

University of Minnesota

AGRICULTURAL EXPERIMENT STATION
THIRTY-FIFTH ANNUAL REPORT

JULY 1, 1926 TO JUNE 30, 1927



UNIVERSITY FARM, ST. PAUL
FEBRUARY 1928

LETTERS OF TRANSMITTAL

MINNEAPOLIS, MINN.,
July 1, 1927

*To His Excellency, Theodore Christianson,
Governor of Minnesota.*

SIR: I have the honor to transmit to you herewith the annual report of the Agricultural Experiment Station of the University of Minnesota for the fiscal year ending June 30, 1927.

Respectfully,

FRED B. SNYDER,
President of the Board of Regents

UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.,
July 1, 1927

*The Hon. Fred B. Snyder,
President of the Board of Regents, University of Minnesota.*

SIR: I have the honor to transmit herewith the report of the Director of the Agricultural Experiment Station of the University of Minnesota for the fiscal year ending June 30, 1927.

Respectfully,

LOTUS D. COFFMAN,
President of the University of Minnesota

UNIVERSITY FARM, ST. PAUL, MINN.,
July 1, 1927

*Lotus D. Coffman,
President of the University of Minnesota.*

SIR: I have the honor to hand you herewith the annual report of the Agricultural Experiment Station for the fiscal year ending June 30, 1927.

Respectfully,

W. C. COFFEY, *Director*

THIRTY-FIFTH ANNUAL REPORT, MINNESOTA AGRICULTURAL EXPERIMENT STATION

JULY 1, 1926 to JUNE 30, 1927

FOREWORD

This report contains outlines of projects in home economics and rural sociology. In these respects it is different from any other report hitherto prepared by the Minnesota Experiment Station. Both are important fields in which the technic of research is in large part yet to be developed. It is to be hoped that there may be a large degree of co-operation between the workers in these newer fields and those who are in more or less related fields that have been subjected to much longer periods of research. Then, too, it is to be hoped that the workers in home economics and rural sociology will early gain the conviction that research is best promoted by organizing the attack on problems without much regard to divisional lines within the Experiment Station. In other words, it will be fortunate if they early come to learn that the project rather than the subject matter division should be the starting point in organizing research. To this matter, all divisions, both new and old, in the Experiment Station need to give increasing attention. Agriculture is placing more and more reliance in research. The responsibility placed on the Experiment Station is such that the full co-operation of all of its divisions will be necessary if it is to fulfil its obligations.

CHANGES IN STAFF

Resignations

Northwest Experiment Station

C. G. Selvig, superintendent, resigned, having been elected as a Member of Congress from the Ninth District.

Entomology and Economic Zoology

S. A. Graham, assistant entomologist, resigned to accept a position as associate professor of forest entomology at the University of Michigan.

Farm Management, Agronomy, and Plant Genetics

F. W. McGinnis, assistant agronomist, resigned to enter private business.

F. H. Steinmetz, assistant agronomist, resigned, and is now botanist at the University of Maine.

Horticulture

B. I. Burrell, assistant horticulturist, resigned to accept a position with R. L. Gould and Company, St. Paul.

Photographic Laboratory

T. J. Horton, photographer, resigned to enter private business.

Plant Pathology and Botany

R. M. Nelson, assistant pathologist, resigned to accept a position as assistant pathologist, Appalachian Forest Experiment Station, Asheville, North Carolina.

Veterinary Medicine

Margaret Sichler, technician, resigned to accept a position in Chicago.

Appointments**Northwest Experiment Station**

A. A. Dowell, superintendent, was appointed to fill the vacancy caused by the resignation of C. G. Selvig.

Agricultural Biochemistry

Roberto Oliver was appointed special analyst.

Agricultural Economics

Warren C. Waite and E. J. Working were appointed associate economists; Dorothea Kittredge was appointed assistant economist; T. G. Stitts and Lawrence Myers were appointed research assistants.

Agricultural Engineering

P. C. Manson was appointed assistant in drainage; Florence Kelley was appointed assistant.

Dairy Husbandry

George Pulkrabek was appointed assistant.

Entomology and Economic Zoology

W. C. Cook, associate entomologist, was appointed for the year; Nordahl Peterson, assistant, was appointed to fill the vacancy caused by the resignation of C. B. Phillip; G. A. Mail was appointed assistant and F. M. Wadley research assistant.

Farm Management, Agronomy, and Plant Genetics

D. W. Sprague, assistant agronomist, was appointed to fill the vacancy caused by the resignation of F. H. Steinmetz.

Horticulture

J. H. Bergen, assistant horticulturist, was appointed for the year.

Plant Pathology and Botany

C. V. Kightlinger, assistant plant pathologist, was appointed for one year.

Veterinary Medicine

Edith Cavilla was appointed to fill the vacancy caused by the resignation of Margaret Sichler.

Leave of Absence**Agricultural Economics**

J. D. Black was granted leave for four months to lecture at Harvard University.

Farm Management, Agronomy, and Plant Genetics

G. A. Pond, associate agriculturist, was granted leave for eight months to complete degree work at Cornell University.

Entomology and Economic Zoology

R. N. Chapman was granted leave for the year to study in Europe on a Guggenheim Fellowship.

Horticulture

W. H. Alderman was granted leave for the year to study western and southern horticulture.

Plant Pathology and Botany

A. W. Henry was granted leave for one year, beginning October 1, 1926, to study in Europe on International Education Board Fellowship.

