICATION OF SOIL-CLIMATE-VEGETATION RELATIONS TO SOIL SURVEY INTERPRETATIONS FOR RANGELANDS. *J. Range Mangt.* 15: 162-166. 1962.

The trend toward intensification in the use and management of rangelands requires more basic knowledge of their potential plant communities. In the absence of the potential plant community, range sites can be identified and their potential approximated through the interpretation of soil and climatic influences known to be associated with specific natural plant communities.

Methods are described for selection of areas of relict vegetation and the detailed concurrent study of soil-plant-climatic relationships on such areas. Vegetation is evaluated in terms of herbage production and species composition by weight as determined by a combination of clipping and estimation and by numerical and adjective classification of important vegetational features. Soils are classified and described according to accepted standard procedures. Specific soil characteristics are revealed through laboratory analysis. Climatic data from Weather Bureau records are supplemented by soil moisture sampling and rain gauge records on representative study locations. Topographic features, history, and other factors influencing vegetation on each study location are recorded.

Relationships between environmental influences and associated quantitative and qualitative plant community characteristics are recognized by use of association tables, scatter diagrams and statistical analysis.

Soil, plant, and climatic relationships from reliable relicts is finally tested by interpreting such relationships for other range areas for which no relicts of potential plant communities are available.

The methods outlined provide information useful to the intelligent interpretation of soil survey data and the identification of range sites. Such interpretations are essential to the planning and application of optimum programs of management and treatment for rangelands.

SCS, USDA, Salt Lake City, Utah.

Obenshain, S. S., Porter, H. C., and Devereux, R. E. SOIL SURVEY FOR URBAN PLANNING AND OTHER USES. *Va. Agr. Expt. Sta. B.* 538, 26 pp. 1962.

During the past several years soil survey information has been increasingly employed as a basis for planning the best use of land, whether it be in rural, rurban, urban, or suburban areas.

Only soil survey makes detailed soil inventories which can serve as a guide to proper soil use.

This bulletin tells of some of the uses made of a soil survey in a suburban area (Fairfax County, Va.) by: (1) County Planning Commission; (2) Health Department; (3) land assessors; (4) County School Board; (5) engineers; (6) real estate agencies; and (7) various side line uses such as: radio towers; radar stations; community houses; dwelling houses; hospitals; school houses; shopping centers; other large structures; fields for special crops (soil for upland cress production); septic tank drainage; experimental plots for grass,

various crops, and trees; planting sites for ornamentals; road building material; fill material, sand and gravel; organic materials, acid soil, and soil material for special purposes; spring developments (source of water); cemeteries; land for prospective buyers; clay materials for making tile and brick; underground water resources; and even soil for growing mushrooms.

Va. Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va.

George, J. E., Jr., and Jensen, M. C. A POWERED SOIL SAMPLING MACHINE. Wash. Agr. Expt. Sta., Sta. C. 395, 15 pp. 1961.

Soil moisture samples are still the most accurate way to obtain detailed field consumptive use information. With this procedure, numerous samples are required to make a representative measurement. It is not uncommon to drive 20 holes, each 9 feet deep with samples taken each foot, to measure one soil moisture condition of a plot.

The conventional hand methods used for taking soil samples require hard work. Samples are obtained with "Veihmeyer" type tubes. The usual hand hammers for driving the tubes weigh from 12 to 28 pounds and sampling becomes especially discouraging when the soil is hard.

A powered soil sampling machine has been designed and developed over the past 2 years to lighten the heavy work. It is designed to drive and pull Veihmeyer type tubes up to 9 feet in length. Two men can operate the machine efficiently, and it is more than twice as fast as hand sampling. Considerably more driving and pulling energy is available and the hard work of hand sampling is eliminated. In addition to driving and pulling the soil sampling tube, the machine is self propelled.

Wash. Agr. Expt. Sta., Inst. Agr. Sci. Wash. State U., Pullman, Wash.

EROSION CONTROL

Erosion Equation

Tovey, R., Myers, V. I., and Martin, J. W. FURROW EROSION ON STEEP IRRIGATED LAND. Idaho Agr. Expt. Sta. Res. B. 53, 20 pp. 1962.

The amount of erosion on steep irrigated land is directly related to the rate-of-advance, size of furrow streams, and infiltration rates of the soil. These in turn are greatly influenced by cultivation methods and soil moisture at the time of irrigation. A summary of the significant findings concerning erosion on steep irrigated land is as follows:

1. The formula, $W = (X-Y) + (X-Y) \frac{1.0}{R. S. - 1.0}$, which was used to calculate the weight of solid materials contained in the erosion samples gave accurate results.
2. There was considerable variation in the extent of erosion shown by the various cultivation and moisture treatments. The lowest erosion rate occurred in the uncultivated furrows.
3. The amount of erosion can be multiplied many times by a slight increase in the size of the furrow stream.

4. The uncultivated treatment resulted in the slowest rate-of-advance.
5. The moisture content of the soil at the time of irrigation greatly influences the rate-of-advance of furrow streams.
6. The rate-of-advance of the furrow stream and the optimum length of run can be modified by a variation of the moisture content of the surface soil and the cultivation treatment.
7. For a particular soil, the infiltration rate is affected by: (1) the moisture content of the soil at the time of irrigation; (2) the wetted perimeter of the furrow; and (3) the furrow cultivation treatment.
8. The use of a furrow shaper tends to reduce slightly the infiltration rate.
9. The difference in infiltration rates for the various moisture treatments persisted 22 hours after irrigation began.
10. There were no noticeable changes in the infiltration rates of any of the experimental plots as the season progressed.

Graphs and Photographs.

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

Wischmeier, W. H. RAINFALL EROSION POTENTIAL. Agr. Engin. 43: 212-215, 225. 1962.

Two types of distribution of rainfall erosion potential are reported. One involves geographic differences in the ability of the average annual rainfall to cause erosion. The other involves location differences in the distribution of erosive rainstorms within the year. Both greatly influence the selection of optimum erosion-control measures on a particular field, and specific data on both are needed for widespread use of the universal soil-loss equation.

Recent analysis of extensive rainfall data provided this information for the 37 States east of the Rocky Mountains. Lines joining areas of equally erosive average annual rainfall were plotted on a county-state outline map of the United States. Such lines are called iso-erodents. The erosion index which is based on the energy and maximum sustained intensity of each rainstorm and which can be mathematically evaluated from recording-raingage records. The erosion-index values recorded on the iso-erodent map are the location values of the rainfall factor in the universal soil-loss equation. If all factors other than rainfall were identical throughout the area, average annual soil losses from cultivated fields would be directly proportional to the location values of this index.

Location values of the erosion index over the 37-state area range from less than 50 to about 600. In the Mississippi Valley, the index increases more rapidly than annual rainfall as one moves from north to south. In the Ohio Valley, the increasing trend is from northeast to southwest. In the Western Plains States, the maximum increase is from west to east.

In the 9 states of the Southeast, the index ranges from 150 in northeastern Tennessee to more than 600 in the lower Gulf coastal plain. In the Northeastern States, it ranges from less than 100 in northern New York and New England to 250 in eastern Virginia. In the five Cornbelt States of the North-Central Valley, the range in the erosion index is from 125 to 250. The range in Kansas is from 90 to 250, and in Texas from 25 at El Paso to 500 at Houston.

Erosion-index distribution curves were plotted to show the distribution of rainfall erosion potential within the year in each 34 relatively homogeneous subareas of the 37-state region. These curves provide the information needed to derive values of the cropping-management factor in the erosion equation which reflect the effects of locality rainfall patterns.

The information provided by the iso-erodent map and the erosion-index distribution curves can greatly enhance the precision of field soil-loss estimates to guide farm planning for conservation of the soil. It makes possible the use of the universal erosion equation anywhere in the 37 states east of the Rocky Mountains.

SWCRD, ARS, USDA, Lafayette, Ind.

Wind and Water Erosion

Bisal, F., and Nielsen, K. F. MOVEMENT OF SOIL PARTICLES IN SALTATION. *Canad. J. Soil Sci.* 42: 81-86. 1962.

The manner in which the movement of particles involved in saltation was studied. The paths of flight of these particles while air borne were also studied.

Initiation of movement can be caused by impulsive forces generated by differences in wind velocity, and by the distribution of particles, at the soil surface. Photographs of particles in saltation show that the paths of descent are nearly straight lines with an angle of incidence of about 6 ± 4 degrees. The data suggest that constant velocity in both the forward and downward directions is attained very quickly and that these velocities remain in essentially a constant ratio for most of the downward path.

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

Lyles, L., and Woodruff, N. P. HOW MOISTURE AND TILLAGE AFFECT SOIL CLODDINESS FOR WIND EROSION CONTROL. *Agr. Engin.* 43: 150-153, 159. 1962.

In a study of the effects of moisture and tillage on a silty clay loam, and without considering residue coverage, the following conclusions were made.

1. SOIL MOISTURE: (1) Soil moisture at time of tillage has a definite effect on the size distribution of clods produced. More erodible particles and fewer large clods were found at intermediate soil moisture levels (15 to 23 percent). This is the range of moisture at which tillage is usually performed. (2) Soil moisture apparently has no measurable effect on the percentage of soil particles greater than 0.84 mm. in diameter as determined by wet sieving. And (3) the differences in clod size distribution due to moisture tend to be lost rather rapidly, especially under excessive rainfall conditions.
2. TILLAGE IMPLEMENT: (1) Type of tillage implement has a decided influence on the size and stability of the clods formed, and the differences persist longer than those due to moisture content. (2) The moldboard plow produces more clods greater than 0.84 mm. with higher mechanical stability than the one-way disk or subsurface sweep. (3) Above certain moisture contents (12 to 20 percent for the soil used) the one-way disk yields more clods greater than 38 mm., greater than 0.84 mm., and fewer clods less than 0.42 mm., with higher mechanical stability than the sweep; however, below these moisture levels the positions of the two implements are reversed. (4) The rate of breakdown after initial tillage was more rapid for the plow. (5) The order of tillage implements in relation to the percent of soil particles greater than 0.84 mm. as determined by wet sieving was plow, one-way, and sweep. And (6) other tillage operations and weathering obliterates differences occurring after initial tillage.

3. CLOD STRENGTH: (1) Clods formed at low moisture content have three to four times more resistance to crushing than those formed at higher moisture; otherwise it increases rather strongly.

SWCRD, ARS, USDA, Weslaco, Tex.

Doty, C. W., and Dendy, F. E. GOOD MANAGEMENT SAVES SOIL, WATER. Miss. Farm. Res. 25(4): 4. 1962.

Although the erosion losses from continuous corn, even with the better practices, were higher than generally accepted limits, the results of 2 years of data from 1/4-acre plots and small watersheds show that soil and water losses can be favorably modified by improved land management.

The early and dense cover provided by well-fertilized, thick stands of corn, precision graded rows that reduce the runoff to non-eroding velocities, and shredding of stalks in the fall to provide a good mulch during the fall and winter months, reduced soil loss by 50 percent and water loss by 22 percent on brown loam soils in North Mississippi.

The reduction in soil loss from improved land management can probably be attributed to three major factors: (1) Precision graded rows which carry part or all of the runoff at non-eroding velocities to the outlet channel. In the poor management areas runoff tends to concentrate in small depressions and flow directly down the slope, thus causing severe erosion. (2) The thick and rapidly growing, well-fertilized stand of corn provides a dense cover 35 to 40 days planting. And (3) residue management from the shredded stalks of the well-fertilized, high plant population corn give an effective mulch for the fall and winter months.

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

Blase, M. G., and Timmons, J. F. SOIL EROSION CONTROL IN WESTERN IOWA: PROGRESS AND PROBLEMS. Iowa Agr. and Home Econ. Expt. Sta. Res. B. 498: 276-324. 1961.

The socio-economic factors that prevented erosion control in western Iowa from coinciding with goals of erosion-control programs were studied. Information was obtained by personal interview from 138 farm operators and 49 nonoperating owners of farms in the area in 1957 in a continuing investigation of the obstacles preventing adoption of erosion-control practices and of possible remedies for these obstacles. The same sample of farms had been included in two previous studies in 1949 and 1952. Data from these three studies were used to analyze the effects of changes in obstacles to erosion control on changes in soil loss.

The average estimated annual soil loss for the sample decreased from 21.1 to 14.1 tons per acre from 1949-57. In an effort to determine why the 5-ton per acre goal of public programs in the area had not been attained in 1957. Multiple variable linear regression was used to analyze the relationships between obstacles, farm characteristics, and soil losses. The statistically significant obstacles preventing the reduction of soil losses by farm operators were: (1) Operators' need for immediate income; (2) their failure to see the need for recommended practices (custom and inertia); and (3) field and road layout of the farms.

Characteristics which explained a significant amount of variation in the estimated soil loss were: (1) Topography of the farm; (2) soil conservation district participation; (3) the operator's ability to borrow funds for erosion-control practices; (4) days of off-farm work;

and (5) recognition of the seriousness of the erosion-control problem by farm operators. While not statistically significant, the most important obstacles for nonoperating landowners were: (1) Need for immediate income; and (2) insufficient roughage-consuming livestock on tenant-operated farms.

Characteristics mentioned by nonoperating landowners which explained a significant amount of variation in estimated soil loss on tenant-operated farms were: (1) Topography; (2) expectation of owning the farm 1 year; (3) need to borrow funds to establish erosion-control practices; (4) additional acres of land owned; and (5) tenant's need for immediate income. A significant amount of variation in changes in estimated soil loss between 1949 and 1957 was not explained by changes in obstacles found to be important in 1949.

Several remedial measures were suggested. These included: (1) A refined and extended method of farm planning with follow-up planning using costs and returns information obtained through further research; (2) additional education about the seriousness of the erosion problem; (3) education of tenants and nonoperating landowners about crop- and livestock-share losses; (4) educational programs about compensation clauses in leases; (5) greater use of long-term loans to cover the initial costs of erosion-control practices; (6) additional effort to inform farm people of non-farm employment opportunities; and (7) revision of real estate tax rates based on long-term land productivity under erosion-control practices.

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

Terraces

Hauser, V. L., Van Doren, C. E., and Robins, J. S. A COMPARISON OF LEVEL AND GRADED TERRACES IN THE SOUTHERN HIGH PLAINS. *Trans. ASAE* 5: 75-77. 1962.

Each terrace type has disadvantages for controlling runoff water in a semiarid climate. A major disadvantage for graded or level open-end terraces is the necessity for field waterways to carry runoff water down the slope. Waterways are difficult to establish and maintain. A major disadvantage for level closed-end terraces on slowly permeable soil is the need for sufficient ridge height to store large volumes of runoff water on the ground surface. In some instances, runoff stored from one storm may still be in the terrace channel when the next storm occurs.

The results of this experiment indicate that level open-end terraces may be better suited to slowly permeable soils of the Southern High Plains than either level closed-end or graded terraces. Level open-end terraces could be blocked for moisture conservation or to protect a new or rebuilt waterway, or the ends could be left open to limit drowning of young plants in the terrace channel.

The authors concluded that: (1) Wheat and grain sorghum yields were almost equal for graded and closed-end level terraces under a wheat-sorghum-fallow sequence on slowly permeable soil for the 1949-60 period. (2) Level open-end terraces may be better suited to slowly permeable soils than either level closed-end or graded terraces. (3) In general, level closed-end terraces produce more sorghum grain in dry years, and graded terraces produce more sorghum grain in wet years. There is no clear trend for wheat yield in a wheat-sorghum-fallow sequence. And (4) wind and water erosion control on terrace ridges has been effected with plantings of native grass. No unusual management difficulties have been encountered with grass-covered terrace ridges.

SWCRD, ARS, USDA, Bushland, Tex.

McCool, D. K., and Beasley, R. P. TERRACE CHANNEL DESIGN USING THE SPATIALLY VARIED FLOW AND TRACTIVE FORCE THEORIES. Mo. Agr. Expt. Sta. Res. B. 778, 32 pp. 1961.

The recent interest in improving terrace channel alignment has made it advisable to reconsider the constant grade terrace channel design widely used at present. The limiting velocity concept has been applied to terrace channel design by the use of a uniform flow step routing method. However, there are inherent inaccuracies when applying this method to terrace channels in which discharge varies with distance and in which the channel gradient may not be constant. It was desired that a more correct approach be made to the problem of selecting the maximum terrace channel gradients safe against erosion in any given reach of a channel on a given soil. The spatially varied flow theory was chosen to consider the effect of changing grade and increasing discharge upon the flow profile. The tractive force theory was chosen to evaluate the erosive force of flowing water under a given flow profile. As a preliminary to development of a new method of design, terrace channels were designed by the limiting velocity and constant grade methods and the maximum tractive force on each length of the channel was determined. The manner in which maximum tractive force varied from lower to upper end of the channel for each design was noted.

A new method of design was developed whereby the tractive force theory was used in combination with the spatially varied flow theory to select maximum terrace channel grades under conditions of changing grade and increasing discharge. Two typical terrace channels were designed for a wide range of inflow and tractive force conditions. An electronic digital computer was used to perform the computations involved in the solution of the problem.

Tables, graphs, and maps.

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

Critical Areas

van't Woudt, B. D., and Uehara, G. EROSION BEHAVIOR AND CONTROL ON A STRIP-MINED LATOSOLIC SOIL. Hawaii Agr. Expt. Sta. Tech. B. 46, 36 pp. 1962.

Soil erosion and its possible control after stripmining were studied on an aluminous Humic Ferruginous Latosol during a 2-year period, when average rainfall conditions prevailed. The study was carried out in plots, 8 x 80 feet, to which various surface treatments were applied. Erosion was very small on surface-protected soil but 20 times as high on unprotected, compacted soil (compacted by the use of heavy machinery in stripping).

Surface soil replacement on subsoil substantially reduced erosion because of: (1) The high structural stability of the surface soil; (2) its high infiltration rate; and (3) scarification of subsoil prior to surface replacement. A decision on whether or not to replace surface soil should be guided by economics.

Field observations led to the following conclusions: (1) Stripmined soil should be graded to even slopes, preferably not exceeding 5 percent. An abrupt change in slope leads to channeling of surface runoff and consequent gullying of the soil. (2) Subsoil exposed after stripmining should immediately be scarified by plowing, disking, or rotary-hoeing, to offset compaction in the surface few inches of soil induced by the use of heavy equipment. (3) Surface drainage should be provided for immediately after the stripping and grading have been completed. Wide and shallow, semicircular surface drains, laid on a grade of

approximately 4 percent are needed. Six-inch boiler pipe (or equivalent pipe) can conveniently be used as culverts to cross access roads. Discharge of runoff water should be on naturally vegetated valley slopes only. (4) Bagasse applications can be made under certain conditions to quickly combat an erosion hazard. Bagasse is effective when applied in patches, allowing simultaneous establishment of a vegetative cover. And (5) various types of reestablished vegetative covers are efficient for erosion control. The establishment of vegetative cover requires heavy fertilizer applications and a combination of slow and fast growing plant cover.

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

Rosenberg, M. M. THE DEAN'S REVIEW: RECLAMATION STUDIES ON STRIPMINED SOILS--A SPECIAL REPORT. *Hawaii Farm Sci.* 10(1): 1-12. 1961.

This issue of the *Hawaii Farm Science* is devoted exclusively to the publication of research conducted by Hawaii Agricultural Experiment Station scientists on the reclamation of land rich in bauxite that had been stripmined. Four station projects were initiated in the areas of agronomy, erosion, soil fertility, and soil physics. Seventeen reports have been prepared resulting from these investigations. These studies will continue for several more years.

Most of these studies have been reported in technical journals. It was decided that an issue of the *Hawaii Farm Science* be devoted to this subject to provide wider distribution and better understanding of the results reported to date.

The following lists the authors and title of the papers presented:

1. Sherman, G. D., Uehara, G., and Ikawa, H. THE PROBLEMS OF BAUXITE MINING IN HAWAII.
2. Takahashi, M., Moomaw, J. C., and Sherman, G. D. CROP PRODUCTION TRIALS ON STRIPMINED FLOOR SOIL SHOW PROMISE.
3. Younge, O. R. FERTILITY REQUIREMENTS OF BAUXITE STRIPSOIL FOR CROP PRODUCTION.
4. Plucknett, D. L. ROOT GROWTH IN BAUXITIC SOILS.
5. van't Woudt, B. D. EROSION CONTROL ON STRIPMINED LAND.

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

Lowry, G. L., Brokaw, F. C., and Breeding, C. H. J. ALDER FOR REFORESTING COAL SPOILS IN OHIO. *J. Forestry* 60: 196-199. 1962.

A field survey of black and speckled alder growing on Ohio coal spoils indicated a rather wide range of soil and other site conditions upon which these species will survive and grow well. The most important deterrents to good growth and survival were believed to be the result of excessive competition from herbaceous vegetation, overtopping by associated black locust, or extremely acid sites. Although their ability to stabilize steeply inclined spoil areas is not quite as good as black locust, the economic return anticipated in the form of posts, pulpwood, or small sawtimber will be, in future years, far greater than black locust. As a companion species in mixed hardwood plantings, both species appeared to be superior to locust since overtopping of other tree species by alders was not serious. This, together with their nitrogen-fixing abilities, would indicate a very promising future for the alders. From the excellent growth noted in this preliminary investigation, similar results would be expected in other parts of the bituminous coal producing region. Climatic and other

site factors encountered were not markedly different from those conditions found in other nearby states. It is anticipated that the use of these or other suitable alder species could largely replace black locust in future spoil bank planting. Additional research is needed for precise species site recommendations.

Jr. Author, Ohio Reclaim. Assoc., Cambridge, Ohio.

SOIL MANAGEMENT

Cropping Practices

Dacus, A. D., Gerard, C. J., Burleson, C. A., and Tayloe, S. D. EFFECT OF ANNUAL GREEN MANURE CROPS AND FERTILIZER PRACTICES ON THE PRODUCTION OF COTTON, LOWER RIO GRANDE VALLEY. Tex. Agr. Expt. Sta. Prog. Rpt. 2196, 4 pp. 1962.

Cotton was grown in rotation with several annual cover crops and winter fallow, and with different fertilizer practices. Cotton yields were increased by nitrogen fertilization. Phosphorus failed to increase yields appreciably whether applied to the preceding green manure crop or immediately before the cotton was planted. Plots receiving nitrogen had a significantly lower cotton root-rot-infestation than those which received no nitrogen.

Although not significant, for the 3 years of the study (1958-60) cotton following oats yielded an average of 58 and 80 pounds of lint per acre more than cotton following Hubam clover and winter fallow, respectively.

There was a high degree of correlation ($r = +0.82$) between the yield of cotton and the percentage of cotton root-rot infestation. The regression of yield on root-rot infestation showed that for each 1-percent increase in root-rot infestation, the loss in cotton yield was 6.6 pounds of lint per acre.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Owen, W. L., Jr. INTERRELATIONS AND CONTROL OF INSECTS ATTACKING LEGUMES AND COTTON. Tex. Agr. Expt. Sta. MP-570, 7 pp. 1962.

The insect populations that transfer to cotton from a legume (alfalfa), planted in a cropping system, were studied in the High Plains of Texas. The effects of management practices on insect infestations with attendant damage to legumes and to cotton, including the results of chemical control tests on both crops were included.

Lygus bugs were the only insects which were a problem on both alfalfa and cotton. Infestations and damage varied greatly during the study. Damage to alfalfa ranged from a slight reduction in florets to destruction of most flower buds, while seed damage ranged from a small percentage of shrunken seed to destruction of practically the entire crop. Large squares, small bolls, and plant terminals of cotton were attacked by the insects. The injured small bolls were shed, while the larger bolls remained and produced poor quality lint.

Lygus bugs did not develop large and destructive populations on alfalfa where hay cuttings were made before heavy blooming and seed production. Heavy infestations appeared on the seed crop at times.

The time of seed sets in alfalfa markedly influenced the degree of insect hazards to cotton. Damaging numbers of lygus bugs did not develop in the alfalfa fields where one or two hay cuttings had been made before the crop was left to produce seed, or until late August after cotton had produced a crop. Lygus bugs developed in alfalfa fields where seed were produced early, thus subjecting cotton to attack by large populations of the migrating insects. Damage to cotton growing in the vicinity of early-maturing legume seed crops was much greater than that to crops growing adjacent to alfalfa which produced a seed crop later in the summer.

Lygus bug infestations on cotton near the legume hay crop were seldom greater than on cotton well removed from alfalfa. Under conditions of light insect infestations, cotton near the seed-producing legume attracted smaller numbers of insects than those on occasional plantings which were well removed from the seed-producing alfalfa.

Small-plot control experiments showed 5% DDT, 3% BHC--5% DDT, 3% BHC, and 10% toxaphene dusts and toxaphene spray applications resulted in effective control of lygus bug infestations on cotton. Yields were increased 90 to 150 pounds of lint per acre with one and two applications.

In a large-scale field test, three applications of 10% toxaphene dust to heavy infestations on cotton early in the season resulted in a yield increase of 483 pounds of lint per acre over an adjacent untreated planting.

In a field-scale experiment on alfalfa heavily infested with lygus bugs, two applications of 10% toxaphene dust resulted in a yield of 436 pounds of seed per acre, while untreated alfalfa produced no seed.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Downs, D. B., Jacobson, H. G. M., and Waggoner, P. E. ROTATIONS, ORGANIC MATTER, AND VEGETABLES. Conn. Agr. Expt. Sta. C. 220, 16 pp. 1962.

The growing of two crops of vegetables each year, year in and year out, is a common practice on the limited acreage of Connecticut soils suitable for truck gardening; this clean cultivation of two crops each year seems extremely exhaustive for the soil. For 8 years early spinach and late cabbage were grown continuously on the commercially fertilized Cheshire fsl of the Lockwood Farm in Mt. Carmel and compared to the vegetables grown in five rotations where green manure was plowed into the soil.

The carbon and nitrogen content of the soil decreased during the 8 years of continuous vegetable growing. After transforming the data into logarithms to equalize variability, one finds that the carbon in the soil decreased a significant 9 percent (of the 1953 level) between 1953 and 1960. The nitrogen in the soil decreased a highly significant 20 percent (of the 1953 level) during the 8 seasons.

The yield of spinach increased 14 times, was unchanged 4 times, and decreased twice under rotation. Only three of these changes were significant.

The yield of cabbage increased 14 times, was unchanged 6 times, and never decreased under rotation. Nine of these changes were significant. No particular rotation was particularly beneficial; all occasionally proved beneficial. The 4-year rotations, that were particularly effective in 1960 in increasing both nitrogen in the soil and spinach yields, were not outstanding in their benefit to the later cabbage of that season.

The cause of increased yield following rotation has not been clearly established by any of the observations. Carbon, nitrogen, and aggregation of the soil all failed to be correlated with yield. A clue to the cause can be seen in the high nitrate concentration of spinach grown following rotation, which indicates a more luxurious nitrogen supply for this spinach than for the spinach grown on soil continuously planted to vegetables. Further, the observed 1 to

2 percent increase in the available moisture storage capacity added a 1- to 2-day supply of moisture for the plants and was certainly beneficial.

The changes in the quality of the vegetables were small and furnished scant basis for discussion.

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

Utter, H. D., and Justus, F. E., Jr. DETERMINING MAXIMUM NET RETURNS FOR CROPPING SYSTEMS ON MARSHALL SOIL USING LINEAR PROGRAMMING. Mo. Agr. Expt. Sta. Res. B. 780, 45 pp. 1961.

The selection of an optimum plan for each of the 24 problems considered was achieved by using the simplex technique of linear programming. The problems considered were developed for a model farm with specified sets of conditions. These conditions were: (1) Three methods of performing farming operations, up and down hill, contouring, and terracing; (2) two price assumptions, one with all grain sold at an expected market price, and the other assuming part of the grain was fed to livestock at a price 10 percent higher than the expected market price; (3) varying percentages of slope for each of the methods of performing farming operations; (4) a land restriction of 200 tillable acres with an average length of slope of 300 feet; (5) restriction of hours of monthly labor for May, June, July, September, and October; and (6) the basic assumptions of linear programming.

The model farm of 200 tillable acres was developed from survey data obtained from 65 farmers on Marshall soil in Lafayette County. Secondary data were used to supplement the survey data in determining the linear programming coefficients.

Farmers estimated average crop yields, operating costs, and hours of needed labor to be higher for terraced land than nonterraced land. The average yield for corn on terraced land was estimated to be 15 bushels per acre greater than for nonterraced land. The amount of labor used was estimated to be higher for all crops except soybeans.

The feasibility of a rotation to be considered in the linear programming was determined by using soil erosion factors which state soil loss in tons per acre per year. Any rotation with an annual soil erosion loss greater than 5 tons per acre for the specific percent slope and erosion control measures was not considered feasible. The optimum plans determined were those rotations or combinations of rotations which maximize annual net returns for the specific land and labor resource available.

The results of the analysis of optimum plans showed an inverse relationship between slope, intensity of land use, and annual net returns. This was true, whether the land was terraced, contoured, or farmed up and down hill.

Terracing, and contouring to a smaller extent, has the effect of reducing the effective slope of the land. Slope had no effect on net return on terraced land of 6 percent or less slope, but a definite decline in net returns resulted between 6 and 8 percent slope. This was the critical slope on terraced land. On contoured land, the critical slope was between 2 and 4 percent.

Net returns from the optimum plans on terraced land were more than double the net returns on nonterraced land of comparable slope. The net returns from optimum plans on contoured land were somewhat higher than on land farmed up and down hill. The increase in net returns was small compared to the increase obtained by terracing.

The marginal value of product and the restricting resource varied among the optimum plans. The marginal value of products indicated that additional land and monthly labor would be profitable in the specified plans in which these resources were restricting. In plans

where land and labor were both restricting the optimum plan, the addition of more units of either or both resources would increase net returns.

Tables and graphs.

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

Wilson, J. D. CROP ROTATION HELPS MINIMIZE INFECTION BY POTATO SCAB. Ohio Farm and Home Res. 47: 4-5. 1962.

The casual organism of potato scab Actinomyces scabies is widely distributed throughout the potato growing areas of Ohio. It frequently causes a considerable crop loss, especially in highly organic (muck) soils. In some instances, where potatoes are grown too frequently on the same land in muck areas, from 50 to 90 percent of the tubers may be rendered unfit for use by the closely spaced lesions of the disease.

The disease is commonly most destructive in soils of alkaline reaction and of high organic content. The use of acid fertilizers and the avoidance of manure are frequently recommended to reduce scab infection where potatoes are being grown in upland (mineral) soils. Infection may become severe in muck soils that have a reaction as low as 5.0 on the pH scale. Various chemical compounds have been recommended for treating the soil to reduce infection of the newly forming tubers, but most of these materials are too costly for use on muck soils, where the application rate must be doubled over that recommended for mineral soils, to obtain a comparable degree of control, and even then they may not be too effective in checking the disease.

In 1957, an experiment was initiated at the Muck Crops Substation at Celeryville on the control of soil-borne diseases, including nematodes, of vegetable crops. Each of the six vegetables (carrot, celery, potato, onion, lettuce, and radish) are now being grown in continuous culture and in various rotations.

The data obtained, in the first 5 years of this experiment indicate that potato scab is one disease that can be greatly reduced in severity below that which may occur in continuous culture by interposing other commonly grown, but not susceptible, vegetables in a 4-year, and even a 3-year, rotation. A 2-year rotation did greatly reduce infection below that present on the tubers produced in the plot planted to potatoes each year, but the percentage of those showing scab lesions was still too high to permit their sale in the usual trade channels.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Thatcher, L. E., and Willard, C. J. CROP ROTATIONS AND SOIL PRODUCTIVITY. Ohio Agr. Expt. Sta. Res. B. 907, 80 pp. 1962.

A report of the Fry Farm rotations, the Five-year Rotation Corn-Agronomy Experiment No. 1, and Continuous Corn Culture-Agronomy Experiment No. 2, at the Ohio Agricultural Experiment Station are given. Some of these rotations were started in 1894. The discussion and conclusions from several bulletins giving some principles of crop rotation on silt loam, silty clay loam, and clay soils in Ohio are presented.

"H" or "hay" was used rather than any specific legume or mixture. This hay in practice should be the most desirable mixture for the particular soil and the use for which planned. In Ohio it should include at least one legume, partly alfalfa if the soil permits, and

necessarily alfalfa if profitable hay is to be had for more than one year, and one grass, timothy, smooth brome grass, or orchardgrass.

Recently, strident voices have been raised declaring that rotations are out-of-date or unnecessary. The alternative, of course, is continuous cropping to a high value crop or crops, using heavy fertilizer applications.

These experiments were planned on the assumption that nitrogen could not profitably be purchased for field crops. Some belated attempts were made to apply enough fertilizer for continuous corn.

Rotation is usually desirable when both grain and roughage for livestock are to be produced on one farm. Insects, plant diseases, and weeds may compel rotation and have often done so, but chemical methods of controlling these pests are steadily reducing that compulsion.

For soil conservation, the first situation in which rotation is essential is on sloping lands. Any overcropped soil can be reclaimed, if the soil is still there; but with our rainfall pattern, continuous cultivated crops on sloping soils are an invitation to land ruin. On considerably sloping lands, 6 to 8 percent slopes and above, the continuous cropping should be of sod crops.

For strip cropping on steep slopes in Ohio, it is hard to find a rotation better than C-W-H-H. By proper selection of the stripped areas, half the land can be pastured after the wheat is harvested without fencing the separate strips. Certainly, one year in four is as often as one can permit intertilled crops on 5 to 6 percent slopes.

On the broad, nearly level areas which in Ohio and the Midwest produce most of the grain, continuous corn or grain is feasible for a long time--indefinitely on some soils. The unanswered question concerning rotation versus continuous cropping is the effect of continuous cropping on the physical structure of heavy soils. Without heavy fertilization, we have abundant evidence of the disastrous effects of continuous cropping on heavy soils.

Experimentally we have not produced in continuous cropping as large corn yields as in a rotation with alfalfa, red clover, or sweetclover, but long-time heavy fertilization tests are lacking. The present tentative answer would be that the more clay there is in the soil, the less feasible is continuous corn over a 10- to 100-year period. On some fine sands, silts, and silt loams with a low proportion of clay it seems that continuous corn is entirely feasible.

Continuous corn can be produced on clays or heavy silty clay loam soils as long as it is economically profitable without permanent injury, provided the soil itself stays in place. The physical condition of soils injured by over-cropping to row crops can be brought back by greater use of the same grass-legume mixtures which would have prevented their breakdown.

All successful rotations follow the general order cultivated crop--small grain--hay or forage. Attempts to go direct from cultivated crop to forage crop have been unsuccessful except for cover and green manure use, where frequent mediocre results can be tolerated.

The use of 2 to 4 tons per acre of manure, the strawiest available, on wheat any time before sowing legumes is one of the best ways to improve legume stands and yields after wheat.

Sweetclover is unexcelled as a catch crop to accumulate nitrogen after a small grain crop. Sweetclover will produce as much corn as 6 tons of manure per acre or commercial nitrogen up to 100 pounds per acre.

At present prices of nitrogen, we cannot afford to use an entire crop year just to fix nitrogen from the air, but the livestock producer, by growing large crops of legume hay, feeding it profitably, and hauling out the manure, can increase his grain yields more economically than anyone who depends entirely on the fertilizer sack.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Dryland rotation studies consisting of 25 treatments were conducted at Lubbock, Tex., in 1914-40, and a modified study of 11 treatments continued through 1949. Data from these experiments showed the following: (1) Continuous cotton produced better economic returns than any of the other cropping systems. (2) Fallow, green manure or barnyard manure had some beneficial effects on cotton and grain sorghum yields. Their use was not justified because of cost of material and application and the loss of alternate production years. (3) Cotton in rotation with grain sorghum produced slightly less than cotton grown continuously. (4) Higher average production of continuous cotton and continuous grain sorghum during 1941-49 than in 1941-40 suggests no serious effect on soil productivity. Improved varieties and better cultural practices could not be evaluated properly. (5) Chemical evaluation of soil samples collected in 1928 indicated a greater depletion of nitrogen from soils under continuous grain sorghum than under continuous cotton. (6) In general, total rainfall may have limited cotton and grain sorghum production, but date of planting, rainfall distribution and frost dates were almost equally important in determining yields. (7) Grain sorghum was affected more by moisture distribution than was cotton. And (8) climatic factors had a greater influence on crop production than cropping sequence, fallow, green manure, or barnyard manure. This suggests more fruitful results from efforts to conserve moisture and control erosion than from procedures to improve soil fertility.

Crop yields are not the only factors to consider in evaluating rotations for dry-farming areas. Distribution of labor, control of wind and water erosion, influence on physical properties of the soil, reduced risk and better control of diseases, weeds, and insects also are pertinent. These factors could not be evaluated properly in this study.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Fulton, N. D. CULTURAL METHODS TO CONTROL VERTICILLIUM WILT OF COTTON. Ark. Farm Res. 10(5): 3. 1961.

Among the cultural methods found to aggravate wilt was deep cultivation to control weeds. Setting cultivation equipment deep enough to cut the roots of cotton plants, especially late in the growing season, resulted in more disease and reduced yields even in years when the wilt was relatively unimportant. Cutting the roots not only increased Verticillium wilt, but also reduced moisture and nutrient supplies to the root systems.

There were minor differences in the incidence of wilt among the various rotations where cotton was not grown continuously. Introducing any crop other than cotton in a rotation will reduce the disease substantially in the cotton crop that follows it. The continuous cotton and the two vetch-cotton series all resulted in a high level of disease year after year.

Best disease control was in such sequences as the 3-year soybean-wheat-cotton rotation. Where cotton was alternated with sweet clover, alfalfa, lespedeza, corn, or fallow the disease was held in check well. Where cotton was grown two or more years before another crop was introduced, the wilt incidence rose each successive year cotton was grown.

Ark. Agr. Expt. Sta., U. Ark. Div. Agr., Fayetteville, Ark.

Hoytville soil is highly productive when adequately drained. This conclusion is based on a detailed study of crop yields and production practices found on 100 farms in Wood County, Ohio, for 1955 and 1956.

For the 2-year period, the best-drained group of farms produced 28 percent more corn, soybeans, and oats, and 12 percent more wheat per acre than the poorest drained group.

Corn yields were affected more by drainage than by any other single factor. Average annual value of the crops from a rotation of corn, soybeans, oats, and meadow was calculated to be about \$9.80 per acre more from the best drained than from the poorest drained land. A small amount of this difference might be attributed to better management. If all of the additional net income were capitalized at 5 percent, a landlord owning poorly drained land could afford to invest about \$70 an acre in additional drainage installations. An owner-operator might be able to justify a higher investment.

Profits from fertilizer were influenced by adequacy of drainage. Above average drained land produced greater profits from a given amount of fertilizer than below average drained land. Except on the best drained farms, applications of fertilizer on corn did not pay when all of the fertilizer was charged against the crop to which it was applied. Since Hoytville soil is high in natural fertility, response from fertilizer usually was small unless other growth-producing factors were favorable.

Farmers on Hoytville soil found it difficult to follow a given rotation. Few were able to avoid deviations in some years. Most of them attributed this situation to unfavorable weather at time of planting and to government control programs for corn and wheat. The cropping programs followed had little effect on the yields of soybeans, oats, or wheat. But corn yields were about 100 percent higher when a mature meadow was plowed under instead of a green manure crop.

Net income figures showed that the most profitable rotation was corn, soybeans, and wheat with a green manure crop grown in the wheat and plowed under the following spring for corn. The following rotation ranked next in profitability and produced about the same net income per acre: Corn, corn, soybeans, wheat, and meadow; corn, soybeans, soybeans, wheat, and meadow; and corn, soybeans, wheat, and meadow. Rotations with oats were not as profitable as rotations with wheat.

When hay was harvested and sold for \$15 a ton, net income was about the same as when no meadow growth was harvested as hay or pasture. Hay would have to be sold for about \$27 a ton at the farm to make a rotation of corn, wheat, and 2 years of meadow as profitable as corn, soybeans, wheat, and 1 year of meadow.

Most farmers on Hoytville soil raise a high percentage of grain crops because markets for hay are generally poor and only enough livestock is kept to consume a few acres of forage. About 45 percent of the farmers reported no livestock of any kind.

Although a high proportion of grain crops have been raised on Hoytville soil during recent years, yields would indicate that productively has not declined greatly. During the 30-year period, 1928-57, corn yields for Wood County increased at an average rate of 0.80 of a bushel per year. For the State of Ohio, the annual increase averaged 0.89 of a bushel per acre for the same period. For the state as a whole, higher corn yields may be partially due to a reduction in the acreage grown on the poorer land.

Ashton, F. M., Harvey, W. A., and Foy, C. L. PRINCIPLES OF SELECTIVE WEED CONTROL. Calif. Agr. Expt. Sta. C. 505, 20 pp. 1961.

The cost of weeds to the American farmer is estimated at 5 billion dollars annually. Losses in California alone have been estimated at 1 million dollars per day. In certain crops the losses due to weeds can exceed \$100 per acre. In many crops these losses can mean the difference between success and failure to the grower.

Selective chemical weed control uses a herbicide to control weeds in a crop without injuring the crop. The chemical "selects" the weed and destroys it because of either a quality inherent in the herbicide or because of the way a nonselective herbicide is used. Selectivity is relative; it depends on proper use of the herbicide. It will work only within a given range of concentration of the herbicide and under particular conditions.

These authors explain: The principles of how herbicides are used on foliage and soil; indicates how herbicides work selectively to kill weeds while keeping crops alive; and suggests how to apply selective herbicides. A glossary of terms used in selective weed control and a list of free publications on weed control are included.

U. Calif., Davis, Calif.

Wiese, A. F., and Rea, H. E. FACTORS AFFECTING THE TOXICITY OF PHENOXY TO FIELD BINDWEED. Weeds 10: 58-61. 1962.

Research from 1953-59 at the Southwestern Great Plains Field Station, near Amarillo, Tex., indicated that 2,4-D was the most effective phenoxy herbicide for field bindweed control. Under good growth conditions, formulation of 2,4-D did not affect toxicity to bindweed, but when growth conditions became less favorable, low volatile ester formulations were usually most effective. When growing conditions were good, 1/2 pound per acre of 2,4-D was as effective as higher rates. However, as growth became less vigorous, 1 pound per acre usually gave maximum bindweed control. Temperature and humidity conditions at various times of the day did not affect 2,4-D toxicity to bindweed. Favorable growing conditions were defined as having at least 1.5 inches of available moisture in the soil profile at the same time bindweed runners were from 6 to 10 inches long. Over a 3-year period, when these conditions occurred, 64% was the minimum control obtained with one application of 2,4-D. With good soil moisture when bindweed runners are 6 to 10 inches long, total carbohydrates were high in the leaves and low in the roots. Soil moisture and percentage total carbohydrates in bindweed tops and roots were responsible for 78% of the variability in bindweed control obtained from applications of 2,4-D. Probabilities calculated from Amarillo, Texas rainfall records indicate that, in semi-arid areas, applications of 2,4-D to bindweed about the end of May should give 50% or more control 54% of the time. If tillage is used to prevent annual weeds and unthrifty bindweed plants from utilizing soil moisture, effective use of 2,4-D should be possible 86% of the time.

SWCRD, ARS, USDA, Bushland, Tex.

Trevett, M. F., and Murphy, H. J. A GUIDE FOR THE USE OF CHEMICAL WEED KILLERS IN 1962: WEED CONTROL IN VEGETABLES, SMALL FRUITS, FIELD CROPS, AND TURF. Maine Agr. Expt. Sta. Misc. P. 652, 41 pp. 1962.

Recommendations based on experimental work at the Maine Agricultural Experiment Station and on the latest report on the Research Coordinating Committee of the Northeastern Weed Control Conference are given for 32 different herbicides. Recommendations are given for weed control in vegetables, small fruits, field crops, and turf.

Maine Coop. Ext. Serv. and Maine Agr. Expt. Sta. Orono, Maine.

Banting, J. D. THE DORMANCY BEHAVIOR OF AVENA FATUA L. IN CULTIVATED SOIL. *Canad. S. Plant Sci.* 42: 22-39. 1962.

Recovery of dormant, non-dormant, and dead wild oat seeds and seedling emergence from naturally infected Regina heavy c-soil was used as a measure of viability during 5 years of consecutive summerfallow subsequent to 13 years of continuous cropping.

Percentage viability and dormancy corresponded closely throughout the first summerfallow period. By season's end, 33 percent of the seeds were viable but mostly dormant. It was concluded that persistence was due primarily to seed dormancy and not lack of germinative conditions.

Numerous seedlings emerged the following spring until early June when viability averaged 4 percent. The potential value of delayed seeding methods of control was indicated clearly at this time. Persistence of seeds in the soil in the second and two succeeding summerfallow years was attributed largely to primary seed dormancy. Lack of moisture and oxygen contributed temporarily. There was little or no evidence of secondary dormancy induction under field conditions. Neither moisture nor oxygen supply appeared to seriously reduce total emergence in adjoining cropland. It was concluded that wild oats could be "grown out" equally well in a 2-year rotation of alternate crop and summerfallow as by means of 2-years of consecutive summerfallow if re-infectation was prevented during the crop year.

Inhibition of germination of surface seeds, presumably by light, did not markedly prolong persistence of viable seeds in the soil. No viable seeds were found on the surface after June of the third summerfallow year.

Results indicated that a minimum of 5 years is needed to eliminate wild oats from heavy clay soils under cultivation.

Canada Dept. Agr. Regina, Saskatchewan, Canada.

Finnerty, D. W., and Klingman, D. L. LIFE CYCLES AND CONTROL STUDIES OF SOME WEED BROMEGRASSES. *Weeds* 10: 40-47. 1962.

In the greenhouse, either vernalization or an inductive period of about 1 month's exposure of plants to short days (photoperiod), followed by exposure to long days, was necessary for panicle production by downy brome (Bromus tectorum L.) or hairy chess (B. commutatus Schrad.).

Downy brome, hairy chess, Japanese chess (B. japonicus Thunb.), and cheat (B. secalinus L.) usually were winter annuals at Lincoln, Nebr. Seeds of downy brome, hairy chess, and Japanese chess sown after April 1 normally did not produce plants that headed in the same year. Cheat did not head in the same year when planted during mid-March or later. Vernalized seeds of all species, even when planted in the field after April 1, produced plants which headed in the same year.

Spring sowing (after April 1) of smooth brome (B. inermis Leyss.) seed known to be contaminated with seeds of weed brome grasses was more advantageous than fall sowing.

A management system was proposed for control of weed brome grasses in winter wheat fields.

The most effective date of mowing for control of hairy chess and downy brome was about one week after the heads had emerged from the sheath.

Effective control of weed brome grasses was accomplished by CIPC, IPC, monuron, TCA, endothal, DNAP, and mixtures of these herbicides.

Jr. Author, CRD, ARS, USDA, Beltsville, Md.

A positive approach to the control of weeds in turf calls for emphasis on practices that increase the vigor of the turf grasses. Although herbicides alone can be used to control many weeds, most effective weed control is achieved when herbicides are used to supplement good management practices.

Several pre-emergence crabgrass killers have provided good seasonal control of crabgrass in Connecticut with little or no injury to established turf grasses. Each of the herbicides has its limitations; none has produced in all situations 100 percent control of crabgrass with no injury to turf. Some (the arsenicals) are more hazardous for use around the home than others. At the present time zytron and dacthal look most promising, but good results also have been obtained with calcium arsenate, diphenatril, bandane, and dipropalin, the latter two in limited trials. Except at rates higher than those suggested on the herbicide labels, chlordane and Pax have not provided consistently good control of crabgrass.

Although a few pre-emergence herbicides are safe to use on seedling turf grasses, no herbicide has effectively controlled crabgrass when applied on bare ground at the time of seedling.

Some pre-emergence crabgrass killers, particularly zytron and calcium propyl arsonate, are effective when applied on crabgrass in its early seedling stages. Several other herbicides, which control only emerged crabgrass, must be applied two or three times during a season for good results. These include DMA, AMA, PMA, CMA, and KOCN. Turf discoloration usually is more of a problem and the timing of application more critical with the post-emergence crabgrass killers than with the better pre-emergence materials.

Some of the most common broadleaved weeds in turf are readily controlled with 2,4-D. Others also are selectively controlled with silvex, endothal, banvel D, or herbicides effective for pre-emergence control of crabgrass. Cautious use to avoid injury to turf and other plantings is required with all of these materials.

At the present time, quackgrass, nutgrass, and undesired perennial grasses, such as tall fescue and orchardgrass, can be eradicated only by non-selective herbicides which require spot reseeding or lawn renovation. In many instances it may be more practical to "learn to live" with these weeds in turf than to attempt to eradicate them. Thus for many weeds, prevention by good cultural practices still is the best cure.

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

Crop Residue Management

Upchurch, R. P., and Mason, D. D. THE INFLUENCE OF SOIL ORGANIC MATTER ON THE PHYTOTOXICITY OF HERBICIDES. Weeds 10: 9-14. 1962.

The influence of soil organic matter on the toxicity of 12 herbicides to cotton was determined under greenhouse conditions. Six soils varying in organic matter content from 0.4 to 16.8 percent were used. Herbicides were incorporated with one-quart volumes of soil and test plants were grown on the soil for 5 weeks. A range of rates allowed the determination of a GR₅₀ value (amount of herbicide required for 50 percent growth reduction) for each herbicide material and each soil type. These GR₅₀ values were found to be highly and positively correlated with soil organic matter, cation exchange capacity, exchangeable calcium, moisture equivalent, free drainage value, and total exchangeable bases. These soil properties were highly correlated among themselves. Although the data do not allow the specific

identification of organic matter as being the only soil factor which brought about the variation in GR₅₀ values encountered, the characteristics of the responses indicate that adsorption of herbicides by organic matter occurs and that this greatly influences their toxicity.

Approximately five times more herbicide was required for a GR₅₀ at 20 percent organic matter as compared to the amount required at 4 percent organic matter regardless of the herbicide involved.

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

Tillage

McCormick, L. L., Melville, D. R., and Oakes, J. Y. COTTON YIELDS INCREASED BY SUBSOILING, La. Agr. 5(3): 4-5. 1962.

Cotton yields on the sandy type soils in recent years have had a tendency to decline and it was thought that the use of anhydrous ammonia fertilizer was causing this reduction. Closer observations and some tillage practices revealed that the source of fertilizer was not at fault, but the use of heavy equipment in applying fertilizer and other machinery may be causing a compacted condition that prevents adequate root development for increased yields of cotton. When this compacted layer was broken, increases in yield were obtained regardless of the row placement of fertilizer.

An experiment was initiated in 1959 to study the effect of certain equipment of the soil and the placement of fertilizer within the row as determined by the yield of seed cotton. The soil was a Yahola vfl and moderately fertile. The test area was flat broken in 1959 and 1961 to a depth of 7 to 10 inches.

The experiment consisted of seven fertility treatments, with one-half of the rows of each plot being subsoiled each year with a Graham Hoeme plow to a depth of 10 to 12 inches. In five of the seven treatments, 80 pounds of nitrogen from anhydrous ammonia was applied before planting.

Analysis of variance of the data indicated a highly significant difference in cotton yield due to subsoiling as compared to no subsoiling. There were no significant differences among fertilizer treatments and no interaction between fertilizer treatments and subsoiling. The practice of subsoiling increased cotton yields, and this increase was consistent for all fertilizer treatments.

Red River Valley Agr. Expt. Sta., Bossien City, La.

Bateman, H. P., and Bowers, W. PLANNING A MINIMUM TILLAGE SYSTEM FOR CORN. Ill. Ext. Serv. in Agr. and Home Econ. C. 846, 12 pp. 1962.

Some Illinois farmers are maintaining maximum corn yields even though they have reduced their growing and harvesting operations to no more than four trips over the field. Others follow more conventional tillage systems but have eliminated two or more operations.

Both groups are using the minimum amount of tillage that will give quick germination, a high percent of germination, and maximum yields on their particular farm. Thus, minimum tillage, rather than being any one given method, is really a principle, which can be applied in many different ways.

The method to choose for a particular farm should be based on a combination of factors including soil type, climate, crop rotation, labor supply, and available machinery.