PUBLICATIONS

The following publications have been issued during the fiscal year, 1926-27:

Bulletins**Agricultural Experiment Station Series**

No. 229. A Mineral Deficiency in the Rations of Cattle, by C. H. Eckles and R. B. Becker, Division of Dairy Husbandry; and L. S. Palmer, Division of Agricultural Biochemistry. 49 pages, edition of 5000.

No. 230. New Fruits Produced at the Minnesota Fruit Breeding Farm, by W. H. Alderman. 48 pages, 15,000.

No. 231. Judging Creamery Efficiency, by B. A. Holt, Division of Agricultural Economics; and W. B. Combs, Division of Dairy Husbandry. 24 pages, 7000.

No. 232. Selection and Use of Bacon, by Alice M. Child, Division of Home Economics. 20 pages, 10,000.

No. 233. Co-operative Egg and Poultry Assembling Units in Minnesota, by H. B. Price and G. W. Sprague, Division of Agricultural Economics. 40 pages, 8000.

No. 234. How Minnesota Farm Families Spend Their Income, by C. C. Zimmerman and J. D. Black, Division of Agricultural Economics. 50 pages, 7000.

Reprint—

No. 218. Feeding the Dairy Herd, by C. H. Eckles and O. G. Schaefer, Division of Dairy Husbandry. 48 pages, 10,000.

Technical Series

No. 36. Flax Rust and Its Control, by A. W. Henry, Division of Plant Pathology and Botany. 24 pages, 1500.

No. 37. Physiologic Specialization and Parasitism of *Helminthosporium sativum*, by J. J. Christensen, Division of Plant Pathology and Botany. 116 pages, 1500.

No. 38. Winter Hardiness in Alfalfa Varieties, by F. H. Steinmetz, Division of Farm Management, Agronomy, and Plant Genetics. 36 pages, 2000.

No. 39. Tables for Determining Contents of Standing Timber in Minnesota, Michigan, and Wisconsin, by members of staff of Cloquet Forest Experiment Station and of Lake States Forest Experiment Station, and of Division of Forestry. 100 pages, 2500.

No. 40. Studies of Self-Fertilization in Rye, by H. E. Brewbaker, Division of Farm Management, Agronomy, and Plant Genetics. 44 pages, 2000.

No. 41. Low Temperature and Moisture as Factors in the Ecology of the Rice Weevil, *Sitophilus oryza* L., and the Granary Weevil, *Sitophilus granarius* L., by William Robinson, Division of Entomology and Economic Zoology. 44 pages, 1500.

No. 42. Determination of Hardiness in Apple Varieties and Relation of Some Factors to Cold Resistance, by A. C. Hildreth, Division of Horticulture. 40 pages, 2000.

No. 43. A Study of the Value of the Living Vaccine in the Control of Bovine Infectious Abortion (Reprint from *Cornell Veterinarian*), by R. E. Lubbehusen, Division of Veterinary Medicine. 20 pages, 1200.

No. 44. A Study of Dairy Farm Organization in Southeastern Minnesota, by G. A. Pond, Division of Farm Management, Agronomy, and Plant Genetics. 112 pages, 2000.

No. 45. The Marketing Attitudes of Minnesota Farmers, by C. C. Zimmerman and J. D. Black, Division of Agricultural Economics. 56 pages, 2000.

No. 46. Inoculation of Alfalfa on Lime-Deficient Sandy Soils, by F. J. Alway and G. H. Nesom, Division of Soils. 64 pages, 1500.

Annual Report Series

Thirty-Fourth Annual Report of the Agricultural Experiment Station. 56 pages, 2300.

Report of Northwest Experiment Station, Crookston, by C. G. Selvig, Superintendent. 64 pages, 2000.

Report of West Central Experiment Station, Morris, by P. E. Miller, Superintendent. 44 pages, 2000.

Publications of Agricultural Extension Service Special Series

No. 108. Raising Dairy Calves on Skimmilk, by T. W. Gullickson, Division of Dairy Husbandry. 8 pages, 10,000.

No. 109. Flax Rust a Preventable Disease, by A. W. Henry, Division of Plant Pathology and Botany. 8 pages, 5000.

No. 110. The Use of Explosives on the Farm, by A. J. Schwantes, Division of Agricultural Engineering. 20 pages, 9000.

No. 111. Farm Building Plans (Superseding Bulletin No. 60), by H. B. White, and M. G. Jacobson, Division of Agricultural Engineering. 8 pages, 10,000.

No. 112. Profitable Dairying, by W. L. Cavert, Division of Agricultural Extension; and G. A. Pond, Division of Farm Management, Agronomy, and Plant Genetics. 16 pages, 10,000.

Reprints—

No. 83. Care and Feeding of Chicks, by A. C. Smith, Division of Poultry Husbandry. 12 pages, 10,000.

No. 92. Judging Dairy Cattle, by W. E. Petersen, Division of Dairy Husbandry. 36 pages, 10,000.

No. 72. Modern Strawberry Growing, by F. P. Daniels, Division of Horticulture. 20 pages, 10,000.

No. 100. Trench Silos, by Andrew Boss, Division of Farm Management, Agronomy, and Plant Genetics; and H. B. White and A. J. Schwantes, Division of Agricultural Engineering. 8 pages, 5000.

No. 94. Mineral Supplements for Farm Animals, by L. S. Palmer, Division of Agricultural Biochemistry. 8 pages, 10,000.

Circular Series

No. 23. Demonstration Windbreaks in Minnesota, by P. O. Anderson, Division of Agricultural Extension. 4 pages, 3000.

No. 24. Prevent Smuts of Small Grains, by E. C. Stakman and H. A. Rodenhiser, Division of Plant Pathology and Botany. 4 pages, 20 000

Reprints—

No. 2. Sources of Information for the Dairy Farmer, by C. H. Eckles and W. E. Petersen, Division of Dairy Husbandry. 4 pages, 5000.

No. 20. Feeding Poultry for Profit, by A. C. Smith, Division of Poultry Husbandry. 4 pages, 10,000.

Miscellaneous

Catalog of Projects of Agricultural Extension Specialists. 18 pages, 300.

Report of First Annual Carload Baby Beef Contest, by A. A. Dowell. 32 pages, 5000.

Extension Folders

No. 14. Pocket Gopher, 10,000.

No. 15. Seed Corn, 20,000.

No. 16. Home Storage of Potatoes, 4 pages, 10,000.

No. 17. Wintering of Bees, 4 pages, 5000.

No. 18. Improved Varieties of Farm Crops for Minnesota, 12 pages, 5000.

Back to the Farm, a Rural Drama, 40 pages, 3000.

Club Songs, 16 pages, 20,000.

Garment Making Project, First Year, 12 pages, 8000.

Garment Making Project, Second Year, 12 pages, 5000.

Bread Making Project, 12 pages, 10,000.

The 4-H Dairy Club Calf, 8 pages, 8000.

The 4-H Club Pig, 8 pages, 5000.

Extension Service News, 2000 monthly.

News Letter, 1100 weekly.

Abstracts of Journal Series Papers

As scientific papers prepared by members of the station staff for publication in scientific journals are in a measure reports of progress on specific research problems, brief abstracts are properly a part of the experiment station report. The following were published during the year.

No. 525. "Potato Varieties," by F. A. Krantz. In *Minnesota Horticulturist*, Vol. 55, pp. 228-230 (1927).

A popular discourse on the history and origin of potato varieties with a discussion of the varieties adapted to Minnesota.

No. 534. "Chromosome Number in Species of *Hordeum*," by Fred Griffiee. In *Research Publication of the University of Minnesota. Studies in the Biological Sciences* No. 6, pp. 320-325 (1927).

Ten species of *Hordeum* were placed in three groups having respectively 14, 28, and 42 somatic chromosomes. These three groups were designated as *Vulgare*,

Jubatum, and *Nodosum*. The pollen size of *H. nodosum*, the only member of the 42-chromosome group, was much greater than that of *H. vulgare*, and the pollen size of *H. vulgare* was similar to that of *H. jubatum*. All important cultivated varieties belong to the group with the lowest chromosome number. This indicates that chromosome numbers are not so important as their inherent genetic composition.

No. 565. "Effect of Mineral Deficiency on the Yield and Composition of Cow's Milk," by R. B. Becker, C. H. Eckles, and L. S. Palmer. In *Journal of Dairy Science*, Vol. 9 (2), pp. 169-175 (1927).

A study was made of the mineral content of milk from cows suffering from long continued phosphorus deficiency in the ration. These cows showed severe physical symptoms, including stiffness of joints, emaciation, and extreme condition of pica. The mineral composition of the milk did not vary appreciably from that of milk from the University herd on typical rations. The yield, however, was very low and was considerably increased by the addition of phosphorus-carrying supplements to the ration.

No. 569. "Studies in the Ecology of Sand Dune Insects," by R. N. Chapman, C. E. Mickel, J. R. Parker, G. E. Miller, and E. G. Kelly. In *Ecology*, Vol. 7 (4), pp. 416-426 (1926).

This paper is the result of an ecological study of a sand dune in Anoka County, Minnesota. The study was undertaken with the object of measuring the physical conditions and their distribution in space and time, their effects on the insects, and the distribution of the insect activity as correlated with environmental conditions. The study included both field observations and laboratory experiments. It was found that the daily fluctuations of temperature and humidity were comparable to those described by other authors for the Egyptian deserts. The highest temperature record actually obtained on the surface of the sand was 56 degrees C., but there were indications that on one day, at least, the temperature might have been as high as 74 degrees C. The possible annual range of temperature for this environment is found to be from -40 to -70 degrees C. The evaporation averaged 394 cc. per week during the summer but on several occasions it was as great as 5 cc. per hour during the middle of the day. It was found that in the normal course of the day all insects left the surface of the sand when its temperature neared 50 degrees C. Some insects avoided this high temperature by climbing grasses, others entered their burrows in the sand, while others flew about some distance above the sand, making hurried landings to enter their burrows. Female mutillids were the only insects which withstood the temperature of 50 degrees C. All others died when confined to the surface of the sand at this temperature. In a laboratory experiment in which the effect of temperature on the various insects was tested, it was found that the sand dune insects were not all alike in their temperature adjustments. In general, the insects which live on the dunes during the heat of the day have a maximum and minimum effective temperature located at higher points on the scale than the others. *Geopinus*, which is active on the dune at night, has the lowest minimum effective temperature of all. On the other hand, both *Bembix* and *Microbembex*, which are characteristic of the day forms, have high minimum effective temperatures and low maximum effective temperatures, leaving but a narrow range of activity.