Table 6.--Corn Yield Comparisons for Various Tillage Systems

Tillage system	No. of comparisons	Harvest population per acre	Yield, bushels per acre
Conventional tillage			
1 to 3 diskings after plowing (check treatment)....	9	14,200	95
4 to 6 diskings after plowing.....	7	13,400	88 *
Minimum tillage			
Plowed soil tilled once with corn cultivator sweeps at planting (System I, page 5).....	2	14,600	95
Plowed with light tillage machine attached to plow then planted (System IIA, page 7).....	9	13,900	92
Soil plowed then planted in tractor wheel tracks (System IIB, page 8).....	8	14,000	94
Plow-plant or plow then plant (System III, page 8)...	9	13,200	91
Other tillage machines			
Soil tilled with chisels and sweeps on a field cultivator	4	14,300	92
Soil tilled with powered rotary tiller.....	5	13,900	88 *

* The difference between this yield and that from the conventional check treatment is significant.

Tables and illustrations.

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

Wittmuss, H. D. INCREASE PROFITS BY REDUCING TILLAGE. Nebr. Agr. Expt. Sta. Q. 8(3): 15. 1961.

Latest research on the till-plant system of minimum tillage shows:

1. Yields are the same as with conventional tillage systems.
2. Labor requirements can be cut in half.
3. Cost of the tillage operations can be cut in half.
4. Soil compaction in the row is reduced.

Other advantages of the minimum tillage system, when compared to conventional tillage, are; volunteer corn can be eliminated; water intake rates are higher; corn matures earlier; and wind and water erosion hazards are reduced.

Some problems that may be encountered include: different equipment is required which must be properly adjusted; winter annual weeds need to be controlled; and the sight of a trashy field may be objectionable.

A 4-row till-planter was developed by modifying a mounted rotary moldboard lister. Conventional cultivators equipped with disk hillers and sweeps were used. The minimum tillage system consists of: (1) Cutting stalks; (2) planting (including tilling, planting, and applying herbicide and insecticide); (3) cultivating; (4) ridging if the field is irrigated; and (5) harvesting.

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

Larson, W. E. TILLAGE REQUIREMENTS FOR CORN. J. Soil and Water Conserv. 17: 3-7. 1962.

Different soil types and climatic conditions result in different requirements for soil and water management and for most effective plant growth. Wind and water erosion are problems on some soils; in other areas moisture conservation is an important consideration; and in many places drainage is a problem.

In some areas, it is essential that crop residues be buried while in other regions it is desirable to keep residues on the surface. Tillage systems should be designed to meet the particular requirements of the soil, crop, and climate.

The tillage requirements for corn in the North Central States are discussed. Parameters that can be used to evaluate the effectiveness of tillage on a particular soil are suggested. An evaluation of how effectively current tillage practices meet tillage objectives was made.

Some of the factors to be considered in a tillage system for corn were indicated briefly to illustrate the many considerations necessary in designing or choosing a tillage system.

The physical conditions of the soil zone between the rows can be quite different from the conditions immediately around the seed and seedling root. The soil zone between the rows can be altered to help solve management problems such as runoff and water and wind erosion. A set of soil parameters for the seedling environment and water management zone are suggested for designing or evaluating tillage systems. Values for each parameter can be set to meet the management problem involved on each soil type.

Reduced tillage systems generally meet the tillage requirements for soils susceptible to water runoff although occasionally soil conditions in the seedling environment zone are not optimum for germination and plant growth early in the season. Conventional tillage systems generally do not take advantage of all possibilities for managing water in the soil zone between the corn rows.

SWCRD, ARS, USDA, Ames, Iowa.

Blake, G. R., French, G. W., and Nylund, R. E. SEEDBED PREPARATION AND CULTIVATION STUDIES ON POTATOES. Amer. Potato. J. 39: 227-234. 1962.

Omitting secondary, pre-plant tillage, after fall plowing Bearden silt, gave as high Red Pontiac potato yield as any secondary tillage treatment tried. Row-matching, a secondary tillage treatment designed to concentrate tillage and planting traffic in the same location, resulted in lower yield than no tillage, in 2 of 3 years.

Where weeds were controlled by an effective herbicide, there was no yield advantage to three cultivations over one cultivation.

Specific gravity of potato tubers was lowered by one tillage treatment in 1960. Though this decrease may not be of practical importance, it confirms earlier findings, namely that soil packing associated with tillage may adversely affect potato quality.

Some secondary, pre-plant tillage treatments increased the force required for penetration of a probe and also digger draft in some of the experiments. Clods carried over the digger apron were sometimes increased. Cloddiness is markedly affected by undetermined relationships of those factors that cause formation of clods, as well as by pre-plant tillage.

The results described apply to Bearden silt under the climatic conditions of the Red River Valley of Minnesota-North Dakota. Though it is probable that minimum tillage principles are universally applicable, some adjustments may be necessary to fit local soil and climatic conditions.

U. Minn., St. Paul, Minn.

Fertility Requirements for Conservation Farming

Rogers, E. M., and Havens, A. E. THE IMPACT OF DEMONSTRATIONS ON FARMERS' ATTITUDES TOWARD FERTILIZER. Ohio Agr. Expt. Sta. Res. B. 896, 26 pp. 1961.

The results of a demonstration program in changing farmers' attitudes toward the use of fertilizer are reported. The program studied was conducted in Miami County, Ohio, in 1959. No fertilizer demonstration plots were conducted in Champaign County, Ohio, the control county. Forty-seven fertilizer demonstration plots were completed by farmers in Miami County in 1959. Major findings were:

1. No significant changes in attitudes toward fertilizer, knowledge about fertilizer, or use of fertilizer could be measured as a result of the fertilizer demonstration program. Aggregate data on total fertilizer tonnage sales reported by fertilizer companies in Miami and Champaign Counties, however, indicated a change in farmers' fertilizer purchases. Reasons for the inconsistent findings between farmers' reported fertilizer use and aggregate sales data secured from fertilizer companies are difficult to explain, but may be partly due to: (1) Differences in measures of fertilizer use, and (2) differences in the exact time periods covered by the two sets of data (although both were gathered before and after the demonstration program was conducted).
2. Individual changes in attitudes toward fertilizer occurred during the demonstration program. Individual changes could take place although the aggregate balance of change was not significant. Those farmers whose attitudes became more positive had more education and tended to adopt farm innovations earlier.
3. Attitudes toward fertilizer, knowledge of fertilizer, and use of fertilizer were found to be interrelated. Knowledge of fertilizer acts as an "intervening variable" between attitudes and use of fertilizer.
4. Farmers who had soil tests averaged 67 percent higher for application of fertilizer nutrients on corn than did farmers who did not soil test. Soil testing acts as an intervening variable between attitudes and use of fertilizer. One way to decrease the negative effect of attitudes toward fertilizer on fertilizer use is to encourage farmers to test their soil.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Rogers, E. M., and Leuthold, F. O. DEMONSTRATORS AND THE DIFFUSION OF FERTILIZER PRACTICES. Ohio Agr. Expt. Sta. Res. B. 908, 24 pp. 1962.

The process by which a fertilizer practice diffuses from farmer demonstrators to the surrounding farmer audiences was studied. Data were gathered from 47 farmers in Miami County, Ohio, who completed corn and hay fertilizer demonstration plots during the 1959

crop year. The main practice demonstrated was the value of higher applications of fertilizer in terms of higher yields or profits. Research interviews were completed with a random sample of 86 commercial farmers in Miami County before the demonstration began. Of the original audience sample 77 were reinterviewed after the demonstration program was completed.

Major findings from the study were:

1. Twenty-eight percent of the audience first learned about the demonstration program by seeing a road sign, 22 percent by talking with a demonstrator, and 19 percent by reading about the program in a newspaper. Sixteen percent actually visited a demonstration.
2. Demonstrators differed from the audience in their personal characteristics. Demonstrators were characterized by more opinion leadership, earlier adoption of farm innovations, more favorable attitudes toward fertilizer, more knowledge about fertilizer, more years of formal education, higher formal participation, less belief in agricultural magic, and higher social status.
3. The more effective demonstrators (who talked to more audience farmers) were slightly higher in opinion leadership than the less effective, but did not differ significantly on other characteristics studied.
4. Demonstrators function as opinion leaders in the two-step flow of communication by which ideas flow from the mass media to local opinion leaders and then to the mass audience. Demonstrators use more cosmopolite information sources than the audience. Cosmopolite sources are those external to the community, such as bulletins, farm magazines, soil tests, and contact with country agents.
5. The portion of the audience that personally communicated with demonstrators was characterized by more opinion leadership, greater knowledge of fertilizer, higher social status, more years of education, more favorable attitudes toward fertilizer, earlier adoption of farm innovations, and more formal participation.
6. Members of the audience tended to communicate personally with demonstrators in the same or earlier adopting categories, with a similar or higher social status, and with those who lived within an average of 4 miles.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Bauder, W. W. INFLUENCES ON ACCEPTANCE OF FERTILIZER PRACTICES IN PIATT COUNTY, ILLINOIS. Ill. Agr. Expt. Sta. B. 679, 36 pp. 1962.

The experiences and opinions of a random sample of 221 farm operators in a cash-grain area, Piatt County, Ill., were analyzed to determine the extent of knowledge and adoption of six principal fertilizer practices; the rate of, and time required for, acceptance; the role of communication in the acceptance process; and the economic, social, and socio-psychological factors influencing fertilizer decisions.

Proportions of operators who used each practice varied from 30 to 90 percent. The use of lime and phosphate was the most general, and the use of potash was the most limited.

Rate of acceptance or adoption as measured by the cumulative proportions of operators using the practice was most rapid for using commercial nitrogen and slowest for liming and soil testing.

Acceptance time--time lapse between first knowledge and trial--was shortest for acceptance of commercial nitrogen and longest for soil testing and liming.

In contrast with the situation for many other recommended farm practices, the mass media--newspapers, magazines, radio, and television--were not the top sources of first

information about fertilizer practices among the sample farm operators. Neighbors and friends ranked first. However, farm magazines were the source of most information.

Farm advisers and vocational agriculture teachers ranked first and second as the most trusted authorities on fertilizer information. The persons who "influenced operators to try fertilizer practices were landlords, neighbors, relatives, and friends." The flow of information and influence in the acceptance process is thus a complex phenomenon involving mass media as chief sources of information; agricultural experts as the trusted authorities; and landlords, neighbors, friends, and relatives as the persons whose opinions carry the most weight in the final decision to try a fertilizer practice.

Farm operators with high fertilizer acceptance scores differed from farm operators with low scores mainly in the size of their operations and income. Owner-operators had smaller operations and lower scores. Age and educational differences were not significant.

Operators with absentee landlords had higher acceptance scores than operators with resident landlords. Operators who felt confident they could continue on their present farms almost indefinitely had higher scores than those who lacked this confidence.

High acceptance of fertilizer practices was associated with acceptance of crop rotations and increased planting rate of corn when nitrogen was used, but not with acceptance of such practices as using certified seed, using chemical weed control, adding grass to legume seeding, conserving manure, or burning plant residues.

Level of schooling was not directly associated with acceptance of fertilizer practices, but certain "educational experiences" such as having been in a 4-H Club or having a child in a 4-H Club or the vocational agriculture program were directly associated.

Although operators who reported that they liked to try new practices soon after they came out had higher fertilizer acceptance scores than those who said they were more inclined to "wait and see," there was no substantial evidence that the former group went through the process of accepting a new practice more rapidly than the others. The time elapsed between first knowledge of a practice and first trial was about the same for operators with high acceptance scores as for those with low scores.

Active participation in formal associations was more characteristic of operators with high acceptance scores than of those with low scores. Membership in the Farm Bureau and the Million Dollar Club--the latter being a part of a comprehensive educational program sponsored by the Agricultural Extension Service to promote better fertilizer practices--was especially characteristic of operators with the higher fertilizer acceptance scores.

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

Hanna, W. J., Rosenberg, N. J., and Willits, N. A. FERTILIZER DOES NOT OFFSET EFFECTS OF SOIL COMPACTION. N. J. Agr. 43 (6): 6-7, 16. 1961.

A study of the relations between soil compaction and fertilization was conducted with a Downer 1s soil from the New Jersey Atlantic coastal plain. Barley, snap beans, wheat and peppers were grown successively over a 2-year period. The test was carried on in metal cylinders 2 feet in diameter by 3 feet long buried to within 2 inches of ground level out-of-doors.

There were five compaction treatments varying from 92 to 112 pounds per cubic foot of soil. This range of compaction treatments varies from loose sandy loam soil to hard-packed soil similar to that of a baseball infield or that of a farm field road.

Phosphorus and potassium fertilizers were applied at three rates. These were 140, 70, and 0 pounds phosphorus per acre, and 320, 160, and 0 pounds potassium per acre.

The results were decreases in yield from increasing severity of compaction and increasing yields and increasing phosphorus and potassium uptake with increasing fertilization.

Fertilization with either phosphorus or potassium, or both, did not offset the detrimental effects of soil compaction on crop growth. Yields of wheat, which are typical of other results, are shown in the table.

Effect of Soil Compaction and Fertilization on Wheat Yields

Fertility Level	Amount	Compaction-lbs. soil per cu. ft.					Fertility averages
		92.4	104.8	109.8	111.7	112.3	
	(lbs/acre)	(grams of dry weight per drum)					
High.....	140	252	272	219	227	186	231
Medium P.....	70	253	268	210	203	188	224
Low.....	0	137	191	147	146	136	152
High.....	320	243	261	190	185	186	213
Medium K.....	160	222	241	235	234	189	224
Low.....	0	177	231	152	160	136	171
Compaction Averages.....	213	244	193	193	170		

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

Committee on Fertilizers. NEW JERSEY FERTILIZER AND LIME RECOMMENDATIONS FOR AVERAGE SOIL CONDITIONS. N.J. Ext. B. 365, 20 pp. 1962.

The results of chemical soil tests are necessary before recommendations for the best use of lime and fertilizer can be made. Soils differ in their content of available plant nutrients because of differences in their natural properties and differences in past fertilization and cropping. The soil's supply of available plant nutrients is the sum of the native and applied nutrients minus the amounts removed by harvested crops, leaching and erosion, and that rendered unavailable by fixation. It is impractical, if not impossible, for each grower to keep a record of the changes that take place in the nutrient supply in a soil without a periodic chemical soil test. It is possible through the use of soil tests to inventory the available nutrients in a soil and thus recommend lime and fertilizer applications to fit specific soil and crop conditions.

General recommendations of mineral and organic fertilizers and lime for average recommendations in New Jersey are presented.

Tables.

Ext. Serv., Col. Agr. Rutgers--The State U., New Brunswick, N.J.

Davan, C. F., Jr., Schmehl, W. R., and Stewart, W. G. FERTILIZER USE AND TRENDS FOR PRINCIPAL CROPS IN COLORADO. Colo. Agr. Expt. Sta. Gen. Series 771, 24 pp. 1961.

In Colorado, the use of commercially produced plant nutrients is increasing. The plant nutrient content of most fertilizer has increased considerably. The total tonnage of fertilizer materials has not increased consistently.

Colorado increased its plant nutrient (N, P₂O₅, and K₂O) consumption by 90 percent between 1954 and 1959. More nitrogen was used in Colorado during the 1959 crop year than the total amount of all three primary nutrients applied in 1954.

Ten percent of all harvested crops and cropland pasture in Colorado received fertilizer in 1959. Variations in percentages of harvested acreages fertilized are closely related to the per acre value of the crop. Highest percentages are associated with high cash-return crops and lowest percentages with low-return crops. Forty-eight percent of the corn acreage was fertilized, 74 percent of the potatoes, 88 percent of the sugar beets, 5 percent of the other crops, 4 percent of the hay and cropland pasture, and 2 percent of the improved permanent open pasture.

Average per acre application rates of nitrogen, available P₂O₅, and potash were 159 pounds for sugar beets, 137 pounds for potatoes, and 84 pounds for corn in 1959. Lowest rates were used in improved permanent open pasture.

Fifty-three percent of all primary plant nutrients used in Colorado were applied to sugar beets and corn. Corn utilized 46 percent of all commercial nitrogen applied in Colorado during 1959. Approximately 30 percent of all cropland harvested in Colorado was irrigated in 1959. Most plant nutrients were applied to irrigated acreages.

Colo. State U., Expt. Sta., Ext. Serv., Fort Collins, Colo.

Jordan, M. F., and Baker, C. B. EFFECTS OF FERTILIZER PROGRAMS ON THE ECONOMIC CHOICE OF CROPS IN SELECTED AREAS OF ILLINOIS. III. Agr. Expt. Sta. B. 683, 40 pp. 1962.

Two Illinois soils areas were studied to isolate the effects of commercial fertilizer on crop selection, and to develop an analytic model that could be used in investigating the effects of technological developments.

Data taken from a sample of contrasting soil types on 182 farms (96 in east-central Illinois and 86 in south-central Illinois) were used to establish resource restrictions and to define production opportunities in models for the two contrasting soil areas at two points in time. Profit-maximizing optima were generated with these models. From optimal responses to price variation, marginal rates of substitution between crops were calculated in each area at each time period and comparisons were made within areas over time. Every effort was made to eliminate causes of variation other than those due to fertilizer use.

The results of this study support the hypothesis that there has been a change over a period of time in the marginal rates of substitution between crops in east-central and south-central Illinois. The study revealed the following about the changes in the use of commercial fertilizer:

1. The effects of the changes in fertilizer programs on crop relationships have been considerably greater in the Cisne soil area than on Flanagan soils.
2. The adoption of improved fertilizer programs has reduced the differences between the Flanagan soil area and the Cisne soil area in the crop substitution relationships involving corn.
3. In both the Flanagan and Cisne soil areas the effects of the changes in fertilizer programs appeared to be more marked on the corn-soybeans relationships than on the corn-small grain relationships.
4. In both the Flanagan and Cisne soil areas the competitive positions of corn and soybeans seemed to be favored relative to that of small grains.
5. The procedures employed in the study were successful in isolating the effects of commercial fertilizer use on the crop substitution relationships.

6. The analytic model developed in analyzing the effects of commercial fertilizer appears adaptable to the investigation of the effects of similar technological developments. The effects of irrigation, herbicides, and insecticides could be certainly analyzed in a similar analytic framework.

Differences between areas and shifts in the production possibilities curves may have significant implications. With the change in fertilizer programs discussed in this study, the advantage enjoyed by farmers on good soils decreased relative to that of farmers on poorer soils. The consequences of these changes in the competitive positions of farmers in relatively large geographic areas may have an important influence on regional specialization. Between the areas investigated in this study the geographic boundaries may become less distinct, and the differences in resource values less pronounced.

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

Walker, O. L., Wiggans, S. C., and Pogue, T. F. AN ECONOMIC ANALYSIS OF FERTILIZER AND SEEDING RATES FOR SPINACH PRODUCTION IN EASTERN OKLAHOMA. Okla. Agr. Expt. Sta. B. 13-596, 15 pp. 1962.

Spinach is grown commercially on alluvial soils in eastern Oklahoma. Both spring and fall crops are normally grown in this area. The spring crop may be an over-wintered crop or it may be from a new seeding. Approximately 15 percent of the crop is sold on the fresh market and the rest is canned or frozen. Average yields per acre have increased considerably, in the last few years, due to new varieties and improved production practices.

A spinach experiment conducted near Bixby, Okla., was used as a basis for estimating the profitability of applying varying rates of nitrogen fertilizer and spinach seed.

One hundred and sixty to one-hundred and eighty pounds of nitrogen and 7.6 pounds of seed per acre produced the greatest profits. This was based on an estimate of 1 year's experimental results and "usual" prices. The estimated yield, for this combination, was about 8.5 tons per acre. A decrease to 5 pounds of seed and 100 pounds of nitrogen decreased returns about \$15 per acre. However, 7.6 pounds of seed and 100 pounds of nitrogen would only drop returns \$4 lower than the optimum input combination. Nitrogen levels of 100 to 180 pounds was in the optimum range. Best nitrogen and seed levels are presented for a number of spinach, seed, and nitrogen prices and different capital costs.

Per acre return gains were not increased by varying seed and nitrogen application as spinach prices changed. Even when seed prices were doubled, optimum seeding rates remained about the same. Carefully chosen seeding and fertilizing levels could be adopted and maintained over a wide range of prices.

Okla. State U. Res. Sta., Stillwater, Okla.

Department of Agronomy and Soils. RESPONSE OF FIELD CROPS TO FERTILIZER AND RETURNS PER DOLLAR INVESTED. Ala. Agr. Expt. Sta. C. 141, 14 pp. 1961.

Fertilizer and lime requirements for a particular field can best be determined by analyzing a soil sample from that field. However, farmers, agricultural workers, and members of the fertilizer industry are frequently interested in the general crop response from nitrogen, phosphorus, and potassium fertilizers. Yield responses of various fertilizers on cotton, corn, oats, Coastal Bermudagrass, and Dallisgrass-white clover are summarized in 11 illustrations.

The data in these charts are from a number of locations, including a range of soil fertility conditions. Experiments on soils low or medium in phosphorus and/or potassium outnumbered those on other soils unless otherwise explained. Where the response to one element is shown, the soil pH and rate of application of the other elements were at desirable levels.

As an indication of value from fertilizer, the dollars returned per dollar invested in fertilizer at the optimum rate of each element are given in the table.

Returns Per Dollar Invested in Fertilizer Using Response Data in Figures 1-10¹

Crop	Fertilizer			Returns per dollar invested
	N	P ₂ O ₅	K ₂ O	
	Lb.	Lb.	Lb.	Dollars
Cotton				
Limestone Valley	60	60	40	4.70
Sand Mountain.....	80	60	60	10.80
Coastal Plain.....	70	60	60	13.20
Corn				
Average.....	90	20	20	4.50
Highest yielding.....	120	20	20	4.40
Oats				
Grain	60	40	20	3.30
Grain and forage	120	40	20	4.30
Coastal Bermuda.....				
	80	(²)	(²)	3.30
	160			3.30
	320			2.40
	640			1.80

¹Fertilizer cost was calculated on basis of 12 cents per pound of N and 6 cents each per pound of P₂O₅ and K₂O; crop value calculated on basis of 12 cents per pound for seed cotton, \$1.20 per bushel for corn, 60 cents per bushel of oat grain, 2-1/2 cents per pound dry matter of oat forage, and \$20 a ton of Coastal hay.

²P₂O₅ and K₂O are not given for Coastal Bermudagrass, since there are insufficient longtime data at various rates of N to justify inclusion. The phosphorus and potassium required would increase with increasing rates of nitrogen; therefore, the cost and return per dollar would be less at each rate of N than shown.

Agr. Expt. Sta., Auburn, U., Auburn, Ala.

Michalson, E. L., and McAlexander, R. H. ECONOMICS OF FERTILIZATION AND USE OF IDLE LAND ON SELECTED NORTHEASTERN PENNSYLVANIA DIARY FARMS. Pa. Agr. Expt. Sta. B. 690, 24 pp. 1962.

An analysis was made to determine the most profitable combinations of crops and livestock on two representative northeastern Pennsylvania farms by the use of the linear programming technique.

Beef, dairy, poultry, and sheep production were the livestock enterprises compared in this study. Dairy was the most profitable of these alternatives. Since the next most profitable enterprise was poultry, any labor available beyond that needed in the crop and dairy enterprises was utilized in the plans in caring for laying hens.

The number of dairy cows in each plan for Farm A was limited by the shortage of land for producing forage. The number of cows on Farm B was limited by the available supply of labor; thus, poultry was not a profitable alternative in plants for this farm.

Two levels of fertilization and land renovation were primary considerations in determining plans for these farms. Yields, fertilization levels, feed requirements along with other input-output information used for planning crop and livestock enterprises are presented in the Appendix. The alternative plans were determined with existing resources of land, labor, machinery, and building space available on both farms.

The initial or benchmark plans for the two farms were based on a medium level of fertilization. Alternative plans were derived for each farm, showing changes in organization and returns between the benchmark plant and plans with (1) A higher level of fertilization for the same acreage; (2) a higher level of fertilization and renovation of idle land.

All plans for the two farms indicated that the most profitable crop rotation among the possibilities considered would be a 7-year, corn-oats-birdsfoot trefoil-timothy meadow association. Corn would be utilized mainly for silage, although it would be harvested for grain when there was sufficient forage available from other sources for the dairy cattle. Oats would be sold as grain, and the birdsfoot trefoil meadow would be used mainly for pasturage and silage; only enough hay would be harvested to meet minimum allowances of 500 pounds per dairy cow and replacement.

In the analysis, grain feeding could be varied between limits of 1 pound of grain to 3 pounds of milk (1:3), and a minimum of 1 pound of grain to 6 pounds of milk (1:6). The most profitable level of grain feeding depended upon the availability of labor relative to land. If labor were plentiful relative to land, the grain to milk ratio tended toward 1:3, and if labor were scarce relative to land, the grain to milk ratio tended toward 1:6.

Results showed that returns associated with increased fertilization and renovation would be dependent on the resource situation on the farms under consideration. A comparison of returns per dollar spent on renovation indicated that funds expended on well drained soils were the most profitable, and that returns diminished as internal drainage became poorer. On Farm A where labor permitted adding cows, if the alternative were between using limited funds for fertilization of well drained soils and renovating poorly drained soils, the higher fertilization program would be the most profitable. Returns also were found dependent on the method of forage crop harvesting, pasture in general returning more per dollar of operating capital spent than hay or silage.

Break-even prices were computed to show relationships between prices of milk and annual costs of renovating and operating land of various soil types were capital and labor were available.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Adams, W. E., and Stelly, M. FERTILITY REQUIREMENTS OF COASTAL BERMUDA-GRASS AND CRIMSON CLOVER GROWN ON CECIL SANDY LOAM: I. YIELD RESPONSE TO FERTILIZATION. *J. Range Managt.* 15: 84-87. 1962.

Yield response of Coastal Bermuda grown in association with crimson clover was measured in a factorial experiment at four N levels ranging from 0 to 400 pounds per acre and four levels each of P₂O₅ and K₂O ranging from 0 to 200 pounds per acre. The results for 1955 and 1956 show that:

1. Coastal Bermuda forage yields ranged from 2.17 tons of dry matter per acre without fertilization to 7.21 tons at the 400-200-200 fertilizer level.
2. Yields were increased markedly through 400 pounds of N per acre. The 100-pound per acre rate produced the largest number of pounds of forage per pound of N.
3. There were highly significant yield responses to both phosphorous and potassium application through the 200-pound rate.
4. Intensified potassium deficiency occurred in Coastal Bermudagrass at high levels of nitrogen fertilization.
5. The soil pH and extractable K_2O decreased sharply as the rate of N was increased.
6. Crimson clover yields were reduced by increasing rates of N applied to the Coastal Bermuda.

SWCRD, ARS, USDA, Watkinsville, Ga.

Gibson, E. J. NUTRITION STUDIES OF TYPE 62 SHADE TOBACCO. Ga. Agr. Expt. Sta. C. N. S. 26, 13 pp. 1962.

Nitrogen--The higher rate of nitrogen produced the best tobacco under conditions of these tests. Split applications with higher percent water-soluble nitrogen were superior to applying all nitrogen three weeks before transplanting. A reduction in fire-holding capacity was obtained with each increase in nitrogen rate.

Phosphorus--The lower rate of phosphorus (100 lbs.) was equal to other rates used. Phosphorus should be applied before transplanting so the plant can obtain maximum use of this plant element. The use of triple superphosphate as a source of phosphorus was equal to other sources used.

Potash--The 250-pound rate of potash was superior to other rates used. The pre-planting method of application was slightly superior to the split application method.

Shade Tobacco Field Expt. Sta., Attapulgus, Ga.

Harper, H. J. YIELD AND CHEMICAL COMPOSITION OF AUSTRIAN WINTER PEAS, HAIRY VETCH AND BIENNIAL SWEETCLOVER, AND THE EFFECT OF FERTILIZATION ON SWEETCLOVER ROOTS. Okla. Expt. Sta. Processed Ser. P-408, 17 pp. 1962.

Top growth was slow during the spring months for Austrian winter peas, hairy vetch, and biennial sweetclover, but increased rapidly after the first of May. Maximum top growth was reached about 2 or 3 weeks before the crops were mature. Root growth did not change appreciably after mid-April.

Austrian winter pea tops were much higher in nitrogen, phosphorus, and magnesium than tops from hairy vetch when the plants were small. The vetch tops contained more calcium than winter pea tops on the same soil. The roots of winter peas were higher in nitrogen and phosphorus than roots of vetch and sweetclover. The nitrogen content of the tops of all three legumes was very similar as the crops approached maturity.

Evergreen and Madrid Yellow sweetclover produced more root and top growth than ten other varieties tested. Root yields were similar for these two varieties on fertilized plots; on unfertilized plots, Madrid Yellow was slightly higher.

Fertilized sweetclover produced higher nitrogen content than unfertilized. Evergreen variety contained the largest quantity of total nitrogen per acre.

Redfield and Spanish sweetclover produced slightly higher total yields than two samples of Evergreen variety. In early spring, the average nitrogen content of sweetclover tops was higher than in the roots.

One ton of limestone produced larger root yields than superphosphate drilled in the seed row on limed plots. However, root growth was even when lime and fertilizer were both applied. Two hundred pounds of rock phosphate drilled in the row with the sweetclover seed increased root production 60 percent on unlimed soil and 56 percent on limed soil.

Tables.

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

Harper, H. J. EFFECT OF FERTILIZERS AND LEGUME ROTATIONS ON CORN PRODUCTION IN CENTRAL OKLAHOMA. Okla. Expt. Sta. Processed Ser. P-416, 9 pp. 1962.

Corn was grown every year on Norge 1 on the Perkins farm for a 26-year period to study the effect of various fertilizers and legume cropping systems on grain production. One hundred pounds of sodium nitrate or ammonium nitrate per acre, applied as a side-dressing, with 150 pounds per acre ordinary superphosphate applied in the row at planting produced about 6 bushels more corn per acre than corn grown on unfertilized soil. Superphosphate and potash produced no significant increase in corn yields as compared to unfertilized plots. Potash applied with superphosphate and nitrogen did not significantly increase corn production. Corn yields obtained where two rows of cowpeas, soybeans, annual sweetclover, or Crotalaria were alternated with two rows of corn that was fertilized with ordinary superphosphate, were similar to yields obtained where corn was planted every year without fertilizer. The average net labor income from corn on these plots was not more than one bushel per acre.

Corn was planted in rotation with oats and seven annual legumes. The average corn yield was less than 2 bushels more per acre when all of the legume residue was returned to the soil as compared with yields obtained when the legume crops were cut for hay. Barnyard manure applied at the rate of 60 pounds of nitrogen per acre on plots where cowpeas were cut for hay produced an average increase in corn yield that was also less than 2 bushels per acre.

Tables.

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

Speights, D. E., and Paterson, D. R. SWEET POTATO FERTILIZER AND VARIETY TRIALS IN NORTHEAST TEXAS, 1961. Tex. Agr. Expt. Sta. Prog. Rpt. 2231, 5 pp. 1962.

Sweet potato fertilizer and variety tests were conducted in Van Zandt and Wood Counties in Texas during 1961. Fertilizer effects in both counties are important since the response was reflected in an increase in the yield of No. 1 grade as the total yield increased. As total yield increased, No. 2 and cull grades remained essentially the same.

As nitrogen was raised from 0 to 100 pounds per acre, a 106 and 68 percent increase in No. 1 grade resulted in Wood and Van Zandt Counties, respectively.

Potassium also caused a 52 percent increase in No. 1 grade when the rate was changed from 0 to 200 pounds per acre in Wood County. In Van Zandt County a 19 percent increase in No. 1 grade resulted from increasing potassium from 0 to 200 pounds per acre.

Fifty pounds per acre of phosphorus significantly increased both total yield and No. 1 grade in Wood County, but the use of phosphorus in Van Zandt County showed no response.

The Porto Rico variety, which had been grown in the area for several years, was used as a check. The differences in variety yields were not as pronounced with this variety as they were in 1960 when Unit 1 Porto Rico was used as a check.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Hunter, A. S., Alban, L. A., Gerard, C. J., Hall, W. E., Cushman, H. E., and Petersen, R. G.
FERTILIZER NEEDS OF WHEAT IN THE COLUMBIA BASIN DRYLAND WHEAT AREA OF OREGON. Oreg. Agr. Expt. Sta. Tech. B. 57, 60 pp. 1961.

During the 4-year period 1953-57 fertilizer experiments were completed on 173 dry-land wheat farms in north central Oregon. Of 173 experimental sites, 152 were in areas of low rainfall and 21 in areas of higher rainfall.

Significant yield increases were produced by one or more rates of fall- and spring-applied nitrogen, respectively, on 109 and 112 of 152 sites in the low rainfall area. For 109 sites, average yield increases from 20, 40, 60, 80, and 100 pounds of nitrogen per acre were, respectively, 6.4, 10.2, 12.2, 12.2, and 12.2 bushels per acre. Average yield increases from spring-applied nitrogen at rates of 20, 40, 60, 80, and 100 pounds, respectively, were 4.9, 8.8, 11.2, 11.9, and 12.8 bushels per acre. Effects of fall- and spring-applied nitrogen fertilizer were too small to be significant on 15.8 and 19.1 percent, respectively, of the sites in low rainfall areas. Significant yield decreases were produced by one or more rates of fall-applied nitrogen on 12.5 percent and by spring-applied nitrogen on 7.2 percent of low rainfall area sites. Considering all sites in the low rainfall area, average yield increases from 20, 40, and 60 pounds of fall-applied nitrogen were 4.8, 7.3, and 8.3 bushels per acre, respectively; higher rates produced lower average yields. For 20, 40, 60, 80, and 100 pounds of spring-applied nitrogen average yield increases were, respectively, 3.9, 6.5, 8.3, 8.5, and 8.7 bushels per acre.

During the 4-year period for all sites, fall-applied nitrogen was superior to spring-applied nitrogen on 38, inferior on 42, and not significantly different on 91 sites. Fall-applied nitrogen resulted in larger average yield increases and also a greater number of yield depression than spring-applied nitrogen. Yield depressions from fall-applied nitrogen were usually associated with soil depths of less than 4 feet.

The amount of nitrogen required to increase wheat yield by 1 bushel per acre varied with year, experimental site, and soil type. It ranged, over the 4 years, from 2.8 to 6.3 for fall-applied and 3.2 to 6.0 pounds for spring-applied nitrogen. For 109 sites an average of 3.7 pounds of fall-applied nitrogen was required to increase wheat yields by 1 bushel per acre. Spring-applied nitrogen was less efficient in increasing yields, requiring an average of 4.3 pounds of nitrogen per bushel increase.

Residual effects of spring-applied were greater than those of fall-applied nitrogen. Substantial residual effects of both fall- and spring-applied nitrogen were measured on 10 sites following a year of fallow.

Protein contents were not, in general, increased to objectionably high levels except by rates of nitrogen greater than the rate required to produce maximum yield. Substantial yield increases were usually obtained from added nitrogen on fields where the grain from the no-nitrogen plots contained less than 8 percent protein.

Amount of available moisture and of nitrate, ammonium, and nitrifiable nitrogen in the soil varied between sites, years, and soil types. Multiple regression equations relating yield responses to available soil moisture (fall and spring), rainfall between time of spring fertilization application and harvest, amounts of nitrogen fertilizer applied, and amounts of

nitrate, ammonium, and nitrifiable nitrogen were not useful in explaining observed variations in yields.

Simple regression analyses, relating maximum yields on all sites to single variables such as available moisture and various forms of soil nitrogen, did not provide an adequate basis for estimating fertilizer needs of wheat crops under the specific conditions of this experiment. Simple regression analyses calculated for individual soil types resulted in higher degrees of correlation between maximum yields and soil variables.

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

Brensing, O. H., and Lynd, J. Q. SOIL FERTILITY STUDIES FOR IMPROVED WHEAT PRODUCTION IN EASTERN OKLAHOMA, 1957-1960. Okla. Agr. Expt. Sta. B. B-594, 16 pp. 1962.

Results from field experiments conducted to determine wheat yield response to various fertilization practices in eastern Oklahoma from 1957-1960 were summarized:

1. Highly significant and profitable increases in wheat yields were obtained with proper rates and combinations of nitrogen (N), Phosphorus (P_2O_5), and potassium (K_2O) fertilization on upland permeable and claypan prairie soils. Results showed the need for proper balance of these plant nutrients.
2. Response to various fertilization combinations varied with the soil type and previous soil management. The first limiting plant nutrient for wheat yields at all field experiment locations was phosphorus, and highest yields were obtained only when adequate phosphorus was applied.
3. Wheat yields increased with nitrogen fertilization when the N treatments were combined with adequate phosphorus and potassium. The magnitude of response to nitrogen additions was influenced greatly by previous soil treatments. Yields were not increased on well-managed Dennis sil to various N and P_2O_5 combinations unless combined with applications of 40 lbs. K_2O per acre.
4. Results showed no significant difference in yields from different times of applying nitrogen fertilizer to the wheat crop. Nitrogen fertilizer applied on Parsons sil to the wheat stubble and straw just prior to plowing was as effective as the same N rates applied at planting.
5. Residual effects from nitrogen, phosphorus, and potassium fertilization applied to previous crops that failed on claypan prairie soils gave significant increases in wheat yields.

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

Nelson, C. E., Roberts, S., and Nelson, G. D. YIELDS AND PLANT RESPONSES OF SIX SOYBEAN VARIETIES TO NITROGEN AND ZINC FERTILIZATION. Wash. Agr. Expt. Sta. B. 642, 12 pp. 1962.

Six soybean varieties were grown under irrigation with and without zinc fertilization at five nitrogen levels on low-nitrogen soil.

The application of 10 pounds of Zn per acre increased yields 10.3 bushels per acre over the check treatment.

Nitrogen fertilizer application at the rates of 40, 80, 120, and 240 lbs. N/A with 10 lbs Zn/A did not increase yields.

Nitrogen fertilization without zinc increased yields. The curvilinear regression of yield on nitrogen fertilization indicated a maximum yield at 160 lbs. N/A. This confirms work with other crops that nitrogen application generally increases the uptake of indigenous zinc, the effect depending on the change in pH by the nitrogen carrier.

Zinc fertilization alone produced a higher yield than the nitrogen treatments without zinc.

Lodging, plant height, and retention of leaves at harvest increased with increasing nitrogen levels.

Lodging, plant height, and retention of leaves were greater for the treatments receiving zinc than those not receiving zinc.

Merit, Ottawa Mandarin, Capital, Norchief, Grant, and Chippewa were all well adapted to this area with yields ranging from 37.3 to 49.9 bushels per acre.

Merit was the outstanding variety, averaging 49.9 bushels per acre. This was 7.4 bushels more per acre than the average of the other varieties except Grant which produced 37.3 bushels per acre. Merit was also one of the best varieties in regard to low growth habit, resistance to lodging, and less retention of leaves at harvest.

Wash. Agr. Expt. Sta., Inst. Agr. Sci. Wash. State U., Pullman, Wash.

Welch, N. H., Burnett E., and Hudspeth, E. B. EFFECT OF FERTILIZER ON SEEDLING EMERGENCE AND GROWTH OF SEVERAL GRASS SPECIES. *J. Range Mangt.* 15: 94-98. 1962.

Low rates of nitrogen and phosphorous fertilizers were banded close to the seed of several grass species at planting time to determine their effect on seedling emergence and plant growth over a 4-year period beginning in 1957. In 1957, a weed control variable was included, and in 1957 and 1958 two fertilizer placements were used in the experiment.

Weed competition reduced plant stands on all treatments in 1957. There was no difference in stand reduction between the fertilized and non-fertilized plots. Weed competition also reduced was significant on all treatments except the nitrogen and nitrogen-phosphorous combination. The increase in plant growth on these treatments was great enough to offset the detrimental effect of weed competition.

Fertilizer placement had no effect on seedling emergence or plant growth in either 1957 or 1958. Fertilizer treatment had no effect on seedling emergence of any of the grass species in any of the years. Final plant stands of Plains bristlegrass were increased by fertilizer in 1959. Fertilizer treatment had no effect on final plant stands of the other species in 1959 or on any of the species in 1960.

The plant growth of species with medium and high seedling vigor was increased by the nitrogen and nitrogen-phosphorous combination treatments. However, the most consistent growth increase in all years was on the nitrogen-phosphorous combination treatment. Fertilizer did not increase the plant growth of species with low seedling vigor.

SWCRD, ARS, USDA, Big Springs, Tex.

Teel, M. R. NITROGEN-POTASSIUM RELATIONSHIPS AND BIOCHEMICAL INTERMEDIATES IN GRASS HERBAGE. *Soil Sci.* 93: 50-55. 1962.

During the sequence of normal metabolic events in plant biosynthesis, if an essential step becomes rate-limiting, the substrate normally accumulates or engages in alternative reactions. With orchard grass (*D. glomerata*), the size and qualitative nature of the resulting

substrate pools varies with, among other things, nitrogen and potassium fertility. Marked accumulation of malate and soluble nitrogen compounds under low potassium regimes, with an equally bold increase in true protein synthesis accompanied by declining malate and soluble nitrogen pools with optimum potassium regimes, suggests a critical potassium level for orchard grass.

A possible connection between soluble nitrogen and herbage quality for ruminants is suggested.

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

Smith, O. E., and Paterson, D. R. SOME EFFECTS OF PHOSPHORUS AND POTASSIUM FERTILIZERS ON EARLY YIELD AND SIZE OF WATERMELONS AT PRAIRIE VIEW, 1958-59. Tex. Agr. Expt. Sta. Prog. Rpt. 2219, 4 pp. 1961.

Research at Prairie View, Tex., in 1958-59 indicated that the use of 40 and 80 pounds per acre of phosphorus increased both total and early yield of marketable Charleston Gray watermelons. One hundred pounds per acre of potassium in combination with 40 and 80 pounds per acre of phosphorus resulted in highly significant increases in the yield of marketable watermelons. The use of 200 pounds per acre of potassium depressed the number of marketable watermelons at low levels of phosphorus, but increased the yield with 80 pounds per acre of phosphorus.

Potassium sulfate (K_2SO_4) proved to be superior to potassium chloride (KCl) or potassium magnesium sulfate ($K_2SO_4 \cdot 2 MgSO_4$) as a source of potassium for watermelons at this location.

The use of 100 pounds per acre of potassium increases significantly the individual weight of Charleston Gray watermelons.

Prairie View A. & M. Col., Prairie View, Tex.

Burton, G. W., and Jackson, J. E. SINGLE VS. SPLIT POTASSIUM APPLICATIONS FOR COASTAL BERMUDAGRASS. Agron. J. 54: 13-14. 1962.

A 5-year factorial experiment designed to show the effect of split applications of 100, 200, 400, and 800 pounds of nitrogen; 0, 75, and 150 pounds of P_2O_5 ; and single and split applications of 0, 100, and 200 pounds of K_2O per acre on Coastal bermudagrass growing on a Tifton 1s revealed that:

1. Potassium applications increased yields on plots fertilized with 800, 400, 200, and 100 pounds of nitrogen per acre after 1, 2, 4, and more than 6 years, respectively.
2. Splitting annual potash applications significantly increased average hay yields at the 100-pound per-acre rate (6.5% in 1955 and 2.6% for the 5-year period) but had no effect at the 200-pound per-acre rate. This relation was the same with larger differences (24.5% in 1954 and 12.4% in 1955) in favor of splitting the 100 pound K_2O rate on plots fertilized with 800 pounds of nitrogen per acre per year.
3. Splitting annual potash applications consistently increased the potash content of the soil measured at the end of the test period.
4. It appears that luxury consumption of potassium by Coastal bermudagrass can be kept at a minimum by keeping soil potassium at rather low level and fertilizing with split applications of potash at rates not to exceed half the nitrogen rates used.

CRD, ARS, USDA, Tifton, Ga.

Pope, A. EFFECT OF APPLICATION SCHEDULE AND SOURCE OF PHOSPHORUS FERTILIZER ON FORAGE YIELD, PHOSPHORUS CONTENT, AND PROTEIN CONTENT OF 12 CUTTINGS OF IRRIGATED ALFALFA. Tex. Agr. Expt. Sta. Prog. Rpt. 2214, 7 pp. 1961.

Three sources of phosphorus were applied to a new seeding of Texas Common alfalfa on a Portales sil in 1957. Part of the plots received the phosphorus fertilizer in one application of 240 pounds per acre of P_2O_5 in 1957 and the remainder of the plots received an 80-pound annual application in 1957, 1958, and 1959.

There was no difference in yield among plots receiving different sources of phosphorus fertilizer or between plots receiving the phosphorus in one 240-pound application or three annual applications of 80 pounds each.

The plots that received no phosphorus produced less than half the forage produced on the phosphorus-treated plots.

Total phosphorus removed in 12 cuttings was more than three times greater on the phosphate-treated plots than on the check plots. There was no difference in total phosphorus removal among plots receiving different sources of phosphorus fertilizers or between plots receiving phosphorus as one 240-pound application or three annual applications of 80 pounds each.

Southwestern Great Plain Field Sta., Bushland, Tex.

Long, O. H. PHOSPHATES IN CROP ROTATIONS IN LAWRENCE COUNTY. Tenn. Agr. Expt. Sta. B. 328, 43 pp. 1961.

The importance of phosphate in a fertilization program in a rotation of corn, cotton, wheat, and alfalfa was studied at four locations in Lawrence County, Tenn., over a 10-year period (1950-59). The soils represented are Pembroke, Dickson, and Mountview.

A moderate application of concentrated superphosphate (40 pounds of P_2O_5 per acre per year) resulted in increases over the unphosphated treatment of 8 to 31 bushels of corn, 160 to 650 pounds of seed cotton, 9 to 23 bushels of wheat, and 1/2 to 1 ton of alfalfa hay. The cost of this amount of phosphate, at current prices, was \$2.83 per acre. The cost of the complete fertilizer treatment--nitrogen, phosphate, and potash--ranged from \$6.44 per acre per year on alfalfa to \$16.59 on corn. Nitrogen and potash were applied to all treatments at uniform overall rates.

Other phosphates under study were calcium metaphosphate, fused tricalcium phosphate, ordinary superphosphate, and rock phosphate; except for rock phosphate, all gave a satisfactory performance. While some yield response was obtained from rock phosphate, its performance was considerably under that of the other phosphates, even though it was applied at a rate 2-1/2 times the other phosphates in terms of P_2O_5 equivalence.

Increasing the rate of phosphate fertilization to 80 pounds of P_2O_5 per acre resulted in little or no increase in yield over that obtained with the 40-pound rate, except at one location where the soil initially was very low in phosphate. Even here 85 percent of the total response to phosphate can be attributed to the first increment.

When phosphate additions were discontinued after several years of application, 1 or 2 years elapsed before crop yields declined materially. By the third year the decline was appreciable, but remained considerably above the yield of the no-phosphate treatment.

The rate of phosphate fertilization was reflected in the available phosphorus level of the soil as indicated by chemical tests made on samples collected at the conclusion of the experiments. The soils also varied widely in reaction (pH) and available potassium both among and within locations, depending on type of soil, liming history, and level of crop production.

The three soils varied considerably in the production of some of the crops. Dickson and Mountview soils were much inferior to the Pembroke soil in the production of corn and cotton but all three soils were about equal in the production of wheat.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

Adams, W. E., Pearson, R. W., and Morris, H. D. RESIDUAL EFFECTS OF FALL AND SPRING NITROGEN APPLICATIONS IN THE GEORGIA PIEDMONT. Ga. Agr. Res. 2(3): 7-8. 1961.

Nitrogen applied in the fall of the year on Cecil sl was much less effective for corn production than spring-applied nitrogen. Surface broadcast urea was inferior to anhydrous ammonia, ammonium sulfate, ammonium nitrate, and sodium nitrate as a source of fall-applied nitrogen. A 30-pound per acre rate of nitrogen applied in the fall was 60 percent as effective as spring-applied nitrogen, whereas a 90-pound rate applied in the fall was only 49 percent as efficient as spring applied.

Residual effects from fall- and spring-applied nitrogen were measured by yields of oat and corn crops following the fertilized corn crop. When nitrogen was applied at a rate of 90 pounds per acre or higher, marked increases in yields of oat forage and corn grain were obtained as a result of the residual nitrogen.

Table. Effectiveness of Fall-applied Nitrogen from Different Sources in Terms of Spring-applied Nitrogen as Measured by Corn Yields. 3-year Average. Cecil Sandy Loam - Watkinsville, Georgia

Nitrogen Applied in Fall		Equivalent to Pounds N Applied in Spring	Relative Efficiency
Source	Rate		
	Lb./A		%
NH ₃	30	19.5	65
	90	55.0	61
Urea	30	11.5	38
	90	34.5	38
(NH ₄) ₂ SO ₄	30	22.5	75
	90	42.0	47
NH ₄ NO ₃	30	19.0	63
	90	47.0	52
NaNO ₃	30	18.0	60
	90	42.5	47
Average	30	18.1	60
	90	44.2	49

Col. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Carter, J. N., and Allison, F. E. THE EFFECT OF RATES OF APPLICATION OF AMMONIUM SULFATE ON GASEOUS LOSSES OF NITROGEN FROM SOILS. *Soil Sci. Soc. Amer. Proc.* 25: 484-486. 1961.

Additions of $(\text{NH}_4)_2\text{SO}_4$ to a sandy loam at concentrations corresponding to those that might be found in band applications resulted in losses of 0 to 30 percent of the added nitrogen in forms other than ammonia. In these studies of limed and unlimed soils, where the pH values were in the range of 4.7 to 6.9, the losses increased with increase in ammonium sulfate additions, and were greater on limed than on unlimed soil.

Losses of ammonia by volatilization from the soils during incubation periods of 6 to 10 weeks were negligible. Losses of ammonia during air-drying of these soils following incubation and prior to analysis were also negligible in the absence of lime, but were as high as 15 percent on soils limed to pH 6.7 and receiving the largest amount of $(\text{NH}_4)_2\text{SO}_4$. Gaseous losses of nitrogen from two silt loams (Crosby and Fayette) were much smaller than from the sandy loam (Branchville).

SWCRD, ARS, USDA, Beltsville, Md. 20705

Kriebel, H. B. FERTILIZATION INCREASES SAP SWEETNESS IN SUGAR BUSH. *Ohio Farm and Home Res.* 46: 92-93. 1962.

Fertilization can increase the sugar content of the sap of sugar maple trees. Its effectiveness depends to a great extent on stand density; the more crowded the stand, the less is the effectiveness of fertilization.

In the Secrest Arboretum at the Experiment Station, nitrogen was applied in the form of ammonium nitrate by punching holes a foot deep in the forest floor with a bar, at intervals of about 2-1/3 feet, filling the holes two thirds full of fertilizer, and capping with soil.

Nitrogen application will take time to produce results in any case, because the response is apparently indirect. The nitrogen stimulates root growth; this stimulates crown development and consequently greater total carbohydrate production.

Proper care of the forest is essential for profitable maple syrup production. Young stands of sapling and pole size should be thinned periodically to maintain full crowns, and thinned more heavily than if timber production is the sole objective. Nitrogen application after thinning can further increase syrup yield by raising sap sugar content. The gain will probably be less than that obtained by periodic thinning, unless nitrogen deficiency of the soil is a limiting factor.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Marriott, L. F. NITROGEN FERTILIZATION OF PERENNIAL GRASSES. *Pa. Agr. Expt. Sta. B.* 688, 17 pp. 1962.

Experiments to measure the effect of top-dressed nitrogen, phosphorus, and potassium on yields of existing grass sods were established in six counties. The grasses under study were Kentucky bluegrass, common timothy, and common orchardgrass. The results of this study were summarized as follows:

1. On all species, a single application of 50 pounds of nitrogen (N) in the spring produced the greatest amount of forage per pound of N applied. The percentage of crude protein in the forage was no greater than where no N was applied.