Another noticeable characteristic of some of the sand dune insects is the small difference between the effective temperature and that of normal activity. In one case a change of 2 degrees C. brought them from dormancy to normal activity.

The conclusions resulting from the study were:

Extreme variations in physical condition of the environment on this Minnesota sand dune are essentially like those which are characteristic of deserts.

The insects which comprise the fauna are not similar to each other when compared on the basis of the temperatures which they can endure.

The successful sand dune insects are capable of either enduring great extremes, or of avoiding them by choosing the times and places for their activities.

The bembicids, among the most characteristic and important species on the dunes, are limited by the narrowest temperature zones of activity, and owe their success to a continued shifting of time and space which results in an existence under conditions that may possibly be more favorable than could be obtained in an environment with more uniform temperature.

No. 599. "Diurnal Fluctuations in the Hydrogen-Ion Activity of a Minnesota Lake," by C. B. Philip. In *Ecology*, Vol. 8 (1), pp. 73-89 (1927).

Colorimetric determinations were made of the hydrogen-ion concentration of the surface water at a number of stations in Crystal Lake, Hennepin County, Minnesota. The stations selected represent different depths and distances from shore in the shallow water of a cove, and the open water above the deepest portion of the lake. Most of the determinations were made in September, but they represent a variety of times of day and weather conditions. A very wide range of pH was observed between different stations and especially between different determinations at the same station, depending chiefly on exposure to light and amount of algae and other vegetation present. A maximum alkalinity of pH 9.8 was noted in the midst of a mass of algae. The author points out that nearly or quite as great a range of hydrogen-ion concentration occurs at a single station as would be found in a considerable series of different lakes or streams. Hence, one or a few determinations of hydrogen-ion concentration can not be taken as characteristic of a body of water, and such determinations, to be of value, should be accompanied by careful notes of the conditions prevailing at the time.

No. 609. "Course of Pollen-Tube Growth in the Apple," by J. H. Beaumont. In *Minnesota Studies in Plant Science* (Research Publications of the University of Minnesota): *Studies in the Biological Sciences*, No. 6 (1927)

The pollen tube, in growing from the stigma to the ovule of an apple carpel, passes through a specialized conductive tissue in the style and over the surface of the placenta. Upon reaching the placenta of the carpel, the pollen tube has access to the placenta of the other carpels and consequently may effect fertilization in them by passing through the partially open sutures of the carpels and over the floor of the central cavity formed by the enveloping carpels and the cessation of growth of the central portion of the torus. Cytological and pollination experiments prove that pollen tubes growing initially in one or more carpels have effected fertilization in any or all of the remaining carpels of the ovary.

No. 614. "Minnesota Glacial Soil Studies: II. The Forest Floor of the Late Wisconsin Drift," by F. J. Alway and P. M. Harmer. In *Soil Science*, Vol. 23, pp. 57-70 (January, 1927).

The forest floor, which includes both the litter and the leafmold, was sampled in nine virgin or nearly virgin Minnesota woods, six being remnants of the original southeastern deciduous forest and three being in the northern coniferous forest. The total amount of oven-dry material per acre was found to vary from 13 to 97 tons, with the content of nitrogen varying from 1.47 to 1.89 per cent, of volatile matter from 52 to 81 per cent, corresponding to 444 to 2847 pounds of nitrogen and 8 to 60 tons of volatile matter per acre. The nitrogen in the volatile matter varied from 2.02 to 2.99 per cent, the organic carbon from 31 to 39 per cent, and the ratio of organic carbon to nitrogen from 18 to 24. The samples showed little or no acidity, carried about 0.30 per cent phosphoric acid, and had moisture equivalents of 97 to 120.

No. 615. "Minnesota Glacial Soil Studies: III. Density of the Surface Foot in Forest and Prairie on the Late Wisconsin Drift," by P. M. Harmer. In *Soil Science*, Vol. 23, pp. 73-80 (January, 1927).

The density of the soil *in situ* was determined in the four 3-inch sections of the surface foot of twelve Minnesota virgin fields developed on the till plains of the Des Moines lobe of the Late Wisconsin drift. Six of these fields were in the deciduous forest and six on the open prairie. In the surface section, the density of the soil was much alike in prairie and forest, but below that it increased gradually in the former but rapidly in the latter, being one-third higher in the lower two sections of the forest soil.

No. 616. "Phosphoric Acid Content of Crops Grown Upon Peat Soils as an Index of the Fertilization Received or Required," by F. J. Alway, W. M. Shaw, and W. J. Methley. In *Journal of Agricultural Research*, Vol. 33, No. 8, pp. 701-740 (October, 1926).