2. The second 50 pounds of an application of 100 pounds of N averaged approximately 67 percent of the efficiency in yields between single and split applications. Average crude protein was increased from 10.6 to 12.3 percent by the addition of the second 50-pound increment.
3. An application of 200 pounds of N per acre, whether in a single or a split application, generally produced the greatest amount of forage and crude protein per acre. The split application produced a greater yield of forage where summer rainfall was adequate, while the single application produced about the same yield of forage but more crude protein per acre in areas subject to summer drought.
4. Split applications of 200 pounds of N tended to result in greater aftermath production of forage combined with a lower crude protein percentage in the first harvest than single applications.
5. No significant differences were observed among the N carriers used, ammonium nitrate, ammonium sulfate, and urea.
6. When the rate of application of P_2O_5 was decreased from 50 pounds per acre to 0, highly significant reductions in yields to timothy in Venango and Tioga Counties and of bluegrass in Bradford County occurred. There was a general decline in yields over the period of the experiments where no phosphate was applied. Yields resulting from the use of 50 pounds of P_2O_5 were not significantly different from those where 100 pounds of P_2O_5 were used, except with orchardgrass in Lebanon County.
7. When the rate of application of K_2O was decreased from 100 pounds per acre to 0, highly significant reductions in yields of the grasses occurred at all sites. Yields from 100 pounds K_2O were also significantly lower than those from 200 pounds for all grasses except timothy in Venango County and bluegrass in Bradford County.
8. The influx of volunteer legumes on plots receiving 0 and 50 pounds N per acre appeared to be chiefly related to lime and potash applications. Phosphorus applications appeared to have little effect on the volunteering of legumes.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Evans, E. M., Ensminger, L. E., Doss, B. D., and Bennett, O. L. NITROGEN AND MOISTURE REQUIREMENTS OF COASTAL BERMUDA AND PENSACOLA BAHIA. Ala. Agr. Expt. Sta. B. 337, 19 pp. 1961.

Field tests were conducted for 8 years to determine (1) the fertility and moisture requirements of Coastal Bermuda and Pensacola Bahia grasses, and (2) the effect of nitrogen fertilization on certain chemical properties of soils. The results are summarized as follows: (1) Both grasses are responsive to nitrogen fertilization and have a yield potential of 10 tons or more of hay per acre. (2) The average response to irrigation was not large for either grass at any location. It ranged from almost no increase to as much as 2 tons per acre. (3) Soil acidity increased with increasing rates of nitrogen applied. Rates of nitrogen in excess of 300 pounds per acre rapidly increased acidity of sandy soils to a level considered unfavorable for forage crops. And (4) the use of high rates of nitrogen and the removal of large tonnages of herbage resulted in rapid depletion of soil potassium and phosphorus unless adequate amounts were supplied as fertilizers.

Agr. Expt. Sta., Auburn U., Auburn, Ala.

In Georgia, a well-established sod of Coastal bermudagrass growing on a Tifton ls was fertilized with 6 nitrogen sources at annual rates of 100, 200, and 400 pounds per acre applied as a single or split application for 5 years. The results of this and related experiments resulted in the following conclusions:

1. Ammonium nitrate, the top source, applied at rates of 100, 200, and 400 pounds of N per acre, gave average hay (16% moisture) yields of 5.35, 7.49, and 10.17 tons per acre.
2. Seasonal variations in yield were small but were greatest at the 400-pound-per-acre rate of nitrogen.
3. Ammonium nitrate, ammonium sulfate, ammonium nitrate solution, anhydrous ammonia, urea-ammonium nitrate solution, and urea gave average relative hay yields of 100.0, 96.2, 98.3, 94.0, 92.3, and 81.6, respectively. Relative nitrogen recoveries from these sources were 100.0, 98.6, 95.2, 96.4, 86.1, and 74.0.
4. In sand culture, Coastal bermuda utilized ammonium and nitrate nitrogen equally well.
5. The consistent spring lag in the response of Coastal bermuda to anhydrous ammonia was shown to be largely due to the placement of this material in 16-inch bands away from young plants developing in new root system in the spring.
6. The percent nitrogen recovered decreased with increasing rates of nitrogen for all sources but anhydrous ammonia, which gave a similar recovery regardless of rate.
7. Splitting the nitrogen application did not increase yields in years with no heavy leaching rains. Over the 5-year period, however, splitting the nitrogen significantly increased the yields from all sources of anhydrous ammonia by 0.6 to 1.2 tons per acre.
8. Anhydrous ammonia was equal to the best source when applied in single application in March but was inferior to most sources when split because of application injury and lag in response.

CRD, ARS, USDA, Tifton, Ga.

Beaty, E. R., Woodworth, R. C., Slappey, G. A., and Powell, J. D. RESPONSE OF PENSA-COLA BAHAGRASS TO NITROGEN. Ga. Agr. Expt. Sta. B. N. S. 85, 27 pp. 1962.

The response of Bahagrass to nitrogen was measured for three seasons, 1955-57, at the Americus Plant Materials Center near Americus, Ga. In terms of 20 percent moisture hay, equivalent yields were estimated to be 3 tons when 40 pounds of N were used per acre, 4 tons when 80 pounds of N were used, 5 tons when 140 pounds of N were used, and 5.7 tons when 220 pounds of N were used.

The nitrogen application rate did not materially influence the seasonal distribution of forage production. June and July accounted for an average of 64.0 percent of total production, April and May production accounted for 12.4 percent, and August and September accounted for 23.6 percent.

Several types of analyses were used to determine most profitable nitrogen rates for Bahagrass production under different farm and economic situations. For situations where land is the limiting resource in the farm business, the most profitable rates were determined for hay values of 10, 20, 30, and 40 dollars per ton. A variation of from 80 to 220 pounds of nitrogen was found to be most profitable, depending on which hay value is appropriate.

Minimum cost per ton is an appropriate objective when land and fertilizer can be varied freely in desirable proportions. Under these conditions, the most profitable fertilization rates varied from 10 pounds of nitrogen when land has no alternative uses to 155 pounds of nitrogen for a \$30 annual land charge. For practical purposes, differences in labor costs had no effect on most profitable fertilization rates. However, increasing land costs require a substantial increase in fertilization to minimize cost of forage per ton.

Nitrogen rates which would minimize the quantity of a particular resource needed to obtain given levels of income when the Bahiagrass was utilized through a grade cow-calf operation was determined. With the number of brood cows as the limiting resource, and with calves selling for 19 cents per pound, use of 20 pounds of nitrogen per acre was found to be most profitable. With land as the limiting resource, 120 pounds of nitrogen per acre was found to be the most profitable rate. The corresponding nitrogen rates per acre for other resources which may be limiting are: With limited cash operating expense, 20 pounds; with limited investment capital 40 pounds; and with limited labor, 20 pounds.

- When calves sell for a price higher than 19 cents a pound, higher nitrogen rates may be used profitably. For example, when the selling price of calves is 24 cents instead of 19 cents and land is the limiting resource, 160 rather than 120 pounds of N is the most profitable rate. For farms with a lower cost structure, or where efficiency of production is higher than that specified above, higher rates of N can be used profitably.

Col. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Thorne, G. N. EFFECT OF APPLYING NITROGEN TO CEREALS IN THE SPRING OR AT EAR EMERGENCE. *J. Agr. Sci.* 58: 89-96. 1962.

Nitrogen applied at ear emergence to winter wheat or spring barley grown in pots with various levels of basal nitrogen fertilizer, increased grain and total dry weight much less than similar amounts of nitrogen applied in March or April. No nitrogen was absorbed after ear emergence from unfertilized soil, or from the early application. At maturity equal amounts of nitrogen had been absorbed from early and late applications.

Early nitrogen increased final ear number by increasing the number at emergence and also increased grain size. Late nitrogen had negligible effect on yield of ears present when it was applied and caused the production of new shoots with small ears. Nitrogen applied at both times increased leaf area duration after ear emergence similarly; early nitrogen by increasing area at ear emergence and late nitrogen by delaying senescence of existing shoots and causing production of new shoots. The efficiency in grain production of the leaf area present after ear emergence was less with late than with early nitrogen.

These results differed from those of field experiments in which early and late nitrogen usually increased grain yield similarly, probably because in the field there were no late unproductive tillers and all the late nitrogen was utilized in increasing grain yield of existing shoots. Another difference was that nitrogen uptake from soil in the field continued until maturity.

These experiments add to the evidence that the results of pot experiments cannot necessarily be applied directly to field crops.

Rothamsted Expt. Sta., Harpenden, Herts, England.

Spurgeon, W. I., and Grissom, P. H. COTTON SEEDLINGS MAY SUFFER FROM NITROGEN DAMAGE. *Miss. Farm. Res.* 25(3): 1-2. 1962.

Greenhouse studies reveal that typical Mississippi Delta cotton soils with a nitrate nitrogen content above 300 p.p.m. produces injury and retards growth of cotton seedlings.

Injury increased as the nitrogen concentration increased and was more severe on sandy soil. Cottonseed germination was retarded at 300 p.p.m. of nitrate nitrogen in the loamy sand soil and at 500 p.p.m. of nitrate nitrogen in the silt loam soil. Seeds germinated slower in both soils at nitrate nitrogen concentrations above 500 p.p.m.

Under field conditions, nitrogen injury to cotton in the germination and seedling stages is caused by improper placement of nitrogen. To avoid the possibility of injury, nitrogen should be drilled into the soil about 6 inches to the side of the seed drill.

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

Jones, W. F., Lancaster, J. D., Arnold, B. L., Hurt, B. C., Jr., Coats, R. E., and Walton, L. NITROGEN SPRAY NOT PRACTICAL ON COTTON LEAVES. Miss. Farm. Res. 25(2): 1, 5-6. 1962.

Field experiments on applying nitrogen to cotton leaves was completed recently by the Experiment Station.

In contrast to soil application, foliar feeding of nitrogen to cotton during the fruiting period does not appear to be practical, even though moderate nitrogen deficiency may be corrected by spraying frequently with dilute nitrogen solutions, particularly urea.

Urea should not be applied to the foliage just to provide insurance against nitrogen deficiency, because yields may be reduced if additional nitrogen is not needed.

Solutions containing ammonium nitrate are considered unsatisfactory for foliar application to cotton. Even at low concentrations, they burn the leaves and the nitrogen is not utilized efficiently.

Biuret, in amounts commonly found in fertilizer grade urea, was not toxic to cotton when applied to the urea solution (3 percent N).

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

Wagner, G. H. NITROGEN FERTILIZATION OF SOYBEANS. Mo. Agr. Expt. Sta. Res. B. 797, 23 pp. 1962.

Different nitrogen fertilizer treatments was studied for their effect on yield and seed quality of the Clark variety and a non-nodulating variety of soybeans over a period of three growing seasons. The soybeans were grown on a claypan soil that had been adequately fertilized with calcium, phosphorous, and potassium.

The nitrogen treatments did not result in any increase in yield of the Clark soybeans. Nitrogen fertilization did result in significant increases in yield of the non-nodulating soybeans in two of the seasons which were apparently associated with limited soil nitrogen. In one of these cases the side-dress treatments were slightly superior to the plow-down treatments. In the other case the reverse was true. Even when given a liberal nitrogen treatment, however, the non-nodulating soybeans yielded no higher than the well nodulated Clark soybeans.

There was little or no evidence that the seed weight of the Clark soybeans was influenced by the nitrogen treatments under study. The seed weights of the non-nodulating soybeans, however, were found to be affected by the nitrogen treatments. The maximum effect was an increase in seed weight of no more than 10 percent. The seed weight was generally correlated with the yield for these non-nodulating soybeans. The coefficient of correlation was rather low, however, which would indicate that at best only a small part of the yield variation attributed to the different treatments could be explained by variation in seed weight. It

is assumed that a factor of greater importance in explaining the effect of treatments on yield is that of the number of mature seeds which were produced. Significant differences in seed weight other than those related to variety or treatment differences were assumed to be related to the supply of moisture during the latter part of the growing season.

The percentages of nitrogen and fat in the Clark soybean seeds appeared to be influenced somewhat by the differences in weather which were noted for the three growing seasons during which the study was conducted. The composition of these soybeans with regard to nitrogen and fat was not affected by the different nitrogen treatments under study. The percentage of nitrogen and fat in the non-nodulating soybean seeds was significantly influenced by the nitrogen treatments. In general, the percentage of nitrogen was positively correlated and the percentage of fat was negatively correlated with the rate at which nitrogen was plowed down. Side-dress treatments at the bloom stage had a greater influence on composition of the seed than did side-dress treatments later during seed set. Only in the one season during which moisture was most limiting did the nitrogen treatment alter the composition of the non-nodulating soybean seed to the extent that the resulting percentage nitrogen was higher and the resulting percentage of fat was lower than for the Clark variety.

Tables.

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

Hatch, R. E., Tefertiller, K. R., and Burleson, C. A. MOST PROFITABLE USE OF NITROGEN IN THE PRODUCTION OF CABBAGE IN THE LOWER RIO GRANDE VALLEY OF TEXAS. *Tex. Agr. Expt. Sta. Prog. Rpt.* 2232, 8 pp. 1962.

A cabbage fertilizer test was conducted on Harlingen c soil in 1960 at Weslaco, Tex. Rates of nitrogen used varied from 0 to 340 pounds. The design of the experiment was a randomized block. At all levels of application, half the nitrogen was banded below the seed zone as a preplant application; the remaining half was applied as a side-dressing later in the growing season.

Maximum production of slightly more than 24 tons of cabbage per acre was obtained with a 238-pound application of nitrogen. The most profitable level of nitrogen fertilization varied from a 133-pound application with cabbage valued at \$5 per ton and nitrogen valued at 16 cents per pound to a 235-pound application with cabbage valued at \$60 per ton and nitrogen valued at 8 cents per pound.

The data indicate that near maximum profits can be made every year by applying approximately 209 pounds of nitrogen per acre.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Tyler, K. B., Lorenz, O. A., Takatori, F. H., and Bishop, J. C. UREA NITROGEN FOR POTATOES. *Amer. Potato J.* 39: 89-99. 1962.

The choice of a nitrogen source for potato production in the light-textured, heavily irrigated soils of California has proven to be of equal importance to the selection of proper rate of application. Many field tests have been conducted at the U.S.D.A. Cotton Experiment Station near Shafter, Calif., in which sources of nitrogen have been compared. Urea was tested against ammonium sulfate in 11 of these tests. In every comparison, yields from ammonium sulfate were higher than yields from the urea with differences as great as 100 sacks or more per acre. In two tests where half of the nitrogen supplied came from urea and the

other half from ammonium sulfate, yields were equal to those obtained with ammonium sulfate alone and appreciably better than those where all of the nitrogen was obtained from urea.

The experiments reported here were conducted in 1959-60 to determine whether or not these observations applied to other areas and soils, and to study the reasons for the inferior behavior of urea as a nitrogen source in comparison with ammonium sulfate. The authors concluded that:

1. The source of nitrogen influenced the total yield of potato tubers, the nutrient concentrations in the potato petiole and the appearance of growing plants, especially in fields of low available phosphorous.
2. Urea resulted in higher nitrate-nitrogen, calcium, and magnesium concentrations in the plant petiole, but in lower phosphate-phosphorous concentrations as compared with ammonium sulfate.
3. Urea application in soils of neutral and alkaline reaction resulted in lower total yields than did ammonium sulfate at equal rates of nitrogen. In acid soils, urea appeared equal to ammonium sulfate.
4. Potatoes from urea-fertilized plants grown on soils of low available phosphorous exhibited symptoms of phosphorous deficiency during early season but outgrew these symptoms as the plants approached maturity.
5. Increasing the biuret content in the urea material from 0.2 to 1.3 percent had no effect on yield or plant appearance.
6. In neutral and alkaline soils, ammonium sulfate was more efficient than urea as a nitrogen source for potatoes. In acid soils, indications were that urea equaled ammonium sulfate in efficiency for potatoes.

U. Calif., Davis, Calif.

Fox, R. L., and Hoover, C. A. SULFUR FERTILIZERS AID CORN AND SOYBEAN PRODUCTION. Nebr. Agr. Expt. Sta. Q. 7 (4): 12-13. 1961.

Beginning in 1959 an intensive program of sulfur research was begun. Eight sulfur tests using corn as the experimental crop were conducted in Northeast Nebraska on acid sandy soils during 1959-60.

On the basis of observations and research completed to date the authors concluded that:

1. Symptoms of sulfur deficiency are frequently seen in young corn growing on sandy soils in northeast Nebraska.
2. The deficiency is most frequently seen in areas where erosion has removed the top soil and organic matter supply is low.
3. Deficiency symptoms are light green or yellow green leaves with green veins. Sulfur deficiency can be mistaken for deficiencies of iron and zinc but the latter most frequently occurs on alkaline soils.
4. Deficiency symptoms tend to disappear as the growing season advances.
5. Maximum response to sulfur fertilizers is seen when the corn is 1 to 2 months old.
6. Greatly improved growth of young corn and the disappearance of deficiency symptoms may result from sulfur fertilization with little or no increase in yield of grain.
7. When a sulfur deficiency exists, sulfur fertilizers will usually hasten maturity.
8. Increased yields, earlier maturity, and/or better early growth and color have accompanied the use of sulfur fertilizers for corn in 8 out of 9 trials conducted during 3 years in Holt, Antelope, Pierce, and Stanton Counties.
9. Increases in corn yields have ranged from 1 to 15 or more bushels per acre.

10. Sulfur fertilizers employed in these tests were: calcium sulfate (CaSO_4 or gypsum), ammonium sulfate, magnesium sulfate (MgSO_4 or Epsom salt), and elemental sulfur (S). Of the fertilizers studied those supplying the sulfate form of sulfur appear to be most readily available in the acid, sandy soils studied.
11. The most logical time to apply sulfur is with the starter fertilizer at planting time. Sidedress applications at first cultivation were also effective.
12. Ten pounds of sulfate sulfur per acre has given results equal or superior to 20 or 40 pounds of sulfate sulfur when the fertilizer was applied under the seed at planting time.

Many fertilizers contain significant amounts of sulfur. Ammonium sulfate (21-0-0) and ordinary superphosphate (0-20-0) are examples of materials which supply sulfur in addition to nitrogen and phosphorus respectively. Agricultural gypsum and elemental sulfur are also economical sources of sulfur.

Results indicate that more efficient methods are needed for utilizing elemental sulfur on acid sandy soils.

Soils are not stable systems. Cultivation has brought about accelerated organic matter decomposition. This decline has decreased the amount of organic sulfur which in turn releases available sulfate.

Large areas of silty soils low in organic matter occur in Nebraska. Sulfur will increase the growth of alfalfa on these soils in the greenhouse; but very little has been done to determine the sulfur needs of crops growing on these soils in the field.

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

Lancaster, J. D., Murphy, B. C., Hurt, B. C., Jr., Arnold, B. L., Coats, R. E., Albritton, R. C., and Walton, L. BORON NOW RECOMMENDED FOR COTTON. Miss. Agr. Expt. Sta. B. 635, 11 pp. 1962.

On the basis of recent experimental results along with the observation of severe boron deficiency in many farm fields, it is recommended that cotton in the Hill Section of Mississippi be fertilized with boron. Fertilization of soils in the Delta-Foothills with boron may also be beneficial particularly following the application of lime.

Cotton may be fertilized with boron by: (1) Applying a borated fertilizer; (2) foliar application perhaps with insecticide solution at regular intervals during fruiting period; and (3) the direct application of borate fertilizers to the soils. To obtain uniform distribution with direct application, it is recommended that a borate solution be sprayed on the soil either before, after, or during seed bed preparation.

Large increases in the yield of cotton were obtained with boron on extremely deficient soils. Fortunately very little of the cotton acreage is severely deficient in boron and a more reasonable expectation would be for yield increases ranging up to 100 pounds per acre. An increase in the yield of over 5 pounds of seed cotton per acre would pay for the boron.

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

Harper, H. J. LIMESTONE FOR IMPROVEMENT OF ACID SOIL IN OKLAHOMA. Okla. Expt. Sta. Processed Ser. P-402, 35 pp. 1962.

Agricultural limestone applied to moderately acid soils increased the average annual yield of alfalfa hay in three experiments more than one-half ton per acre at a prorated annual cost of about \$1 for the lime. Lime also increased the efficiency of superphosphate.

Yields of sweet clover were increased on slightly acid, moderately acid, and strongly acid soils by broadcasting agricultural limestone at rates needed to neutralize acidity, or by drilling the lime in the row at lower rates per acre with a phosphate fertilizer when the sweet clover seed was planted.

The average yields of barley, lespedeza, grain sorghum, and spring oats following alfalfa were increased about 20 percent where lime was applied to improve the growth of the alfalfa on a moderately acid soil containing about 1.5 percent organic matter. The average yields of these crops were increased about 8 percent on land where lime and superphosphate were applied on the alfalfa as compared with superphosphate alone. Cotton yields on the area where alfalfa had been grown for 4 years were not increased as much by liming as were small grain, grain sorghum, or spring oats yields.

Lime applied to a moderately acid soil before bermudagrass was planted increased average beef production 27 pounds per acre over an 8-year period. Korean lespedeza made a better growth on limed soil than on unlimed soil. Superphosphate and lime increased beef production about 33 pounds per acre over the average production obtained on the limed pasture.

Lime applied to a moderately acid soil where Korean lespedeza was grown in a cropping system with fall planted oats, increased the average production of lespedeza hay about 27 percent. Superphosphate and lime produced a further increase of 57.5 percent.

Lime increased the production of sweet clover on a Vanoss s1cl, but the residues from the sweet clover plots treated with a phosphate fertilizer did not increase the yield of oats or produce a profitable increase in the yield of wheat on this soil which is high in organic matter.

Limestone ground to pass a 60-mesh sieve neutralized an acid soil more rapidly and produced a higher yield of sweet clover than the same limestone ground to pass a 10-mesh sieve, or another limestone that contained a higher percentage of coarse particles.

Lime plus superphosphate applied in 4-, 5-, and 6-year rotations with wheat and sweet clover produced as much or more wheat than was obtained where wheat was planted every year on limed land and fertilized with superphosphate.

Lime applied to three areas where wheat was planted every year on moderately acid soils did not produce a significant increase in grain production.

Oat yields were increased 100 percent or more by sweet clover residues on fertilized and unfertilized Woodson c1 soil. Corn yields were not profitable. Wheat and mungbeans were profitable and some yield increase was obtained from lime and superphosphate fertilization.

Oat yields were profitable in eastern Oklahoma over a 3-year period following the growth of sweet clover, and corn yields were profitable where lime and phosphate fertilizer had been applied to improve the growth of sweet clover on an eroded low-nitrogen soil.

Lime increased the production of oats in which Korean lespedeza was planted each year on three of five acid soils in northeast Oklahoma. Oat yields were increased on all soils where treble superphosphate was applied at time of planting. A further increase in yield was obtained on plots treated with lime and treble superphosphate, but the cost of soil treatment was nearly equal to the average value of the increase in yield.

White clover production was increased about 11 percent by an application of lime and superphosphate as compared with superphosphate applied alone on a claypan soil. Very little white clover grew in an upland or a bottomland pasture where lime was applied without superphosphate.

The yields of cotton, spring oats, grain sorghum, and cowpeas were not increased appreciably over a 12-year period on Kirkland sil when these crops were grown in a 4-year rotation on limed and unlimed soil.

Sericea lespedeza production was not improved by liming a moderately acid soil over a 5-year period with or without 20 percent superphosphate applied at the rate of 300 pounds per acre when the experiment began.

The lime need of soil was increased where ammonium sulfate was applied annually for 15 years in a pasture experiment. Annual legumes grown in a rotation with oats and corn and the oxidation of nitrogen in natural soil organic matter also increased the acidity of a high percentage of the samples tested.

Coarse limestone particles varying in diameter from 1/16 to 1/20 inch placed in a strongly acid soil dissolved about twice as fast as particles varying in diameter from 1/8 to 1/16-inch. The 1/16 to 1/20 inch particles dissolved about four times as fast as particles varying in diameter from 1/4 to 1/8 inch.

Tables.

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

Reith, J. W. S. LONG-TERM EFFECTS OF VARIOUS LIMING MATERIALS. Empire J. Expt. Agr. 30(117): 27-41. 1962.

The effectiveness of a range of liming materials was measured in three field experiments carried out for 12 or 14 years. The data for the first 5 years were reported previously and the subsequent results are presented. All lime treatments produced higher yields of most crops and increased the pH value and acetic-soluble calcium content of the soil. Except for blast-furnace slag which was consistently slightly inferior, there were no differences in the residual values of the various materials.

Liming generally increased the calcium contents of the crops and the removal of other nutrients. Burnt magnesian lime produced crops with magnesium contents about 50 percent higher than the other forms, but the yields showed no response to this nutrient.

From the barley yields, and the pH and acetic-soluble CaO determinations on the soils, the average annual loss of lime ranged from about 1.25 to 2.5 cwt. CaO per acre depending on rate of application. At Craigie-buckler, after 14 years, the soils in the plots to which the 35 cwt. CaO treatments were applied had practically the same pH values and acetic-soluble CaO contents as at the beginning of the experiment. For magnesium, the soil results show a mean annual loss ranging from about 5 to 90 lb. MgO per acre depending on the original content of the soil and on lime treatment.

Macaulay Inst. Soil Res., Aberdeen, Scotland.

Hourigan, W. R., Franklin, R. E., Jr., McLean, E. O., and Bhumbra, D. R. GROWTH AND CA UPTAKE BY PLANTS AS AFFECTED BY RATE AND DEPTH OF LIMING. Soil Sci. Soc. Amer. Proc. 25: 491-494. 1961.

The study involved the liming of two acid soils, Astabula high in extractable Al and Wooster of similar pH, but low in extractable Al. Portions of each soil were treated in the laboratory with $\text{Ca}(\text{OH})_2$ (labeled with Ca-45) to bring the pH to three levels. One of the soils also had been maintained in the field at the same pH levels for many years. Three depths of topsoil were used with corresponding depths of subsoil. These soils were placed in 18-inch cylinders and cropped to alfalfa.

Plant yields, root proliferation, and consequent uptake of Ca depend largely on adequate level of lime in both topsoil and subsoil. If sufficient lime was applied to the topsoil, near

maximum yields were obtained regardless of lime level of the subsoil. Subsoil liming had minor effects on yield and uptake of Ca except when the topsoil was shallow and more acid. The soil with the highest level of Al responded proportionately more to the lime added. Freshly added Ca appeared to be more available to alfalfa than Ca added earlier in the field. The percentage of Ca from the topsoil applied source increased from 8 to 100% as the rate of liming increased from 1/2 to 8 tons per acre in a 3-inch layer of the most acid soil. With increased level of lime in the subsoil, smaller percentages came from the Ca applied to the topsoil. Root growth generally reflected what yields and Ca uptake had indicated. Root cation-exchange capacities increased with increased rate of liming.

J. Article 99-60, Ohio State U., Wooster, Ohio.

Spencer, V. E. PERFORMANCE OF SOIL AMENDMENTS ON NEVADA SOILS. Nev. Agr. Expt. Sta. B. 216, 32 pp. 1961.

In terms of profit or loss, returns from the application of soil amendments (and of some fertilizers, for comparison) were reported for 10 experiment fields located in various parts of central and northern Nevada. Soils with pH values up to 9.3 have usually responded very profitably to 1 fertilizer or another, but have shown little or no benefit from the use of sulfur, gypsum, or sulfuric acid.

On the Jones field in Washoe County, the soil had a pH of 10.0, and the alkali was 5 times as strong as the strongest found on any of the other experiment fields. Heavy applications of fertilizer on this field were of no value, while sulfur and gypsum produced good stands of alfalfa. Where neither of these materials was applied, there was scarcely any alfalfa. The sulfur and gypsum were equally effective, as far as the yields they produced were concerned. The high cost of the sulfur prevented its showing a profit, but during a period of two seasons gypsum gave a profit of \$74.10 per acre. The soil's alkali was simply too strong to permit any worth-while crop growth, so the first need was for an alkali corrective.

A grower contemplating treatment of land for alkali correction should first have the pH of the soil determined; and then, unless the value found is quite high, he should be cautious about making any large expenditure for an amendment. A transition range in pH, from soils which respond well to fertilizers up to those which are too alkaline for fertilizer effectiveness and first need elimination of excessive alkali, lies between 9.3 and 10.0. If a soil were found to have a pH value within this range, it would be prudent first to try gypsum or other amendments, and also fertilizer, on a small scale.

Agr. Expt. Sta., Max C. Fleischmann Col. Agr., U. Nev., Reno, Nev.

Eno, C. F. CHICKEN MANURE: ITS PRODUCTION, VALUE, PRESERVATION, AND DISPOSITION. Fla. Agr. Expt. Sta. C. S-140, 18 pp. 1962.

Poultry manure contains more of the nutrient elements than any other farm manure. In this country, however, nutrients from manures of all kinds constitute only a very small percentage of the total quantities applied to cropland. In spite of its beneficial effects on plant growth, in many cases manure is allowed to become practically worthless through improper management. There are several reasons for improper handling and utilization of poultry manure. Among these are: (1) Lack of information on the value of manure as a source of plant nutrients and how to properly care for it; (2) failure to recognize how and where to utilize it; and (3) recognition of the fact that utilizing it as a nutrient source is often not economical.

This circular brings together the information presently available in an effort to promote the better utilization of this valuable byproduct of the poultry industry.

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

Winter, A. R. CHICKEN MANURE--GOOD FERTILIZER. Ohio Farm and Home Res. 47: 29. 1962.

Ground poultry manure will not burn grass, flowers, or vegetables when used in moderate amounts. It is practically odorless, is a good soil conditioner, makes a good mulch, and has about half the fertilizing value of a 5-10-5 inorganic fertilizer. Poultry manure does not contain viable weed seeds.

Fresh poultry manure was mixed with some previously dried and ground manure with a garden rototiller for aeration and drying. When dried to 15- to 20-percent moisture content, it was ground in a hammer mill equipped with a 1/2-inch screen.

The value of the manure was tested on two types of soil. One was a gray heavy clay subsoil on a strip of land fill. The other soil adjacent to it, was a sandy loam sod covered strip that had not been plowed for many years. Both tracts were plowed and prepared for planting in a similar manner.

The manured subsoil produced nearly as good growth of grass as the good soil. Manuring the good soil improved it very little. Applying the manure as a mulch produced slightly better results than working it into the soil with a rototiller. There was no indication of burning of the grass in any of the plots. There were no more weeds in the plots fertilized with poultry manure than in the unfertilized controls. However, the weeds present made more rapid growth where manure had been applied.

Manuring the poor soil improved petunia plant growth and flowering. The plants made excellent growth in the good soil, without the application of manure. No burning or other detrimental effect was observed where manure was applied in the soil, as a mulch, or both ways.

Tomato plants were rated for growth and fruiting. They responded remarkably when grown on the poor soil which had been fertilized with manure. They grew well on the good soil without fertilization. There was no detrimental effect resulting from the dried ground poultry manure application, either in the soil, or as mulch.

Roses and chrysanthemums also made good responses to dried ground poultry manure applications.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Benne, E. J., Høglund, C. R., Longnecker, E. D., and Cook, R. L. ANIMAL MANURES: WHAT ARE THEY WORTH TODAY? Mich. Agr. Expt. Sta. C. B. 231, 15 pp. 1961.

Animal manures have long been regarded as valuable byproducts of livestock farming, but with today's plentiful supply of commercial fertilizers and the high cost of labor and equipment, the question has been raised whether it is still profitable for farmers to collect and use manures for fertilizing purposes.

This study indicates that manures are still valuable as a source of plant nutrients and as soil conserving materials. The byproducts of soil microorganisms are responsible for soil aggregation, a condition essential for high productivity of clayey soil. These organisms require organic matter as a source of energy for their life processes, and animal manures are one of the best sources of food for them, especially where use of green manure crops

may not be practicable. Light applications of manure, added frequently, are inducive to continued microorganism activity in the soil.

After the composition of manures is determined by chemical analysis, the value of the nutrients they contain can be readily calculated. At present day fertilizer prices, the nitrogen, phosphorous, and potassium contained in manures will more than pay the cost of handling and spreading them. The secondary and minor nutrients add to this value on the soils where they are needed. Modern fertilizers contain very small amounts of these extra plant foods, so manures may be even more valuable than when the older, low-grade materials were used.

Field experiments have furnished another way of arriving at manure values. The Michigan data, showing values greater than is accounted for by the value of the nutrients, are typical of those published elsewhere. The extra value no doubt results from the addition of the organic matter, a substance very important in fertility maintenance.

Table 1.--Average amounts and combined value of nitrogen, phosphorus, and potassium in manures from different farm animals

Kind of manure	Percent water	Pounds per ton of manure			Value per ton ^(a)
		Nitrogen	Phosphorus	Potassium	
Chicken--					
a. From dropping boards, without litter.....	54	31.2	8.0	7.0	\$7.06
b. With old floor litter ^(b) ..	61	33.8	12.4	12.8	8.95
Dairy cattle.....	79	11.2	2.0	10.0	2.73
Fattening cattle.....	80	14.0	4.0	9.0	3.61
Hog.....	75	10.0	2.8	7.6	2.63
Horse.....	60	13.8	2.0	12.0	3.22
Sheep.....	65	28.0	4.2	20.0	6.33

^(a) Calculated on the assumption that the present retail costs in cents per pound are as follows: nitrogen 14.5; phosphorus, 26.8; and potassium, 5.7.

^(b) Probably contained some feed residues.

Table 2.--Other essential elements in manures from different animals and in several common livestock feeds

Kind of manure or feed	Percent water	Pounds per ton										
		Boron	Calcium	Copper	Iron	Magnesium	Manganese	Molybdenum	Sulphur	Zinc		
LIVESTOCK												
Chicken--												
a. From dropping boards, without litter.....	54	.12	74.0	.03	.93	5.8	.18	.011	6.2	.18		
b. With old floor litter (a)	61	.03	28.0	.02	.31	2.4	.08	.005	3.3	.10		
Dairy cows.....	82 (b)	.03	5.6	.01	.08	2.2	.02	.002	1.0	.03		
Fattening cattle.....	78 (b)	.04	2.4	.01	.08	2.0	.01	.001	1.7	.03		
Hog.....	72 (b)	.08	11.4	.01	.56	1.6	.04	.002	2.7	.12		
Horse.....	73 (b)	.03	15.7	.01	.27	2.8	.02	.002	1.4	.03		
Sheep.....	69 (b)	.02	11.7	.01	.32	3.7	.02	.002	1.8	.05		
FEEDS												
Alfalfa hay	11-12 (c)	.03	23.8	.03	.27	6.1	.09	.002	5.0	.08		
Corn grain.....	11-12	.01	.4	.01	.10	3.0	.02	.0002	.7	.05		
Mixed hay	11-12	.03	11.6	.03	.27	3.1	.13	.003	3.1	.05		
Oat grain.....	11-12	.01	1.4	.03	.14	3.6	.17	.0005	2.3	.06		
Soybean seeds	11-12	.01	2.8	.05	.28	5.3	.09	.022	5.8	.12		
Wheat grain	11-12	.01	1.0	.02	.07	2.4	.08	.0004	1.6	.06		

(a) Probably contained some feed residues.

(b) Represent different batches of manure than those in Table 1.

(c) Estimated average for air-dry feeds.

Confinement hog systems designed for storing liquid manure for later use on cropland present at best a break-even situation for the typical hog producer raising 500 to 750 hogs, with only a small chance that the manure is worth more than the additional costs involved in saving rather than disposing of it. The most profitable practice for the average farmer who raises hogs in confinement is to dispose of the liquid manure in a lagoon and use commercial fertilizers on his fields. This economic choice is reinforced by esthetic considerations.

These conclusions are drawn from facts observed in a 1959-1960 economic study of confinement hog production on 72 Illinois farms. Most operators in the study used bedding in their barns and removed the solid manure with tractor-powered equipment. Some farms had newly designed finishing buildings which provided for handling manure as a liquid. Manure was scraped or flushed from the feeding floor each day and carried by water to a storage tank for later use on the land, or to a lagoon for disposal.

Findings of the study indicate that the various operations involved in manure removal take about three-fourths of the total labor input used in confinement growing and finishing of hogs on the average Illinois farm. Slotted floors in newly designed buildings offer promise for reducing the work of cleaning.

Adequate facilities for storing and spreading liquid manure consist of a cast-in-place concrete storage tank, and electrically driven auger to pump the manure from storage, and a tractor-drawn 500- to 1,000- gallon applicator tank. Calculated initial capital requirements range from around \$2 per hog for equipping a unit with an annual capacity of 2,500 head to more than \$6 per hog for a 250-hog unit. Annual costs for storing, pumping, hauling, and spreading liquid manure drop from \$1.28 per hog in small operations to 62 cents per hog in units producing 2,500 head annually.

Lagoons for disposing of liquid manure can be constructed on an average site for 30 to 80 cents per hog, depending upon size of operation. Lagoons have low maintenance costs, and they eliminate the expensive and disagreeable task of pumping, hauling, and spreading manure throughout the year. All of the fertility value of the manure, however, must be sacrificed to gain these cost advantages.

Fresh hog manure is a valuable source of nitrogen, phosphorous, and potassium. The quantity of these elements excreted by one hog while growing from 50 to 220 pounds is worth about \$1.62 at 1960 prices for the same elements in commercial fertilizers. Producers could realize up to nearly \$1 per hog above costs if they could preserve all of this fertility value and use it on crops as they would normally use commercial fertilizers.

A high proportion of the fertility value of liquid manure can be utilized if the manure is stored under anaerobic conditions, and if it is plowed under immediately after it is spread on the land. Fertility losses, especially of the highly unstable nitrogen, begin on the feeding floor and continue while the manure is in storage and lying on the fields. Much potential value is wasted when manure must be spread on low-value crops or wasteland.

The typical producer will probably lose one-half to three-fourths of the fertility value in hog manure that is handled as a liquid. If a producer has an effective manure-handling system and thus manages to recover as much as half the original fertility value, he can pay the additional costs of storing the manure and spreading it on cropland, including a \$1.20 an hour charge for labor. Some additional return may be realized in the larger operations, which afford some economies to scale in the use of equipment. If losses are greater than 50 percent, the value of the manure will not pay for the additional costs of getting it on the land.

The relative economic position of the storage method versus lagoon disposal of liquid manure may be influenced by factors other than the value of the soil fertility elements and the cost of getting them on the cropland. Among the items worth considering are; the probable imbalance of the nitrogen, phosphorous, and potassium in manure; the possibility of

reaching a buildup of plant nutrients in the soil on small farms with large livestock enterprises, to the point where additional manure gives little or no response; and compaction of the soil and damage to plants by heavy equipment during the spreading operation. Another consideration is the lessening of odors, flies, disagreeable working conditions, and unattractive appearance when manure is disposed of in a lagoon rather than stored and later spread on the land.

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

Connell, C. H., and Garrett, M. T., Jr. DISINFECTION EFFECTIVENESS OF HEAT DRYING OF SLUDGE. Proc. of the Sixteenth Industrial Waste Conference May 2, 3, and 4, 1961. Engin. B. of Purdue U., Engin. Ext. Serv. Series 109: 105-115. 1962.

Standard tests for bacteria of the coliform group have shown fewer than two per g. in each of 136 samples of heat dried sludge from the Houston plant; in 15 to 30 samples from the Galveston plant; in 10 to 12 samples from Chicago; and in 7 of 11 samples from the Baltimore plant. Of the 15 positive samples from Galveston, 2 from Chicago, and 4 from Baltimore, the highest number of coliforms was 17 per g., and the average for the 21 positive samples was six per g.

The consistent destruction of coliforms, as shown in the 136 samples collected over a 9-month period of standard operation of the Houston plant, substantiated by the results obtained on the samples from the other plants constitute a demonstration of present day colloidal effectiveness of the CE - Raymond Process for heat drying of sewage sludge.

The bacterial, parasitic, and viral enteric pathogens that may commonly occur in sewage sludge have the same order of heat sensitivity as do coliform bacteria. Therefore, it is assumed that accompanying the destruction of coliforms in the heat drying processes, there is equivalent destruction of these enteric pathogens.

The observed numbers of remaining 35 C. organisms in the heat dried samples ranged from 30,000 per g. to 1,500 per g. The indicated number (MPN) of remaining nonconfirming lactose fermenters--predominately spore-bearing bacteria--ranged from 14 per g. to 240,000 per g. The reduction of heat resistant organisms to the comparatively low numbers is further confirmation of the disinfection effectiveness of the heat drying processes. It also affords indirect evidence--that the numbers of pathogenic spore-bearing bacteria, such as Clostridium welchii and clostridium tetani, are significantly reduced.

The results of these studies afford added assurance of safety in the use of heat dried sewage sludge as fertilizer, even for growing flowers and vegetables.

U. Tex. Medical Br., Galveston, Tex.

Salinity and Alkali Problems

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

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.

Results indicate that the harmful effects of soluble salt on barley can be decreased by applying a complete fertilizer, if the salt level of the soil is low to moderate. If the salt level is high, fertilizers intensify 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., State College, New Mex.

Sims, J. R., and Dregne, H. E. FERTILIZER RESPONSE ON A SODIUM SOIL. N. Mex. Agr. Expt. Sta. Res. Rpt. 63, 6 pp. 1962.

A fertilizer experiment was conducted on a calcareous sodium soil, using different sources of nitrogen, phosphorus, and potassium in several different combinations, with and without added calcium. There was no response to nitrogen or calcium but there were significant responses to the nitrogen- phosphorus and nitrogen phosphorus- potassium combination. The combination of potassium and phosphorus in potassium dihydrogen phosphate was much more effective than when superphosphate and two common forms of potash fertilizer were applied together. Muriate of potash produced higher yields than sulfate of potash.

Explanations for the results obtained are based upon the nitrogen-fixing capabilities of blue-green algae and upon the concept of ion antagonism.

The fact that blue-green algae may supply considerable nitrogen to sodium soils is no surprise. Algae grow profusely and rapidly on slowly permeable soils after an irrigation, and their ability to fix atmospheric nitrogen is well known. This experiment indicates that the addition of nitrogen by algae was sufficient to take care of the crop needs.

The apparent absence of beneficial effect from calcium in calcium nitrate and in single superphosphate was not expected. Previous studies had concluded that low calcium availability was a likely cause of poor plant growth in sodium soils. It still seems to be a reasonable explanation, but this experiment did not confirm it.

Agr. Expt. Sta., N. Mex. State. U., State College, N. Mex.

Cairns, R. R. SOME MOISTURE RELATIONS IN A SOLONETZIC SOIL COMPLEX. Canad. J. Soil Sci. 42: 17-20. 1962.

Field study of some of the moisture conditions in a Duagh-Malmo Solonetzic soil complex revealed that the depth of soil drying was closely related to the degree of solodization. Data pertaining to the wilting point and field capacity of the soil did not reveal any reason for the differences in the field productivity and water distribution of these soils. Barley seedlings grown on surface samples of the Solonetz member exhibited a nutritional disorder. The addition of sodium sulphate, the predominant readily soluble salt in the lime-salt horizon of this soil, overcame the nutritional disorder, reduced water uptake, and increased productivity. The addition of up to 20 milli-equivalents of sodium per 100 grams of soil did not create a wilting condition, even when the moisture level was allowed to fall to the measured wilting point. It is suggested that a nutritional problem may have significant bearing on water utilization by plants grown on these soils.

Canada Dept. Agr., Vegreville, Alberta, Canada.

Misra, S. G.. EFFECT OF LEACHING SOILS WITH DIVALENT CATIONS. Soil Sci. and Plant Nutr. 7: 87-89. 1961.

When an alkali soil is repeatedly leached with dilute solutions of calcium chloride, magnesium chloride, and calcium sulphate, the exchange-complex is enriched with respect to divalent cations, Ca^{++} and Mg^{++} , while the monovalent cations, Na^+ and K^+ , greatly decrease leading to a distinct and sudden fall in pH value of the alkali soil. The normal soil, good soil, and the garden soil, however, show no such effect. Only the exchangeable magnesium increased as a result of leaching with a dilute solution of magnesium chloride.

U. Allahabad, Allahabad, India.

van Schaik, J. C., and Milne, R. A. RECLAMATION OF A SALINE-SODIC SOIL WITH SHALLOW TILE DRAINAGE. Canad. J. Soil Sci. 42: 43-48. 1962.

Leaching studies showed that shallow glacial soils that have become saline-sodic can be reclaimed with tile drains installed at a depth of 30 inches with a 30-foot spacing. The glacial till at the experimental site occurred at a depth of 2 to 3 feet below the surface and was slowly permeable. Only after the application of 71 inches of water was the saline-sodic soil sufficiently reclaimed to allow normal plant growth. Some decrease in salt concentration was found below the tile drains. There was no difference in salt movement with respect to proximity to the lines. The development of non-saline-sodic soils was not evident during the trial. Most of the gypsum applied during the trial remained in the surface 6 inches after the final water application.

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

Climatic Influences

Harper, H. J. THE EFFECT OF RAINFALL AND TEMPERATURE ON CROP PRODUCTION IN CENTRAL AND WESTERN OKLAHOMA. Okla. Expt. Sta. Processed Ser. P-407, 43 pp. 1962.

Crop yields obtained at Lawton, Perkins, Stillwater, and Woodward, Okla., for periods varying from 17 to 64 years were compared with rainfall and temperature data collected at these locations. The crops studied were alfalfa, barley, corn, cotton, forage sorghum, Korean lespedeza, peanuts, prairie hay, and wheat. Corn production and the average temperature and rainfall in central and eastern Oklahoma from 1899 to 1960 were also compared.

Alfalfa. Only one crop was produced when rainfall between January 1 and June 30 was less than 10 inches. Maximum yields were obtained when rainfall for this period was between 16 and 22 inches.

Barley. Barley production was not profitable when rainfall from January 1 to April 30 was less than 5 inches. Of the crops 56 percent were profitable when rainfall varied from 5 to 8 inches, and all crops were profitable when rainfall varied from 8 to 11 inches.

Corn. Corn production was not profitable when January 1 to July 10 rainfall was less than 15 inches. The mean temperature from June 20 to July 10 was the most significant factor for corn production at this location. None of the crops were profitable when the mean temperature for this period was above 84° F. Six inches of rain distributed about equally between June and July was required to produce a good corn crop.

Cotton. Cotton production was negatively correlated with August temperature. When the average August temperature was less than 84° F., 17 of 20 crops were profitable.

Forage Sorghum. Forage sorghum production was more closely related to rainfall between October 1 and September 30 than the June, July, and August rain. Drilling sorghum in 7-inch rows produced a higher average yield than planting sorghum in 42-inch rows during the low rainfall years.

Grain sorghum. Grain sorghum was a less dependable crop than forage sorghum. Profitable grain yields were not obtained during 14 of 18 years when rainfall from October 1 to September 30 was less than 28 inches. July temperature was a better index of grain sorghum production than June or August temperature. None of the eight crops produced when July temperature was above 84° F. were profitable.

Korean Lespedeza. Korean lespedeza yields were higher when June, July, and August rainfall was greater than 7 inches, than when rainfall was lower than 7 inches.

Peanuts. Peanut yields were not profitable during 3 of the 7 years when July, August, and September rainfall was less than 6 inches.

Prairie Hay. Prairie hay yields were affected by the quantity of rain that fell from January 1 to June 30 each year. Average production increased as rainfall increased to 18 inches.

Wheat. Seven of 14 wheat crops produced no labor income when March temperatures were above 54° F. Only two high wheat yields were obtained when rainfall from October 1 to April 30 was less than 12 inches.

Tables and graphs.

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

Jensen, M. E., and Hildreth, R. J. RAINFALL AT AMARILLO, TEXAS. Tex. Agr. Expt. Sta. MP-583, 9 pp. 1962.

An analysis of 69 years of rainfall records at Amarillo shows that annual rainfall varied from 9.94 to 37.21 inches. Monthly rainfall varied from 0.07 to 9.81 inches in May.

Rain during the grain sorghum season (June through September) varied from 3.77 to 24.81 inches. Rain during the winter wheat season (October through May) varied from 3.69 to 17.14 inches.

The distributions and probabilities of annual, monthly precipitation, and rain per storm are presented graphically.

SWCRD, ARS, USDA, and Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Parshall, M. METEOROLOGICAL DATA...1887 to 1957. Colo. Agr. Expt. Sta. B. 509-S, 17 pp. 1961.

A summary of 71 years of meteorological data at the Colorado Agricultural Experiment Station Fort Collins, Colo., is presented in 11 tables.

Colo. State U., Fort Collins, Colo.

Newman, J. E. SOME ASPECTS OF APPLIED METEOROLOGY IN THE SOIL AND CROP SCIENCES. *Soil Sci.* 93: 62-67. 1962.

The central concern of applied meteorology in soil and crop sciences is the fate of energy. This involves the need for complete understanding as to how energy is transmitted, stored, and dissipated within soil profiles, in vegetative covers, as well as at soil and crop surfaces. It is these shifts in energy between day and night, day to day, and from summer to winter, that make natural physical environments so dynamic. Also, it is these sharp energy gradients that develop over short distances in the vertical that cause micro-climates to vary violently within the same macro-climate.

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

Longacre, L. L., and Blaney, H. F. EVAPORATION AT HIGH ELEVATIONS IN CALIFORNIA. *J. Irrig. and Drain. Div.*, ASCE 88(IR 2): 33-54. June 1962.

During the years 1946-59, evaporation and meteorological measurements were made at several locations in the upper San Joaquin River Basin in Central California. Data were collected at elevations varying from 410 feet to 9,194 feet above sea level by the Southern California Edison Company in cooperation with the United States Department of Agriculture. Because of the severe winter conditions at high elevations in the Sierra Nevada Mountains, observations may be made only during a 5- to 7- month period each year. Regression equations based on monthly evaporation and other data were developed from which the pan evaporations for the missing months were computed and 13-year normals were established for each location. These equations were used to compute evaporation at high elevations during the winter months when water surfaces were frozen. Evaporation pan coefficients were determined for converting pan evaporation to equivalent evaporation from reservoir water surfaces assuming an annual coefficient of 0.98 for the USDA screened pan.

The authors concluded that: The annual rate of evaporation in the upper San Joaquin River Basin decreased with an increase in elevation. There is a pronounced linear decrease to approximately 4,000 ft. Between 4,000 ft and 8,000 ft, the decrease becomes progressively smaller. Above 8,000 ft, the decrease is small.

Normal evaporation characteristics of a region, for practical applications, may be determined from limited field data obtained under conditions that would be considered somewhat crude by laboratory trained technicians.

South Calif. Edison Co., Los Angeles, Calif.

Rosenquist, D. W., and Gates, D. H. RESPONSES OF FOUR GRASSES AT DIFFERENT STAGES OF GROWTH TO VARIOUS TEMPERATURE REGIMES. *J. Range Mangt.* 14: 198-202. 1961.

Results of germination analysis on beardless bluebunch wheatgrass, hard fescue, big bluegrass, and orchardgrass indicated that germination is inhibited or greatly reduced at temperatures above 100°. Orchardgrass germinated best at the lower temperatures. No apparent detrimental carry-over effects from extreme temperatures were observed after returning seeds to greenhouse conditions.

A pronounced increase in top production was exhibited as the temperature was increased from 55° to 85°. The 85° regime resulted in the greatest top growth over all stages of growth. Little growth occurred at 55°. A sharp decline in top production took place at 115°.

In contrast to the decline in top growth from 85° to 100°, root growth as measured by elongation was greatest at 100°. The stimulation of root elongation at 100° was followed by an over-all decrease in both top and root production during the six-week recovery period.

Jr. Author, CRD, ARS, USDA, Pullman, Wash.

Mulching

Hunt, D. A VEGETABLE SEEDER THAT PLANTS THROUGH PLASTIC AND PAPER MULCH. Ill. Res. III (4): 16. 1962.

Many vegetable growers have been using paper or plastic sheet coverings for some of their specialty crops. While this practice is quite expensive, it may be economically justified when the following benefits are obtained:

1. Retention of soil moisture and control of erosion.
2. Higher soil temperatures, resulting in rapid germination and earlier and faster plant growth.
3. Increased yields of healthier, cleaner fruits.
4. Excellent weed control.
5. Reduced insect damage (if treated papers are used).

It's difficult to place the plastic or paper mulch by hand. Both are purchased in large rolls 40 inches wide or wider. As the roll is unreeled, the edges must be immediately anchored with a soil cover to prevent whipping and tangling by the wind.

A new, commercially available machine to lay mulch under Illinois conditions has been developed along with a vegetable planter that can be attached to the mulch-laying machine that can plant through the mulch.

The machine did a satisfactory job of planting squash, cucumber, and watermelon seed at both Urbana and the Dixon Springs Station last June.

U. Ill., Col. Agr. Urbana, Ill.

Koshi, P. T., and Stephenson, G. K. SHADE AND MULCH AS INFLUENCES ON LOBLOLLY PINE SEEDLINGS AND THEIR IMMEDIATE ENVIRONMENT. Forest Sci. 8: 191-204. 1962.