The phosphoric acid and ash in hays, straws, and grains from unfertilized and adjacent fertilized plots on the Golden Valley, Fens, and Coon Creek Peat Experimental Fields were determined and the relative amounts compared with the response of the crops to phosphate and potash fertilization. The P_2O_5 content of the hays, straws, and even grains grown on phosphate-hungry peats was low, this being most marked on the straws and least in the grains. It was greatly increased by phosphate fertilization, most in the straws and least in the grains, except where the application was very light and where a greatly increased yield resulted. It was greatest where some unfavorable factor, other than the supply of nutrients, caused a low yield. The percentage of P_2O_5 in the ash varies much like that in the dry matter, but as the ash does not vary regularly with the fertilization the proportion of P_2O_5 in the dry matter is more significant than is that in the ash. Potash applications affect the P_2O_5 content of the crop as they affect the yields. When potash increases the yield it lowers the percentage of P_2O_5 in the crop. In some cases an application of a mixture of potash and phosphate will greatly increase the yield of grain without raising the proportion of P_2O_5 . Where a potash application does not increase the yield, it increases the percentage of ash and hence lowers the proportion of P_2O_5 . The extreme variations in P_2O_5 content found, altho much greater than those reported for crops grown on mineral soils, are not wider than those found for crops on peat lands in Sweden, Germany, and

Austria, nor wider than those found in pot experiments. Definite limiting values for the P_2O_5 content of a crop, both an upper one, indicating that the phosphate supply in the soil is adequate for approximately maximum yields, and a lower one, indicating that heavier phosphate fertilization is practically certain to cause a great increase in yield, are difficult to place. The P_2O_5 content of clover and timothy hay grown on phosphate-deficient peats given a phosphate fertilizer at the usual rate of application is lower than that of similar hays on productive mineral soils, but if animal nutrition investigations of hays from peat lands should lead to the conclusion that a certain minimum content of P_2O_5 in the hay is desirable from the standpoint of the feeder, it can be secured by a heavy initial phosphate application, altho with a decreased profit for those peat-meadow owners who produce hay for sale. On phosphate-hungry mineral soils, fertilization with phosphate was found greatly to increase the P_2O_5 content of clover and timothy hay. The analysis of the crops is very useful in detecting mistakes in the application of fertilizers—either the substitution of one nutrient for another or the omission of one from an intended mixture. It also will frequently serve to explain the cause of productive spots and areas on unfertilized fields or plots of a peat that is elsewhere unproductive.

No. 617. "The Vitamin B Requirements of the Calf," by S. I. Bechdel, C. H. Eckles, and L. S. Palmer. In *Journal of Dairy Science*, Vol. 9 (5), pp. 409-438 (1926).

Twelve calves received a ration deficient in vitamin B from the age of 5 months until after parturition. These calves grew normally to maturity and produced normal offspring. If calves require vitamin B as do other animals, the results can be explained only on basis of vitamin B synthesis by bacteria in the alimentary tract. No evidence was found to indicate that the livestock man need be concerned regarding a possible deficiency of vitamin B in raising calves under practical conditions.

No. 621. "Further Investigations with Adulterating Sulfuric Acid so as to Increase Babcock Test Readings," by W. E. Petersen. In *Journal of Dairy Science*, Vol. 10 (3), pp. 261-262 (1927).

It was found possible to make a stable emulsion of saturated solutions of fat in fat solvents in commercial sulfuric acid by the use of soap as a stabilizer. Such adulterated acid appeared normal and did increase the fat reading of milk which was used in the conduct of the Babcock test.

No. 622. "The Immediate Influence of Feeds Upon the Quality and Quantity of Cow's Milk. I. The Effect of Ground Flax," by W. E. Petersen. In *Journal of Dairy Science*, Vol. 10 (1), pp. 70-82 (1927).

It was found that by substituting 2 to 3 pounds of ground flax daily for an equal amount of the regular ration with some cows, both the amount of milk and the fat percentage were increased, with others only the fat percentage was increased, while with still others no increase of either occurred. Whenever ground flax exerted an influence on either percentage of fat or amount of milk, such influence was noticed in the milking following the feeding but the maximum effect was not noticed until the second day.

No. 623. "Determination of Pressure Distribution on Circular Pipe when Tested in the A.S.T.M. Standard Bearing," by D. G. Miller and P. C. McGrew. In *Proceedings of the American Society for the Testing of Materials*, Vol. 26, Part II, pp. 611-620 (1926).

Distribution of pressure in the standard sand bearings has been determined by measuring the starting pull required to move steel strips in canvas laid on the outer circumference of circular pipe and between the pipe and the sand of the bearings.

No. 624. "Breeding Improved Varieties of Smooth-Awned Barleys," by H. K. Hayes. In *Journal of Heredity*, Vol. 17, No. 10, pp. 371-381 (1926).

The awn of barley is an important physiological organ and awned varieties yield better than hooded. In connection with the production of improved smooth-awned varieties by hybridization, a study was made of the genetic relations of black vs. white glume, rough vs. smooth awn, and resistance vs. susceptibility to *Helminthosporium sativum*. Two or three main pairs or groups of genetic factors were involved in resistance vs. susceptibility to the "spot blotch" disease and there was evidence of genetic linkage between the factors for resistance vs. susceptibility to this disease and the factors for black vs. white glume and rough vs. smooth awn. Three new smooth-awned varieties were described. These have been named Velvet, Minn. No. 447; Comfort, Minn. No. 451; and Glabron, Minn. No. 445.

No. 625. "Four Important Factors in the Manufacture of Concrete Pipe for Alkali Soils," by D. G. Miller. In *Transactions of the American Society of Agricultural Engineers*, Vol. 20 pp. 180-188 (1926).

The paper is based on laboratory experiments with portland cement mortar and concrete cylinders stored in solutions of the sulphates of magnesium and sodium. The chief point brought out is the difference among brands of portland cements.

No. 628. "Idiopathic Streptococci Peritonitis in Poultry," by H. C. H. Kernkamp. In *Journal of American Veterinary Medical Association*, Vol. 70, New Series 23, No. 5 (February, 1927).

A study of an unusual form of peritonitis in poultry showed that it was the result of streptococcal infection. A review of the literature shows that very few disease conditions in poultry result from this genus of bacteria. A careful history of the outbreak is here reported, and the post-mortem findings and bacteriological studies are given. As a result of the study the following conclusions are given:

1. An idiopathic or primary fibrinous inflammation of the peritoneum of poultry has been observed.
2. This type of peritonitis is not common. The greater number of peritoneal affections are secondary to disease elsewhere in the body.
3. A streptococcus, *Streptococcus pyogenes*, was isolated. This organism, when injected into susceptible birds, produced a disease typical of the original cases.
4. The disease, under natural conditions and in several birds artificially infected, has a chronic course.

5. Peritonitis was not induced in susceptible birds under artificial conditions by administering the virus directly into the digestive tube.

6. Females are more susceptible than males.

7. The organisms were avirulent after nine months of artificial cultivation on serum-agar. Their ability to cause hemolysis or ferment lactose, saccharose, and salicin was not changed.

No. 629. "The Relation of the Properties of Cerelose to the Manufacture of Ice Cream," by W. B. Combs and Frank Bele. In *The Ice Cream Review*, Vol. 10 (5), pp. 66-75 (1926).

The cerelose used in this study was found to contain 0.063 to 0.69 per cent ash and between 8.23 and 9.11 per cent moisture. The polariscope reading was 99.3 degrees, indicating a small percentage of non-glucose material present. The solubility of cerelose at ordinary pasteurizing temperatures indicated that the ice cream manufacturer will experience no difficulty in getting cerelose to go into solution in the ice cream mix.

Owing to its molecular weight, cerelose depresses the freezing point almost twice as much as sucrose in an equal concentration. Ice cream mixes containing cerelose must be frozen to lower temperatures than mixes of like composition containing sucrose in order to obtain the desired overrun. It was further demonstrated that ice cream containing cerelose must be stored at a lower temperature than that containing sucrose. The rate at which the ice cream cools in the hardening room is also affected by cerelose. It was found, however, that when gelatin is used in ice cream containing cerelose a higher serving temperature may be used.

No. 630. "Cerelose and Its Relation to the Quality of Ice Cream," by W. B. Combs and Frank Bele. In *The Ice Cream Review*, Vol. 10 (5), pp. 132-140 (1926).

When cerelose (corn sugar) was used in ice cream to substitute for varying amounts up to 50 per cent of the sucrose, the lack of sweetness due to the use of cerelose was detectable. When 25 per cent of the sweetener used in the ice cream mix was cerelose, very little difference was noted in the quality of the ice creams containing cerelose and sucrose. In substituting cerelose for sucrose in ice cream, on the sweetening basis of the two sugars, it was found that a good quality of ice cream could be made using cerelose to the amount of 35 per cent of the sugar content. Studies revealed the fact that a 16 per cent sugar is preferred by a majority of individuals. Ice cream containing cerelose was shown to possess less resistance to heat than that containing sucrose.

No. 632. "Inversion of Sucrose Solutions—Use of Invertase for High Density Solutions," by J. J. Willaman. In *Sugar*, Vol. 28, pp. 409-410 (1926).

Concentrated solutions of sucrose can be hydrolyzed to invert sugar by use of commercial invertase preparations. Invert sugar syrups are largely used by the baking industry and in confectionery because they show more desirable physical properties and because there is a gain in sweetness by inversion.

No. 633. "On the Presence of Amines in the Distillate from Kjeldahl-Gunning Nitrogen Determinations," Preliminary Paper, by

Ross Aiken Gortner and Walter F. Hoffman. In *Journal of Biological Chemistry*, Vol. 70, pp. 457-459 (1926).

The Kjeldahl-Gunning distillates, which have been supposed to contain only ammonium hydroxide, were found to contain appreciable amounts of aliphatic amines. Salts of the alkali earths, when present during digestion, increase the amount of amines.

No. 634. "Types of Agricultural Production Affecting Expenditure and Culture," by G. A. Pond. In *Farm Income and Farm Life*, pp. 197-205, University of Chicago Press (1927).

A comparison of a group of intensive dairy farms with a group of corn, beef cattle, and hog farms, indicates that the families on the dairy farms enjoyed a higher standard of living as measured by expenditures for food, educational opportunities afforded the children, modern conveniences in the home, farm work done by women and children, and opportunities for travel and outside contacts. The dairy farmers worked more hours per day but had \$425 more per family per year for family and personal use. The size of income appeared to be a more important factor affecting expenditure and culture than the type of farming.

No. 635. "The Principles Involved in Farm Land Appraisal Procedure for Loan Purposes," by J. D. Black and A. G. Black. In *Journal of Land and Public Utility Economics*, Vol. 2, No. 4, pp. 396-407 (October, 1926).

An analysis is presented of the problems involved in valuing farm land for the purpose of making mortgage loans. A brief description and criticism of current appraisal practices is included. The authors suggest methods of approach to the problem of appraisal through the elaboration and application of methods which have been developed by recent investigations. The importance of improved methods of land valuation is emphasized.

No. 636. "Nature of Resistance of *Berberis* spp. to *Puccinia graminis*," by L. W. Melander and J. H. Craigie. In *Phytopathology*, Vol. 17, pp. 95-144 (1927).