On an abandoned field of Cahaba sl, competing vegetation was eliminated by removing the surface 3 to 4 inches of soil. On plots 20 feet square, 1-0 loblolly pine seedlings were planted at 2- by 2-foot spacing. Four site treatments--baring the soil, shading, mulching, and mulching and shading combined--with three replications, were instituted to evaluate influences on soil moisture and temperature, evaporating power of the atmosphere, and seedling behavior.

Shading which intercepted 50 percent of the direct sunlight reduced maximum temperatures on hot summer days by 10-20° F. at seedling level. It also reduced evaporation potential by about 20 percent, but had no significant effect on soil moisture levels. Seedlings

grown under this shade were taller, but smaller in diameter and with a tendency to have less dry weight than comparable unshaded seedlings.

Planted loblolly seedlings suffered no apparent heat damage, despite August temperatures as high as 119° F. at 6 inches above the ground, 146° F. at the surface of mulch, and 127° F. at the soil surface. These are within a temperature range that has been shown to be lethal to living pine tissue.

Moisture levels were generally higher under pine needle mulch, except after prolonged drought, despite slightly higher moisture depletion rates during much of the time. Higher moisture levels under mulch resulted almost entirely from superior accretion, due probably to higher surface infiltration rates.

Superior seedling growth under mulch is believed to be due largely to more adequate supplies of available moisture.

Mulch did not reduce net soil moisture depletion. If it reduced evaporation from the soil surface, this effect was obscured by other moisture losses.

Rate of moisture depletion appeared to be related to size of seedlings and abundance of available moisture. At least under mulch, moisture depletion rates appear to have been dominated by transpiration from the seedlings, rather than by evaporation.

Nacogoches Res. Cent., Southern Forest Expt. Sta., FS, USDA, Nacogoches, Tex.

Burrows, W. C., and Larson, W. E. EFFECT OF AMOUNT OF MULCH ON SOIL TEMPERATURE AND EARLY GROWTH OF CORN. *Agron. J.* 54: 19-23. 1962.

An experiment with bare soil and with 1, 2, 4, or 8 tons per acre of chopped cornstalks on the soil surface as treatments was carried out to determine the effects of varying amounts of mulch on corn growth and soil temperature. From the data the following conclusions were drawn:

1. Lower soil temperature under mulch was a primary causative factor in reducing growth of corn where mulched soil was compared with bare soil in the North Central States.
2. As the amount of mulch increased, corn growth in terms of plant height and dry matter production decreased progressively. As little as 1 ton per acre of chopped cornstalks materially reduced the growth of corn early in the season.
3. The smaller the amount of soil cover the greater is the amount of heat stored in the soil during the growing season. Each ton of mulch applied over the range from 0 to 4 tons per acre reduced the average soil temperature during May and June at the 4-inch depth by about 0.7° F.
4. Use of thermocouples as soil temperature sensors required considerable subsampling for a precise estimate of soil temperature.

SWCRD, ARS, USDA, Morris, Minn.

Lent, J.M. POULTRY MANURE AS A MULCH ON TOMATOES. Storrs Agr. Expt. Sta. Res. Proj. Rpt. 13, 4 pp. 1962.

In a series of tests in Connecticut the results obtained to date indicate that mulching tomatoes with poultry manure has practical value.

The following table summarized the results of the 1955 tests:

Treatment	1955 Yields In Tons Per Acre			
	Varieties			
	Pritchard	Valiant	Coventry	Total
Check.	10.44	12.86	12.93	36.23
Poultry Manure	15.23	15.29	14.10	44.62
Poultry Manure & Sawdust.	15.56	15.57	13.77	44.90
L,S.D. at 0.05 level.				2.4
L,S.D. at 0.01 level.				3.3

Storrs Agr. Expt. Sta., Col. Agr., Conn., Storrs, Conn.

PLANT MANAGEMENT

Pasture and Haylands

Holt, E. C., Lancaster, J. A., and Buckingham, M. BERMUDAGRASS PRODUCTION IN NORTHEAST TEXAS. Tex. Agr. Expt. Sta. MP-548, 7 pp. 1962.

Bermudagrass is an important forage plant in Northeast Texas. It is best adapted to fertile loam and sandy loam soil but will grow under a wide range of soil conditions. Several varieties of Bermudagrass have been developed and many of these have been tested for adaptation to Northeast Texas. Coastal Bermudagrass has shown the best performance in this area, producing 20 to 50 percent more forage than Common Bermudagrass. Other varieties have been tested and are satisfactory but are not superior to Coastal. These include Midland, Suwannee, and Selection No. 3.

Coastal Bermudagrass responds favorably to nitrogen fertilization, inter-planted winter legumes, and a combination of these two practices. During drought years, Coastal responded favorably to nitrogen applications of 120 pounds per acre per year. The practice of overseeding an adapted winter legume increased total forage production about as much as 60 pounds of nitrogen per acre without the legume. Moisture has not been a serious limiting factor since 1956. Coastal Bermuda overseeded in the fall with crimson clover and fertilized with 120 to 150 pounds of nitrogen per acre beginning approximately June 1 has produced 8,000 to 9,000 pounds of forage. The use of the legume without nitrogen produced about 7,500 pounds annually. The legume results in earlier forage production than Coastal without the legume.

The period of peak forage production is influenced to some extent by the time of nitrogen application. Production can be shifted by delaying the time of initial nitrogen application. Late summer and early fall growth is poor, however, and shows reduced response to nitrogen applications.

Cultivation had no influence on Bermudagrass production in studies conducted in this area on sandy soils.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Donnelly, E. D., and Cope, J. T., Jr. CRIMSON CLOVER IN ALABAMA. Ala. Agr. Expt. Sta. B. 335, 31 pp. 1961.

In Alabama an estimated one-fourth million acres are planted to crimson clover alone or in association with various grasses. This makes it one of the most extensively grown annual winter legumes in the State.

An important seed crop in Alabama, crimson is also an excellent winter grazing crop for all types of livestock. It is also used for silage, hay, and green manure. The reseeding varieties will volunteer year after year when fertilized and managed properly.

This is a complete "culture and care bulletin" for growing crimson clover in Alabama. Agr. Expt. Sta., Auburn U., Auburn, Ala.

Regional Forage Crops Management Technical Committee (NE-29). CUTTING MANAGEMENT OF ALFALFA AND LADINO CLOVER IN THE NORTHEAST. R. I. Agr. Expt. Sta. B. 356 (Northeast Regional Publication), 40 pp. 1960.

Under a variety of management treatments both alfalfa and ladino clover react in different ways, resulting in variation in yields of forage and persistence of the plants. The species were studied in detail at several locations under Regional Project NE-29. Cutting management treatments were uniform for each species. Results, analyzed on a regional basis, provided a coordinated investigation of the effect of cutting management on each species grown alone and in mixtures with grasses.

The authors summarized the results for alfalfa under 1 to 6 and for ladino clover under 7-10 as follows:

1. Cutting management treatments applied to alfalfa varieties and mixtures with grasses gave variable response throughout the region.
2. Alfalfa yields were generally lowest when stands were cut in spring at the early bud stage. Cuttings made at the full bud and early bloom stages gave comparable yields at Maryland and Rhode Island, with higher quality alfalfa resulting from the earlier cutting.
3. Alfalfa season yields were highest when late fall growth was harvested although quality was poor at the last cutting.
4. Cutting management treatments did not significantly change the yields of orchardgrass or brome grass at any location.
5. A general decline in alfalfa yields and plant populations occurred during the 4-year harvest period, but these trends were not markedly changed by cutting treatments.
6. Yields of Narragansett and Vernal Alfalfa, whether grown alone or in mixtures with grasses, were not significantly different, on the average, over the 4-year period. Narragansett performed best at Rhode Island and Vernal at New York.
7. Forage yields of mixtures of grasses and ladino clover were considerably greater than ladino clover grown alone. Brome grass was less competitive than orchardgrass and maintained a more favorable species balance with the clover.
8. Spring cutting treatments had a greater effect on yields of grasses than on yields of ladino clover. Grass production increased with advancing maturity. Early spring harvest resulted in lowest grass yields, but gave a greater proportion of ladino clover in mixtures, particularly with orchardgrass. Grass yields were favored by cutting at the early heading stage at Rhode Island and West Virginia. Ladino clover yields were significantly lower at this stage than at the early (6-inch height) cutting stage at Rhode Island.
9. Fall cutting treatments did not significantly affect the yields or apparent survival of ladino clover or grass species.

10. Weather conditions were a major factor affecting performance of ladino clover among years and locations. Winter injury was important in reducing clover stands at Rhode Island and New York.

Agr. Expt. Sta., U. R. I., Kingston, R. I.

Baker, J. N., and Hunt, O. J. EFFECTS OF CLIPPING TREATMENTS AND CLONAL DIFFERENCES ON WATER REQUIREMENT OF GRASSES. *J. Range Mangt.* 14: 216-219. 1962.

The influence of clipping on the growth of individual grass tillers under drought stress was studied. In the fall of 1958, three intermediate and two pubescent wheatgrass plants were selected from the source nursery located at the Wyoming Agricultural Experiment Station near Laramie. Half of each plant was brought into the greenhouse in September and the remainder in December. These plants were separated into individual tillers and planted in canisters after being rooted in sand. Half of the canisters were maintained at approximately field capacity and the other half were maintained just above the wilting point. The plants were clipped at 2 and 4 inches above the soil surface. Evaluation of the clones was made on the basis of tillering, dry-matter yield, and water requirements.

Differences between the divided plants brought into the greenhouse in September and December in their reaction to total water use and dry-matter yield were observed. The results of the study indicate also that height of clipping affected the number of tillers produced, total herbage yield, and water used per gram of forage produced. There were significant clonal differences in the number of tillers produced and in the efficiency of water use.

Jr. Author, CRD, ARS, USDA, Laramie, Wyo.

Burger, A. W., Jackobs, J. A., and Hittle, C. N. THE EFFECT OF HEIGHT AND FREQUENCY OF CUTTING ON THE YIELD AND BOTANICAL COMPOSITION OF SMOOTH BROMEGRASS AND ORCHARDGRASS MIXTURES. *Agron. J.* 54: 23-26. 1962.

A 3-year study (1958, 1959, and 1960) was conducted at Urbana, Ill., on the effect of height and frequency of cutting on the yield and botanical composition of orchardgrass-legume and smooth brome-grass-legume mixtures. The following results were obtained:

1. Smooth brome-grass mixtures produced more dry matter than orchardgrass mixtures, regardless of frequency or height of cutting or legume association.
2. Yields of the various smooth brome-grass- and orchardgrass-legume mixtures were greater and less, respectively, at the hay and pasture frequencies, than at the silage frequency of cutting regardless of the cutting height which was used.
3. Alfalfa-grass combinations consistently outyielded Ladino clover-grass mixtures regardless of the cutting management used. Alfalfa mixtures produced much higher yields at the hay than at the silage cutting frequently than the Ladino clover mixtures, regardless of height or frequency of cutting.
4. Orchardgrass mixtures produced more herbage at the late compared to the early harvests, relative to the mixture containing smooth brome-grass.
5. Yields of the smooth brome-grass and orchardgrass mixtures were greater and less, respectively, at the 1- and 4-inch than at the 2-inch height of cutting.
6. The average percentage of legumes in the smooth brome-grass mixtures was consistently higher than that in the orchardgrass mixture throughout the test period. This difference was relatively greater in alfalfa than in non-alfalfa combinations.

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

Cosper, H. R. HOW TO INCREASE HAY YIELDS. S. Dak. Farm and Home Res. 13(1): 1-2. 1962.

Efficient use of moisture is a major problem on rangelands of western South Dakota and adjoining States. Annual precipitation is generally 15 inches or less. Storms are often of high intensity and of short duration. The spring thaw generally takes only a few days. In any ranching operation, water conservation is one of the first steps toward increased range production.

Research studies relating rangeland water spreading and commercial fertilizer show that maximum use of available water for forage production was not obtained unless fertilizer was applied. On test plots located near New Underwood, S. Dak., 80 pounds of nitrogen applied per acre more than doubled the 2-year forage yields.

Besides fertilizer and water, another limiting factor is the grass stand; when water is added to a native range, forage production may be limited unless an adequate stand of a productive grass is present. Western wheatgrass, for example, shows excellent yield possibilities with additional water.

SWCRD, ARS, USDA, Newell, S. Dak.

McKee, G. W. EFFECTS OF SHADING AND PLANT COMPETITION ON SEEDLING GROWTH AND NODULATION IN BIRDSFOOT TREFOIL. Pa. Agr. Expt. Sta. B. 689, 35 pp. 1962.

From 1956 to 1960 field and greenhouse experiments were conducted to study the effects of various conditions of shading and plant competition on seedling growth and nodulation in birdsfoot trefoil, Lotus corniculatus L.

The authors concluded:

1. All degrees of shading and plant competition depressed seedling growth and nodulation in Vernal alfalfa, Pennscott red clover, and birdsfoot trefoil from 13 different seed sources.
2. Under conditions of moderate shading, 50 percent of daylight, the leaf area per plant of Pennscott red clover tended to increase, that of Vernal alfalfa remained essentially the same, but that of birdsfoot trefoil decreased markedly. Under a canopy of Clinton 59 oats, seedlings of Pennscott red clover and Vernal alfalfa had as great a leaf area per plant as seedlings produced in the open, but the leaf area of birdsfoot trefoil was reduced one-half.
3. Comparison of top weight/leaf area ratios indicated that Pennscott red clover and Vernal alfalfa were less efficient in the accumulation of dry weight per unit area than birdsfoot trefoil.
4. The compensation point for seedlings of birdsfoot trefoil and Vernal alfalfa was approximately 12.5 percent of daylight, while seedlings of Pennscott red clover survived at one-half or less of this light intensity. Under a dense canopy of oats, wheat, or weeds, light intensity may be reduced to less than 5 percent of daylight. For acceptable survival, growth, and establishment, seedlings of Vernal alfalfa and Pennscott red clover required at least 25 percent of daylight, while seedlings of birdsfoot trefoil required at least 50 percent.
5. Supplemental nitrogen did not compensate for inadequate light. At light intensities of 32 percent of daylight or greater, seedlings of Pennscott red clover and Vernal alfalfa responded proportionately more than seedlings of birdsfoot trefoil to supplemental nitrogen.
6. Shading and plant competition depressed nodulation of seedlings of birdsfoot trefoil, Vernal alfalfa, and Pennscott red clover, proportionately more than top or root

growth. Root growth was depressed more than top growth. Under most conditions of shading and plant competition, seedlings of Vernal alfalfa and Pennscott red clover had more nearly adequate nodulation than seedlings of birdsfoot trefoil.

7. Under a canopy of Clinton 59 oats, seedlings of the three species of legume nodulated but the nodules were not functional.
8. Shading and plant competition depressed the top and height growth of birdsfoot trefoil seedlings proportionately more than that of the associated species.
9. Seedlings of birdsfoot trefoil had a more rapid growth rate relative to competing vegetation, when planted in July or August than from earlier or later seedlings.
10. Slow seedling establishment, stand failure, and inadequate nodulation reported for birdsfoot trefoil may be explained, in part, by its relative intolerance to shading and to its failure to respond to better growing conditions.
11. Failure to nodulate, or inadequate nodulation and subsequent nitrogen deficiency, may be associated with the slow establishment of birdsfoot trefoil. Drought and acid, infertile soils are particularly depressing.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Weeks, S. A., and Kleis, R. W. MECHANIZED HANDLING OF CHOPPED HAY WITHIN STORAGE; DISTRIBUTION AND REMOVAL. Mass. Agr. Expt. Sta. B. 531, 12 pp. 1962.

Two different experimental systems have been designed, fabricated, and tested to remove chopped hay mechanically from elevated mows. The second system described also distributes the hay as it is placed in storage.

The common principle in both systems is that of utilizing an unshrouded, cantilever-mounted, single solid-flight, single pitch, nine-inch auger to move chopped hay. Unit I incorporates both a vertical and horizontal pivot about the drive end to the auger, mounted at the floor level in the center of the mow. Unit II is pivoted only in the horizontal plane with vertical adjustment up and down a center mounting post. Both units are designed for temporarily unattended operation and for control from a point external to the storage compartment.

Both units operate in a cylindrical domain within a square storage segment. With tumbling action at the corners, it is estimated that 90 to 95 percent of the hay is subject to mechanized handling.

Either unit will deliver one-half ton per hour with 1½ HP motor driving the auger. The same auger with increased speed would deliver more, but with greater power demand. Unit II has several times greater capacity in distribution during filling than in unloading.

Expt. Sta., Col. Agr., U. Mass., Amherst, Mass.

Bowers, W., Carlisle, G. R., Fryman, L. R. Guither, H. D., Mueller, A. G., and Pardee, W. D. ILLINOIS FORAGE HANDBOOK; PASTURE, HAY, AND SILAGE FOR DAIRY CATTLE, BEEF CATTLE, SHEEP, AND HOGS. Ill. Agr. Expt. Serv. C. 845, 16 pp. 1962.

Many acres on Illinois farms require continuous cover or cover crops during part of the rotation. On many farms, hay and pasture acreage represents a net loss to the farm business since the costs charged against these acres add up to more than the value of the crop harvested from them. Much of this loss can be explained by low yields and incomplete

use of the forage crop produced. Unused forage has no value except for some indirect added fertility and soil conservation benefits.

The keys to profitable forage production are high yields and a well-managed livestock program that makes maximum use of the forage crops. This handbook is designed to help boost the profits from forage-producing acres.

Tables and graphs.

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

Hall, G. E. FLAIL CONDITIONING OF ALFALFA HAY. Ohio Agr. Expt. Sta. Res. C. 107, 11 pp. 1962.

The major drawback in the use of the flail machine for conditioning forage is the fact that care must be exercised in selecting the proper rotor speed and machine ground speed. It is better to travel at a high rate of speed and keep the rotor speed low. This is just opposite the procedure used by most workers when they are testing a new piece of machinery in the field. If the ground speed is too slow, the forage will be conditioned to a point such that many fine pieces result. This is probably the major cause of the excessive losses reported by some research workers. An additional loss of $2\frac{1}{2}$ percent of the crop due to flailing rather than crushing is an insignificant price to pay for the decreased weather exposure and the decrease in the amount of coarse, sharp material which is possible by flail conditioning that follows good management practices.

It is possible to direct-cut with the flail unit and do less conditioning to the forage stalks than is done with a crusher. This is done by reducing the rotor speed in comparison with the ground speed, resulting in a very ragged appearance of the stubble in the field and a reduced drying rate due to the lack of sufficient conditioning. Care must be taken to prevent under-conditioning as well as over-conditioning. After a round or two in the hay field, the operator of a flail conditioner can determine the proper rotor and ground speeds by a visual inspection of the conditioned material to ascertain the length of cut.

The regrowth characteristics were visually checked and there were not any apparent differences between the flail-cut or the mowed areas of the field.

The author concluded that (1) flail conditioning is an effective way to increase field drying rates of alfalfa; (2) losses due to flail conditioning were approximately, $1\frac{1}{2}$ to $2\frac{1}{2}$ percent of the total yield greater than the losses due to crushing; (3) the optimum severity index obtained was 20, higher values resulted in a decreased field drying rate; (4) regrowth of the alfalfa was not affected by the method of conditioning; and (5) good management practices must be followed to obtain satisfactory results with the flail conditioner.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Ahring, R. M. STORAGEABILITY UNDER LABORATORY CONDITIONS OF SEED OF BLUE GRAMA, SIDE-OATS GRAMA AND SMOOTH BROMEGRASS. Okla. Expt. Sta. Tech. B. T-97, 11 pp. 1962.

Seeds of smooth brome grass and blue grama cannot be safely stored at laboratory room temperature much beyond 24 months if they are to be utilized for planting purposes. Seeds of side-oats grama can be held in storage for as long as 3 to 4 years without a drastic loss in viability.

Blue grama seed stored separately as caryopses and rough seed units appeared to have a greater rate of deterioration than caryopses of side-oats grama or highly processed seed of smooth bromegrass. The pattern of deterioration appeared to be slower when seeds were stored as rough units. The length of time required for both seed forms to completely deteriorate was 52 months.

Bromegrass seed stored in muslin cloth bags lost its viability at a rate 28 to 54 percent faster than seed stored in tightly sealed ice-cream cartons and laminated paper bags. The length of longevity or the presence of a few germinable seeds was found to be the same regardless of storage container. The addition of activated alumina as a desiccant within the laminated bags and carton containers did not alter the pattern of deterioration markedly.

The life-span of side-oats grama exceeded 5 years. After 4 years of storage at room temperature the caryopses had maintained as much as 50 percent of their original germination capacity.

The insecticides aldrin, dieldrin, and lindane mixed thoroughly at 0.5 gram active ingredient per pound of seed with the caryopses form of blue grama did not appear to have any phyto-toxic effect on germination. After 12 months of storage, the heavier rate, 1.0 gram per pound of seed of either lindane or dieldrin reduced the number of normal seedlings and increased the number of abnormal seedlings. However, the rough seed units of this grass germinated higher in the presence of the insecticides than the untreated seed. Abnormal seedlings observed in the caryopses form were highest at the 24-month storage interval.

Caryopses of side-oats grama receiving the same insecticide treatments as both forms of blue grama seed showed no early damage due to treatment. As the length of storage increased, the caryopses stored in the presence of the insecticides deteriorated faster than did the check. However, there was no evidence of decrease until after 36 months of storage.

CRD, ARS, USDA, and Okla. State U. Expt. Sta., Stillwater, Okla.

Harrington, J. D., and Washko, J. B. SOD SUBJUGATION WITH HERBICIDES FOR PASTURE RENOVATION. Pa. Agr. Expt. Sta. B. 694, 17 pp. 1962.

Herbicidal chemicals were moderately successful during three growing seasons in subjugating sod for grassland improvement. Chemicals tested included amitrole, dalapon, 2,2,3-TPA, and TCA. Balbo rye was employed to evaluate its sod suppressing qualities in conjunction with herbicidal treatments and disking. Viking and Empire birdsfoot trefoils and common timothy seeded alone and in association were used to measure the productivity of renovated sod.

Although tested only one season, plowing subjugated sod more effectively than any of the herbicides. Chemical suppression of sod promises to be useful on areas too steep to plow or containing stony outcrops, but appears too expensive for general use.

The following results were obtained:

1. The effectiveness of herbicides in the suppression of Kentucky bluegrass varied with year and season as follows: (1) Applications made in April and May of 1957 were more effective than those made in July 1955 and in July and August 1956. (2) Herbicidal applications made in August and September of 1956 were more effective than those made in July 1955. (3) The least effective herbicidal treatment was that applied in July 1956.
2. The most effective herbicides for the suppression of Kentucky bluegrass were amitrole and dalapon. The least effective herbicide was 2,2,3-TPA. (1) While dalapon and amitrole were effective in suppressing Kentucky bluegrass sod when applied on April 15, the former was better than the latter when applications were made on May 1. (2) August and September applications of dalapon used in conjunction with diskings and a rye cover crop successfully suppressed an established bluegrass sod.

3. Rates of application which were found to be most effective were amitrole at 10 pounds and dalapon at 15 pounds of acid equivalent per acre. No adverse residual effects were noted.
4. Highest forage yields after chemical renovation were obtained with birdsfoot trefoil and timothy, sown in association.
5. These species sown alone and in association produced greater yields of forage when broadcast seeded and when band-seeded in rows 7 inches apart than when band-seeded in rows 11 inches apart with a sod seeder.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Stoddard, E. M., and Ahrens, J. F. ERADICATION OF POISON IVY AND POISON SUMAC. Conn. Agr. Expt. Sta. C. 222, 5 pp. 1962.

A number of herbicides are effective in killing poison ivy and poison sumac without the hazard and labor of hand digging. Amitrol, ammonium sulfamate, and the phenoxy herbicides (2,4-D, 2,4,5-D, and silvex) are best for general home use from the standpoint of selectivity, effectiveness, and lack of toxicity to warmblooded animals. Although they will kill many other plants as well, they can be applied selectively to avoid injury to desirable plants.

Several soil sterilants are effective for killing poison ivy or poison sumac in areas where desirable shrubs, trees, or grass are not present. All of these materials require judicious use to avoid injury to desirable plants.

Although herbicides offer the most effective control of poison ivy, none can be expected to produce 100 percent kill of all plants with one application. Repeated applications are often required. Even when killed with herbicides, poison ivy and poison sumac plants can cause poisoning; therefore removal and burying or burning of dead stems, with care to avoid the smoke, may be necessary.

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

Rodgers, B. J., and Bryan, D. E. CONTROL OF THE SPOTTED ALFALFA APHID THERIOAPHIS MACULATA (BUCKTON) BY SEED TREATMENT METHODS. Okla. Expt. Sta. Processed Ser. P-401, 16 pp. 1962.

No rate of phorate or DI-SYSTON afforded adequate control of the spotted alfalfa aphid when applied to the seed as activated charcoal alone. However, 1-1/2, 2, and 2-1/2 pounds of actual DI-SYSTON, or 1.32, 1.76, and 2.20 pounds of phorate per 100 pounds of seed, when pelleted on the seed with hydroxyethyl cellulose or methyl cellulose, rendered good control for 32 to 36 days. Hydroxyethyl cellulose was a more efficient pelleting agent than methyl cellulose. In the 1.32 to 2.50 pounds per 100 pounds range, high rates of insecticides are slightly more effective than lower rates, dosages below 1.32 pounds per hundred were much less effective.

Systemic seed treatments had no adverse effect on alfalfa emergence.

Systemic seed treated plants, 2 weeks after emergence, are able to withstand high density aphid infestations, suffering only light to moderate chlorosis of the leaves. These plants were not infested for more than 3 days after introduction of the aphids. Cody variety alfalfa was heavily damaged by high density aphid populations. During the 15 days after aphid introduction, half of the Cody plants were killed. Cody showed damage much slower than Buffalo alfalfa which was treated with systemic materials. This suggests that a major part of Cody's resistance is due to its high tolerance of aphid populations; it also suggests that repeated reinfestations of high density aphid populations might cause severe damage or death of plants of the Buffalo variety.

Systemic seed-treated plants were effectively protected immediately after emergence of the plants but this protection decreased with increase in age of the plants. The resistant variety, Cody, was not protected immediately after emergence but became less susceptible later. Systemic seed treatment of Cody variety alfalfa with 1-1/2, 2, or 2-1/2 pounds of toxicant per 100 pounds of seed, pelleted with hydroxyethyl cellulose, might be employed to give immediate and lasting control of the spotted alfalfa aphid.

Tables.

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

Lilly, C. E., and Hobbs, G. A. EFFECTS OF SPRING BURNING AND INSECTICIDES ON THE SUPERB PLANT BUG, ADELPHOCORIS, SUPERBUS (UHL.), AND ASSOCIATED FAUNA IN ALFALFA SEED FIELDS. *Canad. J. Plant Sci.* 42: 53-61. 1962.

Thorough spring burning of the plant debris in an alfalfa field effectively controlled an economic infestation of the superb plant bug, Adelphocoris superbus (Uhl.). It also destroyed two predators, Phymata fasciata (Gray), and Sinea diadema (F.), that overwinter in the egg stage in alfalfa fields. Burning reduced the severity of black stem, yellow-leaf blotch, and common leaf spot produced a healthier stand and heavier seed yield of alfalfa.

Infestations of A. superbus were significantly reduced with a single application of either toxephene at 0.4 to 1 pound of toxicant per acre or DDT at 0.3 or 0.5 pound per acre, applied as a spray after many of the overwintering eggs had hatched. Predacious insects did not seem to be adversely affected.

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

Cortney, W. D. STEM NEMATODE OF RED CLOVER IN THE PACIFIC NORTHWEST. *Wash. Agr. Expt. Sta. B.* 640, 17 pp. 1962.

The stem nematode, Ditylenchus dipsaci (Kuhn, Filipjev), has caused a varying amount of damage to red clover in the Pacific Northwest. In transfer studies with 54 other species, 12 were nematode resistant, 2 were nematode carriers, and 3 were definite hosts (alsike clover, phacelia, and strawberry).

Studies on the longevity of the nematode showed that a 25 percent stand of volunteer red clover having a 36 percent nematode infection could still occur after 6 years of other clean cultivated crops under practical farming conditions. This extended longevity may be partly attributed to the destruction of very young clover volunteer seedlings by nematode infection before the plants reached noticeable size.

Nematodes were revived from red clover hay stored for 3 years but not after 4.

Stem nematodes were found in the ripening heads of red clover, attached to the seed coats in the sticky "honeydew" produced by the clover aphid. After these heads had dried or cured, stem nematodes soaked free in water regained motility.

Infected red clover seed, hay, and trash in manure are probably the most important agents in spreading nematodes from one farm or field to another. Spread from infested spots and areas in the field is mostly due to surface water movements.

Red clover varieties Merkur and Resistenta, developed in Sweden, showed considerable resistance to nematode attack in that country.

Wash. Agr. Expt. Sta., Inst. Agr. Sci. Wash. State U., Pullman, Wash.

"Will it pay to seed cropland to grass?" Actually, the farmer is the only one who can answer this.

Every situation is a special case to analyze to find the answer. This circular helps find a reliable answer by presenting: (1) Costs of seeding cropland to grass; (2) income that occurs when cropland is seeded to grass; and (3) a set of guides for analyzing a case.

Table 1: Cost of seeding dry cropland to grass

Item	Cost	Per Acre
	Dol.	Dol.
Summer fallow-operations:		
One-way disk	2.20	
Shovel and rod-weeder (twice over)	4.00	
Rod-weeder	1.00	7.20
Seeding:		
Packing	1.00	
Drilling	1.25	
Seed	2.50	4.75
Spray for weed control ¹		1.60
Total Direct Cost		13.55

¹ Usually it isn't necessary to spray for weed control. This practice can be used if competition from broadleaved plants is very great.

Mont. Agr. Expt. Sta., Mont. Agr. State Col., Bozeman, Mont.

Gray, J. R., and Springfield, H. W. ECONOMICS OF LAMBING ON CRESTED WHEATGRASS IN NORTHCENTRAL NEW MEXICO. Mex. Agr. Expt. Sta. B. 461, 34 pp. 1962.

The effects of lambing on crested wheatgrass pastures in northern New Mexico are reported. The information is included in a series of budgets based on the operating records of a group of sheep ranch enterprises in the area. Some of the findings are:

1. Plant Measurements: (1) Herbage production from crested wheatgrass pastures in northern New Mexico was four to five times greater than native range. (2) The January-through-May precipitation totals accounted for 99 percent of the variation in air-dry crested wheatgrass production. Crested wheatgrass production increased at the average rate of about 200 pounds of air-dry plant material per acre per additional inch of precipitation. (3) Utilization of crested wheatgrass pastures for lambing averaged 39, 53, 72, and 84 percent by weight of current growth. Despite spring grazing at these widely varying rates, there were no differences in the production of crested wheatgrass in the pastures the following year. Long-term effects were not tested. (4) At the heaviest grazing rate, each acre of crested wheatgrass pasture provided an average of 150 sheep days of grazing for lambing purposes. At the lightest rate, the pasture provided 75 sheep days per acre. And (5) the ratio of the number

of young crested wheatgrass plants to the number of dead plants decreased as utilization became heavier.

2. Animal Measurements: (1) Daily lamb gains were highest on crested wheatgrass pastures utilized at the lightest rate. Fall market weights were 75.7 pounds per head for lambs from the 39 percent use crested wheatgrass pastures vs. 73.0 from the 84 percent use pastures, and 73.9 pounds per head for lambs born on native ranges. (2) Lamb crops were 4.5 to 7.1 percent larger when ewes lambled on crested wheatgrass than on native ranges. The highest percentages were attained by ewes utilizing crested wheatgrass at the 53 and 72 percent levels. And (3) death losses were 1 to 3 percent less on crested wheatgrass than on native range.
3. Economic Measurements: (1) After all costs were paid, ewes lambled on crested wheatgrass increased the return to the operator for his labor and management from 19 to 27 percent over that received when ewes were lambled on native range. (2) The data indicate that the crested wheatgrass investment could be repaid by increased net returns in from 4 to 7 years. And (3) the highest profit rate of lambing on crested wheatgrass in northern New Mexico lies between the 53 and 72 percent utilization level. The estimated maximum return is achieved at about the 66 percent utilization level.

Tables, graphs, and photographs.

FS, USDA, and Agr. Expt. Sta., N. Mex. State U., State College, N. Mex.

Woods, S. G., Ables, J. R., and Edwards, R. L. COMPARISON OF COASTAL BERMUDA HAY AND PENSACOLA BAHIA GRASS HAY IN WINTERING RATIONS FOR YEARLING STEERS. S. C. Agr. Expt. Sta. C. 131, 7 pp. 1961.

Three feeding trials were conducted at the Edisto Experiment Station, Blackville, S.C., to compare the use of Coastal Bermuda and Bahiagrass hays in wintering rations for yearling steers. A total of 330 steers of beef breeding, averaging initially approximately 500 pounds, was used in these trials during the winter of the years 1957-58, 1958-59, and 1959-60.

Coastal Bermudagrass hay and Bahiagrass hay proved to be satisfactory roughages in wintering rations when fed with 3.5 pounds blackstrap molasses, 1 pound cottonseed meal (36 percent protein), and 1 pound of alfalfa pellets (16 percent protein). Winter gains on both rations were satisfactory: 0.73 pound daily for steers fed Coastal Bermuda hay and 0.76 pound daily for those fed Bahia hay. The daily cost per steer was \$0.25 for the steers fed Coastal Bermuda hay and \$0.26 for those fed Bahia hay.

Coastal Bermuda and Bahiagrass hays proved to be similar in feeding value as measured by average daily gains. The choice of which hay to use in wintering rations of steers would appear to depend on availability of the grass on the farm or the purchase price.

S.C. Agr. Expt. Sta., Clemson, Col., Clemson, S.C.

Wysong, J. W. COSTS, RETURNS AND PROFITABILITY OF ARTIFICIAL HAY DRYING ON NORTHEASTERN DAIRY FARMS. Md. Agr. Expt. Sta. B. 471, 29 pp. 1961.

When only small quantities of hay are dried, the costs of drying, in general are higher than the returns. When large tonnages of hay are dried, the fixed costs are distributed over more tons of hay, giving lower costs per ton. This means that artificial hay drying is most likely to be adopted on the dairy farms with large numbers of cattle and large amounts of hay produced.

The system of hay drying with the highest average cost of initial investment is the "purchased" wagon drier system with shed. A saving in cash outlay is possible if the farmer can build the wagon and shed. The initial investment will be considerably lower if a tarpaulin is used instead of a shed. About 175 tons of hay dried, or feed for a 60-cow herd, is necessary to reach the break-even point with a home-built, four-wagon drier with tarpaulin.

Farmers with fewer than 30 cows should figure all costs very closely before investing in a home-built mow drier with heat which is likely to be under-utilized and uneconomical if fewer than 90 tons of hay are dried annually.

The mow-driers without heat did not increase returns enough to pay variable costs. The wagon and platform systems which dried hay from 45 to 15 percent moisture did not have sufficient returns to cover variable costs. This means that dairymen should rely on natural drying until hay approaches the 30 percent moisture level. In some cases, rain damage is incurred unless the drying operation is started at high moisture levels. This type of expensive drying may be unavoidable occasionally.

Results indicate that the nutrients stored from a given acreage of hay are increased by artificial drying as compared with field-curing. Dairymen should compare probable returns from capital invested in hay driers with probable returns from other uses of the capital. Because of the relatively high costs involved, increased net returns from artificial hay drying are likely only under conditions of low initial investment and relatively large tonnages of hay dried.

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

Rangelands

Weeks, R. CONSERVATION AND COMMON SENSE. J. Range Mangt. 15: 22-24. 1962.

A "popular type" article on the value of a Conservation Plan for the Range Country written by the Past President of the Nevada Cattlemen Association.

Wells, Nev.

Rogler, G. A., Lorenz, R. J., and Schaaf, H. M. PROGRESS WITH GRASS. N. Dak. Agr. Expt. Sta. B. 439, 15 pp. 1962.

Proper use of grass can result in more efficient farm and ranch operation, greater livestock production, and increased profits. Forty-eight years of research with grass at the Northern Great Plains Field Station have amply demonstrated these facts. More than 80 publications have been written giving the research results. Twelve new grasses have been developed and released from the station since the start of a grass breeding program in 1936.

This bulletin is a summary of the 80 different publications and gives results of seeding, fertilization, range management, and adapted varieties.

CRD, ARS, USDA, and N. Dak. Agr. Expt. Sta., N. Dak. State U. Agr. and Appl. Sci., Fargo, N. Dak.

Kinsinger, F. E. THE RELATIONSHIP BETWEEN DEPTH OF PLANTING AND MAXIMUM FOLIAGE HEIGHT OF SEEDLINGS OF INDIAN RICEGRASS. J. Range Mangt. 15: 10-12. 1962.

The depth of germinating seed and maximum foliage height of 1,125 seedlings of Indian ricegrass has been measured since 1956. The seedlings were growing on sandy soils of low fertility under natural climatic conditions at Fernley and Fallon, Nev. Correlation and regression coefficients and statistical significance for linearity of regression were determined to learn the influence of depth of germinating seed on maximum foliage growth.

A positive and highly significant correlation was found to exist between depth of seed and maximum foliage height. Results indicate that deeper seeds have an advantage, perhaps better moisture, for germination and growth over seeds planted shallow. However, greenhouse studies indicate the same relationship exists when moisture is ample at all soil depths. The presence or absence of soil moisture undoubtedly plays a prominent role in growth after the seedling becomes established.

The long, slender, delicate seedlings from seed at deeper depths suggested that light or heat may inhibit germination at shallow depths.

Correlation coefficients of depth of seed and height of foliage of 100 marked seedlings measured on April 26 and May 27, 1957, and again on April 30, 1958, were $r = 0.397$, 0.562 , and 0.736 , respectively. Of the 100 original seedlings, 88 percent survived on May 27 and 71 percent on April 30.

As the seedlings became older, depth of seed had more influence on maximum foliage height. For instance, when the seedlings were first measured on April 26, 16 percent of the variation in foliage height was due to variation in depth of seed. On May 27, 1957, and April 30, 1958, the values were 32 and 54 percent, respectively.

Average depth of seed of all seedlings measured was 59.0 mm. or 2.3 inches. Sixty-two percent of the seed germinated between depths ranging from 1.6 to 2.8 inches. When seeding Nevada's arid southern rangelands to Indian rice grass, planting the seed at this range of depths has these distinct advantages: (1) The seed is placed nearer the limited soil moisture; and (2) away from high soil surface temperatures common on southern desert ranges. However, seedlings from seed planted deep are slender and delicate compared to more tillers and thick, sturdy stems of seedlings of shallow planted seed.

Recommendations for most grass species state the seed should be planted at depths of one-half inch. Few grass species can be planted deeper than 1 inch and produce a crop. Indian ricegrass seed is unique in that the majority of seed will germinate and emerge from depths up to 3 inches in a sandy soil providing distinct advantages in seeding arid ranges which have loose, sandy, well-aerated soils.

Nev. Agr. Expt. Sta., U. Nev., Reno, Nev.

Sautter, E. H. GERMINATION OF SWITCHGRASS. J. Range Mangt. 15: 108-110. 1962.

Switchgrass (*Panicum virgatum* L.) is one of the dominants of the tall grass prairies. Moreover, it is one of the few native American forage species of which certain strains have been domesticated.

The observed differences in sites and plant communities strongly indicated that switchgrass was more tolerant of saline conditions than the usually associated native grass species.

Additional information was sought through a series of greenhouse experiments.

Table i.--Germination of switchgrass as affected by temperature, darkness, and scarification

Experiment ¹	Germination
	Percent
Darkness	0
Seeds wetted under total darkness (discontinued after 21 days)	
Constant temperature--80° to 85° F (discontinued after 19 days)	0
Cold nights--38° to 40° F (discontinued after 49 days)	50
Constant low temperature--30° to 40° F.	
14 days	10
31 days	66
49 days	76
54 days	56
Constant freezing	
14 days	0
31 days	0
49 days	0
54 days	2
Freezing nights (discontinued after 49 days)	0
Scarified seed (greenhouse)	84
Check (greenhouse--discontinued after 49 days)	0

¹ The experiments were started on October 30 and were continued for 75 days. Seed was harvested 33 days prior to the beginning of the experiments.

Table 2.--Germination of switchgrass as affected by salt concentration

Salt concentration (percent)	Number of seed germinated				Average (percent)	
	S ¹		N-S ²			
	Rep. I	Rep. II	Rep. I	Rep. II	S ¹	N-S ²
0.00 (check)	5	5	2	5	50.0	30.5
.0099	10	9	6	7	95.0	65.0
.0499	5	3	0	4	40.0	20.0
.0999	5	1	4	0	30.0	20.0
.497	0	0	4	3	0.0	30.5
.990	0	0	0	0	0.0	0.0
1.477	0	0	0	0	0.0	0.0
1.961	0	0	0	0	0.0	0.0
2.912	0	0	0	0	0.0	0.0
4.762	0	0	0	0	0.0	0.0
6.542	0	0	0	0	0.0	0.0

¹ Seed from the saline area.

² Seed from non-saline area.

SCS, USDA, Scottsbluff, Nebr.

There are about 240,000 acres of "go-back land" and other eroded cropland in the Flint Hills. The reasons for abandonment include: (1) Low productivity capacity from soils initially low in productive ability and further handicapped by loss of topsoil and drought, and (2) low prices for the crops grown on these marginal lands. These conditions have often been concurrent. While abandonment has been going on since the land was broken, the rate was accelerated during the drought and depression of the 1930's. The severe drought during the early 1950's resulted in some additional land abandonment, but the total acreage abandonment was small because of the effectiveness of conservation practices applied since the 1930's and because smaller amounts of marginal land were under cultivation.

It has been common practice to remove the fences when abandoning cropland and to simply let the area become a part of the adjoining grasslands without further treatment. With normal grazing pressures and the natural limitations of soil, climate, and modes of native grass establishment, the vegetation on "go-back land" makes little or no progress toward becoming anything like it was originally. Even 30 years after abandonment, desirable grasses have not been re-established.

During the past 8 years an active revegetation program has been underway in the Flint Hills area. An estimated 240,000 acres in the area need to be seeded. In 1959, about 13,560 acres were seeded to native grasses in the 11 counties in the Flint Hills. Most soil conservation districts have special drills available for use by farmers.

Since most of the areas to be reseeded are actively eroding, it is common practice to fill gullies and reduce concentration of runoff through the use of diversions and terraces before seeding. Soil physical characteristics, particularly the massive clayey nature of the material, make seedbed preparation difficult. Revegetation has been most successful on the better sites; these are usually the gently sloping uplands that have few gullies and a little topsoil. These sites can be prepared for reseeding with a minimum of expense.

It would be desirable to have each field that is to be reseeded classified by range site and to have a suitable mixture of native grass seed for each of the individual range sites. Research and experience may make this possible in the future, but current practice is to use mixtures of grass seed harvested from native pastures in the vicinity of the field to be reseeded. At the present time there is plenty of this kind of seed available although it often has a low pure-live seed index and species composition varies greatly by location and year in which it was produced. These seed mixtures are predominately big and little bluestem. Increased production of native grass seeds by individual species from cultivated land can be expected.

SCS, USDA, Cottonwood Falls, Kans.

Gomm, F. B. RESEEDING STUDIES AT A SMALL HIGH-ALTITUDE PARK IN SOUTH-WESTERN MONTANA. Mont. Agr. Expt. Sta. B. 568, 16 pp. 1962.

Experiments comparing differences between seedbed treatments, seeding methods, species, and fertilizer treatments for seeding high altitude rangeland were conducted in the Carrot Basin of the Gallatin National Forest in Montana. Seedling counts and basal area occupied were used as measures of the effects of seedbed treatments, seeding practices, and site conditions on the emergence and establishment of seeded species. Production and plant development were used as measures of plant vigor, growth characteristics, and response to site conditions.

1. The reduction of native vegetation through cultivation increased the number of seedlings established. The reduction of native plants from a density of 36.2 on the non-cultivated plot to 22.6, 12.6, 12.0, and 7.1 percent, respectively, for disking once, twice, three times, and plowing plus disking, increased establishment from 0.1 to 1.4, 3.3, 3.8, and 4.2 plants per square foot in the second year of establishment. The basal area and herbage yields in mature stands were similarly increased with more through tillage of the seedbed.
2. Plant vigor was directly affected by the method and degree of seedbed preparation. Average leaf-heights of reseeded grasses were increased from 4.1 inches on non-treated soil to 6.3 inches where the seedbed had been plowed and disked. Plant vigor was affected by site with average leaf heights of 5.1 inches on north exposures as compared to 5.8 inches on south exposures.
3. There was no difference between drilling and broadcasting treatments on the initial establishment of the reseeded grasses except on plots plowed plus disked. On this treatment, broadcasting was superior to drilling.
4. Meadow foxtain and smooth brome were well adapted for reseeding at the altitude and conditions studied. Species which showed some adaptability were western wheatgrass, bearded wheatgrass, slender wheatgrass, mountain brome, orchardgrass, and Kentucky bluegrass.
5. Data from field plots were not sufficient to show definite responses to fertilizers. There was some indication that fertilization decreased the number of established seedlings. More research is needed to determine the effects of fertilizers and their placement on seedling establishment.
6. In the greenhouse, the fertilizer treatment did not affect vigor before the seedlings reached the second leaf stage. By the third leaf stage seedlings seeded in Carrot Basin soil averaged 2.7 inches taller from the fertilized than from the non-fertilized treatment.

CRD, ARS, USDA, and Mont. Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

Burzlaff, D. F. A SOIL AND VEGETATION INVENTORY AND ANALYSIS OF THREE NEBRASKA SANDHILL RANGE SITES. Nebr. Agr. Expt. Sta. Res. B. 206, 33 pp. 1962.

The vegetation of the grasslands of the Nebraska sandhills may be subdivided into range sites on the basis of the individual species' ability to adjust to factors of the environment and its interrelations with the other components of the plant community.

Using vegetation cover as a measure of forage production, these sites, in respect to their potential, are the dry valley, the rolling sands, and choppy sandhill range site. Each of these sites possesses a set of model soil and vegetation characteristics with definable limits.

When soil characteristics were measured and analyzed, highly significant differences were recorded among areas, among sites within areas, and among depths at the same site. These differences supported the delineation of range sites on the basis of soil characteristics.

Correlations of organic matter content and percentage of soil particles in the silt-clay fraction with the percentage of moisture retained between 1/10 and 15 atmospheres and with the cation-exchange capacity were highly significant. This indicated these factors to be highly interdependent variables.

The variation in chemical and physical properties at each sampling location and depth was assumed to be reflection of the rate of formation and deposition of clay and its diffusion pattern throughout the profile. Organic matter content, cation-exchange capacity, and the

percentage of soil moisture in the available range were the edaphic characteristics most influencing the distribution of vegetation within the study areas. Indirectly, the silt-clay fraction may be considered to be influencing the distribution of vegetation since it controls the soil-moisture relationships. It also regulated other chemical and physical properties of the soil that appeared to be associated with the distribution of plant species within the ecosystem.

Four unions (structural units) of the vegetation were delineated on the basis of an understanding of ecologic amplitude, phenology, and, to a lesser extent, life form of the constituents of the flora. They were designated the Festuca octoflora, the Stipa comata, the Sporobolus cryptandrus, and the Calamovilfa longifolia unions.

The most important segment of the flora on the sandhill range sites was the Calamovilfa union. It contained most of the tall, warm-season grass species that contributed aspect and dominance to the vegetation of the area.

The sporobolus union was of second-most importance. The components of this union were not only extremely heterogeneous in life-form, but represented, to a large extent, the group of species that increase in composition percentage under adverse grazing conditions.

Calamovilfa longifolia stood out as the most uniformly distributed and the most abundant species of the vegetation on all range sites. Andropogon hallii was considered a most important co-dominant.

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

Duvall, V. L. BURNING AND GRAZING INCREASE HERBAGE ON SLENDER BLUESTEM RANGE. J. Range Mangt. 15: 14-16. 1962.

This paper describes how prescribed burning, in combination with cattle grazing of various intensities, affected grass production, utilization, and litter accumulation in the bluestem-longleaf pine type. The study was conducted on open grassland of the Palustris Experimental Forest in central Louisiana. Most of the longleaf pines had been cut over 20 years previously.

Prior to 1951, the area had been burned every 2 or 3 years during winter or early spring according to local custom of removing litter and hastening new grass growth.

Moderate grazing is preferable on bluestem-longleaf pine ranges. Though heavy grazing may increase herbage yields, it is likely to damage forest regeneration and lessen the vigor and survival of some forage species. It may also impair soil and hydrologic conditions. Moderately stocked ranges are more likely to have a reserve of forage during droughts and for winter grazing.

Preventing large accumulations of herbaceous litter is apparently the key to high herbage yields. Ranges that have been ungrazed for several years should be burned before they are stocked with cattle. On lightly grazed ranges, burning on a 3 to 4-year cycle will help maintain high yields. Where grazing is moderate to heavy, burning does not appear to benefit herbage production.

Southern Forest Expt. Sta., FS, USDA, Alexandria, Va.

Kinsinger, F. E., and Eckert, R. E., Jr. EMERGENCE AND GROWTH OF ANNUAL AND PERENNIAL GRASSES AND FORBS IN SOILS ALTERED BY HALOGETON LEACHATE. J. Range Mangt. 14: 194-197. 1961.

Soils which supported whitesage, shadscale, and saltsage vegetation types were treated with halogeton mulch under greenhouse conditions. Eight perennial grasses, 4 annual grasses, and 4 forbs were planted in the treated soil and the emergence and height of the seedlings were recorded after 2 weeks.

Sodium and perhaps potassium appear to be the water soluble materials responsible for reducing the emergence and growth of the species tested. One inch of mulch (27,000 pounds per acre air-dry weight) and three inches of mulch (95,000 pounds per acre air-dry weight) reduced the percent emergence and height growth of most perennial and annual grasses. One inch of mulch on the saltsage soil increased the percent emergence of all forbs except sweetclover and reduced slightly the height growth of all forbs. Under the 3-inch treatment percent emergence of tall wheatgrass, bassia, and Russian thistle was reduced about 45 percent while the emergence of halogeton was reduced an average of only 24 percent. On the saltsage soil treated with 3 inches of mulch, the emergence of halogeton was 182 percent.

Results indicate that soils altered by halogeton leachate are more favorable for halogeton and other low value or worthless forb species. Of the three soils used, the saltsage soil appears to be most favorable for germination and emergence of halogeton.

Jr. Authors, CRD, ARS, USDA, Reno, Nev.

Hyder, D. N., Booster, D. E., Sneva, F. A., Sawyer, W. A., and Rodgers, J. B. WHEEL-TRACK PLANTING ON SAGEBRUSH-BUNCHGRASS RANGE. J. Range Mangt. 14: 220-224. 1962.

A planting machine that will operate satisfactorily on soft, plowed seedbeds, which often cause seeding failures with conventional seeders, has been developed in Oregon. The planting mechanism, designed to produce a specific seed-soil relation found desirable in basic research, is a simple and direct fulfillment of wheel-track planting. The machine largely eliminates the problem of planting depths and obtains approximately an optimum seed-soil relation for assurance of successful germination, emergence, and survival of crested wheatgrass. The new seeder, which has been accepted for testing by the Inter-Agency Range Seeding Equipment committee, will be called the Oregon Press Seeder.

CRD, ARS, USDA, Corvallis, Oreg.

Schmutz, E. M., and Whitham, D. W. SCHRUB CONTROL STUDIES IN THE OAK-CHAPARRAL OF ARIZONA. J. Range Mangt. 15: 61-67. 1962.

During the period 1957-59 both airplane- and hand-spray herbicide tests were made on a burned and reseeded oak-chaparral area near Dewey, Ariz. Beginning 1 year after burning, silvex and 2,4,5-T herbicides were applied to replicated plots at single heavy rates (3 to 5 pounds per acre) and at light rates (1-1.67 pounds per acre) at single-, alternate-, two-consecutive-, and three-consecutive-year intervals.

Evaluations were made of the effect of herbicide treatments on total-kill and topkill of shrub live oak, on ground cover and numbers of various shrubs, and on the production of grass. An economic analysis was made based on herbicide treatment costs and increased forage production.

Results were variable but data show that whether applied by hand or[®] airplane methods, repeated light applications of silvex and 2,4,5-T herbicides were generally more effective in controlling shrub live oak than single heavy applications. The three-consecutive-year light applications, which averaged about 40 percent total-kill and 80 percent topkill, were most effective but only slightly more effective than the two-consecutive-year aerial application. In general, topkill was more than twice as high as total-kill and high-volume hand-spray applications were more effective than low-volume aerial-spray applications. Propionic formulations of 2,4,5-T were usually more effective than acetic formulations but results were not consistent.

In general, as shrub cover and shrub numbers were reduced, grass production increased. The average effect of all aerial herbicide treatments was to increase grass production 655 pounds per acre, from 345 pounds on the unsprayed areas to over 1,000 pounds per acre on the treated plots. The greatest increase was 1,030 pounds per acre from the three-consecutive-year treatments with the two-alternative-year-light, single-year-light, and single-year-heavy applications resulting in smaller increases of 867, 448, and 278 pounds per acre, respectively.

An economic evaluation of herbicide treatment costs versus corresponding increased forage production indicated that, based on grass hay values, 3 to 5 years of sustained forage production would be required to repay costs of light applications and 11 to 14 years would be required to repay the cost of a single heavy application.

It was concluded that on many burned and reseeded areas of oak-chaparral in Arizona, multiple-light applications of 2,4,5-T or silvex herbicides may provide an economic means of reducing shrub growth and increasing forage production.

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

Rodgers, E. G., Burt, E. O., and Upchurch, R. P. REPLACEMENT OF TURKEY OAK VEGETATION WITH LOW-GROWING SOIL COVER. Weeds 10: 48-53. 1962.

Seven experiments were conducted over a period of 4 years in an attempt to suppress or eradicate Turkey oak and to substitute certain desirable vegetation types for Turkey oak-wiregrass vegetation. Investigations were conducted on the Lakeland fs soils of Florida where this oak thrives. The principal results were summarized as follows:

1. Monuron, diuron, and fenuron at approximately 10 lb./A were effective in eradicating Turkey oak and wiregrass. The most appropriate season for application and the exact rate required depended on which of these herbicides was used.
2. Within 2 years after using the above three herbicides, Pensacola bahiagrass and weeping lovegrass could be established.
3. Any of several low-volatile esters of 2,4-D, 2,4,5-T, or silvex at about 4 lb./A. were effective in suppressing Turkey oak. Annual applications were required for continued suppression. These continued applications or less frequent applications of a higher rate resulted in some Turkey oak kill.
4. AMS, dalapon, and various formulations of benzoic acid were ineffective in Turkey oak control with the techniques used.
5. Pensacola bahiagrass and particularly weeping lovegrass were well adapted to the Lakeland fs soil. Establishment of these species required some suppression of the native vegetation.
6. The Marden chopper, Rome plow, and a disc plow were satisfactory devices for suppressing native vegetation prior to seeding grasses.

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

Cook, C. W., Taylor, K., and Harris, L. E. THE EFFECT OF RANGE CONDITION AND INTENSITY OF GRAZING UPON DAILY INTAKE AND NUTRITIVE VALUE OF THE DIE ON DESERT RANGES. J. Range Managt. 15: 1-6. 1962.

During two winter grazing seasons--1957 and 1959--a study was conducted on typical desert ranges in southwestern Utah to determine the effect of range condition and intensity of grazing upon the daily intake and nutritive content of the grazing animals' diet.

At each of two locations three areas displaying fence-line contrasts of good and poor range were selected and fenced so that areas on each side included equal herbage for the same number of experimental animals. Three sheep with esophageal fistula and six wethers equipped with fecal collecting bags were grazed on each side of the fence. Daily intake and digestibility were determined by the lignin-ratio technique. Each paddock was grazed for two 5-day periods, the first representing light use and the second, heavy use.

Ranges in good condition produced more herbage than those in poor condition.

Even though the same quantity of herbage was available on both good and poor ranges, the use was lighter on poor ranges.

Diets showed that animals ate more grass in some areas and more browse in others. Likewise, diets changed from a large percentage of one forage class to a large percentage of another with increased intensity of use.

The nutrient content of the diets on good and poor ranges depended upon the species composition and the intensity of utilization. When browse was high in the diet, the nutrient intake was generally high in protein, ash, lignin, and ether extracts; but when grass was high in the diet, the nutrient intake was generally high in cellulose, other carbohydrates, and metabolizable energy.

The digestibility of nutrients in diets on both poor and good ranges was about the same if use of similar species was not too different. Increased utilization decreased digestibility of forage unless the diets changed substantially in percentage of grass or browse.

Daily intake was less on poor ranges than on good ranges, and increased intensity of grazing reduced daily intake on both good and poor ranges.

Utah State Agr. Expt. Sta., Logon, Utah.

Plant Materials

Newell, L. C., Staten, R. D., Jackson, E. B., and Conard, E. C. SIDE-OATS GRAMA IN THE CENTRAL GREAT PLAINS. Nebr. Agr. Expt. Sta. Res. B. 207, 38 pp. 1962.

Six strains of side-oats grama were evaluated for adaptation to mid-latitude conditions to discover their suitability for seed increase as varieties. Their responses to photoperiod were determined under controlled greenhouse conditions to aid interpretation of field results.

Only adapted varieties of side-oats grama should be planted in the latitude of the central plains. Northern strains moved southward are low in production, whereas winter hardiness is a critical factor in the choice of southern varieties or strains. Two Nebraska strains and one Oklahoma strain were found to be adapted in parts of the Central Plains.

Butte (Nebraska 37) and North Dakota 97 exhibited typical growth and reproduction of long-day plants. They were relatively earlier in maturity than more southern strains and were winter hardy. Butte was found best adapted for sites low in soil moisture or fertility in the northern Central Plains. North Dakota 97 was too low in production in that area. Only Butte and Trailway (Nebraska 52) survived winter conditions in Nebraska, Wyoming, and Dakota.

Trailway and El Reno received an intermediate classification as to photoperiod and adaption. They produced good forage yields and utilized most of the growing season in the mid-latitudes. Trailway is a productive leafy, winter-hardy variety with forage characteristics intermediate between northern and southern types. It was found adapted for forage production in pure stands and mixtures on good soils with favorable moisture conditions in eastern and southern parts of the region. El Reno was winter susceptible in the Nebraska comparisons, but gave good results in the Kansas trials.

In photoperiod studies, Tucson and Vaughn (A-3603) initiated the reproductive phase in shorter days than other varieties with which they were compared. In field studies, they flowered earlier in the summer than the varieties of the central group, but continued comparable growth throughout the summer, such varieties and strains from southern sources were winter susceptible in all northern comparisons.

Yields of seed spikes and pure live seed of side-oats grama were increased with a moderate application of nitrogen (30 lbs. of N per acre), but higher rates failed to give significant additional yields under non-irrigated conditions. Effects of phosphorus were negligible. Caryopses were larger when more nitrogen was applied under favorable moisture conditions but applying nitrogen decreased quality and seed set with limited moisture. Moderate, timely irrigation improved the yield of spikes and the quality of caryopses.

Caryopses of side-oats grama of good quality may be described as varying from 550,000 to 750,000 per pound, based on average performance of Trailway and Butte in 2 years. Average quality of the two varieties in a season favorable to seed production on non-irrigated land was approximately 600,000 per pound. As commercial seed is composed of a mixture of whole and broken seed spikes, yields were calculated on the basis of pure live seed produced per acre. A selected rate of planting of 4-1/2 pounds of pure live seed per acre would plant 20 viable seed units per square foot.

Side-oats grama grows well in mixtures with other warm-season grasses to produce maximum forage for summer use. It is an important component of mixtures to be planted on fine-textured, upland soils for conservation and forage.

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

Dunn, G. M., and Kilpatrick, R. A. PERFORMANCE OF FORAGE VARIETIES AND STRAINS IN NEW HAMPSHIRE (1955-1960). N.H. Agr. Expt. Sta., Sta. B. 470, 12 pp. 1961.

The New Hampshire Station conducted variety trials with the following forage species during 1955-60: bromegrass (Bromus inermis Leyss), Alfalfa (Medicago sativa L.) and Ladino white clover (Trifolium repens L.). The authors concluded that: (1) Saratoga brome-grass appears to be superior to other available brome-grass varieties which have been tested in New Hampshire. (2) Narragansett and Dupuits alfalfa have performed well in limited alfalfa tests in New Hampshire. Vernal alfalfa is suggested for trial in New Hampshire, particularly in areas where bacterial wilt may be a problem. And (3) pilgrim white clover (large type), although not outstanding, has consistently performed somewhat better than other strains and lots of white clover which have been tested in the State.

Agr. Expt. Sta., U.N.H., Durham, N.H.

Denman, C. E., Richardson, W. L., and Harlan, J. R. LEGUME ADAPTATION STUDIES IN NORTH CENTRAL OKLAHOMA. Okla. Agr. Expt. Sta. B. B-587, 11 pp. 1961.

Suitable legumes are needed in north-central Oklahoma for use in range and pasture improvement and for maintenance of soil fertility on farm crop lands. Many desirable native legumes exist in the area but not in sufficient quantity to be of real value and, to date, only limited success has been experienced in establishing them. Very few exotic legumes have been found that are adapted to local conditions.

In 1951, a very extensive program was initiated to obtain samples of the legumes of the world that might prove of value for local conditions. The soil (Kirland cl) was liberally limed and treated with superphosphate.

Of the 54 genera, 216 species, and 1,366 entries of legumes checked for adaptation at the Stillwater Agronomy Farm from 1951 through 1959, only alfalfa and some of the vetches showed real promise for use as forage legumes. Lespedeza, birdsfoot trefoil, and sanfoin were fairly well adapted but vegetative growth was somewhat limited most years. Practically all of the Trifolium species were eliminated by summer heat or drought or both.

Some of the sweet clovers, Cassia, Crotalaria, Psoralea, Sesbania, and Tephrosia species made good growth and may be of value for maintaining soil fertility or in reclaiming abandoned lands.

A table is presented that shows adaptation and forage potentials of the 216 species.

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

Soil Conservation. 27(9): 195-215. 1962.

The April issue of Soil Conservation is devoted to Plant Material as it applies to soil and water conservation. The following is author, title, and address of author for each article presented:

1. Williams, D. A. PLANT MATERIALS BASIC TO SOIL AND WATER CONSERVATION. SCS, USDA, Washington, D.C. 20250
2. Hafenrichter, A. L. GRASS IMPROVEMENT BENEFITS RANCHERS AND COMMUNITY. SCS, USDA, Portland, Oreg.
3. Tossett, O., and McDermand, J. TREES FOR NORTH DAKOTA'S FUTURE. Chairman N. Dak. Assoc. SCD, Lansfork, N. Dak.
4. Hill, W. O. SAND EROSION, PLANTS TO THE RESCUE. SCS, USDA, Amherst, Mass.
5. Loudermilk, H. MOJAVE DESERT WINDBREAKS. SCS, USDA, Victorville, Calif.
6. Bates, R. W. COASTAL BERMUDAGRASS PROVES SELF IN WEST. SCS, USDA, Tucson, Ariz.
7. Haynsworth, H. J., and Blickensderfer, C. B. BETTER PLANTS FOR FLORIDA'S "FLATLANDS".
8. Hawk, V. B., and Douglas, D. S. CROWN VETCH, NEW PASTURE LEGUME. SCS, USDA, Ames, Iowa.
9. Smith, J. E., Jr. SOMETHING DIFFERENT ON THE PLAINS. SCS, USDA, Temple, Tex.
10. Ruffner, J. D. NEW PLANTS FOR STRIP MINE SPOILS AND SHALE SOILS. SCS, USDA, Morgantown, Va.
11. McDermand, J., and McWilliams, J. L. GARRISON CREEPING FOXTAIL: A NEW GRASS FOR WETLANDS. SCS, USDA, Bismark, N.D.
12. Topholm, A. S. NEVADA LAND RESPONDS TO GRASS IMPROVEMENT. SCS, USDA, Wells, Nev.
13. Bohart, C. V. 8000 ACRES IN WOODY PLANTINGS FOR NEBRASKA WILDLIFE. SCS, USDA, Lincoln, Nebr.

Zielinski, Q. B., Sistrunk, W. A., and Davidson, T. P. PLUM VARIETIES FOR OREGON. Oreg. Agr. Expt. Sta., Sta. B. 582, 22 pp. 1961.

Oregon's extensive plum variety program now includes nearly 150 varieties. The results of the testing program and outstanding features of varieties best suited to various areas of Oregon are described. Choice of variety depends upon where plums are to be grown and the use to be made of the fruit.

The best varieties to grow for commercial fruit are not always the best ones for farm orchards or for backyard gardens. The large commercial grower needs only a few varieties that crop heavily every year. His fruit must handle, ship, or process well and it must be attractive in appearance.

For home use more varieties may be chosen because heavy yields are not too important. Emphasis should be placed on high quality, season of maturity, value for canning or drying, resistance to diseases, and adaptability to local conditions.

For local markets more varieties should be grown to spread the marketing period and to satisfy various consumer preferences. Less attention should be given to handling and shipping tolerance and more to high dessert quality and suitability for home canning and drying.

Care is necessary to choosing plum varieties for the colder parts of Oregon. Careful attention should be given to frost hardiness of blossom buds, time of bloom, and especially to winter hardiness, and sunscald.

The problem of winter hardiness is a complex one. Some of the things involved are: physiological condition of the plant, variety, rate of maturity, resistance to exposure, winter desiccation, time, and rate of development of cold resistance, and ability to regain cold resistance.

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

Slate, G. L., Watson, J., and Einset, J. GRAPE VARIETIES INTRODUCED BY THE NEW YORK STATE AGRICULTURAL EXPERIMENT STATION, 1928-1961. N.Y. State Agr. Expt. Sta. B. 794, 47 pp. 1962.

The origin, introduction, characteristics, and technical descriptions of 23 varieties of grapes originated at the New York State Agricultural Experiment Station are reported. The varieties described have not been previously described.

In addition to these 23 varieties, 15 more were named earlier and their origins, characteristics, and technical descriptions were recorded in the New or Noteworthy Fruits Bulletin series of this Station. These varieties are listed in this report.

N.Y. State Agr. Expt. Sta., Geneva, N.Y.

Aspelin, A. L., and Miller, C. J. PRODUCTION COSTS FOR CERTIFIED SEED OF SELECTED CROPS IN NEBRASKA. Nebr. Agr. Expt. Sta. SB 468, 32 pp. 1961.

Production costs were determined for certified seed production in Nebraska. Crops selected were hybrid corn, soybeans, winter wheat, oats, spring barley, sudangrass, and brome grass.

Data were obtained by personal interviews with growers randomly selected from the membership lists of the Nebraska Crop Improvement Association. The number of growers interviewed for each crop depended on the total number in the state and variations in production methods. The surveys were conducted between 1957 and 1959; data for two growing seasons were collected for most crops.

The survey data, together with cost estimates from related studies, provided the basis for cost determination. It was necessary to supplement the survey data with other information because some types of data were not directly obtainable from the growers.

For analysis and presentation purposes, the production cost data were separated into three categories: (1) Pre-harvest production costs not related to certification; (2) pre-harvest costs related to certification; and (3) post-harvest costs. Tables were compiled

showing costs per bushel or per hundredweight at various yield levels for each crop. From these figures, costs may be estimated for yield levels of future years.

Certified seed may be sold by the grower through various channels, with varying amounts of processing and marketing expense.

This information should be particularly useful to seedsmen and present seed growers in helping them determine their pricing policies. In addition, this report should help prospective growers in deciding whether or not to enter into certified seed production.

Tables

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

Miller, C. J., and Aspelin, A. L. PRODUCTION METHODS AND COSTS FOR CERTIFIED GRAIN SORGHUM SEED IN NEBRASKA. Nebr. Agr. Expt. Sta. SB 469, 30 pp. 1962.

The production methods used for certified variety and hybrid grain sorghum seed are described and the associated production costs were determined.

Data were obtained by personal interviews with growers who produced certified seed during the 1956 and 1957 growing seasons. The growers in the sample were primarily in eastern and central Nebraska. From the survey data, production methods and costs were determined. Estimations from other studies were used to supplement the survey data for some costs which were not directly available from the growers.

A discussion of the production methods and associated costs which comprise total production costs are given. Labor requirements and production costs per acre for all items up to and through harvesting of the seed are summarized. Sample budgets based on average costs and returns for the most common marketing methods were made.

The information should be useful to seedsmen and seed growers in determining pricing policies and should help prospective growers decide whether or not to raise certified sorghum seed.

Table. Summary of total production costs per bushel for certified hybrid grain sorghum seed^a

	Dryland		Irrigated	
	1956	1957	1956	1957
Labor included:				
Average.....	\$3.59	\$2.03	\$1.68	\$1.34
High.....	25.37	9.78	4.96	2.14
Low.....	.88	.86	.82	.92
Labor excluded:				
Average.....	2.48	1.41	1.33	1.05
High.....	17.73	5.53	3.50	1.80
Low.....	.60	.62	.61	.69

^a Based on 1956 and 1957 yields and 1958-60 production costs on sample farms. Costs include all items with the exception of seed hauling, processing, storage, marketing and 2.5 percent certification sales fee. Labor costs calculated at \$1.08 per hour.

Tables.

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

Niles, G. A., and Richmond, T. R. PERFORMANCE OF COTTON VARIETIES IN TEXAS, 1957-59. Tex. Agr. Expt. Sta. B. B-983, 19 pp. 1961.

Performance data for cotton varieties tested at 26 locations in Texas are summarized for 1957-59. Information is given on lint yield, lint percentages, boll size, staple length, and micronaire (fiber fineness).

Yield performance data for the various land resource areas in Texas are summarized in tables for both dryland and irrigated variety trials. Performance data for individual locations are given in the Appendix.

Classification of varieties into varietal types is presented, and recommendations in terms of varietal types are given for the various land resource areas in Texas.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Clark, F. FLORIDA 22 - A NEW NEMATODE RESISTANT FLUE-CURED TOBACCO VARIETY. Fla. Agr. Expt. Sta. C. S-134, 12 pp. 1961.

Yields of Florida 22 range from 10 to 15 percent higher than many of the leading commercial flue-cured tobacco varieties. It has performed well in resistance to nematodes and has a fairly high tolerance to brownspot. It is susceptible to blackshank and the wilts. It combines a high yield with a satisfactory alkaloid content, which doesn't occur with many of the presently grown commercial varieties. The chemical constituents compare very favorably with those of any of the leading commercially grown varieties, particularly with Hicks and 402--the two leading varieties grown in Florida.

There has not been any need for special handling of this variety in the seedbed. Florida 22 appears to be a vigorous feeder of plant nutrients and a slight modification of the fertilizer practices may be desirable to reduce growth vigor and improve field quality of the green leaf.

There should not be any particular need to adjust curing techniques, if the leaf is permitted to fully ripen. The leaf cures more easily to the orange color than with most other varieties.

Seasonal conditions will affect this variety to the same extent as other commercial varieties; however, seven to eight harvests may be required to properly harvest this variety under favorable climatic conditions.

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

Woodlands

McGahan, M. W., Brown, J. H., Jr., Gould, W. P., Lampe, H. C., and Shearin, R. E. SITE CONDITIONS AND TREE GROWTH ANALYSES IN RHODE ISLAND FORESTS. R. I. Agr. Expt. Sta. B. 357, 32 pp. 1962.

In a study of composition and growth of Rhode Island forests a total of 70 one-quarter acre plots were established from 1955 to 1957.

The most important species based on frequency, density, and dominance values were found to be white oak (Quercus alba), red maple (Acer rubrum), scarlet oak (Quercus coccinea), white pine (Pinus strobus), and black oak (Quercus velutina).

Prediction equations through multiple regression analysis, whereby height of the important native tree species including the oaks (mixed oak), red maple, and white pine could be predicted given certain variables of site and stand were developed.

Age was an important variable in each analysis. Age was the only consistently significant variable in the white pine analysis.

Factors of soil and topography which were consistently highly correlated with height growth in the mixed oak stands were soil drainage class, soil texture class, and thickness of the A horizon. Height growth of mixed oak stands was greatest on the more poorly drained, finer textured soils having the deeper A horizons.

Percent slope showed a significant inverse correlation with height growth of red maple.

Past history of burning and cultivation was significantly correlated with height growth of mixed oak and red maple. A decrease in height growth occurred with an increase in use and abuse of the site in terms of fire and cultivation.

Stand-density index was more strongly correlated with height than was basal area per acre. Stand-density index proved significant in at least one equation for each species evaluated.

Although significant regressions were developed for all species, they are considered inadequate for accurate height growth predictions, since coefficients of determination (R^2) generally were smaller than those usually considered acceptable. This was attributed to the possible influence of variables not included in this study, and methods of measuring the variables which may not have been accurate enough to indicate the true relationships.

Tables, graphs, and maps.

Agr. Expt. Sta., U. R. I., Kingston, R. I.

Zahner, R. LOBLOLLY PINE SITE CURVES BY SOIL GROUPS. *Forest Sci.* 8: 104-110. 1962.

Tree height and age data site information were obtained from 353 well-stocked even-aged stands of loblolly pine from ages 15 to 80 years. Five soil groups of southern Arkansas and northern Louisiana were presented. Regression analyses were made within groups to account for soil and topographic influences on height-over-age relationships.

An equation of the form $\text{Log ht} = \log S.I. - b/50 + b/\text{age}$ was established for each group. The b coefficients were tested for significant differences among groups. Site index curves were constructed from these equations for groups found different from others.

Significantly different height-over-age relationships were found for three soil groups (the nonsignificant groups were pooled): (1) Loess soils; (2) well aerated upland soils, well drained internally with strong profile development; and (3) poorly aerated soils, with or without profile development, but with poor surface or internal drainage.

Trees on loess maintain height growth at relatively good rate to age 50. In the poorly aerated group growth is good to about age 30, but then slows more rapidly than for the other groups. The well aerated group behaves intermediately.

Sch. Nat'l Resources, U. Mich., Ann Arbor, Mich.

Hosner, J. F., and Boyce, S. G. TOLERANCE TO WATER SATURATED SOIL OF VARIOUS BOTTOMLAND HARDWOODS. *Forest Sci.* 8: 180-186. 1962.

There are differences in the relative tolerance to saturated soils of seedlings of different bottomland tree species. Shumard oak and cherrybark oak seedlings suffered heavy mortality, but some seedlings of all species survived continuously saturated soil conditions

for sixty days. Four species, green ash, pumpkin ash, pin oak, and water tupelo grew significantly taller in saturated soil than in well-aerated soil on the greenhouse bench.

The seedlings can be classified according to tolerance to water saturated soil conditions as follows: Tolerant--green ash, pumpkin ash, water tupelo, and willow; intermediate--eastern cottonwood, boxelder, red maple, silver maple, pin oak, and sycamore; intolerant--Shumard oak, cherrybark oak, American elm, willow oak, sweetgum, hackberry, and sugarberry. It appears that the occurrence of continuously saturated soil conditions for long but varying periods in bottomlands results in a competitive advantage for certain species. The resultant reproduction of different species subsequently affects the species composition of bottomland stands associated with sites with different drainage conditions. Some seedlings of all 17 species tested could be expected to be occasionally found in all bottomland stands except in deep swamps where flooding, except during prolonged dry periods, is continuous.

The mechanism of tolerance to saturated soil conditions is attributed to one or more of the following seedling characteristics--(1) the ability of established roots to continue to grow and function under poorly aerated soil conditions; (2) the formation of adventitious roots at and above the root collar; and (3) the drought resistant characteristics of the stems and leaves of different species.

Va. Polytech. Inst., Blacksburg, Va.

Bateman, B. A., and Wilson, W. F., Jr. MANAGEMENT OF PINE STANDS FOR STRAW AND TIMBER PRODUCTION. La. Agr. Expt. Sta. B. 543, 23 pp. 1961.

Timber management practices for the production of both wood products and pine straw were begun on the Louisiana State University Fruit and Truck Experiment Station in southeastern Louisiana in 1947. At the beginning of the experiment, 12 plots were established in a 23-year-old loblolly pine stand with four thinning treatments, each treatment being replicated three times.

Basal area was used to measure and control density. After thinning, scheduled at 5-year intervals beginning in 1947-48, the basal areas of thinned plots were 80, 90, and 100 square feet. In 1952, three additional plots in the same timber type were thinned to 100 trees per acre, which reduced the stocking to an average of 74 square feet of basal area per acre. Four plots in unthinned 17-year-old stands were also checked for straw production.

The 9 thinned plots in the original group of 12 have been thinned three times--first, at the beginning of the study, and the next two times at 5-year intervals. The three plots added in 1952 have been thinned once.

Basal area growth decreased slightly as per-acre basal areas increased. Sawtimber and cordwood growth on thinned plots exceeded growth on unthinned plots. The average volume harvested in the three thinnings was 21.8 cords per acre, valued at \$87.20 on the stump.

Straw yields decreased slightly as the per-acre basal area decreased. The 17-year-old stand produced much more straw than the older plots. Stands at the age of 12 years produced commercial straw yields. Approximately 2 acres of timber were required to produce sufficient straw to mulch one acre of berries.

Thinning recommendations are presented which will maintain long, well-rounded crowns after stems with three logs clear of live limbs have been obtained. This will produce both good growth of high-quality wood and satisfactory straw yields.

Hardwood brush has been controlled with chemicals after the brush was cut at the time of the first thinning. For stumps after large brush has been cut, it is recommended that a 5 percent solution of 2,4,5-T (low-volatile ester) in fuel oil be used; for a foliage spray on smaller brush, use a 2 percent solution of 2,4,5-T (low-volatile ester) in water.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Walker, L. C. THE EFFECTS OF WATER AND FERTILIZER ON LOBLOLLY AND SLASH PINE SEEDLINGS. *Soil Sci. Soc. Amer. Proc.* 26: 197-200. 1962.

Slash pine and loblolly pine seedlings in a Bladen cl soil were treated with water at four levels, from 4 inches above the ground to 4 inches below for 2 years. Superimposed on these water treatments were three fertilizer levels to determine if fertilization in the presence of adequate and excessive moisture may result in growth responses and if fertilization may aid seedlings to overcome deleterious effects of high water tables.

Survival, height-growth, needle lengths, foliage color, and foliar N, P, and K of slash pine and loblolly pine were influenced by water and fertilizer treatments.

Survival was lessened by fertilization only when water was ponded on the surface, and mortality increased with each fertilizer application. Height growth was stimulated through the second growing season by nutritional supplements under all water conditions, except for loblolly pine in plots permanently inundated to 4 inches. Needle lengths and foliar N, P, and K increased with drainage and fertilization, particularly early in the season. No certain evidence of the usefulness of foliar diagnosis in analyzing nutritional maladies of these species was indicated.

Draining the plastic Bladen cl soils of the Southeastern Tidewater area to depths of 4 inches is recommended, and appreciable height growth during the first 2 years of plantation establishment may be obtained with first-year spring application of 1,000 pounds per acre of 8-8-8 plus 100 pounds per acre of a mixture of trace elements.

Agr. Expt. Sta., U. Ga., Athens, Ga.

Zahner, R., and Oliver, W. W. THE INFLUENCE OF THINNING AND PRUNING ON THE DATE OF SUMMERWOOD INITIATION IN RED AND JACK PINES. *Forest Sci.* 8: 51-63. 1962.

The influence of thinning and pruning, on the initiation of small-diameter, summerwood-like tracheids was studied in young red and jack pines in southern Michigan. The dates of changeover from large- to small-diameter cells were established at two stem positions--at the base of the live crown, and at breast height--by comparing photomicrographs of new xylem tissue sampled weekly throughout the summer of 1959.

Thinning had the most pronounced retarding effect on the initiation of flattened summerwood tracheids. In all trees released by thinning, the changeover occurred consistently about two weeks later than in the unthinned controls. The delay in changeover was associated with delays in soil moisture depletion and in periods of decreased diameter growth. It is interpreted that auxin synthesis by terminal activity was maintained at a high level longer in the thinned trees than in the unthinned, thus prolonging the production of large-diameter cells in the thinning treatment.

Pruning alone delayed the average cell-size changeover in red pine only, and by about 1 week. It is interpreted that reduced transpiration, resulting from the reduction in crown, maintained the pruned trees in a state of lower water stress and longer auxin synthesis than that of the controls. Pruning combined with thinning had no significant effect on the date of summerwood initiation beyond that of thinning alone.

Cell-size changeover generally occurred about one week earlier at breast height than at the base of the crown.

Sch. Natl. Resources, U. Mich., Ann Arbor, Mich.

Roy, D. F. CALIFORNIA HARDWOODS: MANAGEMENT PRACTICES AND PROBLEMS. J. Forestry 60: 184-186. 1962.

If forest landowners begin to manage native California hardwoods they probably will limit their efforts to red alder, tanoak, and California black oak. Other hardwoods growing along streams and in valleys may receive attention from farmers.

Intelligent, effective management of hardwoods will require: (1) Information on growth and yield, growth habits, and inherited characteristics; (2) development of coppice management skills; (3) control of seed insects and seedeating animals for tanoak and California black oak; and protection from browsing for the black oak; and (4) exclusion of fire from tanoak and California black oak stands.

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

Worthington, N. P., Ruth, R. H., and Matson, E. RED ALDER--ITS MANAGEMENT AND UTILIZATION. U.S. Dept. Agr., Forest Serv. Misc. P. 881, 44 pp. 1962.

Since World War II, attention of Pacific Northwest forest industries has been increasingly drawn to the comparatively untapped native hardwood resources of the region.

Red alder, the most important hardwood in Oregon and Washington, comprises about two-thirds of the hardwood timber resource in the two-State region. About 11-3/4 billion board feet are available in commercially operable stands, nearly all of which occur west of the Cascade Range.

Several factors have prompted an accelerating industrial demand for red alder: (1) Technological advances in alder pulping have expanded this use to the point of exceeding all other uses combined; (2) a decline in hardwood quality on the national scale has stimulated a growing recognition of alder as a wood possessing both high quality and value; (3) expansion of local markets on the West Coast, particularly in California, has substantially favored locally grown hardwoods in railroad shipping costs; (4) long recognized as a versatile wood in furniture manufacture, red alder has continued to meet the expanding requirements of the furniture industry; and (5) effective promotion by an association of hardwood producers and landowners, both in establishing new markets and further exploiting current manufacturing outlets, has stressed the desirable qualities of the species.

The unprecedented industrial demand for red alder has stimulated interest in its management and utilization.

Prospects for continued improvement in utilization of red alder are promising. The overall increase in markets for wood products and the decreasing per-capita timber supply are directing more attention to western hardwoods. Although alder use has increased markedly since the 1950's, the species is still not harvested as fast as it is growing.

When properly manufactured, alder lumber can compete successfully with eastern hardwoods in western furniture plants. This market should continue to expand to keep pace with furniture needs for the rapidly growing western population. The recently developed market for pulpwood provides an important gain in utilization of alder, since only trees growing on moist sites reach saw-log size.

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

Uyl, D. D. NATURAL TREE REPRODUCTION IN MIXED HARDWOOD STANDS. Purdue U. Agr. Expt. Sta. Res. B. 728, 19 pp. 1961.

Natural tree regeneration has taken place in wood protected from fire and grazing. Most woodlands, following protection, require a 3 to 15 year period of adjustment before natural regeneration becomes established. The soil becomes loose and porous, as leaf litter

develops forest floor conditions and ground cover changes, and tree seedlings become established. The general trend is for sod cover to break up and to be followed by a cover of weeds and briars. Tree seedlings, especially light-seeded ones like sugar maple, elm, ash, hophornbeam, and bird disseminated black cherry, appear first and are most frequent and abundant. As the period of protection increases, a greater variety of species appears. Species that persist under grazing are hawthorn, pawpaw, hophornbeam, and sprout growth of hickory, black cherry, and elm.

The most frequently encountered species in natural reproduction in woodlands was sugar maple. Regardless of soil type or forest type group, this species was present in all woods. Elms, ash, hophornbeam, and black cherry were frequent and abundant. Dogwood, hawthorn, and pawpaw were frequent.

Although basswoods, oaks, and hickories were present on some plots in 1931-1932, it wasn't until 1938 to 1940 that these became frequent and abundant. Very few tulip, poplar, or beech came into sample plots and black walnut was absent from all but one quadrat.

Regeneration of hickories and beech was predominately of root sprout origin while most of the oaks were seedling sprouts.

Natural regeneration was found to be very uneven in its distribution.

On exposed sites, such as south and west woods borders, natural regeneration is extremely slow in becoming established. Desirable tree species can hardly be expected to regenerate naturally under exposed environmental conditions.

Tree species recorded on milacres during 1931-40 were essentially the same as those present in 1957-1960. The change was in frequency and abundance. Sugar maple, ash, and elm continued to be most numerous, while basswood, oaks, and hickories increased in number of established seedlings.

There appears to be no fixed pattern of establishment and growth of natural tree regeneration. Each milacre represented a specific environment which underwent changes during 1931 to 1960. Seedling establishment was cyclic and variable, survival was temporary on many areas and those species that grew to sapling or larger size were on areas where open canopy and reduced competition from overhead stand prevailed.

A study of tree regeneration at any one time will not reveal much except number and size of species present. It requires detailed studies of species characteristics to determine age since small trees may be 20 or more years old and yet appear to be young seedlings. Some of the larger saplings may be younger than smaller sized regeneration.

The composition of tree regeneration on any given area is often not of the same species represented in overhead stand. Seed production, dissemination, seedbed conditions, and other site factors determine what species become initially established. These may later be replaced by other species or number of initially established species reduced. Species not present at first may later come into an area and eventually develop into sapling or larger size.

Hardwood seedlings, except black walnut, appeared to be shade tolerant. They persisted for many years under a canopy of established stands, even though their height growth was small. Their development to sapling or pole size required overhead and side light and during this period of growth tolerance differences varied with species.

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

Tryon, E. H., and Carvell, K. L. ACORN PRODUCTION AND DAMAGE. W. Va. Agr. Expt. Sta. B. 466T, 18 pp. 1962.

Production of northern red oak and white oak acorns, and the amount and types of acorn damage was studied. The data were obtained from 14 red and 14 white oaks over a 5-year period. The major findings were:

1. Mature acorn production--The great variation in number of acorns among the individuals within the species and among years was outstanding. The red oaks produced a yearly average of 170 acorns per milacre of crown areas as compared with 96 for the white oaks.
2. Individual tree production by sites--Size of the acorn crop showed no strong relationship to site quality, although the production by white oaks was relatively lower than the red oaks on the better sites (site index 75 to 80). There was a large variation in production among trees of the same size on similar sites.
3. Immature acorn production--The number of immature acorns of both red and white oaks made up 34.7 percent of the total crop. The number of immature acorns was related to the crop size.
4. Damage to acorns--The acorn crops were heavily damaged by agents, especially animals and insects. The condition of all acorns follows: sound, 13.5 percent; insect damage, 32.8 percent; animal damage, 53.2 percent; and other, 0.5 percent.
5. Application of crop variation--The great variation in size of acorn crops produced among trees within a species was discussed, especially from the standpoint of reproducing mature oak stands by natural regeneration methods.

W. Va. U. Agr. Expt. Sta., Morgantown, W. Va.

Bernstein, D. A. USE OF AERIAL PHOTOGRAPHY IN UNIT AREA CONTROL MANAGEMENT. J. Forestry 60: 191-195. 1962.

The uses of aerial photography in unit area control management in ponderosa pine were studied on the Ochoco National Forest in Oregon. The study covered the role of photography in mapping and sales layout work, as well as the effect of large-scale photography. Photographs were used to construct a condition class map, select boundaries of cutting units, and lay out skidroads within cutting units. Three different scales of photography--1 :12,000, 1 :8,000, and 1 :5,000--were employed. Results obtained with the medium scale (1 :12,000) and the two large scales (1 :8,000 and 1 :5,000) were compared to see if there were any advantages in large-scale photography.

A satisfactory condition class map can be made using any of the three scales of photography. Such a map is basic to the forester's decision as to where to install cutting units. The accuracy of the map does not significantly improve when large-scale photography is used.

After he has selected cutting areas from the condition class map, the forester can again use the photos while marking unit boundaries in the field. Premarking cutting-unit boundaries on the photographs is not recommended. There is no appreciable advantage in using large-scale photography in cutting-unit layout work.

When final cutting-unit boundaries are marked on the photos, the forester can draw the skidroad systems on the photos in the office. He need not make his field marking until the sale is in operation.

Aerial photographs are excellent tools for office planning and field marking of skidroad systems in cutting units. The field men prefer the 1 :8,000 scale, although 1 :12,000 was considered acceptable.

Aerial photographs at a scale of 1 :12,000 furnish the necessary information for condition class mapping, cutting-unit selection, and skidroad planning at a savings over ground survey costs. There are minor advantages in using large-scale photographs.

Pacific Northwest Reg., FS, USDA, Portland, Oreg.

Gilliam, J. H. GROWING AND MARKETING CHRISTMAS TREES. N.C. Agr. Ext. Serv. Ext. C. 436, 26 pp. 1962.

North Carolina could be a major producer of Christmas trees. Climate, nearness to large metropolitan markets, and excellent transportation facilities should enable it to sell all the high-quality trees it can grow at competitive prices.

The many problems involved in growing and marketing Christmas trees are discussed. Ways to cope with the problems are outlined. The author concluded that:

1. Christmas tree crops require intensive management to produce a quality product.
2. Selection and preparation of planting sites are very important. Such factors as accessibility to roads, topography, cost of the land, soil type, vegetative cover, fire risk, exposure, and elevation should be considered very carefully.
3. Selection of the right Christmas tree species for the site and its market appeal should be carefully considered.
4. Diversify plantings. Do not plant all of one species. The consumer likes a choice.
5. Select good planting stock, take care of the seedlings, and plant properly to insure a good survival of healthy trees.
6. Control competing weeds, grasses, and brush to insure a fast-growing, well-formed tree.
7. Shear the tree properly at the right time to improve quality and increase profits.
8. Protection is a must. Keep livestock out of the plantation at all times. Carry out a good insect-and-disease-control program and keep out fire.
9. Use proper harvesting techniques that are adapted to your situation.
10. Know the markets, and sell wisely.

N.C. Agr. Ext. Serv., N.C. State Col., Raleigh, N.C.

Fox, H. W. CHRISTMAS-TREE FARMING CAN BE A PROFITABLE ENTERPRISE. Ill. Res. III(4): 10-11. 1961.

Illinois produces a substantial percentage of its own Christmas trees. Some growers have developed Christmas-tree farming into a sound business enterprise, but most growers are still in the beginning stage. Many do not realize the labor and costs involved or the profit that can be expected.

Cost records have been kept for 10 years on a pine Christmas-tree rotation area on Sinnissippi Forest in Ogle county, Ill. The area consists of 13.05 acres of sandy loam soils which were farmed at one time, then abandoned to pasture.

Annual shaping, or shearing, is essential to produce dense, uniform trees. It is done in the spring with hedge shears.

The first shearing is done 3 years after planting--5 years before final harvest. Double or multiple leaders are reduced to one, and extra long leaders are cut back. Many trees are not touched, although each must be inspected. Even the following year, a few trees at Sinnissippi do not need shearing, but most require cutback of the leader and side branches where the tree appears out of balance.

Trees to be harvested in 1, 2, or 3 years usually require complete shearing. About half the trees require shearing in the spring of the year they are to be sold. This is to shorten the leader and laterals on fastgrowing trees which would appear ragged.

The table is a summary of all investments and income that can be expected on an acre of trees with 4- by 5-foot spacings. Figures are based on detailed records kept at Sinnissippi Forest for an 8-year cycle.

Table-Average per acre expenses and income, using 4- by 5-foot spacing or 2,178 trees per acre

Species of pine	Total costs	Gross Income	Eight-year net profit	Net profit per year
White	\$389.90	\$2,638.38	\$2,248.48	\$281.06
Red.....	500.61	2,912.25	2,411.64	301.45
Scotch.....	391.74	^a 2,598.58	^a 2,206.84	275.85
Jack.....	424.79	1,592.56	^b 1,167.77	145.97
Aver	422.50	2,480.24	2,057.74	257.22

^a This average does not include 1959, because it was not representative.

^b Jack pine is normally harvested after 7 years. However, under the planting program at Sinnissippi Forest, the land is not used the eighth year, so net profit was figured on an 8-year cycle.

Expenses in the table do not include any risk for fire, theft, or insect damage. No mowing or cultivating was done. In a continuous operation, one would expect a fire loss and some insect-control work. Mowing will probably come into the operations in the next few years. These things can add up to higher expenses, while greater competition will likely reduce future prices. A grower can expect a profit for many years if he handles his operations in a business like manner and does all he can to produce a superior product.

Sinnissippi Forest, Oregon, Ill.

Cunningham, G. R., and Winch, F. E., Jr. SHAPING CHRISTMAS TREES FOR QUALITY. Cornell Ext. B. 1080, 16 pp. 1962.

Shaping is necessary to improve the quality of Christmas trees and to increase the number that are salable. Without shaping, only 10 percent of the pines and 30 percent of the spruces and firs in an average plantation would be marketable. The rest would have grown too fast, too wide, too lopsided, or with too many leaders. Few buyers will hunt through an unshaped plantation for the few salable trees present.

If quality is not considered, the supply of Christmas trees grown far exceeds the demand. High quality trees, however, are in short supply. A high quality tree will be U.S. No. 1 grade or better.

Any Christmas tree grower in New York State who wants to sell trees at prices that will exceed growing costs should plan and work toward marketing U.S. No. 1 and better trees. To do this, he must shape most of his trees.

Trees should be shaped whenever they become too open, too wide, too lopsided, or develop more than one leader; some trees, especially spruces, can produce more than one leader the year they are planted. Although little or no shaping may be necessary for several years after planting, trees should be checked every year.

Once shaping is begun, it must be continued until the tree is marketed. Many growers shape only lightly the year of sale.

Shaping of spruce, firs, and various species of pines are illustrated and described.

Cornell U. Ext. Serv., N.Y. State Col. Agr., Ithaca, N.Y.

Brown, J. H., and Tryon, E. H. SHAPING NORWAY SPRUCE FOR CHRISTMAS TREES. W. Va. Agr. Expt. Sta. Cur. Rpt. 31, 8 pp. 1962.

In West Virginia, plantations of Norway Spruce make up approximately one-fourth of all the trees planted for Christmas tree production. Because of irregular density, uneven branch length, and other deformities, few unpruned Norway spruce trees meet the requirements for U.S. Premium, U.S. No. 1, and U.S. No. 2 grades.

Pruning experiments conducted from 1957-59 show that Norway spruce may be pruned at any time of the year without damage to the tree. If shearing is done while the tree is making its summer growth, however, a second pruning in the same year may be necessary to correct a ragged appearance. For most areas of West Virginia, Norway spruce may be successfully pruned from mid-August to mid-April.

During the year in which trees are to be harvested, pruning should be done in late summer or early fall, so as to allow time for cuts to darken and the pitch to harden before harvesting for sale.

A minimum of three prunings is needed if a high percentage of U.S. Premium grade trees is expected. One pruning will do much to shape the tree, but will not correct variations in density. With two shearings, there is still usually some variation in density from top to bottom of the tree. More than three prunings will bring increasingly compact trees and an even higher yield of U.S. Premium grade Christmas trees.

W. Va. U. Agr. Expt. Sta., Morgantown, Va.

Shea, K. R., Johnson, N. E., and McKee, S. DETERIORATION OF PACIFIC SILVER FIR KILLED BY THE BALSAM WOOLLY APHID. J. Forester 60: 104-108. 1962.

An exploratory study of Pacific silver fir killed by the balsam woolly aphid was designed to provide foresters with data useful for planning salvage operations.

Insects encountered included ambrosia beetles, roundheaded borers, horntails, and bark beetles. Preferences of these insects for certain portions of the trees were observed.

Decay fungi most frequently identified were Fomes pinicola, Polyporus abietinus, Stereum chilleitii, and Armillaria mellea in order of decreasing importance.

Deterioration of study trees averaged 13 percent of the merchantable cubic volume per year, reaching an average of 53 percent of the cubic volume in 3 to 5 years.

When compared with wood from living trees, pronounced changes in the physical and chemical properties of pulp were evidenced 3 years after death. Wood from trees dead 3 to 5 years would not produce an acceptable bleached pulp if this type of wood constituted the major portion of the wood supply.

The time of death of Pacific silver fir can be determined with reasonable accuracy from examination of visible characteristics. This examination when accompanied by deterioration data, provides useful procedures for estimating volume in dead trees and planning salvage operations.

The study shows that Pacific silver fir should be salvaged soon after death due to attack by the balsam woolly aphid, preferably within 3 years.

Forestry Res. Cent., Centralia, Wash.

Himelick, E. B., and Fox, H. W. EXPERIMENTAL STUDIES ON CONTROL OF OAK WILT DISEASE. Ill. Agr. Expt. Sta. B. 680, 48 pp. 1961.

An experimental program to control the oak wilt disease was carried on in the Mississippi Forest in northern Illinois. Experimental control measures were tested for 7 years to

determine their effectiveness in preventing further spread of the disease. It was necessary to make either ground or aerial surveys two times a year. To prevent further spread of the disease, it was essential to treat infected trees as early as possible.

In the forested area, the number of trees infected annually through root grafts remained at a relatively low level during the last 3 years of the study. Where only currently infected trees and surrounding healthy trees were poisoned, the amount of root-graft transmission was reduced to less than 10 percent of what it was previous to treatment. In wilt areas where poison barriers were established around currently infected trees and around all infected trees killed in the previous 3 years, a substantial reduction in new infections by root-graft transmission was noted.

The number of white oaks infected annually does not appear to be affected by the eradication program, but it does appear to fluctuate up and down in alternate years.

Approximately 91 percent of currently infected trees of the red oak group were within 30 feet of trees previously killed by the oak wilt fungus. In untreated areas nearly one-third of the 279 infection centers studied were active after 5 years. Thirty-three percent of the single-tree infection centers did not repeat in 6 years of observation, and only 1 percent of all centers which contained five trees or less were active after 5 years. Periods between the appearance of new infection in individual oak wilt centers varied from 1 to 6 years. Control was obtained in 71 percent of the areas where barriers were placed around only currently infected trees. It was necessary to re-treat 24 percent of the infection centers a second time and 5 percent a third time.

Sodium arsenite proved very effective in killing oak trees. Trees were killed more rapidly with sodium arsenite than with 2,4,5-T, Ammate, or CMU. Mat formation by the oak wilt fungus and insect activity were limited or prevented, and some root-kill occurred with the use of sodium arsenite.

In the 7-year program, poison barriers were placed around 918 currently infected trees of the red oak group which were 4 inches in diameter and larger. In the entire program only 14 trees became infected beyond the barrier zone. With the establishment of poison barriers, an average of 2.9 healthy trees was poisoned for every infected tree.

Six chemicals, Vapam, methyl bromide, sodium pentachlorophenate, copper naphthenate, CMU, and Monsanto soil sterilant CP376, were tested on a small scale to determine if the roots could be killed in a limited zone by applying the chemicals to the soil. Both Vapam and methyl bromide killed all roots as large as 3 inches in diameter and to a depth of 3 feet. No chemical injury occurred on adjacent untreated trees. The remaining four chemicals were ineffective.

Ill. Natl. Hist. Sur., and U. Ill., Agr. Expt. Sta., Urbana, Ill.

Abbott, H. G. TREE SEED PREFERENCES OF MICE AND VOLES IN THE NORTHEAST.
J. Forestry 60: 97-99. 1962.

White-footed mice, boreal red-backed voles, and meadow voles (field mice) were confined in individual cages and fed the seeds of eastern white pine, red pine, eastern hemlock, white spruce, red spruce, and balsam fir. Seed preference tendencies of these animals were observed, based upon the number of seeds consumed of each species. The results of these laboratory feedings showed that:

1. All three species of animals rejected the seeds of balsam fir when pine, hemlock, and spruce seeds were made available to them in sufficient quantities to meet their food requirements.
2. Some mice rejected fir seed even when placed under a stress of extreme hunger, while others were inclined to tolerate it as a supplement to a starvation diet.

3. The seeds of both red and white pine were preferred, for the most part, over the smaller seeds of eastern hemlock and white spruce.
4. Boreal red-backed voles rejected balsam fir but readily ate the seeds of red spruce in numbers exceeding those of white pine.

U. Mass., Amherst, Mass.

Carvell, K. L., and Goodspeed, A. W. FROM BRUSH TO PLANTATION--AN ECONOMIC AND SILVICULTURAL STUDY. W. Va. Agr. Expt. Sta. B. 469, 16 pp. 1962.

Over a 5-year period, 31 half-acre plots were established on completely brush-covered land. Eight widely advocated methods of brush control were tested prior to planting these plots with pine or hardwood seedlings.

When costs, survival, and growth are considered, foliage spraying, bulldozing, and the brush-cutting saw appear to be the most effective methods of preparing brush-covered lands for coniferous plantings. These methods, when correctly applied, open up the site adequately for the shade intolerant conifers. Foliage spraying is most effective where brush is less than 10 feet in height; the brush cutter is satisfactory when few trees exceed 20 feet in height or 2 inches in diameter; and the bulldozer is needed where larger vegetation is encountered.

For hardwood plantings, a combination of frilling and basal spraying controls brush and woody growth at a relatively low cost, and provides a suitable environment for hardwood seedlings to become established and grow rapidly.

Because of the high cost of hardwood control and planting, it appears economically impractical to convert brush-covered lands purely for pulpwood and sawtimber production. Costs vary with the extent of the brush cover, hardwood control method employed, and species planted, but all costs are far in excess of those currently considered feasible for plantation establishment. Recently abandoned fields, where brush has not yet invaded, must be purchased--not brush-covered lands--since the former can be planted at far more reasonable costs and will present fewer management problems.

When products other than pulpwood and sawlogs are to be produced, the capital needed for brush control and seedling establishment can be a sound investment. Production of Christmas trees or ornamentals involves a rapid turnover of invested funds. Since interest on costs will be accumulated over a much shorter period, a greater initial expenditure is allowable. Christmas trees or ornamentals may be harvested in conjunction with the first pulpwood and sawlog rotation, thus providing the needed early income to offset high site preparation and planting costs.

Where aesthetic factors are a serious consideration, large expenditures can be justified to replace brush with plantations.

W. Va. U. Agr. Expt. Sta., Morgantown, W. Va.

Windbreaks

Morrow, R. R. WINDBREAKS FOR MUCK LAND. Cornell Ext. B. 1078, 8 pp. 1961.

A large proportion of New York's vegetable crops are produced on a relatively small area of muck land. The combination of light soil and flat topography results in large losses

of these valuable soils, frequent loss of the crops grown on them, and added labor for cleaning out drainage ditches.

Soil and crops can be protected by windbreaks that reduce wind speed near the ground, and by cover crops or irrigation that reduce soil movement. A combination of protective methods usually is most desirable. In summer the growing crop, combined with appropriate irrigation, may give adequate protection. Cover crops may prevent erosion in fall and winter. Windbreaks are most necessary in spring and early summer when the new crop is developing on clean, cultivated soil.

Three shrubs--red willow, bay willow, and Amur pivot--were introduced in the Oak Orchard area in Western New York in the last decade. Although research on these plants is incomplete, their use and development have been widespread and their potential is promising.

Purple willow, Salix purpurea, was the most common shrub used on New York muck land prior to 1955.

White cedar or arborvitae, Thuja occidentalis, has been used extensively on the muck at South Lima, N.Y.

White pine, Pinus strobus, has been used on muck land in Michigan.

Woven picket fence, such as that used for snow fence, is commonly used to help check the wind between plant windbreaks. On small muck areas with hills or woodlands to the windward side, snow fencing alone sometimes offers adequate protection. Fencing is also used as supplemental protection with young, undeveloped plant windbreaks. When placed at the ends of fields, at right angles to permanent windbreaks, they check shifting winds and reduce eddies around the edges.

Cornell U. Ext. Serv., N.Y. State Col. Agr., Ithaca, N.Y.

Pacific Northwest Cooperative Extension Service. TREES AGAINST THE WIND. Pacific Northwest Coop. Ext. Serv. PNW B. 5, 38 pp. 1962.