No indication was found that sporidial germ tubes of *Puccinia graminis* Pers. entered an immune host like *Berberis thunbergii*. There was a positive correlation between the immunity of this species and the thickness of the outer walls of the epidermal cells and resistance to puncture. The difference between the resistance to puncture of one-day-old leaves of *B. thunbergii* (immune) and *B. vulgaris* (susceptible) was more than 24 times the probable error of the difference. One-day-old leaves of *B. chinensis* (resistant) have a puncture index intermediate between those of the susceptible and immune varieties. The resistance of some species of *Berberis* and *Odostemon* apparently is not due to morphological characters. Varieties whose leaves are characterized by a thin and easily punctured outer wall of the epidermal cells were most susceptible. That leaves of both susceptible and resistant varieties become immune from rust with increased age can be explained by the thickening of the outer epidermal cell wall and the accompanying rapid increase in resistance to puncture.

No. 637. "The Relation of Sunlight to the Growth and Development of Calves," by T. W. Gullickson and C. H. Eckles. In *Journal of Dairy Science*, Vol. 10 (2), pp. 87-94 (1927).

Calves were kept in darkness from the age of seven days to more than two years. Check animals receiving the same ration were exposed to sunlight regularly. So far as could be measured by general observations, weights, and skeletal growth, the absence of sunlight was without effect upon the animals kept in darkness. Reproduction was normal. These results indicate that the well-being of bovines, unlike that of some other animals, especially fowls, is not dependent upon sunlight.

No. 638. "The Fundamental Food Requirements for the Growth of the Rat. I. Growth on a Simple Diet of Purified Nutrients," by L. S. Palmer and Cornelia Kennedy. In *Journal of Biological Chemistry*, Vol. 74, pp. 591-611 (1927).

It has been shown by experiments repeated at intervals covering nearly five years that young rats fail to grow normally, if at all, when fed a basal diet of specially purified casein, dextrin, wheat embryo extract, butterfat, mineral salts, and agar, in proportions presumably adequate for satisfying the growth requirements for protein, energy, mineral elements, and vitamins A and B, and so housed as to repress the natural coprophagistic habits of the species.

The conclusion has been drawn from these data that the requirements for normal growth of the rat involve other nutrients than those usually recognized and incorporated in our basal diet. Further studies, referred to but not presented in this paper, suggest a need for vitamin-like factors other than those at present generally recognized.

No. 640. "The Relation of the Crude Protein Content of Flour to Loaf Volume," by C. H. Bailey and R. C. Sherwood. In *Cereal Chemistry*, Vol. 3, pp. 393-401 (1926).

The coefficient of correlation of protein content of flour and loaf volume of bread baked from flour as milled in the State Testing Mill during five crop seasons, 1921-1925 inclusive, was of the order of 0.3 ± 0.04 . It is observed that loaf volume did not increase regularly with increasing protein content. A plot of loaf volume as ordinates and crude protein as abscissas takes the form of a hyperbolic curve that can be expressed by the equation:

$$(\text{loaf volume}) y = \frac{x}{a + bx} + c$$

The data available were used in the solution of the constants a and b through the use of which it was possible to construct a smooth curve which expresses loaf volume in terms of protein content.

No. 642. "The Imbibition of Gelatin Dried as a Gel and as a Sol," by Ross Aitken Gortner and Walter F. Hoffman. In *Journal of Physical Chemistry*, Vol. 31, pp. 464-466 (1927).

There is a marked difference in the physical properties of gelatin dried above 40 degrees C. when compared with the corresponding properties of preparations of gelatin dried at room temperature. It is suggested that possibly some

of the divergent results noted by different investigators, when working with supposedly the same grades of gelatin, may be attributed to a difference of temperature during the drying process.

No. 644. "The Water Requirement and Cell Sap Concentration of Australian Saltbush and Wheat as Related to the Salinity of the Soil," by Frank M. Eaton. In *American Journal of Botany*, Vol. 14, pp. 212-226 (1927).

Experiments with Australian saltbush and wheat show that the water requirements of these plants were inversely proportional to the concentration of the expressed cell sap when sodium chloride was added in varying concentrations. Electrolytes were largely responsible for the increased cell sap concentration. There is a marked osmotic gradient between the sap of the plants and the soil solution, and the osmotic concentration of a soil containing 25 per cent of added sodium chloride at the moisture equivalent, is over twice as great as the same concentration of salt in a true solution.

No. 645. "Physiologic Specialization of *Ustilago nuda* and *Ustilago tritici*," by H. A. Rodenhiser. In *Phytopathology*, Vol. 16, pp. 1001-1008 (December, 1926).

A detailed study was made of the cultural characteristics of six distinct forms of *Ustilago nuda* and three of *Ustilago tritici* collected in widely different localities. Some of the forms of *U. tritici* resemble some of *U. nuda* more closely than they do certain other forms of *U. tritici*. As no morphological differences were found between these two species, it is considered that they are nothing more than physiologic forms of a single morphological species, altho it may be convenient to designate them as two species because of their apparent restriction to certain host plants.

No. 646. "Sulfur in Proteins. III. Derivatives of *l*- and *i*-cystine," by Ross Aiken Gortner and Walter F. Hoffman. In *The Journal of Biological Chemistry*, Vol. 72, pp. 433-448 (1927).