A revised "culture and care" publication for the growing of windbreaks in the Pacific Northwest. Recommended trees for windbreaks are included.

Tables and illustrations.

U. Idaho Ext. Serv., U. Idaho, Moscow, Idaho.

Management of Coffee Plantations

Singh-Dhaliqal, T., and Torres-Sepulveda, A. RECENT EXPERIMENTS ON ROOTING COFFEE-STEM CUTTINGS IN PUERTO RICO. Puerto Rico Agr. Expt. Sta. Tech. Paper 33, 26 pp. 1961.

The results from experiments on rooting cuttings from different varieties of Coffea arabica, carried on at the Castaner Substation of the Agricultural Experiment Station of the University of Puerto Rico during more than 6 years past, are presented.

Cuttings of different lengths and stages of maturity were tested. They were planted in the field in Alonso cl, in carefully prepared beds, wooden boxes, and the Trinidad-type propagator containing different rooting media.

Cuttings were taken from untreated shoots or suckers for many of the experiments. They were planted with or without treatment with root growth-promoting substances. The percentages of rooted and callused cuttings varied greatly and, in general, were quite low. Many cuttings decayed before callusing. The callused cuttings usually developed roots when left planted in the rooting media long enough.

The shoots or suckers were treated in different ways to induce the development of calluses before taking the cuttings. A very high percentage, over 90 percent, of the cuttings rooted and callused when the following procedure was used:

The shoots or suckers were selected to make the cuttings about 1/3 inch thick with their apical ends measuring 2 to 3 inches, green but hard, and the basal ends 6 to 9 inches, and brown. Below a node just above the point through which the basal cut of the cutting would pass three incisions each 1/2 inch long and 1/4 inch wide, cutting through the bark and a little of the wood, were made around the shoot or sucker without letting them overlap. The incisions were smeared with paste containing 0.5 gm. of 3-indoleacetic acid (IAA) per 100 gm. of hydrous lanolin. The incisions and a few inches of the stem above and below them were covered with moist sphagnum moss and the whole covered with opaque waxed paper. After 60 to 70 days the cuttings were taken and all the lateral growth except a pair of half-cut leaves at the uppermost node, was removed from them. They were planted in the wooden boxes containing coarse river sand and peat moss mixed in the proportion of 3 to 1 by volume, and placed in a cool place under about 70-percent natural shade. They were given all the necessary care such as watering and control of diseases and insects.

The cuttings treated with root growth-promoting substances generally had more and longer roots than the untreated cuttings.

Plants 1 to 3 years old raised from cuttings were observed to be quite healthy and vigorous.

U. Puerto Rico, Agr. Expt. Sta., Rio Piedras, Puerto Rico.

Dhaliwal, T. S. RECENT EXPERIMENTS ON COFFEE GRAFTING IN PUERTO RICO.
Puerto Rico Agr. Expt. Sta. Tech. Paper 30, 38 pp. 1961.

Using Puerto Rican coffee (*Coffea arabica*) and Bourbon coffee (*C. arabica*) as scions, and Columnaris coffee (*C. arabica*), Maragogipe coffee (*C. arabica*), Excelsa coffee (*C. excelsa*), and Robusta coffee (*C. canephora*) as rootstocks, grafting experiments were carried on for more than 6 years at the Agricultural Experiment Substation of the University of Puerto Rico located at Castaner, Puerto Rico.

A series of experiments was conducted to study the influence of different factors such as the time of the year, age of the rootstock and the scion, material for tying the grafts, and graft covers on the percentage of successful grafts.

Of the many grafting methods tested cleft grafting, side cleft grafting, bark grafting, tongue grafting, approach grafting, and bud grafting or budding, seemed promising. They were tested on a large scale over a period of several years. These grafting methods are briefly described and illustrated. The data from many experiments concerning them are presented.

When any of the above-mentioned six grafting methods was carefully used a fairly high percentage of the grafts were successful. Cleft grafting, side cleft grafting, and approach grafting proved to give relatively higher percentages of successful grafts. In several experiments when cleft grafting and side cleft grafting were done in March and April, more than 90 percent of the grafts were successful. In some experiments when approach grafting was done during January, February, April, July, and November more than 90 percent of the grafts were successful.

Experiments were carried on for top-working of old and low-yielding trees of Puerto Rican coffee with scions from Puerto Rican, Columnaris, and Bourbon coffees, using cleft-grafting and bark-grafting methods. The percentage of successful grafts was generally low.

Four hundred and twenty-nine grafted coffee trees comprising different rootstock and scion combinations and planted in the field were studied for several years. The grafted coffee trees grew normally except for a very small number of them which showed some symptoms of rootstock and scion incompatibility.

Two statistically designed field trials were recently established to compare the grafted and the ungrafted coffee trees of different types as to growth, yield, and quality of the product, over a period of many years.

It was suggested that the coffee growers of Puerto Rico should carry on coffee grafting on a small scale to gain experience in it and to observe the performance of the grafted coffee trees under the environmental conditions prevailing on their farms.

U. Puerto Rico, Agr. Expt. Sta., Rio Piedras, Puerto Rico.

Fruit and Nut Crops

Rollins, H. A., Jr., Howlett, F. S., and Emmert, F. H. FACTORS AFFECTING APPLE HARDINESS AND METHODS OF MEASURING RESISTANCE OF TISSUE TO LOW TEMPERATURE INJURY. Ohio Agr. Expt. Sta. Res. B. 901, 71 pp. 1962.

Low temperature injury has caused the death of crippling of thousands of apple trees. This injury occurs with distressing regularity. It is not restricted to the colder climates but is also a serious problem in southern apple producing areas.

One of the more important facts revealed from an evaluation of the hardiness curves was that once past the early dormant period, the apple attains sufficient hardiness to withstand rather severe low temperature periods and that the relative comparison of varieties or treatments at this time would have little commercial significance. The most vulnerable period is early in the dormant season and those varieties that are slow to attain cold resistance in the fall and those treatments that delay the normal development of hardiness are the most likely to be associated with low temperature injury in the orchard. The early fall is the most vulnerable period and serious damage may be caused by temperatures not normally considered severe provided the tree has not yet attained a significant degree of cold resistance. Low temperature injury has been frequently observed in the orchards of Virginia, and North Carolina.

In recent years there has been an increasing tendency for growers to encourage the rapid vegetative growth of non-bearing trees in an attempt to develop as large a bearing surface as possible by the time the trees come into production. Such practices result in young trees that are very vigorous and frequently delayed in their normal hardening.

Another practice that may still further aggravate the problem in the future is the wider use of milder pesticide spray chemicals. In the past apple growers were forced to use spray chemicals, such as lime-sulphur, and Bordeaux which were phytotoxic. This resulted in earlier leaf drop and encouraged earlier hardening of the trees. The currently used, less phytotoxic spray chemicals allow the foliage to remain in a more succulent condition longer and consequently delay the normal hardening of the trees.

The hardiness curves for a number of different varieties illustrate that some varieties, particularly, Staymared, Baldwin, and Rome Beauty are slow to attain cold resistance in the fall.

The results of the cultural treatment study indicate that any practice which will stimulate a high level of vigor and/or retard normal hardening will increase the potential hazard of low temperature injury.

The pruning study shows that for a short period after a tree is heavily pruned, the cold resistance of that tree is reduced. Growers pruning prior to the first of the year should avoid pruning the more tender varieties if severe low temperatures are predicted within a few days.

In recent years, there has been an increased interest in the use of size controlling rootstocks in commercial plantings. An important consideration in determining the most suitable stock to use is the cold resistance of the stocks.

While growers are powerless to modify many of the environmental factors that result in low temperature injury in the orchard, there are certain precautions that can be taken to reduce potential hazards. Prior to planting the relative hardiness of varieties, rootstocks, interstocks, etc., should be given serious consideration in planning the orchard. Once the orchard is established care should be taken to avoid those cultural practices that will result in excessive vigor and delayed hardening.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Hill, R. G., Jr. THE EFFECT OF SOD AS A SOIL MANAGEMENT PRACTICE UPON THE GROWTH AND YIELD OF THE PEACH. Ohio Agr. Expt. Sta. Res. B. 903, 35 pp. 1962.

The suitability of sod as a soil management practice for the peach was studied at Wooster, Ohio. Comparison was made between the growth and yield responses of bearing Halehaven peach trees maintained in sod under different nitrogen treatments and under cultivations plus cover crops and normal (0.05 pounds of nitrogen per year of tree age) nitrogen. Data obtained in this study indicated:

1. The growth and yield responses of the trees maintained in sod which received twice the normal rate of nitrogen fertilization were comparable to those of the trees maintained under cultivation plus cover crops and normal nitrogen fertilization.
2. Comparisons between trees growing in sod and under cultivation which received the normal rate of nitrogen showed the sod grown trees made significantly less growth and yield. The fruit from the sod grown trees was characteristically more highly colored and earlier in ripening.
3. There was no important or significant difference in the yield of the sod grown trees that received four times as much nitrogen in a single application as comparable cultivated trees. Sod grown trees which received the same heavy rate of nitrogen in a split application produced significantly more fruit than the cultivated trees. The heavier rates of nitrogen were associated with delayed maturity and reduced red overcolor.
4. Sod grown trees were more sensitive to periods of moisture stress, as indicated by the amount of shoot elongation, than trees maintained under cultivation.
5. Peaches may be expected to perform as satisfactorily in sod as under cultivation, so long as ample quantities of moisture and nutrients are available.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Morris, H. F., Denman, T. E., Randolph, U. A., Storey, J. B., Sorensen, H. B., Brison, F. R., Burns, E. E., and Hancock, B. G. PRODUCTION AND MARKETING PRACTICES FOR TEXAS PEACHES. Tex. Agr. Expt. Sta. B. B-986, 16 pp. 1961.

Current developments in production and marketing practices for Texas peaches are presented. Results of research on peach growing at Tyler, Stephenville, Montague, and College Station, Tex., are covered. Generally accepted practices are discussed.

A strong consumer demand for quality tree-ripened dessert peaches has influenced the development of the industry in recent years. Full-ripe fruit is wanted for the rapidly expanding frozen food industry and for the manufacture of ice cream. The Texas peach industry can increase its share of the peach market by concentrating on producing and marketing tree-ripened fruit. Better production methods are increasingly important. These methods include good cultural practices, followed by improved harvesting, transportation, and marketing methods.

PRODUCTION--A complex of cultural factors produce top-grade fruit. A good site, high enough for good air drainage, is important. Good soil--deep, fertile, well drained, and adequately supplied with moisture--and a favorable climate are essential.

Other cultural practices indispensable are: (1) Choice of the peach variety best adapted to the site, and marketable in terms of ripeness, size, color, and flavor; (2) thorough preparation of the site and clearing out of unwanted weeds and grasses; (3) adequate spacing of trees; good pruning, and fruit thinning; proper attention to specific fertilizer needs; and (4) the control of insects, and diseases.

HARVESTING AND MARKETING--In producing quality peaches it is important that the fruit remain on the tree until it attains ripeness that insures good eating quality.

Harvesting and marketing practices should be designed to protect the perishable tree-ripe fruit and get it to the consumer in top-quality shape.

Picking containers should protect the fruit from bruising and be suitable for hauling it from the orchard to the packingshed.

Shipping containers should provide this same protection against bruising in transit; in addition, they should be attractive in appearance so that the buyer will be favorably impressed with the product.

New sizing units that work well with a roller-grader and revolving table also provide maximum protection from bruising.

Hydro-cooling is a method used to preserve the fruit at the proper stage of ripeness until it reaches the market, mainly by removing field heat which produces overrapid maturation.

Decreasing the time of handling and transportation has become more important when dealing with tree-ripened fruit. Texas peach growers tend to market their fruit in a local area and avoid long hauls to market.

Because the peach is highly perishable, it is necessary for the grower to work along with the wholesale and retail grocers in planning the movement of the crop. A well-organized marketing system requires about 30 days to plan and move the product from the farm to the consumer.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Harrington, F. M., and Frahm, E. E. SWEET CHERRIES IN MONTANA. Mont. Agr. Expt. Sta. B. 567, 19 pp. 1962.

The results of investigations on sweet cherry production in Montana are given. The experiments began in 1936 and ended in 1953-1955. The Lambert variety was the main

commercial variety grown in the area. The experimental orchard was located on the east shore of Flathead Lake. To start the orchard 4- to 6-foot, 1-year-old whips were used. One pollinizer was planted for each eight trees. One-half of the orchard was placed under clean cultivation, and alfalfa was seeded as a cover-crop in the other half. The alfalfa was not harvested. Results of cultural and fertilizer trials are reported.

Recommendations on pruning and shaping trees as orchard develops were: (1) Head back whips to about 36 inches; (2) leave buds in position for branches, rub off other buds; (3) head back scaffold branches to induce formation of secondary branches, rubbing off buds to space branches; and (4) favor central branch so it is dominant over others.

Recommendations on cultural practices were: (1) Keep area under clean cultivation for at least the first 2 years; (2) discontinue cultivation and irrigation in late summer, not later than the latter part of August, to help bring about maturity; (3) cover-crop or weeds are desirable in late summer or fall as competition with young trees for plant nutrients in order to assure good tree maturity by winter; (4) build up the organic matter of the soil by green manure crop before planting and after trees are established (2 years); (5) if irrigation water is not available, practice clean cultivation; and (6) shading the trunks of young trees is necessary and advisable in older trees in order to prevent sunscald.

Results and recommendations on the use of commercial fertilizers were: (1) Phosphorus gave the best results of any single fertilizer element, as determined by fruit yield and quality, fall maturity of wood, and tree loss because of winter injury. (2) Nitrogen may be needed with the phosphorus. The ratio of nitrogen to phosphorus will vary depending on whether or not a cover-crop is used. The yearly terminal growth of branches depends on available nitrogen, and greater amounts of nitrogen fertilizer may be needed. (3) Rates of application of all fertilizers and fertilizer combinations will depend on whether or not clean cultivation or cover crop is used and upon the age and the size of the trees. And (4) size of fruit decreases with the age of the tree. Special attention must be given to fertilizers, irrigation, and culture in aged orchards.

Early and preliminary investigations indicated that the use of Potash (K_2O) in commercial fertilizer caused a delay in both harvest of fruit and fall maturity of the wood. This fertilizer element was not used in the long-term fertilizer trial.

Experiences and observations indicated that the sweet cherry tree is not a long-lived tree in Montana. Some replacements can be expected in an average orchard practically every year. Crippled trees or those badly damaged by winter injury or sunscald never seem to recover satisfactorily and make good trees. Cherry trees may be topped to reduce height or control growth, provided cuts are made just above a lateral. Avoid dehorning.

Mont. Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

Cain, J. C. THE NEW LOOK IN CHERRY TREES. N.Y. Farm Res. 27(4): 8-9. 1962.

The principal values in the mechanical harvesting of sour cherries are the reduced cost of harvesting and the improvement in quality achieved by the rapid transfer of fruit from the tree to ice water soak tanks. The efficiency of the operation depends on how rapidly the equipment can be moved into position, the tree shaken, and then the equipment moved on to another tree.

The equipment consists of a catching frame and a shaker. It is by nature bulky and not readily maneuvered around sharp corners or in close places. The shaking machine can generally approach the tree only from the general direction in line with the conveyer.

Since the trees themselves are the principal obstruction to smooth efficient operation of the equipment, some modified pruning must be done on most trees to make mechanical

harvesting a successful and economical operation. The following pruning is recommended: (1) Branches must be removed which interfere with the placement of the catching frame under the tree; (2) branches to be shaken should be distributed so they can be shaken generally from a direction with about 30° of the row of trees; (3) the point of attachment of the shaking arm on the branch should be free from lateral branches and visible from the shaking direction; and (4) branches which cannot be easily shaken with the above specifications should be removed.

With careful selection of the least productive branches for removal this loss can be kept to a minimum. An average of 30% loss in production the first year resulted from pruning conventionally pruned 11 year old trees for maximum efficiency of mechanical harvesting. This loss was largely recovered after 2 years.

N.Y. State Agr. Expt. Sta., Geneva, N.Y.

Snyder, J. C., and Brannon, D. H. GROWING GRAPES IN WASHINGTON. Wash. Ext. B. 271, 26 pp. 1961.

Grapes grow under a wide variety of conditions and in all of Washington's counties. Most of the State's acreage is concentrated in the lower Yakima Valley. Except in years of near catastrophe, the State produces over 35,000 tons of grapes per year. Most of the crop is marketed as unfermented juice. Sugar seldom needs to be added since the quality of the juice is high.

The State's 8,000 plus acres are mainly planted to the American (Vitus labrusca) species. Concord is the predominant variety. Approximately 500 acres are of the European (Vitus vinifera) species.

This is a complete "culture and care" bulletin on growing grapes in Washington.

Ext. Serv., Inst. Agr. Sci. Wash. State U., Pullman, Wash.

Kochan, W. J., Verner, L., Kamal, A., and Braun, R. CONTROL OF FRUIT DROPPING IN ITALIAN PRUNES BY FOLIAR SPRAYS OF 2,4,5-TP. Idaho Agr. Expt. Sta. B. 378, 12 pp. 1962.

A spray of 20 p.p.m. 2,4,5-TP applied 800 to 1,100 degree days above 43° F. following full bloom will substantially reduce prune dropping in both the Standard and Demaris early strains of Italian prune. In Idaho, Agricultural Extension agents will record the number of degree-days starting at full bloom and inform fruit growers when it is time to spray.

To be most effective 2,4,5-TP should be used every year and should never be used before 800 degree days have accumulated. If 2,4,5-TP is used too early, fruit of poor quality and limb breakage due to an excessively large crop may result.

Although spraying with 2,4,5-TP reduces the amount of fruit dropping and thereby increases the size of the crop carried to maturity, the size of the individual fruit from treated trees has been as large or larger than fruit from non-treated trees.

Prune growers should not wait until normal fruit dropping has thinned the crop to the level desired at harvest. In a large percentage of trials, spraying with 2,4,5-TP resulted in an increased amount of fruit dropping for a short period of time following treatment, and virtually no dropping for the remainder of the growing season. If the grower waits until the

trees are carrying the desired size of crop before treating with 2,4,5-TP, a light harvest may result due to the thinning that occurs immediately after treating.

The use of 2,4,5-TP will increase the size of the crop carried to maturity even in a year when the amount of fruit has been reduced by late spring frosts.

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

Day, B. E., McCarthy, C. D., and Jordan, L. S. DALAPON, AMITROLE, AND WEED OIL COMPARED FOR EFFECTIVENESS IN CONTROL OF BERMUDAGRASS IN CALIFORNIA CITRUS ORCHARDS. *Hilgardia* 32(2): 207-227. 1962.

A number of herbicides were screened for herbicidal action on Bermudagrass (*Cynodon dactylon* (L.) Pers.) in California citrus orchards. Spray programs tested included use of petroleum oil, amitrole, and dalapon alone, combined with one another, and combined with other herbicides. Atrazine and prometone at 10 or more pounds per acre effectively controlled bermudagrass. Ipazine, trietazine, simetone, simazine, CIPC, EPTC, and maleic hydrazide were not highly herbicidal. Sodium 2,3-dichloroisobutyrate, a dalapon analogue, was one-eighth as effective as dalapon. Spray programs based on applications of weed oil, amitrole, and dalapon were highly effective. Spraying with weed oil at 3-week intervals was as effective as spraying at more frequent intervals. Amitrole was more effective late in the growing season. This was also true of dalapon, but to a lesser extent. Variations in spraying volume, presence or absence of surfactant, and admixture of small amounts of kerosene were without appreciable effect on the action of amitrole. Inclusion of small amounts of monuron in amitrole sprays reduced phytotoxicity. Mixtures of amitrole and dalapon were less toxic than the same rates of dalapon alone. In multiple applications of amitrole, effectiveness increased as the time between applications was decreased. A single application was more effective than split treatments employing the same total amount of herbicide.

Prior or subsequent treatment with weed oil reduced the herbicidal effectiveness of applications of amitrole or dalapon over a wide range of timings between applications.

Multiple treatments with low dosages of dalapon were equal to or superior to single sprayings with the same total amount of herbicide provided applications were spaced to avoid spraying when all top growth of the grass had been killed by previous treatments.

A spray program of three applications of dalapon per growing season, at the rate of 3 pounds per acre at 8-week intervals, is considered a reasonable compromise among the factors of cost, effectiveness, and minimum risk of tree injury from spray residues.

U. Calif., Riverside, Calif.

Madsen, H. F., and McNelly, L. B. IMPORTANT PESTS OF APRICOTS. Calif. Agr. Expt. Sta. B. 783, 40 pp. 1961.

A pest control program for apricots presents special problems because apricots are a short season crop as compared with other deciduous fruits. Proper timing of the control program is of critical importance. Such timing can be achieved only by an understanding of the life cycle of the specific apricot pest.

Each major pest of apricots is discussed in the light that various research studies have thrown upon identification, life cycles, and economic damage. The biology and control data established by these studies were summarized in order to provide the reader with a basic approach to intelligent control of the pests. Discussion of control itself is limited to those natural factors which regulate the abundance of the pest, or which provide a basis for the proper timing of necessary artificial control measures.

U. Calif., Berkeley, Calif.

Barnes, M. M., and Madsen, H. F. INSECT AND MITE PESTS OF APPLE IN CALIFORNIA. Calif. Agr. Expt. Sta. C. 502, 31 pp. 1961.

The most important insect and mite pests of apple orchards in California are described.

Sound procedures in insect and mite control in the apple orchard are based upon recognition of the pest and of the damage it causes, and upon a knowledge of its life history and habits. Several pests of apple trees are found in almost every orchard--the codling moth, the woolly apple aphid, and the green apple aphid, for example--while other pests vary somewhat more in their distribution over the State. All of them are subject to fluctuations from year to year in their severity as apple pests. Often the chief pest of the season in an apple orchard may have developed as a result of side-effects of the spraying program. Insecticides and acaricides are more or less specific in their effects. In apple orchards, predatory insects and mites and parasitic insects may be almost eliminated by necessary spray treatments, and with them goes a powerful influence upon levels of pest populations. As a result of this circumstance and accompanying the change in insecticide usage a "new" pest may appear or a well-known species may flare up. Sometimes a high pest population may be related to the development of insecticide resistance, necessitating a change in the spray program. A pest outbreak may be related to seasonal variations over which there is no control. It is desirable that the grower be able to recognize or readily identify the insect and mite pests with which he may be currently dealing.

Many insects and mites may require chemical control in apple orchards, but the principal species, the codling moth, is the perennial pest around which most of the pest control program is built. Other pest species may be equally destructive, and the indirect effects of foliage feeders on the quality and quantity of the crop must be recognized. All of these pests can be controlled.

Care should be taken that the chemical control of insects in the apple orchard does not result in inadequate pollination because of effects of insecticides on honey bees and other insect pollinators. Most varieties of apples grown under California conditions are either unfruitful or set unsatisfactory crops unless they are cross-pollinated, and this may largely be accomplished by honey bees. Insecticides are not needed during bloom. Because of damage to nearby apiaries many insecticides should not be used when cover crops are in bloom, even in winter, unless proper precautions are taken. Other insecticides may be used around bees safely.

The judicious use of insecticides, avoiding unnecessary treatments, and selecting the proper chemicals have become an important part of practical horticulture. The spraying program in apple orchards includes more than a knowledge of insects and mites and of insecticides and acaricides. The horticulturist recommends sprays for nutritional purposes, thinning, or for prevention of harvest drop, while the plant pathologist recommends for control of diseases.

Calif. Agr. Expt. Sta., Riverside, Calif.

Muma, M. H. MITES ASSOCIATED WITH CITRUS IN FLORIDA. Fla. Agr. Expt. Sta. B. 640, 39 pp. 1961.

Mites play an important part in the production of citrus. Many species feed on the plant and cause direct injury and loss by increasing leaf and fruit drop, decreasing fruit size, reducing tree vigor, and causing blemishes that reduce external fruit quality. Other species are predatory and may affect yield by contributing to the natural control of injurious species of insects and mites. Others are scavengers and fungus feeders and are relatively unimportant to citrus production.

It is important that workers associated with the Florida citrus industry be able to identify and separate the plant feeders and predators from the scavengers. Illustrations and descriptions of mites found on citrus are in most cases unobtainable or of a highly technical nature. Many mites are nearly microscopic in size, and the distinguishing characters given in scientific descriptions are visible only through a high-powered microscope. This bulletin is a non-technical publication to permit the identification of mites under grove conditions by persons not specifically trained in acarology, the study of mites.

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

Green, R. W. AN ESTIMATE OF THE SIZE, VALUE, LOCATION, AND MARKET STRUCTURE OF THE FRUIT AND VEGETABLE INDUSTRIES IN GEORGIA. Ga. Agr. Expt. Sta. Mimeo. Ser. N.S. 136, 36 pp. 1962.

The fruit and vegetable industry in Georgia is presented by showing the areas of production, harvest season, acreage, yield per acre, value, utilization, and competitive areas for the major types of fruits and vegetables grown.

Horticultural crops are grown commercially in every section of the State. Most of the commercial apple orchards are in the northern section. Most of the peaches are grown in the central part of the State. Pears are grown practically all over the State but most of the commercial orchards are in the southern half. Pecans are grown over a large part of the State. Grapes, plums, and figs are also produced in Georgia but do not contribute as much income as do apples, pears, peaches, and pecans. The preliminary reports of the 1959 Census of Agriculture indicate that there are 195,329 acres of land in bearing and nonbearing fruit orchards, groves, vineyards, and planted nut trees.

Georgia produces over 30 different vegetables for commercial use and they are harvested for sale every month of the year in some area of the State. They are produced both for the fresh market and for processing. Of the leading vegetables produced, pimento pepper is the only one produced exclusively for processing. Cabbage, cantaloupes, lettuce, tomatoes, and watermelons are the leading vegetables produced primarily for fresh market sales. There are some tomatoes processed in the State but the volume is small. Small amounts of cabbage may reach the processors. Lima beans, snap beans, pole beans, collards, cucumbers, kale, mustard greens, okra, field peas, bell peppers, rape, spinach, squash, sweet potatoes, and turnips are the leading crops produced both for processing and fresh market. A considerable portion of the acreage of these crops is grown under some type of contract for processing.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr. Athens, Ga.

Field Crops

Cooperative Extension Service. TOBACCO PRODUCTION IN KENTUCKY. Ky. Coop. Ext. Serv. Agr. and Home Econ. C. 482-A, 47 pp. 1962.

Tobacco is Kentucky's chief cash crop. In most years, it accounts for a third to half of the cash receipts from farming for the State as a whole (see Table 1). It can be grown in a short rotation under favorable conditions with good soil-management practices.

Because of its high value per acre (\$400 to \$1,000 per acre in recent years), tobacco is particularly important on small- and medium-size farms. Much of the land in the State is hilly and rolling and erodes easily; hence, it should be kept in sod crops most of the time. A crop like tobacco makes this possible.

The total acreage planted in tobacco in Kentucky is only about 2 percent of the total cropland of the State. It accounts for the use, however, of about 27 percent of the productive farm labor, or about 12 million man-work days per year. About 21 percent of all the tobacco grown in the United States and nearly 70 percent of the burley are grown in Kentucky. Of the Kentucky crop, 85 to 90 percent is burley. This is a complete "culture and care" bulletin. It concerns the production of burley, but much of it applies also to other types of tobacco grown in the State.

Table 1.--Percent of Cash Sales from Tobacco on Kentucky Farms

Year	Value of all farm products sold	Value of tobacco sold	Percent tobacco is of total sales
1939	\$128,262,000	\$50,538,000	39
1944	337,633,000	180,351,000	53
1949	527,920,000	190,309,000	34
1954	558,991,000	250,340,000	45
1959	570,688,000	220,144,000	40

U. Ky. Coop. Ext. Serv. Agr. and Home Econ. Lexington, Ky.

Kapusta, G., French, E. W., and Swallers, C. AN OILSEED CROP--SAFFLOWER PRODUCTION IN NORTH DAKOTA. N. Dak. Farm. Res. 22(4): 4-11. 1962.

Safflower (Carthamus tinctorius L.) is an oilseed crop that was commercially introduced into North Dakota in 1957. It had been grown experimentally in North Dakota since 1928. Annual production has increased rapidly to over 40,000 acres in 1961, largely in western North Dakota.

The development of high seed yielding varieties with satisfactory oil content, together with new and expanding markets, have stimulated considerable interest in safflower. The offer by Pacific Vegetable Oil Corporation to contract for the entire production of individual farmers has brought a satisfactory market to western North Dakota.

The bulk of the oil is currently being used in the paint and varnish industry. An expanding medicinal and diet food market has developed recently due to reports that the high linoleic acid content reduces the cholesterol level of the blood serum in heart and other circulatory-system diseases.

Meal, seedcake, or pelleted forms of residue from the oil extraction process is a protein supplement for cattle, sheep, and poultry feeds.

This is a culture and care publication on safflower production in North Dakota.

N. Dak. Agr. Expt. Sta., N. Dak. State U. Agr. and Appl. Sci., Fargo, N. Dak.

Staniforth, D. W. RESPONSES OF SOYBEAN VARIETIES TO WEED COMPETITION. Agron. J. 54: 11-13. 1962.

The responses of four soybean varieties to the competitive effects of heavy infestations of annual weeds were investigated. Other experimental variables included two rates of soybean planting and three levels of soil fertility which resulted from nitrogen fertilizer treatments to corn in the previous year. Dry matter yields of aboveground plant parts of weeds, and seed yields of soybeans were obtained.

Weed growth and resulting soybean yield reductions were greater following applications of 70 or 140 pounds of nitrogen the previous year. Soybean stands of 13 to 15 plants per foot of row suppressed weed growth and suffered less yield reduction than soybeans in stands of 7 to 9 plants per foot. The responses of the four soybean varieties to weed competition were the same under all varieties of soil fertility, bean stand, and seasonal effect encountered in the study.

This similarity among varieties in response to weed competition emphasizes the use of adapted varieties in studies of soybean-weed ecology. Adapted varieties reflect accurately the effects of weed competition and their use may minimize the effects of frost and other experimental hazards.

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

Lamp, B. J., Johnson, W. H., Harkness, K. A., and Smith, P. E. SOYBEAN HARVESTING APPROACHES TO IMPROVED HARVESTING EFFICIENCIES. Ohio Agr. Expt. Sta. Res. B. 899, 54 pp. 1962.

Results of 5 years of research directed to improved soybean harvesting efficiencies are reported. Date of harvest, variety, machine adjustment and operation, hour of harvesting, design changes, planting method, and other variables were studied for effect upon harvesting efficiency.

Proper adjustment and operation are required for satisfactory performance; even then, the harvesting efficiency generally will not be over 90-92 percent.

Principal source of loss was found to be gathering loss. Shattered loss was the largest individual loss. Cylinder, rack, and shoe losses were generally very acceptable.

High moisture combining (when kernels are above 12 percent moisture and the pods are dampened from dew or rain) resulted in reduced shattered losses and an overall improvement in harvesting efficiency. Cylinder speeds had to be increased to insure complete threshing. Germination was depressed when high cylinder speeds were required.

Design changes in the gathering components of the machine are suggested for the unique characteristics of the soybean.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Leffel, R. C. PLANTING DATE AND VARIETAL EFFECTS ON AGRONOMIC AND SEED COMPOSITIONAL CHARACTERS OF SOYBEANS. Md. Agr. Expt. Sta. B. A-117, 69 pp. 1961.

Variety and date-of-planting studies with soybeans were conducted in nine environments at three locations (Beltsville, Upper Marlboro, and Trappe) in Maryland from 1951 to 1958. Each experiment consisted of varieties of soybeans of varying maturity planted at dates throughout the planting season. The extreme range in planting dates for all experiments was May 1 to July 28. All experiments were evaluated for seed yield and quality, plant maturity, height, lodging, and purple stain score of seed. Seed size was evaluated in all but one environment; oil and protein contents of seed were evaluated in five environments. Shattering of seed was observed in only one year and iodine number of the oil was determined from seed samples from one environment only. Only tests at Trappe in 1957 and 1958 were evaluated for height of first pod-bearing node and dates of first flowering, first pod-setting, and termination of flowering.

These studies led to the following general conclusions:

All varieties exhibited curvilinear relationships between characters evaluated in these studies and date of planting. This tendency of a character to exhibit a greater or lesser effect as planting was delayed was interpreted as the effect of photoperiod on the character. Delays in planting date of any variety past June 20 appeared hazardous.

Delay in planting had more effect on maturity date and less effect on seed yield, size, and quality, plant height and lodging score, and oil and protein contents of early varieties than on the same characteristics of later maturing varieties.

For maximum yields of highest quality soybeans, late varieties should be planted in their areas of adaptation as early in the season as soil temperatures and environmental conditions conducive to good weed control will allow. Soybeans of early maturity produced maximum yields of seed when planted May 20 to 30. Seed quality of later maturing varieties deteriorated as a result of delayed planting; seed quality of early soybeans improved with delayed planting. Seed yields of early soybean varieties were superior to the late maturing varieties when planting of each was delayed 30 days or more past the optimum, earliest planting date for full-season varieties.

Infection by purple stain fungus was most severe with earlier maturing varieties of soybeans. Lee never exhibited more than 1 percent visibly infected seed by the purple stain fungus. Infection of varieties by purple stain fungus was influenced to a great degree by environmental conditions.

Variety and date-of-planting interactions were paramount in these studies. Varietal performance was obviously affected by variations in soil moisture throughout the growing season.

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

Knake, E. L., and Slife, F. W. COMPETITION OF SETARIA FABERII WITH CORN AND SOYBEANS. Weeds 10: 26-29. 1962.

The treatments in this 3-year study consisted of 54, 12, 6, 3, 1, 1/2, and no foxtail plants per foot of crop row. Yield reductions for the heaviest stand of foxtail averaged 25% for corn and 28% for soybeans. For both corn and soybeans, the increase in foxtail dry matter was proportional to the decrease in the dry matter from the crop; the combined yield did not vary significantly. As stand of foxtail increased, there was a decrease in yields of grain, cobs, stalks or straw, diameter of cornstalks, ear weight, light intensity beneath the crop, soil temperatures under corn, and number of soybean pods. There was little or no significant effect on moisture content of grain, height or crop, shelling percentage of corn, oil or protein content of beans, weight of 100 beans, or number of beans per pod. Increased corn lodging was associated with increasing foxtail stand in one of 3 years.

U. Ill., Urbana, Ill.

Williams, L. G., and Martin, J. W. DRYING SHELLED CORN. Idaho Agr. Expt. Sta. B. 382, 23 pp. 1962.

Shelled-corn-drying tests were conducted at Caldwell, Idaho, with heated and unheated air. Weather data involving temperature, relative humidity, and wet-bulb depression were gathered for an 18-year period. Regression curves were drawn showing the expected drying conditions for each week of the drying period.

From the test results and the analysis of weather data, curves relating air-flow rate, drying conditions, crop moisture content, and drying time were drawn. The operating costs

for several sizes of drying units were recorded and the results presented in charts and tables. Cost estimates of the drying equipment were made. A comparison of the total drying cost for unheated-air and heated-air drying was made.

Both unheated-air drying and heated-air drying are highly dependent on natural drying conditions. The air-flow rate must be high enough to dry the corn in 15 days or before mold damage develops. High air-flow rates are not economical when drying in deep layers. The most satisfactory and economical design provides 5 c.f.m. per bushel.

Unheated air was the most economical drying method; however, unheated air can be relied on for drying only in October and early November. An LP-gas heater allowed drying in almost any weather. If more than one batch is to be dried per season with the same unit, then a heater should be used.

Power costs for drying with unheated air was about 2 cents per bushel. Power and fuel costs, when using heated air, was about 3 cents per bushel. The total cost for 1 batch per year ranged from 15 cents to 20 cents per bushel using unheated air and 20 cents to 25 cents using heated air. The use of heated air allowed an additional batch to be dried and reduced the total cost to 10-15 cents per bushel.

Tables and graphs.

U. Idaho, Col. Agr., Agr. Expt.

Foth, H. D. ROOT AND TOP GROWTH OF CORN. *Agron. J.* 54: 49-52. 1962.

Knowledge concerning corn root distribution at various stages of plant development is contained largely in root distribution drawings. The results of studies (1959-61) designed to measure the root growth associated with stages to top growth are reported.

Root growth consisted of a series of overlapping stages which were associated with stages of top growth. Early root growth occurred largely in a downward-diagonal direction followed by extensive lateral growth. Lateral growth was completed a week or two before tassel emergence and caused a marked uniformity in root density in the upper 12 to 15 inches of soil. Appearance of brace roots occurred near the completion of lateral growth. Extensive growth of roots below 15 inches occurred near tasseling time, and by early roasting ear stage, root growth was completed with cessation of brace root growth.

Pronounced changes in the rate of growth of both tops and roots occurred during the growing season. Early development of the plant was characterized by rapid growth of both roots and tops. The weight of the latter increased more rapidly and caused an increase in the top-root ratio. This period was followed by one in which extensive brace root development caused a decline in the top-root ratio. Grain development occurred largely after root growth ceased and was associated with an increase in the top-root ratio.

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

Tweeten, L. G., and Heady, E. O. SHORT-RUN CORN SUPPLY AND FERTILIZER DEMAND FUNCTIONS BASED ON PRODUCTION FUNCTIONS DERIVED FROM EXPERIMENTAL DATA; A STATIC ANALYSIS. *Iowa Agr. and Home Econ. Expt. Sta. Res. B.* 507, 575-608. 1962.

Physical conditions of production are the foundation of product supply and factor demand in agriculture. This study relates technology, as expressed in production functions estimated from experimental data, to the market phenomena of price determination--demand and supply. The nature of corn supply and fertilizer demand functions for a within-season period are examined.

The major emphasis throughout the report is on methodology.

The approach is normative since the functions indicate what the supply and demand would be based on production functions derived from fertilizer experiments if farmers maximized profits under conditions where capital, institutional, and behavioral restraints are unimportant. Such normative concepts are referred to simply as "static supply" and "static demand."

The static supply and demand elasticities estimated in this study do not entirely parallel such quantities as they might be expressed in the market. Analysis of these differences suggests that the elasticity estimates represent the upper boundary of the actual short-run supply and demand elasticities. The estimates indicate the maximum short-run production response which farmers might be expected to make to changes in price.

Three algebraic forms of the production function, the quadratic, square root, and logarithmic, were examined to determine the advantages and restraints which each possesses for projecting physical relationship in nature into estimates of supply and demand curves and elasticities. The algebraic form of the production function was found to have a highly significant effect on the estimated supply and demand functions. Of the three algebraic forms examined, the quadratic and square root forms appeared most appropriate for the type of analysis reported in this publication.

Ten production functions fitted to experimental data obtained in Iowa, Kansas, Michigan, North Carolina, and Tennessee provide the basis for inferences about static supply and demand curves and elasticities. The results of the analysis are consistent with the hypothesis that short-run corn supply is highly inelastic. For all soil and weather conditions, and for all prices considered in the empirical section, static supply elasticity is low. Without exception, static supply is inelastic ($E_s < 1$) for corn prices over 40 cents per bushel. The supply elasticity ranges from zero to less than 0.3 for corn prices above \$1 and from zero to less than 0.2 for corn prices above \$1.20 per bushel. Supply tends to be most elastic in situations where the soil is low in fertility but is otherwise satisfactory for corn production; i.e., adequate rainfall, good soil structure, etc. The analysis supports the hypothesis that considerable variation in supply elasticity exists among soil types and years within a given area such as Iowa.

The study shows that static supply elasticity increases as the price of corn falls.

Static factor demand tends to be more elastic than static product supply. The price elasticity of the short-run demand for nitrogen, for example, lies between 0.2 and 1.7 (with the exception of Wisner 1) when the price of nitrogen is 13 cents per pound. The demand for K_2O is more elastic than P_2O_5 , which, in turn, is more elastic than the demand for nitrogen. The soils which are low in the particular nutrient but which are otherwise suitable for corn production, tend to display the highest and least elastic static demands.

The static demand in marginal corn production areas tends to be lower and more elastic than static demand in the Corn Belt. The results emphasize the need for price-quantity data as well as elasticities. That is, because of the high level of demand for fertilizer and the large areas suited for corn production in the Corn Belt, the greatest change in pounds of fertilizer applied to corn resulting from price changes would occur in this area.

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

DeLong, H. H. CORN DRYING. S. Dak. Agr. Expt. Sta. C. 152, 24 pp. 1962.

In a study of corn drying in South Dakota the authors concluded:

1. Picker-sheller machinery for field harvest of corn has proven satisfactory for corn harvesting in South Dakota. All stalks, husks, and cobs are left in the field and grain alone is hauled to the farmstead.

2. Shelled corn needs less bin space than ear corn and fosters storage in tighter structures that are weather proof and bird and rodent proof.
3. The shelled corn is in a semi-fluid form that is well suited to move through conveyors and machines enroute to and through automatic feed yard machines.
4. The picker-sheller allows for early and rapid corn harvest. The picker-sheller does an acceptable job with mature corn at 30 percent moisture and an excellent job with corn at 25 percent moisture or less.
5. Unheated air drying of corn is a satisfactory and trouble-free way to dry corn that is placed in the bin at near 20 percent moisture or less. It does little good, with respect to drying, to blow below 0° F. air through the grain. Unheated air drying is slow and the fans may need to run from 2 to 5 weeks.
6. Supplemental heat drying can be done with the same bin and fan equipment as unheated air drying, with the addition of the burner and fuel storage facilities. Corn that is 25 percent moisture or less is workable with such a drying system. Corn must be added in 2 to 4 foot layers, and when drying is approaching completion the next layer is added. Drying periods are shortened as compared to unheated air drying, but fuel costs and equipment costs are added.
7. The batch dryer, using drying temperatures of 140° F. or higher will dry corn in 1 to 4 hours, depending on its moisture content. Grain above 30 percent moisture content could be dried, but it does not shell satisfactorily. No special bin arrangements are needed since the batch dryer is a self-contained unit. The high initial cost, and its effect on total cost of drying indicate it is best suited for the large operator, for joint ownership arrangements, or for the custom operator.
8. An accurate, low-cost, portable moisture tester is by far the greatest aid to the successful operation of any crop dryer. Such a tester takes the guesswork out of drying and helps plan proper bin management.

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

Longnecker, D. E., and Lyerly, P. J. YIELD POTENTIAL OF UPLAND COTTON BY SKIP-ROW PLANTING IN THE EL PASO VALLEY. Tex. Agr. Expt. Sta. Prog. Rpt. 2237, 6 pp. 1962.

Yield comparisons of inside and outside rows of 1517C cotton were made in combination fertility-irrigation tests at El Paso, Texas in 1958 and 1961. The effects of nitrogen, phosphorus, and two frequencies of irrigation water on yields and earliness were evaluated.

Outside rows produced 500 to 700 pounds more lint per planted acre than inside (solid planted) rows in both tests. This represents yield increases of a bale or more per planted acre if all rows are outside rows (plant two--skip two or plant two--skip four) and one-half bale per acre if only half of the rows are outside rows (plant four--skip four).

Skip-row cotton farming presents opportunities for greatly increased yields and larger profits in the Trans-Pecos area under careful management, since USDA controls on skip-row planting have been eased.

Tex. Agr. Expt. Sta., Substation No. 17, El Paso, Tex.

Peterson, G. D., Jr., Cowan, R. L., and Van Schaik, P. H. COTTON PRODUCTION IN THE LOWER DESERT VALLEYS OF CALIFORNIA. Calif. Agr. Expt. Sta. C. 508, 31 pp. 1962.

This circular brings together information developed by the U.S. Department of Agriculture, University of California, and cotton growers in the desert valleys of California on

the history, soils, climate, varieties, production practices, harvesting, and ginning. Information is given on the pests, diseases, and weeds which occur in the area.

Calif. Agr. Expt. Sta. Ext. Serv., U. Calif., Berkely, Calif.

Utah Agricultural Experiment Station Symposium. SYMPOSIUM PAPERS ON CONTRIBUTIONS OF RESEARCH TO THE AGRICULTURE OF THE INTERMOUNTAIN AREA TOGETHER WITH THE ADDRESS MADE AT THE DEDICATION CEREMONY OF THE CROPS RESEARCH LABORATORY AND THE APICULTURE RESEARCH LABORATORY AGRICULTURAL RESEARCH SERVICE U.S. DEPARTMENT OF AGRICULTURE AT UTAH STATE UNIVERSITY LOGAN UTAH, OCTOBER 26, 1961. Utah Agr. Expt. Sta. B. 431, 62 pp. 1962.

This publication commemorates the dedication of the new U.S. Department of Agriculture Crops Research and Apiculture Research Laboratories on the campus of Utah State. It contains the dedicatory address presented by Dr. Bryon Shaw, administrator of the Agricultural Research Service of the U.S. Department of Agriculture, and the symposium papers on the contributions of research to the agriculture of the Intermountain Area.

The following papers were presented:

1. Shaw, B. T. THE PUBLIC PARTNERSHIP IN AGRICULTURAL RESEARCH. ARS, USDA.
2. Owen, F. V. RESEARCH ON SUGAR BEETS. CRD, ARS, USDA.
3. Jorgenson, E. C. RESEARCH ON NEMATODES. CRD, ARS, USDA.
4. Leninger, L. N. RESEARCH ON SAFFLOWER. CRD, ARS, USDA.
5. Keller, W. RESEARCH ON FORAGE CROPS. CRD, ARS, USDA, Beltsville, Md.
6. Bohart, G. E. RESEARCH ON LEGUME POLLINATION. ERD, ARS, USDA.

Agr. Expt. Sta., Utah Agr. Expt. Sta., Logan, Utah.

Friesen, H. A., Banting, J. D., and Walker, D. R. THE EFFECT OF PLACEMENT AND CONCENTRATION OF 2,3-DCDT ON THE SELECTIVE CONTROL OF WILD OATS IN WHEAT. *Canad. S. Plant Sci.* 42: 91-104. 1962.

A series of experiments on different soils and with varying concentrations demonstrated that the herbicidal activity of 2,3-DCDT (2,3-dichloroallyl diisopropylthiolcarbamate) is primarily via the coleoptile rather than the root system of wild oats and wheat. The degree of this activity differed between the two species depending on the stage of development when they came in contact with treated soil, the concentration of the herbicide, and the length of time that the coleoptile was in contact with treated soil. In wild oats, there were two distinct periods of high sensitivity--during the initial half-inch of coleoptile growth and a stage that coincided with the initiation of the crown node. Wheat was highly sensitive at only the early period. This crop was tolerant to sufficiently high concentrations of 2,3-DCDT, when planted at least a half-inch below a surface layer of treated soil, to permit the selective control of wild oats in wheat. However, the relative placements were critical. The pattern of response was similar in each of the soils but the degree of response was distinctly higher on the heavy clay than on the loam soils.

Canada Dept. Agr., Expt. Farms, Lacombe, Alberta, Canada.

Tingey, D. C. LONGEVITY OF SEEDS OF WILD OATS, WINTER RYE, AND WHEAT IN CULTIVATED SOIL. *Weeds* 9: 607-611. 1961.

Seeds of wild oats, winter rye, and winter wheat were sown in late October of 1950, at 1, 3, and 6 inch depths for 1 year. The land was fall plowed 1 year later and thereafter and spring tilled each year. Most of the seedlings of the three species emerged within a month after seeding. A small percentage of wild oat seeds persisted up to June of the third year. A few seeds of winter rye and wheat persisted in the soil for almost a year. The deeper the seeds were placed in soil, the fewer the seedlings emerged. Wild oats showed more of a tendency to emerge in the fall than in the spring.

Utah State U., Logan, Utah.

Henne, R. C., and Friesen, G. HERBICIDAL EFFECTS OF TCA AND DALAPON ON FLAX. *Canad. J. Plant Sci.* 42: 62-68. 1962.

The herbicidal effects of TCA (trichloroacetic acid) and dalapon (2,2-dichlorophropionic acid) on three flax varieties (Marine, Redwood, and Raja) were studied in 1958-59. Morphological deformities, seed yield, oil content, iodine values, and seed viability were used to measure the tolerance of flax to these herbicides.

In 1958, TCS and dalapon applied at the recommended rates of 4 pounds and 1 pound per acre, respectively, did not result in appreciable injury to flax plants. In 1959, comparable treatments reduced yields significantly and in several instances lowered the oil content and iodine values. TCA applied at 8 pounds per acre and dalapon applied at 3 pounds per acre resulted in considerable crop injury in both years. Stage of flax growth at time of treatment did not appear to influence the degree of injury. No consistent differences in the tolerance of flax varieties were apparent with respect to the factors studied. TCA treatments were, in general, less injurious than dalapon treatments.

U. Manitoba, Winnipeg, Manitoba, Canada.

Hudgins, H. R. CONTROL OF BARNYARDGRASS IN RICE WITH DPA. *Tex. Agr. Expt. Sta. Prog. Rpt.* 2229, 4 pp. 1962.

Tests with 3,4-dichloropropionilide (DPA) herbicide for the control of grass in rice were conducted in 1960-61 at the Rice-Pasture Experiment Station, Beaumont, Tex.

Tests, based on 1,280 separate yield determinations, indicate that 3 pounds of active material per acre combined with 8 gallons of water for aircraft application or 10 to 40 gallons of water for ground sprayer application, will control barnyardgrass, millet, purple stem, baronetgrass, and crabgrass.

The best time to apply the chemical is when most of the grass is in the one-to-three-leaf stage. Grass plants that have started to tiller are difficult to control with the 3-pound per acre rate of application.

Rice-Pasture Expt. Sta., Beaumont, Tex.

Tomlinson, J., and Plaxico, J. S. AN ECONOMIC ANALYSIS OF MUNGBEANS AS A CROP FOR SANDY SOILS OF CENTRAL OKLAHOMA. *Okla. Agr. Expt. Sta. B. B-595*, 31 pp. 1962.

The mungbean, a summer legume, may be grown for its forage, seed, or soil-conserving qualities. Mungbean forage and seed are excellent livestock feeds, but the primary use of

the seed is for producing bean sprouts used principally in oriental foods. It is estimated that the United States uses about 11 million pounds of mungbeans annually for commercial sprouting and that Oklahoma mungbean growers produce 90 percent of the sprouting beans grown in the United States. The estimated acres, yield, production, price, and farm value of mungbeans in Oklahoma for the years 1943 through 1958 are given. The profitability of growing mungbeans on sandy soils in central Oklahoma are reported. Economic data were developed to show estimated costs and returns from mungbeans when grown in a double cropping system with wheat. These cost and return estimates were compared with similar estimates for wheat grown as a single crop.

The farmers surveyed typically grew small grains on 84 percent of their cropland with over half of all cropland devoted to wheat production. Mungbeans were grown in a double cropping system with wheat on 70 percent of the wheat acreage or 38 percent of the cropland. The survey farmers were very consistent in mungbean production, and accounted for 18 percent of the planted mungbean acreage of the state.

Mungbean production provided an additional source of income from wheat land without lowering the yield of wheat. No equipment was required other than that commonly used for small grains. The extra labor and machine time required to produce one acre of double crop wheat and mungbeans compared with one acre of single crop wheat was very little more than that required to plant and harvest the mungbeans.

Budget analysis based on the inputs, yields, and prices assumed for the study showed much higher returns from the wheat-mungbean double crop than from single crop wheat. The per acre return to land, labor, risk, and management was \$12.72 for single crop wheat and \$31.00 for double crop wheat and mungbeans.

Mungbeans as a dairy feed would have a \$0.028 per pound value based on current grain sorghum and cottonseed meal prices. Budget analysis using \$0.028 as the price of mungbeans still showed a higher return to all combinations of factors for double crop wheat and mungbeans than single crop wheat.

Regression analysis indicated that 70 percent of the yearly variation in planted acreage of mungbeans was explained by the June 10 to July 10 rainfall and the price of mungbeans the previous year.

The analysis indicated that rainfall from July 10 to September 15 and the price of mungbeans the current year accounted for 73 percent of the annual variation in yields of mungbeans per harvested acre. (A relatively high price of mungbeans at harvest time should result in the harvesting of lower yielding beans).

Regression analysis of change in price of mungbeans failed to indicate independent variables of significant importance.

Tables and Maps.

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

Vegetable Crops

Windham, S. L. BELL PEPPER PRODUCTION IN MISSISSIPPI. Miss. Agr. Expt. Sta. B. 639, 6 pp. 1962.

Bell peppers have been grown in Mississippi for more than 50 years. The bulk of the crop is grown for the mature green fresh market, with smaller acreages for the pickling and the mature red industry. Practices reported are primarily for production of mature

green fruit but most of them are also applicable to other types of production. This bulletin is a summarization of results obtained at the Truck Crops Branch Experiment Station and is a complete "culture and cure" publication on raising bell peppers.

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

Bingley, G. W., Leonard, R. K., Buchele, W. F., Stout, B. A., and Ries, S. K. MECHANIZED CUCUMBER HARVESTING: DESIGN AND DEVELOPMENT OF A MECHANICAL HARVESTER. Agr. Engin. 43: 22-25, 34. 1962.

Picking forces are related to the weight of the cucumber and do not depend upon the time of day or their position on the vine. The picking force varies with variety and maturity of the plants. A relationship was discovered between weight and size of the cucumber. These relationships are important because the picking force can be related to length or diameter by using the appropriate equation.

The pneumatic vine trainer was more than 75 percent effective in positioning the vines in the desired direction for harvesting. The optimum time for training is when the vines are 12 to 16 in. long and occurs shortly after the vines have started to "run". The dollar return per acre was reduced by 10 percent when the vines were pneumatically trained. The capacity of the vine trainer ranged from 1-1/2 to 2-1/2 acres per hour based on a row width of 8 ft.

The mechanical cucumber harvester provided an effective means for obtaining data on machine efficiencies, design parameters, and the reduction in yield and return.

The capacity of the harvester ranged from 0.8 to 1.2 acres per hour based on a row of 8 ft. The row width is expected to decrease to a minimum of 5 ft. for a machine designed to harvest trained rows.

The return per acre was reduced by 75 percent owing to the combined effects of a pneumatic vine trainer and the mechanical cucumber harvester. Using hand labor to supplement the harvesting operation, a maximum value of 40 percent of the value normally received by a grower was obtained.

Ford Motor Co., Bingham, Mich.

Saidak, W. J. CHEMICAL WEED CONTROL IN TRANSPLANTED TOMATOES. Canad. J. Plant Sci. 42: 190-197. 1962.

Experiments on the chemical control of weeds in tomatoes were conducted in 1959 and 1960 at Ottawa and Smithfield, Ontario. The weed populations were dominated by annual broadleaved weeds.

Granular formulations of amiben(3-amino-2,5-dichlorobenzoic acid), CDEC(2-chloroallyl diethyldithiocarbamate), DNBP(4,6-dinitro-o-secondary butylphenol), EPTC(ethyl N,N-di-n-propylthiol-carbamate), simazine(2-chloro-4,6-bis(ethylamino)-s-triazine), CIPC(isopropyl N-(3-chlorophenyl) carbamate), and neburon(1-n-butyl-3-(3,4-dichlorophenyl)-1-methylurea), were applied in 1959 as pre-emergence herbicides to established transplanted tomatoes. Solan(N-(3-chloro-4-methylphenyl)-2-methyl-pentanamide), was applied as a post-emergence spray about 1 month after transplanting when the weeds were less than 4 inches high. Amiben, solan, and CDEC were selected for further evaluation in 1960 on the basis of weed control effectiveness and lack of crop injury.

The effect on yield, of single and double applications of amiben, solan, and CDEC, was not statistically significant. Two applications of amiben and CDEC provided significantly

better weed control than single applications at Smithfield, but little difference was found at Ottawa where the weed population was smaller.

In these experiments, solan, amiben, and CDEC at 4 to 6 pounds per acre have produced reliable and effective weed control from shortly after transplanting until harvest time. Neither solan, amiben, nor CDEC caused injury to the tomatoes.

Canada Dept. Agr., Ottawa, Ontario, Canada.

Jasim, J. J., and Coiteux, J. S. F. SOME EFFECTS OF 4-(MCPB) WHEN USED AS A SELECTIVE HERBICIDE ON CELERY GROWN ON ORGANIC SOIL. *Canad. J. Plant Soil* 42: 40-45. 1962.

4-(MCPB) [4-(2-Methyl-4-Chlorophenoxy) butyric acid] can be safely applied as a selective herbicide to celery plants at rates up to 36 ounces of pure acid per acre. Several varieties grown on organic soils have shown a great degree of tolerance to this hormone type of herbicide although the reaction was not the same for all varieties. There was little influence on the uptake of phosphorus, nitrogen, potassium, calcium and magnesium by celery following the application of this herbicide. 4-(MCPB) does not influence the quality of celery or shorten its storage life when applied at rates ranging from 12 to 72 ounces of acid equivalent per acre.

Organic Soil Substation, Res. Br., Canada Dept. Agr., Ste-Clotilde, Quebec, Canada.

Bruns, V. F., Clore, W. J., and Dawson, J. H. WEED CONTROL IN ASPARAGUS WITH MONURON AND DIURON. *Wash. Agr. Expt. Sta. B.* 635, 15 pp. 1962.

In greenhouse studies, monuron at rates of 5 lb./A. or more severely injured or killed asparagus in fine sandy loam after three surface waterings, each at a volume equivalent to 3 acre-inches. Injury symptoms from 40 or 60 lb./A. usually appeared after the first or the second watering. Injury from lighter rates generally appeared after the second or the third watering.

In field studies on fine sandy loam, annual applications of monuron were made at 4 lb./A. in late February or early March, followed by shallow rotovation, and at 4 or 6 lb./A. in November or December, not followed by rotovation. Both treatments gave excellent year-long control of annual weeds without apparent injury to asparagus. High rates of monuron (40 lb./A. on December 6, 1954, or 20 lb./A. on December 6, 1954 plus 10 lb./A. on March 26, 1956) controlled annual weeds effectively for 2 1/2 years, but caused severe injury to asparagus in one surface-eroded block where the crowns were near the soil surface.

Except in the first year, annual applications of diuron at 3 or 4 lb./A. in late February or early March, followed by shallow rotovation, also gave excellent, year-long control of annual weeds without detectable injury to asparagus. After the first year, annual applications of diuron at 2 lb./A. in late February or early March, followed by shallow rotovation, were effective during the asparagus cutting season (April, May, and June).

After the last in a series of annual applications of monuron and diuron at 4 lb./A. had been made in February 1957, residues of both chemicals in the soil in February 1958 were sufficient to cause severe or lethal injury to oats. Diuron was very immobile, being concentrated in the first 2 inches of soil (approximate depth of rotovation). Monuron, however, was detected 4 to 5 inches deep in the soil. Additional studies with wheat indicated that susceptible crops such as the cereals should not be planted for at least 2 years after the

last application of monuron or diuron to control annual weeds in asparagus in the irrigated areas of central Washington.

After initial applications of monuron at 3.7 lb./A. on December 1, 1958 plus retreatments at 3.2 or 4 lb./A. on March 4, 1960, asparagus spears collected on May 5 and June 16, 1960, contained less than 1 p.p.m. of monuron.

Wash. Agr. Expt. Sta., Inst. Agr. Sci. Wash. State U., Pullman, Wash.

Miller, P. M., and Edgington, L. V. CONTROLLING PARASITIC NEMATODES AND SOIL-BORNE DISEASES OF POTATOES WITH SOIL FUMIGATION. Amer. Potato J. 39: 235-239. 1962.

The fumigation of soil infested with a moderate population of parasitic nematodes and fungi very effectively improved the growth, quality, and yield of potatoes. The beneficial effects of fumigation with DD and Vorlex were mainly attributed to control of nematodes, particularly the meadow nematode. The fumigants did effectively reduce the population of Rhizoctonia solani on potato roots and "scurf" on tubers caused by R. solani. Less vascular browning of tubers developed in fumigated soil. The effects of soil fumigation were complex, affecting many microorganisms and consequently producing numerous manifestations in the growth of potatoes.

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

Simpson, G. W., and Shands, W. A. PROGRESS ON INSECT AND DISEASE PROBLEMS OF POTATOES IN MAINE. Maine Agr. Expt. Sta. B. 602, 54 pp. 1962.

Some of the more important recurring problems associated with potato production in Maine are due to fungus, bacterial or virus diseases, and to insect pests. All of these can affect the growing potato plants and the yields obtained. Since production costs are largely dependent on yields, these problems are of vital concern to growers. Some of these diseases also affect the storage of tubers and their eating qualities. The more important fungus diseases that affect the growing plants and their tubers are late blight, scab, and Rhizoctonia. The bacterial diseases include ring rot and blackleg. Less important virus diseases are latent mosaic, common or mild mosaic, rugose mosaic, spindle tuber, and leafroll.

The most important insect pests are aphids, potato fleabeetle, wireworms, Lygus bugs, and on occasion leafhoppers. In recent years, the Colorado potato beetle has been of very minor importance. In the order of decreasing relative abundance, over a period of years, the four species of aphids that infest potatoes in Maine are the buckthorn, potato, green peach, and foxglove aphids. Their relative abundance and destructiveness vary between seasons and between localities in any one season.

Chemical control of potato insects has progressed markedly in recent years. This has been due to the development of efficient insecticides and to an increasing knowledge of how to use them most effectively.

Spray programs have been developed that offer considerable hope of keeping the spread of virus diseases to a minimum. The recent development of systemic insecticides has provided a means of preventing the establishment of aphid colonies on potatoes until well into August, a period too late in the growing season to permit the development of damaging populations of the aphids.

A considerable number of different insecticides have been tested in Maine with the result that growers may now choose from among a number of satisfactory materials those insecticides best suited to their needs.

A well integrated and carefully supervised program for the production of good seed has been developed and is in use in Maine. Seed potatoes of high quality are available in quantity for the use of table stock growers in Maine and elsewhere. Based on the results of research and grower experience, the over-all seed program is divided into five phases, namely, the continuing production of foundation seed by the State Seed Board, the annual testing in Florida of representative samples from seed fields, the increase of good seed through the Foundation Seed Program, the Generation Program, and the Certified Seed Program.

Maine Agr. Expt. Sta., Orono, Maine.

Ford, K. E. THE SUPPLY, PRICE, VALUE, AND DISPOSITION OF PEANUTS. Ga. Agr. Expt. Sta. Mimeo. Ser. N. S. 143, 77 pp. 1962.

Most of the available statistical data on peanuts with special reference to Georgia and states competing with Georgia were reported. These data are designed to facilitate comparisons, study, and interpretation of trends and changes in the peanut industry. Problems in production and marketing should be clearer and more easily grasped. Such a compilation of data is basic to the formulation and execution of research studies designed to aid in the correction of inefficiencies in the industry. The authors concluded that:

1. There are three major peanut production areas in the United States and in each area a different type predominates: (1) The Virginia type in the Virginia-Carolina area, comprised of Virginia, North Carolina, and Tennessee. (2) Runners in the Southeastern area, comprised of South Carolina, Georgia, Florida, Alabama, and Mississippi. And (3) Spanish type in the Southwestern area, comprised of Arkansas, Louisiana, Oklahoma, Texas, and New Mexico.
2. The Southeastern area has produced over 50 percent of equivalent solid acreage of peanuts harvested for all purposes in the United States.
3. Trends in acreage for the United States, the Southeast, and the Southwest were similar. Less change has occurred in acreage in the Virginia-Carolina area during the 1909-60 period.
4. Georgia and Alabama had about the same acreage each year prior to 1920; however, Georgia acreage followed the United States' trend from 1921 while Alabama acreage decreased.
5. Georgia growers have harvested 50 percent or more of the peanut acreage in the Southeast since the 1920's.
6. Of the United States' peanut acreage harvested for all purposes since 1940, approximately one-third of the acreage has been in Georgia.
7. The acreage of peanuts picked and threshed showed trends and relationships similar to those for acreages of peanuts for all purposes.
8. The trend in per acre yields of picked and threshed peanuts in all areas has been upward during the 1909-60 period.
9. Yields in the Virginia-Carolina area have been the highest and were frequently twice the national average.
10. Yields have been the lowest in the Southwest, frequently as low as one-half the national average.
11. Yields in the Southeast have been just below the national average.
12. Yields in Georgia have been about the same as those in the Southeast each year.
13. With respect to the production of peanuts picked and threshed and to the sales of farmers' stock peanuts, the statements made in items 2-6, above, would apply with only slight variations, if any.

14. The long-term trend in prices received by farmers for peanuts has been similar to that of the general economy, from an all time low of 1.5 cents per pound in the early 1930's to 12.2 cents in 1954 for all growers in the United States.
15. Prices in the Virginia-Carolina area have been higher than in the other areas.
16. Prices in the Southeast were usually a little below the national average.
17. Prices received by Georgia growers have been approximately the same as received by growers in the Southeast.
18. When monthly prices for the period August 1910-July 1957 were used to compute an index of seasonal variation, they ranged from 94.4 percent of the annual average to 105.2 percent; however, with the control programs of recent years, the range has been reduced until there was very little variation in monthly prices through the year.
19. Items 2-6 apply with respect to the value of picked and threshed peanut production and to the value of sales of farmers' stock peanuts.
20. The proportion of total production sold has increased in the United States, in the Southeastern area, and in Georgia. Over 95 percent of production was sold during the 1950's.
21. The most important type milled during the 1940's was Spanish; however, in 1955-1959, millings were about equally divided among the three types: Virginia, Runner, and Spanish.
22. The Southeast was the leader in the milling of Spanish type peanuts in the 1940's; however, the Southwest led in milling this type during the 1950's.
23. The Spanish type was the leading shelled, edible peanut during the 1940's, accounting for approximately 50 percent; however, each of the three types accounted for 30-40 percent of the shelled edibles in the 1950's.
24. Peanut butter has been the most important use of shelled, edible peanuts, and accounted for slightly more than 50 percent of production. Peanut candy and salted peanuts accounted for 20-30 percent each.
25. Spanish is the predominate type used in peanut candy.
26. Approximately 70 percent of the salted peanuts was of the Virginia type.
27. Nearly 50 percent of the peanut butter was made from peanuts of the Runner type.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Experiment, Ga.

Hilsenkopf, R. J., and Suter, R. C. WATERMELONS AND CANTALOUPS; COSTS AND RETURNS. Purdue U. Agr. Expt. Sta. Res. B. 729, 24 pp. 1962.

Watermelon growers in Knox, Gibson, and Daviess Counties received an average return of \$162.57 per acre of watermelons raised, or \$2.96 per hour, in 1957. Growers who raised cantaloups received an average of \$122.83 per acre, or \$1.45 per hour without fumigating or spraying; and \$246.74 per acre, or \$2.54 per hour when fumigant and spray materials were applied. These are the dollar returns to labor and management, after paying all other costs.

Melons are traditional in southwestern Indiana; an average of 28 acres of watermelons and 11 acres of cantaloups were being raised on the farms surveyed in 1957. This acreage amounted to 25 percent of the total crops raised. In 1958, 11 growers had built and were using a mechanical planter to transplant melons.

The cost of raising watermelon plants averaged \$85.15 per 10-sash bed. The average cost of raising cantaloup plants was slightly less--\$81.21 per 10-sash bed. The cost of raising watermelons averaged \$124.93 per acre. The cost of raising cantaloups averaged \$171.21 per acre.

Tables and Graphs.

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

Padgett, J. H., and Risse, L. THE ECONOMICS OF PRODUCING SOUTHERN PEAS FOR CANNING IN GEORGIA. Ga. Agr. Expt. Sta. Mimeo. Ser. N.S. 129, 12 pp. 1961.

Canning plants handling southern peas are able to operate for only 350 to 400 hours per year canning peas. On the basis of a 40 hour week, plants would can peas for 8 to 10 weeks per year. Specialized pea canning equipment would be idle for the remaining 40 to 42 weeks each year. Plant managers would like to "spread out" the southern pea season and operate their equipment for 500 to 600 hours per year.

Producers could do a great deal about extending the pea season. Additional fertilizer applied after the first picking will stimulate a second crop of peas on old vines when sufficient soil moisture is available. Irrigation equipment, if owned by the farmer, might be profitably used with southern peas.

The average pea producer in Georgia spends \$25 on production expenses plus \$16 more for picking, giving a total cost per acre of \$41. Returns from sales to canning plants average \$64 per acre leaving a net return to management and land of \$23. Some farmers had a net return per acre of \$50 and this figure is not at all unrealistic. To achieve a net of \$50 or more farmers must follow good management practices including a careful spraying program.

Southern peas, with careful planning could be a profitable crop in many farm programs. They are soil improving or soil building. A good crop rotation system including southern peas could be arranged with other crops in the pea producing areas of Georgia.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

ECONOMIC AND SOCIAL ASPECTS OF SOIL AND WATER CONSERVATION

Costs and Returns

Edmondson, V. W. AN ANALYSIS OF FULL-TIME COMMERCIAL FARMS IN NORTHEAST TEXAS. Tex. Agr. Expt. Sta. B. B-988, 15 pp. 1962.

Opportunities are available to raise incomes from full-time commercial farming operations in Northeast Texas, especially on farms where livestock enterprises are predominant. Many of the dominantly crop farms could be reorganized into livestock type farms.

Land resources (cropland and pastureland) are not being fully utilized. Output of forage crops (pasture, hay, and silage) is responsive to soil treatments, such as tillage, fertilization, and crop variety improvement. Rainfall is usually sufficient, if utilized properly in combination with other inputs, to bring about a more productive basis for livestock production.

Management is probably the most significant obstacle to increased incomes on many of the full-time commercial farms, although factors beyond the operators' control prohibit substantial increases in incomes. Many factors such as lack of land, livestock, equipment, and other capital which limit production on many farms, are directly related to management. Efficient management tends to diminish the extent of other restrictions on productivity.

A fifth to a fourth of the cropland on the farms studied was idle. Fifty to 80 percent of the pastureland was frequently unimproved; it was not well "cleared," was covered with poor quality grass and the soil fertility level was generally low. Productivity can be increased without heavy expenditures in most cases.

Both crop and livestock production rates are significantly low; they are considerably lower than the State average. To a certain degree, production rates can be increased through improved management and very little additional expense.

The average full-time commercial livestock-type farm paid a 5.5 percent return on its capital investment and approximately \$2,300 to the operator for his labor and management. The average crop-type farm paid less than 5.5 percent interest on investment and nothing to the operator for his effort.

Generally, livestock farms have the following advantages over crop farms in Northeast Texas: (1) Livestock enterprises are more efficient users of labor, since the labor requirements are distributed more evenly over the whole year; (2) livestock production improves soil fertility in the long run without excessive expenditures; and (3) the maintenance and production of livestock do not depend so critically on the farm where in-place-production conditions become unfavorable to crop production.

The size of business directly affected the level of production and income. The average farm employed one man productively only 59 percent of the time. The average livestock farm had enough employment for only 55 percent of one man's time. These types of farms had incomes considerably higher than other types. With increased size of business, operators engaged in livestock farming can expect considerably higher incomes. This appears especially true for qualified business and technical management.

More than half of the operators interviewed indicated that obtaining control of more acreage was not a significant problem.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Russell, J. R., and Elrod, J. C. COST AND UTILIZATION OF TRACTOR POWER AND EQUIPMENT IN NORTH GEORGIA. Ga. Agr. Expt. Sta. B.N.S. 95, 32 pp. 1962.

Information related to the cost of operating tractors and tractor-drawn equipment on sample farms in North Georgia is presented.

A sample of 151 farms was selected from 36 sample counties, and all data were collected from farmers by personal interview. A field schedule was used to obtain data from farmers on their 1959 farming operations. The use of each piece of machinery for 1959 by type of operation was recorded.

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.

Annual use of tractors varied with size. Small tractors had an average annual use of 293 hours per year, medium 462 hours, large 507 hours, and extra large 637 hours. The average annual use for all tractors was 457 hours.

The proportion of use for various operations averaged 30.5 percent for land preparation, 23.5 percent for miscellaneous operations, 19.1 percent for harvesting, and 10.0 percent for cultivating. These major uses of tractors accounted for 83.1 percent of the total tractor use.

Many of the sampled farms were using more than one tractor. There were 102 farms, or 67.6 percent of total sampled farms, with two or more tractors per farm.

The total cost of operating the 311 tractors in the sample averaged \$11.43 per 10-hour day. Operating cost was \$6.57 and fixed cost \$4.86. The cost of operating a tractor increased as the size of tractor increased with an average cost of \$10.11 for all small tractors, \$10.83 for medium, \$12.19 for large, and \$13.63 for extra large per 10-hour day.

The cost per hour of use for some of the more important farm implements was: 10-ft. lime spreader \$0.44; two-row planter and distributor \$0.56; two-row cultivator \$0.52; 7-9 ft. sickle mower \$0.96; and 13-disc grain drill \$1.31. Many pieces of equipment with a low annual use had extremely high cost per hour of operation.

Approximately 51 percent of the sampled farms had equipment for land preparation, seeding, planting, fertilizing, cultivating, and harvesting.

The most important factor affecting costs of operating tractors was annual use. Farms with only one tractor had an annual use of 369.5 hours. Farms with only one large tractor had the highest annual use with an average of 412.4 hours per tractor, while farms with only one small tractor averaged 222.7 hours.

Farms with less than 50 acres of cultivated land had an average of 4.7 tractors per 100 acres of cultivated land, while farms with 200 acres or more of cultivated land averaged 0.8 tractors per 100 acres of cultivated land. This indicates the small cultivated acreage is not sufficient to justify the ownership of a tractor for this small an operation.

The type of operation performed affected the annual cost of operating a tractor. Heavy loads required a considerable increase in consumption of fuel and increased the operating cost considerably. The small tractor averaged using 3.6 more gallons per 10-hour day for heavy work than light work. Extra large tractors used 10.7 more gallons of gasoline when doing heavy work than for light.

The annual use and type of operation performed were the most important factors affecting costs of operating farm equipment. In many cases, there were more tractors found on the farm than were really needed to operate the given cultivated land. Farmers, in most cases, would have a large tractor to do the land preparation and a small tractor to do the cultivating. This usually resulted in a low annual use of both tractors and a high cost per hour.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Heady, E. O., and Krenz, R. D. FARM SIZE AND COST RELATIONSHIPS IN RELATION TO RECENT MACHINE TECHNOLOGY; AN ANALYSIS OF POTENTIAL FARM CHANGE BY STATIC AND GAME THEORETIC METHODS. Iowa Agr. and Home Econ. Expt. Sta. Res. B, 504: 444-466. 1962.

The relation of more recent machine technology to per-unit costs of crop production for farms of different sizes was studied. The types of new machine technology of particular interest included large-capacity equipment such as 4- and 6-row corn planting and cultivating equipment and picker-sheller harvesting machines.

This study was based on data for the Carrington-Clyde soils in northeast Iowa and the Ida-Monona soils in western Iowa. Cost functions are estimated for farms of different sizes or acreages by budgeting procedures. More specifically, cost curves are derived as a function of acreage per farm. Losses in crop production resulting from untimely field operations are considered as costs for different acreages and are related to particular machine combinations. Parametric linear programming was used to permit analyses of livestock optimum enterprises and to consider the effect of subjective discounting of returns on size considerations. For decision making under risk and uncertainty, game theory models were employed to incorporate consideration of weather variations on optimal machinery-land or farm-size relationships.

The results, assuming average weather and current cropping methods, indicate that cost advantages associated with 6-row cropping equipment and field corn shellers are small relative to more standard sizes and types of machines. An expansion of farm size from 200 crop-acres operated with 2-row equipment to 400 crop-acres operated with 4-row equipment is estimated to reduce costs by 6 cents per \$1 of crop produced. Expansion to 600 crop-acres operated by 6-row equipment would further reduce costs by only 1.5 cents per dollar of crop product.

Under a farm organization including cash cropping and current rotations, minimum per-unit production costs (per dollar of product) are retained in the range of 600 to 680 crop-acres.

The reduction in per-unit costs is small as acreage is extended from 400 to 800 crop-acres. With a continuous-corn rotation minimum per-unit costs are attained at a size of 320 crop-acres.

The static budgeting analysis indicates small cost reductions are possible as machinery investment is increased and as crop acreage is expanded beyond 320 acres, but these savings alone probably are not great enough to "force" much larger farms.

A consideration of the yearly weather variation and days suitable for field operations indicated that an analysis based on average weather causes long-run per-unit production costs to be underestimated. Low per unit costs in favorable weather are outweighed by extreme crop losses in years of unfavorable weather if only average weather is assumed. Hence, optimal machinery investment per acre to meet weather variations is higher than would be necessary if weather were static among years.

Several game theoretic criteria were applied in the examination of optimum farm size under uncertainty. The strategy selected by the Wald maximin criterion, a conservative model, is that which gives maximum expected profits under supposition of the least favorable weather. The specified acreage is 520. The Savage minimax-risk criterion, a strategy which minimizes the maximum risk, specifies a farm size of 560 acres. The Hurwicz pessimism-optimism index shows an optimum size of 520-720 acres.

When these same game theoretic techniques were applied to decision making under uncertainty, it was found that a larger machine investment proved optimal than was true when analysis was based on static budgeting approaches. For example, the static budget approach specified only 2-row machinery for a 200 acre farm. When game models were applied under assumptions of weather variation and uncertainty, however, 4-row machinery proved to be optimal.

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

McConnell, D., Schmidt, J. R., Staniforth, S. D., and Christiansen, R. A. RELATIVE PROFITABILITY AND ORDER OF ADOPTION OF SOIL CONSERVATION PRACTICES. Wis. Agr. Expt. Sta. Res. B. 237, 40 pp. 1962.

Three basic objectives were studied: (1) The relative profitability of selected individual soil conservation practices; (2) the optimum combination of such practices; and (3) the priority of practice adoption leading to the most profitable conservation plan.

The relative profitability and order of adoption of selected conservation practices were analyzed on a representative farm for the Fayette soils of southwestern Wisconsin. This 180-acre farm had 100 acres of cropland. Cropland was assumed to be equally distributed on 4, 8, 12, and 16 percent slopes. In addition, the size and choice of livestock enterprises were restricted to what was considered typical.

These limits included up to 30 dairy cows, up to 60 feeder calves, and facilities for 10 brood sows, with expansion beyond this limit allowed at \$60 per sow for new facilities. No direct limit was placed on grain purchase, but hay purchase was not permitted. A level of excellent management was assumed.

The effects of selected conservation practices on net farm income, using selected types of farm organization, were used to rank and order individual soil conservation practices. Net farm income meant income remaining after subtracting ordinary cash farm operating expenses but excluded costs for labor and interest on capital investment.

Practice	Dairy	Sows	Sheep	Feeder Calves	Net Farm Income
1. Terracing	24	28	--	--	\$15,485
2. Interplanting plus Terracing	29	18	--	--	\$15,180
3. Interplanting plus Contouring	30	15	--	--	\$14,786
4. Contour Strip Cropping	30	13	--	--	\$14,539
5. Contouring	30	15	--	--	\$14,235
6. Field Strip Cropping	30	10	25	--	\$13,473
7. Rotation Effect Only	30	15	--	--	\$13,240
8. Interplanting	28	2	77	4	\$12,309

Most farmers use several recommended soil conservation practices rather than only one practice--to consider a practice "alone" is not always realistic.

Choosing from the five most efficient practices and their rotations permitted selection of that practice and rotation for each slope of cropland that would maximize income for the entire farm. The most efficient cropping plan for any particular slope would not necessarily be best for the farm as a whole. Also, selecting this kind of practice and cropping plan would depend on the particular livestock enterprises allowed and their relative levels of efficiency. It was necessary to determine simultaneously the optimum practice and the optimum combination of livestock to use the feed produced.

When the five practices with the highest net income were considered in combination, the result was a net income of \$15,855.

Farmers, when installing soil conservation practices, must consider their effect upon livestock programs, crop rotations, and net farm income. Only in this way can they effectively predict the practices' impact upon their farm business. It is not sufficient just to say that "soil conservation pays." The critical question is--"What is the relative profitability of individual practices and how can they be combined to give highest net farm income?"

FED, ERS, USDA, and U. Wis., Madison, Wis.

Micheel, C. C., and Nauheim, C. W. ECONOMICS OF SOIL CONSERVATION, NORTH-EASTERN KANSAS. Kans. Agr. Expt. Sta. Agr. Econ. Rpt. 101, 69 pp. 1962.

Some of the basic data gathered and analyses of the costs and benefits of conservation practices and systems of farming, on the major soils in the Walnut Creek Watershed in northeastern Kansas, are presented. The conservation practices considered are terraces, waterways, rotations, grade stabilization structures, retired cropland, contour farming, fertilizer, and lime. The soils studied are the Marshall s1cl, Sharpsburg s1cl, Grundy s1cl, and Shelby cl.

Soil losses of 5 tons per acre annually can be tolerated on the soils studied with no adverse effect on crop yields. On soils with a 5 percent or more slope, terraces are usually needed to control soil losses. On soils with slopes of less than 5 percent, the use of appropriate rotations with fertilizer will control soil losses at tolerable limits.

Yields of crops were estimated for two periods, "present" and "projected." On soils in this area, yields of crops are not greatly affected by soil losses in a short period (5 to 10 years) under present conditions, but over a long-time period (75 to 80 years) soil losses could reduce yields substantially. Under some systems of farming, corn yields on some soils would be reduced more than 40 percent.

The amount of unproductive cropland will increase considerably over a long-time period, if soil losses are not controlled. The unproductive area now ranges from 2 to 7 percent of all cropland, depending on the soil situation. If soil losses are allowed to continue, the unproductive area is expected to range from 3 to 18 percent of all cropland in 75 or 80 years, depending on the soil situation and the system of farming used.

The cost of a conservation practice or system consists of two parts, the initial cost of constructing or applying the practices, and the annual cost of maintaining or replacing practices and of interest on the investment. All prices and costs in this report are at a 1955 level.

Construction costs for terraces averaged 3.6 cents per lineal foot when built by contractors. Annual maintenance costs averaged about 15 cents per 100 lineal feet of terraces.

Whenever land is terraced, waterways are necessary. The construction cost (including shaping and seeding) per acre of waterway averaged about \$89. Annual maintenance cost was \$7.50 per acre of waterway without fertilizer and \$15.10 per acre of waterway when the cost of fertilizer and lime was included. From 5 to 7 percent of the cropland acreage, depending on the soil type, length, and percentage of slope, is needed for waterways.

One grade stabilization structure was planned for about every 230 acres of cropland on 2-4 percent slope soils and every 220 acres on 5-7 percent and 8-11 percent slope soils. Cost of constructing the average structure was \$754. Annual costs for interest and maintenance were estimated to average 6 percent of the initial cost.

The cost of shifting 1 acre of cropland to permanent grass (retired cropland) was \$11.70. The annual maintenance cost per acre of retired cropland averaged \$1.95 without fertilizer and \$15.10 when the cost of fertilizer and lime were included.

The total cost of constructing or applying the recommended practices on 100 acres of cropland on the soils studied ranges from \$600 for lime on Grundy, 0-1 percent slope soil to almost \$2,700 for terraces, waterways, grade stabilization structures, retired cropland, and lime on Shelby 8-11 percent slope soil. Total annual costs for maintenance and interest of the practices on the soils studied range from \$30 to \$384.

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

Gibson, W. L., Jr., Arnold, C. J., and Aigner, F. D. THE MARGINAL VALUE OF FLUE-CURED TOBACCO ALLOTMENTS. Va. Agr. Expt. Sta. Tech. B. 156 (Southeast land Tenure Res. Comm. P. 41) 29 pp. 1962.

Reduction in flue-cured tobacco allotments during 1955-57 resulted in a significant increase in the amount an acre of tobacco allotment contributed to the sale value of a tobacco farm. A acre of tobacco allotment, independent of the land and buildings associated with it, was estimated to add \$1,673 to the sale value of tobacco farms in Pittsylvania County, Va., during 1957.

A survey of a sample of farms in Pittsylvania County provided data to delineate two typical sizes of tobacco farms and the resources available on each. Budgets were prepared for typical enterprises and, using the linear programming technique, the marginal value of an acre of tobacco allotment was determined for each size of farm under conditions of two levels of operating capital.

On the typical small farm with 3.2 acres of tobacco allotment and \$1,000 operating capital, the capitalized marginal values of an acre of tobacco allotment ranged from \$990 to \$2,475 with the discount rate lowered from 10 percent to 4 percent. A discount rate of 6 percent or greater reduced the capitalized value of the net income below the estimated sale value of an acre of tobacco allotment.

On the typical medium sized farm with 6.0 acres of tobacco allotment and \$2,100 operating capital, similar capitalized values ranged from \$1,600 to \$4,000. A discount rate greater than 9.6 percent reduced the capitalized value below the estimated sale value of an acre of tobacco allotment.

Removal of the operating capital restriction on both sizes of farms resulted in a required discount rate of 15.3 percent to reduce the capitalized marginal values to the estimated sale value of an acre of tobacco allotment.

Additional conclusions were:

1. Any further reduction in tobacco allotments would affect small tobacco farms more than medium-sized farms. On the typical small farm with operating capital restricted to \$1,000 and \$2,000 the marginal value of an acre of allotment rose rapidly when the present allotment was reduced from 3.2 to 2.2 acres. On the typical medium-sized farm, a reduction of allotment by 1 acre raised the marginal value only slightly when \$2,100 of operating capital was unavailable and, if \$4,200 of operating capital was available, the marginal value remained unchanged.
2. In all situations studied, it was profitable to plant the full tobacco allotment and increases and decreases in the tobacco allotment by 1 acre were accompanied by increases and decreases in net returns. The availability of operating capital determined whether it was profitable to plant the remaining cropland (except the idle cropland in the tobacco rotation) in crops presently grown--corn, wheat-lespedeza, and alfalfa. Under conditions of \$2,000 and \$4,200 operating capital on the small and medium-sized farms, respectively, the cropland was fully utilized. When operating capital was restricted to \$1,000 and \$2,100 on the respective farms, however, full utilization of the cropland did not maximize net returns except when the tobacco planted was reduced by 1 acre below the present allotment.
3. Since the benefits of the price support program are capitalized into the sale value of tobacco farms, knowledge of farmers' discount rates and the factors that determine the level of the rates, both for a given time and between points in time, are of great importance in appraising the full effects of the price support program.

Va. Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va.

Callahan, J. W., and Crossmon, B. D. PRODUCTION ADJUSTMENTS ON MASSACHUSETTS FARMS WITH TOBACCO ALLOTMENTS. U. Mass. Agr. Expt. Sta. B. 529, 25 pp. 1962.

The development of manufactured sheet binders requiring smaller amounts of natural leaf has resulted in a dislocation of binder tobacco production in the Connecticut Valley region of Massachusetts. Farm operators who formerly depended on tobacco as the principal income producing enterprise on their farms find themselves facing a limited market for their product. For many years the Valley crop had enjoyed a "preferred position" among binder tobaccos of the world.

While mounting stocks of natural binder leaf tobacco remain unsold in Commodity Credit Corporation warehouses, tobacco growers face the problem of adjusting their individual farm operations to compensate for lower prices at the same time that production costs continue to rise.

Analysis of factors concerned with ownership patterns on farms holding tobacco allotments in the area was studied. A method of evaluating production adjustments is presented.

Binder type tobacco will become more of a side-line cash crop unless new developments change the present market demand. The greatest proportion of farmers who continue to produce tobacco will be full-time operators with more than one enterprise.

Although tobacco budgets continue to show possibilities of greater income compared with other cash crops, the income is based on the concept of additional cash costs and additional cash returns, not on total cost of production. Farms specializing in production of binder tobacco, where total costs must be borne by the tobacco crop, are unlikely to develop under present acreage allotment patterns and prevailing price support levels.

Decisions to produce tobacco should be made with a short run outlook, on a year-to-year basis, because the long run market outlook offers little encouragement to Connecticut Valley binder producers. Limitations to change are:

1. Valley farms are small in size; 60 percent of the farms of tobacco allotment holders containing 40 acres or less.
2. Advancing age of farm operators discourage changes in farm organization and management unless sons are available to carry on after death or retirement of present operators.
3. Off-farm opportunities paying higher wages are attracting younger men away from farming.
4. The backlog of supplies of tobacco in C.C.C. warehouses has created competition for current year-to-year production and limits the prospects for price increases in the future.
5. Cigar manufacturers have shown little interest in Connecticut Valley binder tobacco.
6. As long as the majority of allotment holders vote for price support for tobacco, quotas will be in effect. If supply continues to remain out of balance with demand and yearly quotas continue to be reduced, the quota (allotment) on many farms will eventually become so small that economic tobacco producing units will no longer exist.
7. The number of tobacco allotment holders is gradually decreasing.
8. Even where successful methods of mechanization have been developed for tobacco harvest operations, many of the present farms can not justify the machines because of the small production units that exist.

Expt. Sta., Col. Agr., U. Mass., Amherst, Mass.

Carter, H. O., Dean, G. W., and Reed, A. D. RISK AND DIVERSIFICATION FOR CALIFORNIA CROPS. Calif. Agr. Expt. Sta. C. 503, 12 pp. 1961.

Certain unpredictable factors, such as weather, cause important variations in crop yields, prices, and income. In the past the farmer has had to rely primarily upon his own experience in estimating the risks associated with different crops and cropping systems. This circular supplements the grower's experience by presenting indexes of California crop variabilities in yields, prices, and income. Variabilities are expressed as relative percentages of variation from the average over a period of many years and are based on a detailed study of California state and county agricultural records.

The information presented will enable the California grower to better estimate the relative variations to be expected from year to year in yields, prices, and incomes of individual crops. Possibilities for reducing risks through crop diversification are also considered for several major farming areas of California.

U. Calif., Davis, Calif.

A 1958 study of crops grown on a rotation basis in Preble, Miami, Madison, Fayette, and Pickaway Counties showed that corn gave a net return of \$16.19 an acre; soybeans \$15.83, and wheat \$5.20 an acre on farms having about 220 acres of land. These profits were left even after making a land charge of \$16.50 an acre and paying all labor \$1.50 an hour.

This same method of figuring showed that oats produced an average loss of \$9.56 an acre. Alfalfa, clover, and timothy hay also showed a loss of \$2.45 an acre on these farms when only one cutting was made and the meadow was not pastured the remainder of the season.

Profits from two cuttings of hay could not be studied satisfactorily on the 220-acre group of farms because one crop was all that was harvested on most of these farms. For all sizes of farms included in the study, a net profit of \$6.95 an acre was obtained for two cuttings of hay. Net income from meadows could be further increased by making a third cutting of hay or pasturing profitable for livestock after harvesting the second crop.

The average cost of producing an acre of the various crops declined as size of farm increased. Most of the monetary gains from using large tractors and machinery were obtained when size of farm reached about 400 crop acres. By increasing the number of crop acres per farm from 100 to 700, the total cost of producing an acre of crops was reduced as follows: corn, about 15 percent; soybeans, 17 percent; and wheat and hay, 11 percent.

Cost of production figures show that farmers on small farms can compete with operators of large tracts of land on a unit cost basis if they can use their harvesting equipment efficiently.

On small farms, crop production costs can be kept to the minimum by: (1) Hiring crops harvested; (2) owning new equipment and doing some custom work for neighbors; or (3) purchasing secondhand harvesting equipment when a new machine would become obsolete before it wears out. If these alternatives are followed on a 160-acre farm, cost of producing crops per acre will be about the same as on a 280-acre farm where all machinery is owned by the operator, and they will be only slightly higher than the costs incurred on a 500-acre farm.

An efficient farmer may not have the lowest possible crop costs on an acre basis. But he will have low costs per bushel of grain or ton of hay produced. The average farmer on a 220-acre farm had the following total crop costs per acre: corn, \$59; soybeans, \$44; oats, \$45; wheat, \$47; and one cutting of hay, \$38. Crop costs per acre averaged about 10 percent lower on a 640-acre farm than a 220 when all factors were held constant except size of machinery used.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Bolton, B. FARM INCOME PREDICTIONS FOR SMALL FARMS IN THE CENTRAL LOUISIANA MIXED FARMING AREA. La. Agr. Expt. Sta. D. A. E. C. 308, 33 pp. 1962.

A basis for predicting levels of farm income, for various sizes of farm operation and levels of crop yields, for small crop farms in the Central Louisiana Mixed Farming Area is given.

Predicted incomes were developed separately for owner farms with workstock power, owner farms with tractor power, tenant farms with workstock power, tenant farms with tractor power, and sharecropper farms. Owner operated farms would have larger farm incomes than tenant operated farms of comparable size, both with and without tractor power.

Income expectations developed indicated the possibilities for increasing farm incomes through increasing scale of operation and increasing yield levels. Expected farm incomes

for small farms of a given tenure level can be determined with a reasonable degree of confidence.

The analyses assume that all farm labor was performed by the family labor force. These figures can be applied to farms where farm labor is hired, by the simple procedure of subtracting cost of hired labor from the farm income figure given.

The procedure used should increase the usefulness of the data by making them applicable to a wide range of situations in which labor is hired, such as the old age, disability of the operator, or the nonfarm employment of the operator.

In comparing predicted farm income figures for different levels of mechanization within a tenure group for a given size of farm, farms with workstock power have larger incomes than those with tractor power. This relationship can be expected to hold on smaller farms. More hired labor is likely to be required for a non-tractor farm with a relatively large acreage of cotton and other cash crops than for a comparable tractor-powered farm. This could reduce the income differences between larger farms that are based on source of power, or even swing the income difference in favor of the tractor farm.

Tables, maps, and graphs.

FED, ERS, USDA, and La. State U., Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Jacks, B. H., and Phillips, T. D. COST OF PRODUCING HOGS IN CONFINEMENT. Miss. Agr. Expt. Sta. B. 628, 16 pp. 1961.

Established producers in Mississippi are producing and finishing hogs in confinement the year around. Estimates are given of costs of producing feeder pigs and of finishing hogs to market weights when recommended practices are followed.

The effect of size of operation and level of management on costs of the study included three sets of variable conditions. Pig production costs were estimated for breeding herds of 50, 75, and 100 sows farrowing twice annually. The number of pigs saved per litter was varied from 7 to 9. Estimates of feedout costs are based on feed conversion ratios of 3.25, 3.50, and 3.75.

Costs of producing 40-pound feeder pigs ranged from \$10.18 for 7 pigs saved per litter in the 50-sow enterprise to \$8.42 for 9 saved in the 100-sow operation. Costs of finishing a hog from 40 to 200 pounds ranged from \$17.24 when 800 are finished annually at a feed conversion ratio of 3.75 to \$14.88 when 1600 are finished at a feed ratio of 3.25.

When production cost of the feeder pig is included, costs of finishing a pig from a litter of 7 in the 50-sow enterprise averaged \$13.76 per hundredweight when a 3.75 feed conversion ratio was obtained. Corresponding costs for a hog from a litter of 9 in the 100-sow operation with a feed conversion ratio of 3.25 averaged \$11.62 per hundredweight.

At the level of hog prices that has existed over the past five years, confinement production appears highly profitable. Where 8 pigs are saved per litter, feed conversion ratio is 3.50, and 1,600 hogs are finished annually, the margin above the \$12.54 production costs would have averaged \$8.05 per hundredweight in 1958; \$2.72 in 1959; and \$4.99 over the 5 years. In each of the 5 years there would have been a sizeable profit margin even for the producer whose costs averaged as high as \$13.76.

Tables.

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

Fuller, E. I., and Jensen, H. R. ALTERNATIVE DAIRY CHORE SYSTEMS IN LOOSE HOUSING. Minn. Agr. Expt. Sta., Sta. B. 457, 40 pp. 1962.

Ten dairy chore systems: a typical Minnesota stanchion barn system, a mechanized stanchion modification, and eight loose housing alternatives were examined. Changes in work procedures are emphasized.

These systems are compared as alternatives for expanding herd size. The results show that loose housing either with switch milking or with a low-cost, level-floor parlor is a favorable investment alternative for farms with ample labor for expansion. The capital required to expand a 20-cow typical stanchion barn system to a 30-cow switch system or a low-cost, level-floor parlor system can be repaid in about 2 to 2½ years.

If extra labor for expansion must be charged against the added income, then low-cost, level-floor parlor systems are still favorable, while the switch milking system no longer shows up as well. When labor is charged, the new investment for changing to a switch milking system and expanding to 30 cows pays for itself in about 6 years. However, less than 4 years are required with the level-floor parlor systems.

The comparative analysis suggests that the more expensive, improved forage feeding and herringbone parlor systems do not appear favorable unless the herd is expanded from 20 up to 40 or even 60 cows, despite the fact that these systems require relatively less labor per cow added to the herd. A farmer handling a 20-cow herd in a typical stanchion barn system can hardly expect these more expensive systems to pay for themselves in less than 8 to 9½ years if he changed to one of them and expanded his herd to 30 cows. This length of repayment period is based on the assumption that change in chore system is accompanied by a shift from the sale of grade B milk to grade A; without this shift even more time would be required. A changeover to one of these more expensive systems and an expansion of herd size from 20 to 40 cows reduces the time for the investment to pay off to 6 or 7 years. Increases in production per cow or per forage acre should make the investments in these more expensive systems pay for themselves more quickly.

The chore systems were also compared on the basis of labor requirements for a given herd size. The mechanized stanchion barn chore system makes relatively efficient use of labor. However, the level-floor parlor arrangements show up even better in most comparisons--without considering the added flexibility of these arrangements.

With the typical stanchion barn system and a 40-cow herd as a base for comparison, the capital required to mechanize can be repaid in about 11 years from the value of the labor saved. However, the value of the labor saved in a 40-cow herd by changing over to a level-floor parlor system can pay off the new investment in 8 years. But as many as 13 to 18 years are required before the value of the labor saved pays off the relatively high investments incurred when changing over to the improved forage feeding and herringbone chore systems.

ERS, USDA, and U. Minn., Agr. Expt. Sta., St. Paul, Minn.

Duncan, H. R., and Felts, J. H. PRODUCTION OF SLAUGHTER YEARLINGS. Tenn. Agr. Expt. Sta. B. 334, 23 pp. 1961.

In a 4-year study in Tennessee, steer calves were wintered: (1) In the barn; (2) in an outside lot; and (3) on an orchardgrass-bluegrass pasture. They were then grazed on: (1) Un-nitrated; (2) nitrated; and (3) nitrated and irrigated bluegrass-clover pastures until September 30th. Later they were given a 70-day full-fed in the barn. The authors concluded:

1. The wintering period results were: (1) Steer calves wintered in the barn gained 82 pounds or 27 pounds more and returned \$5.47 more per head than calves subjected

- to the cold weather, rain, and mud in an outside lot on the same amount of feed. And (2) calves wintered on orchardgrass-bluegrass pastures gained as well as those wintered in the barn. The pasture replaced about 40 percent of the hay requirements.
2. The grazing period results were: (1) Applying 120 pounds of nitrogen without irrigation practically eliminated the clovers in the blue-grass pastures. (2) Although nitrogen increased the acre-beef yield 33 percent over pastures not nitrated, its use proved to be uneconomical at any of the price level interpretations applied. (3) Nitration plus irrigation did not depress the clovers but improved the average quality and carrying capacity of the pasture and acre-beef yields. (4) Nitration plus irrigation increased the acre cost \$51.46. This combination of practices would not be profitable unless cattle prices were very high. And (5) the bluegrass pastures treated with lime, phosphate, and potash returned \$26.44 per acre over fertilizer costs with cattle at \$20 per hundredweight.
 3. Dry lot period showed that a short, dry-lot feeding period of 70 days was desirable and profitable in producing good slaughter cattle from these yearlings after the grazing trials were concluded.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

McClagherty, F. S., and Carter, R. C. PRODUCING YEARLING SLAUGHTER STEERS FROM PASTURE WITH A MINIMUM OF GRAIN. Va. Agr. Expt. Sta. B. 531, 24 pp. 1962.

A 5-year study to compare methods of producing yearling slaughter steers from pasture with a minimum of grain was conducted at the Southwest Station at Glade Spring, Va., from 1955-60, using 258 beef breed steer calves averaging about 475 lbs. at weaning. The authors concluded that:

1. The calves were wintered at 2 gain levels, one group gaining 1.43 lbs., the other 0.95 lbs. per day, for the winter feeding period of 140 days. The higher gaining group consumed 8.4 bu. more corn but 400 lbs. less silage than those on the lower gain level.
2. Both groups were grazed together on bluegrass pasture without supplementary grain from April 20 to July 1. The steers on the high winter gain level averaged 1.21 lbs. gain per day, compared to 1.60 for those making the lower winter gains, for this period of approximately 65 days.
3. One-half of the steers in each winter gain group were fed an average of 22-1/3 bu. of coarsely ground corn per head, supplemental to the pasture, from July 1 to the end of the grazing season in early October. Steers fed grain on pasture averaged 1.76 and 1.84 lbs. per day gain for the higher and lower winter gain levels respectively; those not receiving grain gained 0.98 and 1.16 lbs. per day for this period. Average live slaughter grades were middle Good for the steers fed grain on pasture and Standard plus for those on pasture alone.
4. One-half of each of the four sub-groups of steers was slaughtered at the end of the grazing season in October. Those receiving grain on pasture averaged middle Good in carcass grade with dressing percentages of 58.5 percent and 57.8 percent for the higher and lower winter gain levels. Those not receiving grain on pasture graded Good minus and Standard plus in the carcass with dressing percentages of 55.4 percent and 54.3 percent, respectively, for the two winter gain levels.
5. The remaining half of each group was fed in the dry lot to an average grade of Choice minus. Those receiving grain on pasture required 60 days dry lot feeding to reach this grade; those on pasture required 125 days.

6. Steers fed grain on pasture returned \$11.25 more per head above initial cost of the calf and feed cost than those on pasture alone when slaughtered in October. Those grazed on pasture alone and fed 125 days in the dry lot returned \$18.60 per head more above initial and feed cost than those receiving grain on pasture and fed 60 days in the dry lot.

Va. Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va.

Institutional, Educational, and Social Factors Affecting Conservation Farming

Polopolus, L. LOUISIANA AGRICULTURE: ECONOMIC TRENDS AND THE CURRENT STATUS. La. Agr. Expt. Sta. B. 550, 63 pp. 1962.

The recent historical trend in Louisiana agriculture is encouraging in terms of resource adjustment. Area specialization is developing in line with physical and economic factors. Areas of relatively infertile soils are reverting to forest or other use, while areas of reasonably fertile soils are becoming the major contributors of agricultural output. Also, areas having climate and/or soil characteristics necessary for particular crops--rice, sugar cane, oranges--continue to specialize in those products.

The level of performance in terms of yields and adoption of mechanical and biological innovations has greatly improved. Particularly noticeable have been yield increases for cotton, sweet potatoes, soybeans, and sugar cane during the past 30 years. Mechanical harvesting methods are almost universal for rice and sugar cane, while mechanical cotton pickers harvest approximately 60 percent of the total cotton acreage.

Within the past few decades the cattle industry has greatly increased in relative importance. In 1957 and 1958, cattle and calves accounted for the largest portion of Louisiana's total cash farm income, replacing the perennial leader--cotton. Also, commercial broiler, milk, soybean, and wheat production has increased significantly in recent years.

Some agricultural commodities have performed poorly in terms of yield and production. Total production of peaches, oranges, sheep, hogs, and pigs, strawberries, Irish potatoes, commercial vegetables, and sugar cane for syrup has generally declined over the past 30 years. Tung nut production has generally declined in the past 10 years.

These changes in product composition, production, and performance of Louisiana agriculture are the result of numerous interrelated physical and economic factors.

Various lags in adjustment and performance in Louisiana agriculture must be recognized. Some of these problems are: (1) The solution to the low income, low production, farm problem is vexing and to date remains unsolved. Approximately 70 percent of Louisiana farms in 1959 earned less than \$2,500. (2) Large numbers of low income farms have been slow in adoption of mechanical and biological innovations. (3) Even among commercial-sized units, there has been a lag between technological knowledge and actual farm practices. (4) Average managerial ability is still quite low. Educational attainment of the rural farm population 25 years of age or over, although improving over time, could stand further improvement. In 1950, 80 percent of the rural-farm population over 25 years of age had not attended high school. And (5) the amount of individual farm planning is still at a relatively low level. Much could be done to improve net income on many Louisiana farms by systematic reorganization and careful planning.

Although serious lags and imperfections exist in the Louisiana farm sector, considerable adjustment has occurred in recent years. This is some indication that the future will provide a more effective utilization of Louisiana's abundant and diverse agricultural resources.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

This is the second of two reports of analyses of capital structure and productivity on family-operated farms. This analysis ascertains the productivity of additional investments and determines how changes in capital levels and structure affect capital productivity and volume of business on family-operated farms. The specific objectives were: (1) To determine the relationship between specified kinds and amounts of resources and the volume of business for family-operated farms by types and geographic areas; (2) to estimate marginal value productivities of capital resources for different capital levels and structures; and (3) to evaluate the implications of these findings for future adjustments on family-operated farms.

Multiple regression procedures were employed to estimate production functions from basic resource and income data for 392 family-operated farms in the Piedmont, Mountain, and Limestone Valley areas of Georgia. These basic data were obtained for farms financed by the Farmers Home Administration.

Production functions, of the Cobb-Douglas type, were first determined for all farms in each area, irrespective of type of farm, and then for each type of farm in the Piedmont Area. Because of the small number of farms by type in the Mountain and Limestone Valley Areas, only one over-all function was determined for these areas.

The results for these areas showed that variations in the amounts of four forms of capital--real estate, productive livestock, machinery and equipment, and cash operating expenses--were associated with 71 percent or more of the variation in gross cash farm incomes on all of the types of farm except cotton farms.

The results for all areas in the State were combined in order to isolate the broad nature of capital productivity and the changes in capital structure that are likely to be profitable.

Although the analyses showed that the specific changes in capital structure that would be profitable vary not only by type to farm but also for different capital levels for a given type of farm, the results led support of the following conclusions:

1. The marginal returns to real estate were low on all types of farms analyzed.
2. The marginal returns to investments in productive livestock were high on the dairy farms but relatively low on the cotton and general farms.
3. The marginal returns at usual levels of investment for machinery and equipment were relatively low for all types of farms analyzed.
4. The marginal returns at usual levels of investment for cash operating expenses were relatively low on all types of farms analyzed for the Piedmont, Mountain, and Limestone Valley areas.
5. The return to capital resources on the cotton and general types of farms in the Piedmont, Mountain, and Limestone Valley areas tended to be lower than for the dairy farms.
6. When considering all farms in each of the areas analyzed, little expansion above usual levels is indicated for real estate, very good opportunities for expansion of productive livestock at all capital levels, some expansion for machinery and equipment, and a slight expansion in cash operating expenses, but only if other capital resources are above usual levels.
7. On each type of farm analyzed, the gross returns per dollar of total capital investment decreased as the level of capital increased; thus, indicating decreasing returns to scale on the farms analyzed.

The effect of farm consolidation on agricultural adjustment was studied. The specific objectives were to: (1) Determine changes in resource use and combination brought about by the consolidation process; (2) analyze the effect of farm consolidation on agricultural output; (3) examine the effect of farm consolidation on the income expectations of operators whose farms were involved in consolidation; (4) analyze the economic and managerial characteristics of persons who leave farms and of operators who take over their land; (5) determine the characteristics of land and other physical resources involved in consolidation; (6) determine the income levels that would induce farm operators to accept nonfarm employment; and (7) examine farm operators' knowledge of government employment facilities and services.

Four counties in southwest Iowa--Fremont, Mills, Montgomery and Page--were selected as the survey area. The study includes the complete population of farm consolidations within the four-county survey area. All consolidations took place following the 1956 crop year and were in effect during the 1957 crop year.

A total of 214 farm units were involved in the consolidations analyzed. Ninety-nine farm units were absorbed by 115 other farm units. (Those farm units absorbed will be referred to as merged units; those 115 units which annexed them will be referred to as adding or base units.) After consolidation, the status of the 99 former operators was as follows; 23 had accepted nonfarm jobs outside of Iowa, 22 had shifted to nonfarm employment within Iowa, 10 had moved to farms of similar or smaller size, 19 had moved to larger farms, 20 had retired, and 5 were deceased. Fifty of the adding operators owned more than half of the base farm unit, while the other 65 adding operators rented more than half of the base farm unit.

The average number of acres per farm in the survey area in 1956 was 207.7 acres. The average size of the merged units in the same year was 150.5 acres per farm, while base or adding units averaged 252.5 acres. After consolidation, the combined units averaged 390.2 acres per farm.

Operators of base or adding units had used more labor, less custom work, and a higher percentage of hired labor per unit than had operators of the farms which were merged. Operator labor had supplied a larger percent.

Operators of the farms which were merged had employed an average of \$2,930 of machine resources in 1956. The machine resources on base units had an average value of \$7,344 at that time.

The average value of commercial fertilizer used in 1956 was \$208 per base unit and \$30 per merged unit. The value of commercial fertilizer used by base-unit operators on merged units increased to \$193 the first crop year following consolidation.

In 1956 the average value of total capital managed by operators of merged units was \$40,403, and that of adding operators was \$80,422. Following consolidation, the average total capital managed by adding operators increased to \$110,882.

It appears that the group of operators who remained in farming and who took over the units of those who left generally were the better managers and had more capital. From the same land area, that area operated previously plus that taken over from farmers who left, the adding operators would be expected to produce more crops than before consolidation.

Crop-share and crop-share-cash leases are the predominant lease types in east-central Illinois, accounting for 84 percent of the leases in the area. Livestock-share leases account for 13 percent, while cash, labor-share leases, and special arrangements make up the remaining 3 percent.

Prevailing rent shares on grain crops are almost exclusively one-half of the crop, except that on some of the sandy or timbered soils, the landlord receives only a two-fifths share. The basis for a one-half rent share is an approximate equality between the annual values of the fixed inputs or contributions of both parties--land and the improvements on it by the landlord, and labor, power, and machinery by the tenant.

Variable costs such as crop seeds, annual fertilizers, corn shelling, and insect control are shared in the same way as the crops are shared, namely 50-50 or 40-60.

Only 34 to 50 percent of the tenants shared in the cost of limestone, but 44 to 60 percent shared in the cost of rock phosphate, and 64 to 77 percent shared in the cost of potash applied as a single plant food.

Livestock-share leases, in which the landlord usually owns a half interest in the major livestock enterprises and receives one-half of the livestock returns, generally also provide for an equal sharing in such costs as legume and grass seeds, hay baling, silo filling, weed control chemicals, livestock expense, purchased feed, and feed grinding. Most of the livestock-share leases also provided for the landlord to share half of or to assume all of the expense of the purchase of such livestock equipment as self-feeders, waterers, and water heaters.

Many equipment, power, and fuel costs under livestock-share leases are shared in a variety of ways ranging from 100 percent by the landlord to 100 percent by the tenant. These items may be bargaining points or opportunities by which tenant and landlord can achieve a balance of total inputs in line with the way returns are shared.

Cash rent on tillable hay and pastureland is found only in crop-share-cash leases. The most common rates are \$5, \$6, \$8, and \$10 per acre with almost the same frequency for each rate. Cash rent on nontillable land also ranges from \$5 to \$10 per acre, but most rates are in the \$5 to \$8 range.

Cash rent on buildings, where such occurs, usually takes the form of charging the same acre rate for the area in the farmstead as is charged for tillable hay and pasture. Lump-sum rents on the farmstead or buildings range mostly from \$50 to \$250.

A little less than half of the farm lease agreements in east-central Illinois are in writing. Yet such important considerations as: (1) Notice to terminate the lease; (2) reimbursement guarantees; (3) rights of entry; and (4) management prerogatives must be in writing to be legally enforceable if they deviate from common law or customary arrangements.

Three out of every four landlords are farmers, retired farmers, or widows of farmers, or have had some farm experience. Of the landlords 85 percent live within 50 miles, or about an hour's drive, from their rental property. Only 1 out of 8 employs an agent or manager.

In general, both tenants and landlords are satisfied with their lease agreements. Only 84, or 1 out of every 8 tenants or landlords, made suggestions or changes in their leases. Changes desired by tenants include: (1) More sharing in variable costs by landlords; (2) written leases; and (3) more capital improvements by the landlord or written reimbursement guarantees for improvements made by the tenant. Landlords wanted higher cash rents to offset higher taxes.

Tables.

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

Dyksterhuis, E. J. WHEN ILLINOIS WAS RANGE COUNTRY, CITY DWELLERS HAD "CHRISTMAS BEEF", AND THE USDA WAS BORN--1862. J. Range Mangt. 15: 149-151. 1962.

A report on early history of agriculture in the United States and the early development of the United States Department of Agriculture.

SCS, USDA, Lincoln, Nebr.

Johnson, R. D. THE CONSERVATION RESERVE PROGRAM IN NEBRASKA. Nebr. Agr. Expt. Sta. SB 470, 31 pp. 1962.

The Conservation Reserve Program is accomplishing its objectives of reducing production of surplus crops, facilitating desirable adjustments in land use and conserving soil, water, forest, and wildlife resources in the areas studied.

The program is saving the Government money in the cost of the price-support program. Given the existing (1959) price supports, acreage controls and costs of the programs, it is cheaper to place land in the conservation reserve than to place the normal production of this land under price-support loans.

About 5 percent of the total Nebraska cropland acreage reported by the 1954 Census of Agriculture was in the conservation reserve in 1960. Legislative authority for writing new contracts expired in 1960. Some contracts are effective as long as 10 years.

Conservation reserve participants in the areas studied generally are people who are retired or semiretired; people who have off-farm employment; absentee landowners; heirs; investors; and farmers who own land that is not convenient to farm. The retired and semiretired is the largest group.

Most of the land placed in the conservation reserve in the study areas was below average in value and productivity. This represents the most profitable land use to owners and allows many of them to retire, semiretire, or seek other employment. Landowners, particularly those who place their "whole farm" in the program, are relieved of much of their management responsibilities, are assured a steady income, are able to renovate land without loss in income, and can devote more time to off-farm employment.

Most landowners who did not place land in the conservation reserve had a definite reason. About 85 percent said that they could make a greater return from farming than from participation. Six or seven percent were not well informed about the program and probably would have participated if they had better understood the program. Another 6 or 7 percent were not interested in maximizing farm income. The other 2 or 3 percent were not interested in taking part in any Government program.

A comparison of participants and nonparticipants shows that nonparticipants tended to have more productive farms; more intensive farming operations; more invested in land, machinery, and equipment; and higher percentage of land under cultivation. Nonparticipants generally are not anti-farm program or anti-Government. Most are in sympathy with the program but prefer not to participate because they can make more money by farming their land.

Since the least productive land usually is the first placed in the "reserve," the reduction in production during the early stages of the program is likely to be less than the reduction in cropland acreage.

The most significant change due to the program is in the use of land taken out of production. Permanent adjustments in land use will be made on much of the land placed in the conservation reserve. The long-run effects of the program will be more beef and dairy cattle, fewer crop acres, and a more stable agriculture.

Major impediments to participation in 1959 and 1960 were program uncertainty, lack of Government funds, and an announcement date that came too late in the fall to permit the winter-wheat farmer to participate.

The Conservation Reserve Program was not large enough to balance the supply of and demand for agricultural commodities at existing price levels. However, it has improved the situation by reducing production.

FED, ERS, USDA, and U. Nebr. Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

Shepherd, G. APPRAISAL OF THE FEDERAL FEED-GRAINS PROGRAMS. Iowa Agr. and Home Econ. Expt. Sta. Res. B. 501 (North Cent. Region. P. 128); 350-375. 1962.

The original objective of the storage programs in 1933 was to operate them as price-stabilization programs to stabilize the prices of farm products against year-to-year variations in production. After the first few years, the objective changed from merely stabilizing prices to "stabilizing them upward." Loan rates at certain percentages of parity prices were set above the average-weather-crop levels. This raised the level of prices as well as stabilized them against variations in supply. This high level of prices stimulated production, reduced consumption, and led to the accumulation of unsalable surpluses in storage.

On Feb. 28, 1961, the investment of the CCC in price-support programs amounted to \$9,193,721,000--made up of loans outstanding of \$2,141,507,000 (including \$946,376,813 of loans financed by lending agencies) and the cost of inventories, \$7,052,214,000.

The "realized cost" of "programs primarily for stabilization of farm prices and income" in fiscal 1960 was \$2,094,300,000. The total cost since the programs began in 1932 was \$19,847,400,000.

For corn, in fiscal 1958 about one-third of the cost went to the grain trade and transportation agencies to cover storage and handling charges.

The acreage-control programs of the 1930's had little effect on production. The programs after World War II had more effect, but since cross-compliance was not included, the effect was mostly to shift production from one crop to another.

The acreage restrictions and other features of the corn programs did not drive corn acreage and production out of the Corn Belt. From 1938-59, corn and oat acreage and production became more concentrated in the original 1938 commercial area. Cattle production just held its own, but hog production became more concentrated.

The storage programs had some supporting effect on farm prices and incomes. Most of the gain in farm income, however, was only temporary.

Over the past 10 years, average farm income per person in the United States remained practically constant. Most of the benefits of the farm programs were capitalized into land values rather than increasing farm incomes. The reason for this is that the low farm-income problem is the result not only of a continuous over-supply of farm products but also of a continuous over-supply of farmers. This over-supply results from the high birth rate on farms and the decline in the demand for farmers as farming becomes more mechanized. Only about one-sixth of the boys now growing up on farms will be able to find good jobs as farm operators.

Two kinds of programs are needed to solve the farm-income problem. One is a program to reduce the production of farm products. The other is a program to reduce the supply of farmers.

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

The January issue of "Soil Conservation" is devoted to Rural Area Development. The following is author, title, and address of author of each article presented:

1. Williams, D. A. RURAL AREAS DEVELOPMENT THROUGH SOIL AND WATER CONSERVATION. SCS, USDA, Washington, D.C. 20250
2. Fox, L. RURAL AREA DEVELOPMENT AT ITS BEST IN VIRGINIA. SCS, USDA, Upper Darby, Pa.
3. Turner, J. J. NATION'S FIRST SMALL-WATERSHED PROJECT SPURS ARIZONA AREA'S ECONOMY. SCS, USDA, Phoenix, Ariz.
4. McDonald, L. J. TEAMWORK SAVES A BRIDGE. SCS, USDA, Stillwater, Okla.
5. Stephens, H. V., and Graeber, F. BIG C STANDS FOR CONNALLY--CATTLE--AND COASTAL BERMUDAGRASS. SCS, USDA, Alice, Tex.
6. Alverson, K. PROJECT SOLVES WATER PROBLEMS FOR ILLINOIS CITY AND FARMERS. SCS, USDA, Milwaukee, Wis.
7. Baker, J. A. RAD--A NEW TOOL FOR RURAL COMMUNITY IMPROVEMENT. Agricultural Credit, USDA, Washington, D.C. 20250
8. Williams, H. ARKANSAS WATERSHED PROJECT BOOSTS 2 COUNTS AREA ECONOMY. SCS, USDA, Washington, D.C. 20250
9. Johnson, D. J. DISTRICT PROGRAM RESTORES GHOST LAND IN NEVADA GHOST TOWN AREA. SCS, USDA, Caliente, Nev.
10. Bornstein, J. ONLY A STONE'S THROW TO RURAL AREA IMPROVEMENT. SCS, USDA, Burlington, Vt.
11. Smith, G. S. COMMUNITY ACTION IN WEST VIRGINIA BRINGS MULTIPLE AREA BENEFITS. SCS, USDA, Upper Darby, Pa.
12. Fischer, O. L. GRASS IS KEY TO NEBRASKA RURAL AREA IMPROVEMENT. SCS, USDA, Loop City, Nebr.

The March Issue of Soil Conservation is devoted to Soil and Water Conservation as it applies to outdoor preservation. The following is author, title, and address of author for each article presented:

1. Williams, D. A. SOIL AND WATER CONSERVATION BASIC TO OUTDOOR PRESERVATION. SCS, USDA, Washington, D.C. 20250
2. Dahlstrand, N. P. PEOPLE MAKE LAKES "GROW OLD": CONSERVATION REJUVENATES THEM. SCS, USDA, Rhinelander, Wis.
3. Bedanbaugh, P. H. YOUNG CAMPERS LEARN ABOUT OUTDOOR CONSERVATION: SCS, USDA, Chesterfield, S.C.
4. Pawlowski, T. W. CONNECTICUT "DUCK MAN": BUCKS WILDLIFE SHUTOUT. SCS, USDA, Spencer, Iowa.
5. Winn, D. S. ROOM FOR OUTDOOR DEVELOPMENT DEMONSTRATED IN WIDE OPEN WEST. SCS, USDA, Logan, Utah.
6. Smith, G. S. NEW USES FOR OLD FARMS. SCS, USDA, Upper Darby, Pa.
7. GrandPre, L. MORE DUCKS--BIRDS--BEAUTY--: BARE PLAINS AREA TRANSFORMED. SCS, USDA, Dickerson, N. Dak.
8. Brown, C. B. LAKES AND PONDS BOON TO RECREATION AND WILDLIFE. SCS, USDA, Washington, D.C. 20250
9. Swenson, W. S. COLORADO TREE PLANTINGS MULTIPLY GAME AND SONG BIRDS. SCS, USDA, Colorado Springs, Colo.

10. Osburn, B. D. FISH AND FOWL AND FINE BLACK ANGUS. SCS, USDA, Teppenisk, Wash.
11. Bell, R. N. FISHING TOURISTS NEED BAIT. SCS, USDA, Las Vegas, N. Mex.
12. Wilbert, D. CONSERVATION WATERSHED MANAGEMENT RESTORES CREEK FLOW. SCS, USDA, Riverton, Wyo.
13. Hypes, W. M. FLOOD PREVENTION DAM BRINGS OUTDOORS TO THE KIDS. SCS, USDA, Staunton, Va.
14. Riergaard, K. E. MEET MR. BEAVER . . . ENGINEER AND CONSERVATIONIST. SCS, USDA, Moscow, Idaho.
15. Fox, L. VILLAGE FOREST CONSERVATION MEANS MORE WATER FOR POWER. SCS, USDA, Upper Darby, Pa.
16. Andrews, A. W. A FISH STORY--PLUS. SCS, USDA, Portland, Oreg.

Richards, W. E. CONSERVATION'S CHALLENGE TO STATE GOVERNMENTS. J. Soil and Water Conserv. 17: 8-10. 1962.

Few State governments have accepted primary responsibilities for dynamic programs of soil and water conservation within their borders. Too often State legislation has resulted in a multitude of agencies having overlapping responsibilities in the resource use and conservation field. The magnitude of the conservation job ahead demands that states implement a more comprehensive program of resource management.

Pres. Natl. Assoc. of Soil Conserv. Districts.

BIOLOGY

Fish

Bond, C. E. KEYS TO OREGON FRESHWATER FISHES. Oreg. Agr. Expt. Sta. Tech. B. 58, 42 pp. 1961.

These keys for the identification of Oregon fresh-water fishes were originally designed for use in ichthyology classes at Oregon State University and are an outgrowth of the Oregon Agricultural Experiment Station research project on Oregon fishes. Included in the key are the fishes known to occur in the fresh waters of the State and a few species which, although marine, occasionally move into fresh water at the head of tidewater. The grayling is included although all of the introduced populations of this species have probably disappeared without reproducing. Also included is the green sunfish, which is found in California near the Oregon border but has not yet been reported from Oregon.

The keys are arranged in two sections. The first is a key to families, and the second a key to species of each family.

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

Jordan, L. S., Day, B. E., and Hendrixson, R. T. CHEMICAL CONTROL OF FILAMENTOUS GREEN ALGAE. Hilgardia 32(9): 433-441. 1962.

Four series of experiments were conducted in replicated ponds to compare herbicides for control of filamentous green algae. The predominant alga present was Cladophora. The

herbicides tested were simazine, atrazine, atratone, prometone, acrolein, 06K, monuron, diuron, copper sulfate, dichlone, 2,4-D, and endothal. Results were evaluated by rating algal density on the day of treatment and one and two weeks after treatment. Analysis of variance and multiple range tests were employed to determine statistical significance of the data.

During the first trial, diuron, copper sulfate, and 06K significantly reduced algal density at the 1-week rating, but not at the 2-week rating. During the second trial, diuron, copper sulfate, 06K, and acrolein significantly reduced algal growth one week after treatment, but copper sulfate was the only chemical which gave significant control at the 2-week rating. In the third trial, diuron, and copper sulfate were significantly more effective than other chemicals after 1 week, and copper sulfate was significantly more effective after 2 weeks. Diuron significantly reduced algal density at the 1- and 2-week ratings in the fourth trial. The other herbicides did not significantly reduce algal density because they were either not herbicidal to Cladophora or the treatment rates were below the toxicity threshold. There was a general lack of residual control of algae. This may have resulted from relatively high percolation rates in the ponds. Acrolein was the only chemical which killed bluegill or goldfish.

U. Calif., Riverside, Calif.

Warner, D., and Fenderson, O. C. EFFECTS OF DDT SPRAYING FOR FOREST INSECTS ON MAINE TROUT STREAMS. *J. Wildlife Mangt.* 26: 86-93. 1962.

Populations of brook trout and other fishes were reduced considerably as a result of DDT spraying to control the spruce budworm in northern Maine. The most serious effect was the reduction in populations of young-of-the-year trout of the 1958 year class. A strong 1959 year class was responsible for rapid population recovery by 1960. Retention of DDT in body tissues of trout could have been a cause of delayed mortality. Significant growth increases were demonstrated for trout in some brooks during the year after spraying, and trout growth decreased in some brooks by the second fall after spraying. Caddisfly larvae were less abundant in trout stomachs after spraying. In brooks where there was an apparent scarcity of aquatic insects after spraying snails and terrestrial insects were utilized.

Maine Dept. Inland Fisheries and game, Ashland, Maine.

Upland and Wetland Wildlife

Gibbens, R. P., and Schultz, A. M. MANIPULATION OF SHRUB FORM AND BROWSE PRODUCTION IN GAME RANGE IMPROVEMENT. *Calif. Fish and Game.* 48: 49-63. 1962.

The effect of different periods of protection on the form and production of browse plants was studied on a winter range in Madera County, Calif. The study plots were established following manipulation, by mashing and burning, of an area of mature, mixed chaparral. Important sprouting browse plants were western mountain mahogany and flannel bush. Nonsprouting species, represented by large numbers of seedlings, were wedgeleaf ceanothus and chaparral whitethorn.

Two rotating exclosures were used to provide 1, 2, and 3 years of protection preceding browsing in one exclosure, and following like periods of browsing in the other exclosure.

Observations were carried out from 1955 to 1960. The authors concluded: (1) Sprouting species grew rapidly following manipulation, and a single year of protection allowed them

to escape the deer. Continuous use appeared to be the best treatment for sprouts because they were thus maintained in an available form for a longer period of time. (2) Wedgeleaf ceanolus seedlings protected for only 1 year and those browsed continuously made little growth in height after the second season. Seedlings protected for 2 and 3 years made rapid growth until exclosures were opened to browsing. After six growing seasons significant height differences still prevailed among treatments within exclosures. The only difference between protection periods preceding and following browsing occurred with 1 year of protection. Chaparral whitethorn seedlings were larger than wedgeleaf ceanothus in all treatments, and were able to make consistent gains in height under continuous browsing. Two years of protection appeared to be the best treatment for wedgeleaf ceanothus, and continuous browsing seemed best for chaparral whitethorn. (3) Utilization checks showed that 98, 94, and 98 percent, respectively, of the terminal buds on wedgeleaf ceanothus, chaparral whitethorn, and Mariposa manzanita seedlings were destroyed by browsing although reduction in leader length on individual plants ranged from 5 to 66 percent. (4) Plants of western mountain mahogany and flannel bush on a 22-year-old wildfire burn indicated that these species will develop a treelike, largely unavailable form even under long periods of heavy use. Wedgeleaf ceanothus plants on the wildfire burn were nearly all in an available, "basket" form. This form produces maximum amounts of browse, but not the seed which is a necessary insurance against recurring wildfires. And (5) browsing pressure greatly influences the form of plants, and through manipulation of this factor, desirable forms may be maintained. Plant density also affects the form of plants and may be manipulated by cultural and grazing practices. Cattle might be used to provide greater flexibility and control of browsing and grazing pressure.

Sch. Forestry, U. Calif., Berkeley, Calif.

Wieggers, H. L., and Agee, C. P. THE BIG QUESTION--CAN MORE PHEASANTS BE PRODUCED? Nebr. Agr. Expt. Sta. Q. 9(1): 20-21, 24. 1962.

The number of pheasant chicks produced on an area is generally a function of the quality and quantity of nesting cover. Since production is the key to the population level, improvement of nesting environment probably offers the greatest potential for increasing pheasant populations. The most productive nesting cover is that which offers maximum concealment and minimum disturbance. Following are practices of roadside management which will encourage pheasant production:

1. Mow only when absolutely necessary and never before July 1. Mowing after this time will disturb fewer nests but may drastically reduce brooding cover.
2. Eliminate burning. This prevents all early season nesting. Grass and weeds from the previous growing season are the only cover available at that time.
3. Increase vegetation by eliminating the use of roadsides as turn-rows or as pasture.
4. Limit spraying. Recognize that herbicides reduce cover, insecticides reduce foods and either may endanger the lives of pheasants and other wildlife.

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

Bateman, B. A. FOOD PLOTS FOR GAME. La. Agr. 5(2): 6-7, 14. 1962.

The abundant game supply found on farms prior to the second world war is a thing of the past. Clean cultivation, shifts to new crops, rapid crop rotation, and increasing acreage of improved pastures have greatly reduced the amount of game food and cover on farms. In the forest, thick stands of reproduction, the deadening of cull hardwoods, and the accumulation of a forest rough have eliminated many of the more important game food producers.

Certain cultural practices on the farm and in the forest can be used to improve the habitat for game. For some of our most important game species, good populations can be maintained by establishing food plots that will increase the available food supply.

Provided other requirements are ample, game food plots will benefit bobwhite quail, turkeys, rabbits, and squirrels. Food grown for doves and waterfowl is primarily for the purpose of increasing hunting success.

A highly productive food plot, one-tenth acre in size, should supply all the food needed by one covey of bobwhite. Plots of this size often become unproductive because of competition from surrounding trees and other vegetation. A minimum size of one-half acre is preferred.

Table 1.--Cultural Practices For Game Foods, Classified By Game Species

Food Plant	Planting		Pounds Seed per acre	Dates of Planting	Period Available
	Broad- cast	In Rows			
			Rabbit		
Oats	X		60	Sept. 1 - Oct. 15	Oct. 15* - May 1
Wheat	X		60	Sept. 1 - Oct. 15	Oct. 15* - May 1
Rye grass	X		20	Oct. 1 - Oct. 15	Nov. 15* - May 1
S-1 white clover	X		5	October	Feb. 1* thru summer
Hairy vetch	X		30	Sept. 1 - Oct. 1	Nov. 1* - May 1
Alyce clover	X		10	June 1 - Aug. 1	July 15* - until frost
			Bobwhite		
Improved Pelican soybean	X	X**	40	May 15 - June 15	Oct. 15* - March 1
Sesbania	X		20	April - May	Nov. 1 throughout year
Kobe or common lespedeza	X		15	March	Nov. 1 - March 1
Combine pea	X		30	June 1 - July 15	Oct. 1 - March 1
			Turkey		
Improved Pelican soybean				Same as for bobwhite	
Chufa		X	20	March - April	Nov. 1 - April 1
Oats or wheat				Same as for rabbit	
Brown-top millet	X		20	April 1 - Aug. 15	June 1* - March 1
S-1 white clover				Same as for rabbit	
			Squirrel		
Corn		X	15	March 1 - June 1	July 1* - March 1
			Dove		
Brown-top millet	X		20	July 1 - Aug. 15	Sept. 1* - March 1
			Ducks		
Brown-top millet				Same as for dove	
Corn				Same as for squirrel except used later	

* Date available from earliest planting date.

** Fair yields are obtained from broadcast plantings.

Browning, B. M. FOOD HABITS OF THE MOURNING DOVE IN CALIFORNIA. Calif. Fish & Game 48: 91-115. 1962.

A total of 1,016 mourning dove crops was collected over a 4-year period, 1956-59, from five study areas in California. These areas are representative of much of the floor of the Sacramento Valley, the fringe of rangeland surrounding the valley, the southern San Joaquin Valley, the foothill area of the central section of the inner coastal mountains, and the Imperial Valley.

Food habits determinations show that the seeds of 162 plant species, from 38 plant families, made up 99.9 percent of the total volume of food eaten. Seven items of animal food accounted for the remaining 0.1 percent. However, the seeds of only 22 plant species contributed as much as 10 percent of the volume of food eaten in any one month on any one area. These important or principal food items are turkey mullein, red maids, buckthorn weeds, wheat, barley, sorghum, safflower, California poppy, milk thistle, Mediterranean canary grass, flax, lambs quarters, water grass, rice, common sunflower, miner's lettuce, Napa thistle, common chickweed, prostrate pigweed, cup grass, watermelon, and corn.

Approximately two-thirds of the food is comprised of the seeds of annual weed species. Turkey mullein, red maids, and the buckthorn weeds are the most significant of the weed species; occurring in over 30 percent of the crops collected and contributing over 44 percent of the total volume of food. The other one-third is the cereal grains.

A study of the seasonal consumption of the preferred plants on the 5 areas reveals a shift from the seeds of early maturing weedy annuals in the spring to those maturing later in the summer, and then to cultivated plants in the fall and winter. Utilization correlates strongly with availability; however, the fact that 22 plant species contributed almost 92 percent of all of eaten and that the seeds of only 10 out of the 162 plant species identified occurred in as many as 10 percent of all of the crops collected, strongly suggests that the dove is a selective feeder.

The dove cannot be considered an important control of noxious weeds in California. Only two secondary noxious weeds, as classified by the State Department of Agriculture, appeared in as many as three percent of the 1,016 crops.

The use of animal food items was insignificant except for the small percentage of snail and bone fragments, which may provide a nutritional requirement particularly during the nesting season.

Approximately 13.6 percent of the food eaten by 307 nestling birds sampled from the study areas was "dove milk."

Results of food habits determinations made of crops collected during hunting seasons from regions not included among the study areas brought the total to 187 food items identified in 1,333 dove crops. No new principal items were added.

The mourning dove in California obtains most of its food from lands disturbed by man, either by cultivation, grazing, ditch and road bed maintenance, or similar practices which encourage weedy annuals and cultivated plants. As long as man continues these practices, food should not be a limiting factor for the mourning dove in California.

No address given.

Brenner, F. J. FOODS CONSUMED BY BEAVERS IN CRAWFORD COUNTY, PENNSYLVANIA. J. Wildlife Mangt. 26: 104-107. 1962.

Beaver colonies in Crawford County, Pa., utilized 34.2 percent of the quaking aspen and 18.2 percent of the red maple available. Beavers fed primarily on herbaceous material during the spring and summer months. An individual beaver's daily food consumption was 23.4

oz. of woody vegetation. Waste amounted to 1.03 oz. of food per beaver per day. According to data from this study, 1 acre of aspen would produce an average of 5,840 lb. of food and would support 10 beavers for 1 year provided a high degree of waste does not occur and herbaceous material is utilized during spring and summer months.

Pa. State U., University Park, Pa.

J. Forestry 60: 6-53. 1962.

The January issue of the Journal of Forestry is devoted to forest-wildlife relationships. The following is author, title, and address of the author of each article presented:

1. Janzen, D. H. WILDLIFE AND THE FOREST ENVIRONMENT. Bur. Sport Fisheries and Wildlife, U.S. Dept. Interior, Washington, D.C.
2. Heacox, E. F., and Lawrence, W. H. INDUSTRIAL FORESTRY AND WILDLIFE--THE NORTHWEST. Weyerhaeuser Co., Tacoma, Wash.
3. Kitchens, J. H., Jr. INDUSTRIAL FORESTRY AND WILDLIFE--THE SOUTH. T. L. James & Co. Inc., Ruston, La.
4. Hurd, E. S. INDUSTRIAL FORESTRY AND WILDLIFE--THE LAKE STATES. Consolidated Water and Paper Co., Rhinelander, Wis.
5. Bennett, A. L. INDUSTRIAL FORESTRY AND WILDLIFE--THE NORTHEAST. Armstrong Forest Co., Johnsonburg, Pa.
6. Swift, L. W. WILDLIFE AND FEDERAL LANDS--THE NATIONAL FORESTS. FS, USDA, Washington, D.C. 20250
7. Horning, W. H. WILDLIFE AND FEDERAL LANDS--THE BUREAU OF LAND MANAGEMENT IN WESTERN OREGON. (Deceased - Formerly U.S. Dept. Interior, Washington, D.C.)
8. Newman, C. C., and Carlson, S. T. WILDLIFE AND FEDERAL LANDS--THE PARK SERVICE. National Park Service, U.S. Dept. Interior., Washington, D.C.
9. Spencer, D. A. CHEMICAL CONTROLS AS A MANAGEMENT MEASURE. Wildlife Res. Cent., U.S. Dept. Interior, Denver, Colo.
10. Swank, W. G. MANIPULATION OF HUNTING REGULATIONS AS A MANAGEMENT MEASURE. Ariz. Fish and Game Dept., Phoenix, Ariz.
11. Brown, E. R., and Mandery, J. H. PLANTING AND FERTILIZATION AS A POSSIBLE MEANS OF CONTROLLING DISTRIBUTION OF BIG GAME ANIMALS. Wash. State Dept. Game., Longview, Wash.
12. Faulkner, C. E., and Dodge, W. E. CONTROL OF THE PORCUPINE IN NEW ENGLAND. Bur. Sport Fisheries and Wildlife, U.S. Dept. of Interior, Boston, Mass.
13. Royall, W. C., Jr., and Ferguson, E. R. CONTROLLING BIRD AND MAMMAL DAMAGE IN DIRECT SEEDING LOBLOLLY PINE IN EAST TEXAS. Bur. Sport Fisheries and Wildlife, U.S. Dept. Interior, Mesa, Ariz.
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18. Gill, T. THE NATIONAL RESEARCH COUNCIL'S COMMITTEE ON PEST CONTROL AND WILDLIFE RELATIONSHIPS. (No address given.)
19. Leedy, D. L. A LOOK AT THE FUTURE. Bur. Sport Fisheries and Wildlife, U.S. Dept. Interior, Washington, D.C. 20240

Rediske, J. H., and Lawrence, W. H. SELENIUM AS A WILDLIFE REPELLENT FOR DOUGLAS-FIR SEEDLINGS. *Forest Sci.* 8: 142-147. 1962.

This study consists of two parts: (1) Determination of the tolerance of Douglas-fir seedlings to selenium employed systematically and as a contact foliage repellent; and (2) repellent properties of selenium as a systemic and as a contact repellent for controlling clipping by rabbits. The author concluded:

1. The threshold tissue level of selenium as selenate ion is 0.5 p.p.m. for Douglas-fir seedlings before toxic levels are attained.
2. The absorption by Douglas-fir seedlings of selenate ion from a nutrient solution is proportional to the selenate ion concentration in the solution through the range of 0.01 to 100 p.p.m. selenium up to the lethal concentration of selenium in the plant tissue.
3. Sulfate ions will depress the absorption by Douglas-fir seedlings of selenate ions from nutrient solutions.
4. Douglas-fir seedlings treated with the maximum amount of systemic selenium as selenate ion (0.5 p.p.m.) did not reduce the consumption of these seedlings by laboratory rabbits. On the basis of coating studies, seedlings would have to contain at least 50-75 p.p.m. selenium to reduce rabbit consumption 50 percent.
5. Coating Douglas-fir seedlings by dipping in a non-phytotoxic selenium-Rhoplex mixture reduced consumption by rabbits to 42 percent when the coating contained 500 p.p.m. and to 9 percent when containing 5,000 p.p.m. selenate selenium.
6. In tests with snowshoe hares, a 0.5 percent (5,000 p.p.m.) selenate selenium coating was more effective than the standard 10 percent thiram coating in preventing damage.

Weyerhaeuser Co., Forestry Res. Cent., Centralia, Wash.

SUPPLEMENT

Problems Indirectly Affecting the Application of Soil and Water Conservation Practices

Beckham, C. M., and Morgan, L. W. THE EFFECT OF CERTAIN INSECTICIDES ON THE GROWTH, DEVELOPMENT, AND MATURITY OF THE COTTON PLANT. *Ga. Agr. Expt. Sta. Mimeo. Ser. N. S. 145*, 28 pp. 1962.

Field experiments were conducted in 1960 and 1961 at Experiment and Tifton, Ga., to determine any effects of certain insecticides on the growth, development, and maturity of the cotton plant. The insecticides used were toxaphene + DDT, methyl parathion + DDT, and toxaphene + DDT + methyl parathion. The same general procedure in conducting the tests was followed at the two locations. Data were obtained on plant height, number of squares, blooms and bolls, insect infestation, maturity and yield, and fiber analysis.

There were a few slight differences during the season in some of the counts and measurements between the insecticide treatments. However, no marked differences or consistent patterns were noted. Most of the differences occurred between the insecticide treatments and the untreated check. These differences were attributed mainly to lack of insect control in the check plots. All insecticide treatments gave good control of boll weevil and increased yields when the infestation was sufficiently high to justify control measures. There were no significant differences in final yield between insecticide treatments except in one instance, which was unexplainable.

There was some indication that the use of toxaphene + DDT resulted in the cotton maturing earlier than cotton treated with methyl parathion + DDT. However, this difference was not consistent and was not considered as pronounced or of any major importance. The insecticides had little effect on the fiber qualities.

It was concluded that any of the insecticide treatments tested may be used for control of insects at the recommended rates and will cause no adverse effect on the cotton plant.

Ga. Expt. Sta., Experiment, Ga.

Bishop, R. F., and Chisholm, D. ARSENIC ACCUMULATION IN ANNAPOLIS VALLEY ORCHARD SOILS. *Canad. J. Soil Sci.* 42: 77-80. 1962.

Use of arsenicals for insect control has resulted in an appreciable accumulation of arsenic in the surface soil of Annapolis Valley apple orchards. Levels of total arsenic in 25 representative orchards ranged from 9.8 to 124.4 p.p.m., whereas the content of comparable samples taken in non-orchard land ranged from a trace to 7.9 p.p.m. In some orchards the arsenic accumulation is of sufficient magnitude to be detrimental to the growth of such arsenic sensitive crops as peas and beans.

Canada Dept. Agr., Kentville, Nova Scotia, Canada.

Stessel, G. J. NEMATODES OF WOODY PLANTS IN RHODE ISLAND. *R. I. Agr. Expt. Sta. B.* 360, 19 pp. 1961.

The survey indicates that plant-parasitic nematodes may be limiting the optimum production of first quality nursery stock. They may reduce the growth rate of some plants when present in sufficient numbers. They are widespread in the state and in some areas occur in large numbers. Large populations of plant-parasitic types have been observed in association with leaf yellowing, stunting, abnormal root systems, and slow growth of nursery stock. Most of the plant decline symptoms associated with an abundance of nematodes did not appear to be due to pH or nutrient deficiencies, improper culture, or other primary pathogens.

The most serious nematode pests on nursery stock in Rhode Island appear to be members of the genera Rotylenchus, Pratylenchus, Tylenchorhynchus, and Paratylenchus. Each genus was found in about 40 percent of all samples studied. Although these genera are distributed widely in the State, Rotylenchus and Paratylenchus were found most frequently and in largest concentrations in the nurseries of Newport County. This county has for many years produced the majority of nursery plants in the state.

Continuous culture of ornamental plants on the same ground may provide favorable conditions for the buildup of plant-parasitic nematodes. Many nurseries in the state use buckwheat, *Fagopyrum esculentum* Gaertn., as a cover crop between plantings of woody plants. The role played by buckwheat, if any, in effecting the population of plant-parasitic nematodes has not been studied.

Nearly all soil samples used were obtained from root zones of plants growing in clean culture. Where plant-parasitic types of nematodes were recovered, it is likely that the roots of associated plants furnished the food source.

Genera found most frequently were Rotylenchus, Pratylenchus, Tylenchorhynchus, Paratylenchus, Aphelenoides, Aphelenchus, and Dorylaimus. Other genera occurring less frequently, but suspected of parasitizing nursery plants, were Ditylenchus, Tylenchus, Tetylenchus, Xiphinema, and Trichodorus. Eleven other genera of stylet-bearing nematodes were found in the samples. Rotylenchus robustus, and species of Pratylenchus, Tylenchorhynchus, and Paratylenchus, were frequently associated with poor growth of some species and may be serious nematode pests in nurseries.

In a few instances only one genus of plant-parasitic nematodes was present in the rhizospheres of a given host. Usually several genera were found, and occasionally five or six.

Certain genera whose parasitism has not been proven, but which probably feed on plant roots were recorded. The role of known and suspected plant-parasitic nematodes as vectors of other diseases or as predisposing agents may be important and should receive increased attention.

From observations made concerning types, populations, and distribution of forms found, it appears that nematodes may reduce potential growth of woody plants in nurseries from 10 to 30 percent.

Agr. Expt. Sta., U. R. I., Kingston, R.I.

Radioactive Fallout

Graham, E. R., Clark, M. W., and Renner, V. E. REMOVAL OF RADIOACTIVE FISSION PRODUCTS FROM SURFACE WATER SUPPLIES. Mo. Agr. Expt. Sta. Res. B. 787, 14 pp. 1961.

Human and animal food can be sealed in cans or dried and kept in airtight containers. Livestock can be kept under a roof of tight covering. But providing a supply of radioactive-free water for the family and livestock for a fallout period may be more difficult, particularly where the only adequate supplies of water are from surface streams, lakes, ponds, and cisterns. The problems occurring with underground water, deep wells, or properly protected, bacterially-safe springs are simple, compared with the problems associated with surface water supplies.

In many parts of Missouri, adequate water cannot be obtained from deep wells. People in these areas depend upon streams, lakes, and ponds for water for themselves and their livestock. The contamination of such sources of water with radioactive fallout could not be avoided. In large areas of the country, some means of removing radioactive contaminants from surface water supplies would be needed.

Results of the study show that a properly constructed, 30-foot sand filter will remove such fallout as Strontium-89, Strontium-90, and other cations.

There was no channeling of the sand to let through the most minute quantity of water without proper filtering. Shortlived radioactive isotopes and the counting equipment could be used to detect any leak that would come in any open channel, and would be useful tools to test the effectiveness of a filter to be used for filtration of bacteria as well as radio-nuclides.

The sand-clay filter was not effective against water-held Iodine-131.

The activated carbon filter was effective in removing the Iodine-131 from sediment-free water. A comparatively small unit handling well-filtered and clarified water would be large

enough for emergency use for any farm family and their livestock. The two filters combined would be a practical, economical, and very effective means of removing radioactive fallout from surface water for individual farm and ranch water systems.

The activated carbon filter should be installed into the surface water system, including cisterns so that if it isn't needed for regular use it will be immediately available for any emergency. Rural America can then be confident of the safety of its vital surface water supply against radioactive fallout in times of emergency.

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

Popenoe, H., and Eno, C. F. THE EFFECT OF GAMMA RADIATION ON THE MICROBIAL POPULATION OF THE SOIL. *Soil Sci. Soc. Amer. Proc.* 26: 164-167. 1962.

Arredondo fs was exposed to gamma radiation from a cobalt-60 source at doses of 1, 4, 16, 32, 64, 256, 512, 1024, and 2048 kiloroentgens (kr.).

Percentage survival of fungi and bacteria decreased with each increase in radiation dose to <4% at 1024 kr. Algae were not as drastically reduced as bacteria and fungi: some survived at 2048 kr. and greatest reduction occurred above 64 kr. A few nematodes remained in the soil 2 days after irradiation with 1024 kr., but none were recoverable from doses >256 kr. after 14 and 28 days.

Carbon dioxide evolution was initially reduced by irradiation of the soil. The reduction was generally inversely related to radiation dose except for the 64-kr. treatment. Later, all irradiated soils, except those which received doses < 256 kr., essentially equaled or exceeded the control in CO₂ production. Soils treated with 512 and 1024 kr. produced only very small amounts of CO₂ throughout the 23-day period; soil receiving 256 kr. later recovered completely. The soil irradiated by 64 kr. attained the highest daily production rate. Similar relationships for CO₂ evolution occurred in an earlier study except for some shifts in time and magnitude.

Nitrate production in a 14-day period was progressively reduced by increasing doses of radiation. Recovery from 32 kr. or less occurred in 28 days; these soils produced at least 87% as much nitrate as the control during this period of time. Average production in 28 days at 64, 256, and 1024 kr. was 55, 7, and 3% of the control, respectively.

The production of sulfate from elemental sulfur was also affected by radiation in much the same manner as nitrate production, though radiation damage at doses less than 64 kr. were not readily apparent until the third week. Two populations, one more sensitive to radiation than the other, were probably involved in this reaction.

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

Evans, E. J., and Dekker, A. J. THE INFLUENCE OF SOIL PROPERTIES AND SOIL AMENDMENTS ON THE Sr-90 CONTENT OF OATS GROWN IN SELECTED CANADIAN SOILS. *Canad. J. Soil Sci.* 42: 23-30. 1962.

Oats were grown in the greenhouse in six soils varying widely in pH, organic matter content, C.E.C., (cation-exchange capacity) percent saturation, and exchangeable calcium. Sr-90 was added to all soils and its concentration in oats, as influenced by soil properties or soil treatment, was determined.

The Sr-90 content of oats grown in six soils, which included both saturated and unsaturated soils, was highly significantly correlated with the reciprocal of the exchangeable Ca contents of the soils with correlation coefficients of 0.99 for both the straw and the grain. The correlation coefficients between Sr-90 concentration and the reciprocal of the

C.E.C. for oat straw and oat grain were 0.65 and 0.55, respectively, which were not significant at the 5-percent level.

When calcium salts were added to three acid soils the larger applications of CaCl_2 and CaSO_4 lowered the soil pH, whereas CaCO_3 raised the soil pH, but all three salts caused a decrease in Sr-90 concentration in oats. A greater decrease in Sr-90 content was effected by the addition of Ca salts to soil with low exchangeable Ca and low percentage Ca saturation than to soil with high percentage Ca saturation. It was concluded that the exchangeable Ca content, not C.E.C. or pH, was the dominant soil property upon which the Sr-90 concentration in plants depended.

Canada Dept. Agr., Ottawa, Ontario, Canada.

Wallace, A. T. FALLOUT...AND FARMING. Fla. Res. Rpt. 7(1): 6-8. 1962.

Table 1 shows how long a farmer can stay out of his shelter after 2 weeks and up to 3 months in light or heavy fallout.

If the fallout is relatively low--no greater intensity than 1,000 roentgens per hour--a farmer may be able to stay out for 10 minutes on the third day after the attack and by the end of 2 weeks he can spend up to 2 hours per day outside of a shelter. On the other hand, if the fallout intensity is high--as much as 4,000 roentgens per hour--then he can only spend as much as 30 minutes out of the shelter after 2 weeks. These exposure periods are based on the assumption that the human body can tolerate up to 2 or 3 roentgens daily for several months. When one leaves the shelter he should wear a dust mask to avoid inhaling any radioactive dust particles.

TABLE 1.

Time after radiation measurement (Hrs.) (Da.)		Decay rate	Radiation intensity(1)	Hrs. a Day(3) Exposure	Radiation intensity(1)	Hrs. a Day(3) Exposure
1			4000 r/(2) hr.	---	1000 r/hr.	---
7	7 1/3	1/10	400 r/hr.	---	100 r/hr.	---
7x7	49 2	1/100	40 r/hr.	---	10 r/hr.	2
7x7x7	343 14	1/1000	4 r/hr.	1/2	1 r/hr.	2
7x7x7x7	2401 100	1/10,000	.4 r/hr.	5	.1 r/hr.	20

(1) No one knows the amount of radioactivity that will be present after an attack. Two examples are used, 4000 r/hr. and 1000 r/hr. (2) r stands for roentgen--A standard measure of radiation exposure. (3) To avoid exposures greater than 2 roentgens per day.

"What is the shielding ability of various building materials?" Table 2 gives the "one-tenth value layer" of several. The "one-tenth value layer" is the thickness necessary to reduce the penetration of the average fallout radiation to one-tenth of that entering the material. That is, a reduction of 90 percent. (Table 2)

TABLE 2.

Dense concrete	Tamped earth	Water	Aluminum	Steel	Lead
5.7"	11"	14"	4.6"	2"	1.2"

A shelter covered with 33 inches of tamped earth reduces the radioactivity inside the shelter of only a thousandth of that on the outside. Seventeen inches of concrete will give the same protection.

Fallout can be just as dangerous to livestock as to human beings. The penetrating rays from the radioactive fallout can damage the animal, or if the animal eats feed which is contaminated with radioactive fallout, then the rays from contaminated feed can damage the livestock internally. There are three main types of radiation from fallout particles. Two types, alpha and beta, have very low penetrating ability. The other, called gamma rays, has high penetrating ability. If the fallout particles are allowed to fall on the skin of livestock, then they will be damaged from both the low and high penetrating rays. If they are put under a shelter which keeps the dust particles off of them, then the livestock will be subject to only the high penetrating rays of the gamma rays.

Radiation will not harm feed or water provided they are not contaminated with the actual fallout dust particles. Water can be stored and will remain safe if kept covered. Water from a freely running spring or a covered well will probably be safe to use.

Feed that has been covered with tarpaulins should be safe, provided the dust from the exposed side of the tarpaulin is not allowed to fall on the feed in the handling operations. Stacked feed will be contaminated only on the outer portion.

In the absence of any other feed, contaminated feed can be fed to livestock if the meat and milk products from the animals are not used. Unless the livestock are dying of starvation, it will be best to postpone giving them contaminated feed for a few days. Because radioactive particles naturally decay, the contaminated feed will be less dangerous after a few days than it is when it is highly radioactive. Less harm will befall livestock by letting them go hungry for a few days than by giving them highly contaminated feed.

All contaminated feed should be held--not destroyed. Over a period of time the feed will lose its radioactivity and will be useful again at a time when there is great shortage of other feed.

In the event of fallout the soil will be contaminated. The most dangerous radioactive isotopes following an attack will be Iodine-131, Cesium-137, Strontium-89, and Strontium-90. Iodine-131, with a half life of 8 days, will be mostly decomposed and rendered harmless after 60 to 70 days. Cesium-137, with a half-life of 27 years, and Strontium-90 which has a half life of 28 years will remain in the soil for quite a long time. Strontium-89 has a half-life of 53 days and will be around for nearly 2 years.

City people, suburbanites, and farmers will need gardens to feed themselves in the months after a nuclear attack. Each family should store seed in a fallout shelter or bury it in sealed cans.

The best way to have a clean plot of ground is to protect it from fallout with a dustproof covering. For a small garden, cover an area with a tarpaulin, polyethylene, or even a heavy straw mulch. The next best procedure will be to grow a thick covercrop or sod on it, the area should be "scraped" so that the sod and 3 to 4 inches of soil are removed. Caution should be used in piling the scraped-off soil in unused areas that drain away from the cleared land. The addition of lime to strongly acid or moderately acid soils helps. Leaching soils with large amounts of water, or deeply plowing the surface layer of the soil, also helps. Such crops as peas, beans, potatoes, cowpeas, sweet potatoes, and corn, whose surface layers can be discarded, can be grown. When crops are grown on non-radioactive soil, dust particles from the surrounding radioactive soil can be cleaned off by repeated washings and then shelling--in the case of peas, etc., or repeated parings--in the case of potatoes. Hands and utensils should be washed thoroughly before and after each paring.

"Nuclear survival" gardens will need fertilizer, especially potash and nitrogen. This can be stored at the same time the seed is stored. Since the fertilizer will be in closed containers, surface dust can be removed from the containers at the time it is used. If seeds are

sealed in an oxygen free atmosphere--in a vacuum or in nitrogen gas--the germination can be protected.

In areas of light fallout, pasture forage could be usable after a few days. If the fallout is heavy, cattle should not be allowed to graze the forage.

"What are the hazards of eating meats from animals which have survived a nuclear attack?" After the first 60 days, the principle hazards of radioactive contamination in meat will be Strontium-90 and Cesium-137. Cesium-137 is found in muscle tissue, but this isotope will not be retained long in the body of the animals. It continually enters and leaves the system. Strontium-90 is deposited in the bones. Meat from animals that have been eating feed from low-level contaminated land can be used, provided all of the organs are discarded and the flesh is deboned.

It is the total radiation exposure from which you need to be protected. If your external exposure is low, then you can risk eating slightly contaminated food; if your exposure is high, then you dare not eat anything except non-contaminated food, to reduce your internal exposure.

Seafood and fish should be checked for radioactivity before it is eaten.

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

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