A number of derivatives of *l*-, *i*-, and "stone" cystine were compared. The physical properties of the preparations were in no instance identical. It is suggested that these different forms of cystine may account for much of the divergent data in the cystine literature.

No. 647. "Biochemistry of Plant Diseases. IX. The Pectic Enzymes," by F. R. Davison and J. J. Willaman. In *The Botanical Gazette*, Vol. 83, pp. 329-361 (1927).

A study of various plant tissues has shown that there are at least three distinct pectic enzymes—(1) protopectinase, the enzyme which hydrolyzes or dissolves protopectin, thus causing the maceration of plant tissues; (2) pectase, the enzyme which converts pectin into pectic acid, thus causing gel formation; and (3) pectinase, the enzyme which hydrolyzes pectin to simpler substances such as arabinose, glucose, and galacturonic acid. These enzymes were studied in considerable detail in regard to the optimum conditions for their activity and their possible rôle in plant diseases.

No. 648. "Mold and Yeast Counts and Their Relation to the Composition of Butter," by H. Macy. In *Journal of Dairy Science*, Vol. 10 (5), pp. 384-395 (1927).

Mold and yeast counts of 2700 samples of market butter were correlated with the composition of the butter. The moisture content does not appear to be a factor, but a marked relation exists between the salt percentage and the mold and yeast content.

No. 649. "The Effect of the Source of Nursery Stock on the Growth of Apple Trees in Minnesota," by W. G. Brierley. In *The Minnesota Horticulturist*, Vol. 55, pp. 129-134 (May, 1927).

The behavior in variety in a locality depends more upon the method of propagation than upon the place where the nursery stock was grown. Nursery trees from southern sources, when budded on more or less tender French crab roots, show a high percentage of failure due to the winter-killing of the tender roots. Hardy roots are as necessary as hardy tops, in Minnesota. Such hardy roots may be obtained by using seedlings of hardy varieties in budding or root grafting.

No. 650. "Vegetable Possibilities on Muck Land," by F. A. Krantz. In *Minnesota Horticulturist*, Vol. 55, pp. 37-38 (February, 1927).

A discussion of the development of the vegetable industry on muck and peat lands in Minnesota, and of the factors both favorable and unfavorable which will affect further development on this type of soil.

No. 651. "The Use of Ethylene, Propylene, and Similar Compounds in Breaking the Dormancy of Seeds and Bulbs," by R. B. Harvey and G. A. Vacha. In *Plant Physiology*, Vol. 2, pp. 187-194 (1927).

The effect of ethylene, propylene, and ethylene oxide on breaking the rest period of seeds and cuttings of ornamentals and tubers is summarized. Ethylene oxide is too toxic for use, but ethylene and propylene in concentrations up to 1:500 may be used to break the dormancy of potatoes, dahlia, canna, and gladiolus bulbs, and some seeds. Considerable stimulation of growth is noticed as an effect of the treatment.

No. 654. "Use of Ethylene in the Chemical Ripening of Fruits and Vegetables," by R. B. Harvey. In *Chemical Bulletin*, Vol. 14, p. 101 (1927).

This gives the results of the use of ethylene and propylene in hastening the ripening of fruits and vegetables, with a summary of the chemical changes accompanying the changes. Translated into Russian and German for publication.

No. 655. "Treatment of Green Celery with Ethylene," by R. B. Harvey. In *American Produce Grower*, Vol. 2, p. 20 (1927).

This gives the method of blanching celery by the use of ethylene gas and the precautions necessary to insure success. A discussion of the function of chlorophyll is also included.

No. 656. "Physiologic Specialization and Mutation in *Ustilago zeae*," by J. J. Christensen and E. C. Stakman. In *Phytopathology*, Vol. 16, pp. 979-1000 (December, 1926).

Ustilago zeae is a group species comprising numerous physiologic forms. Fifteen forms were studied in detail. The forms can be distinguished in artificial culture by the following characters: rate of growth, color, topography, zonation, and conidial production.

Some forms are very virulent, some moderately so, while some are relatively innocuous. The most virulent form was obtained from Pennsylvania and the weakest from Massachusetts. Some selfed lines of corn which had been resistant in the field for several years at University Farm, St. Paul, were completely susceptible to at least one of the physiologic forms.

So-called mutants occur frequently on culture media as wedge- or fan-shaped sectors. Some forms mutate readily, others do not. The mutants differ from their parents not only in general appearance on culture media but also in pathogenicity.

No. 657. "Studies on the Parasitism of *Fusarium lini* Bolley," by W. C. Broadfoot. In *Phytopathology*, Vol. 16, pp. 951-978 (December, 1926).

At least nine physiologic forms of *Fusarium lini* can be distinguished by their parasitic action on the following four varieties of flax: Primost, Minn. No. 25 (C.I. No. 177); Winona, Minn. No. 182 (C.I. No. 179); N. D. No. 3080 (C.I. No. 275); and N. D. No. 40013 (C.I. No. 241). The four differential varieties vary in degree of resistance and susceptibility to seven physiologic forms. Two forms are about equally virulent, except that one consistently causes loss of chlorophyll above the cotyledons in all varieties of flax inoculated, as well as in barley, oats, and rye. The cultural characteristics of some forms differ from those of others, but this alone is not a safe criterion for the determination of all the forms. Neither can the forms be differentiated by rate of growth at different temperatures, nor on the basis of spore morphology. Some of the forms infect heavily certain resistant varieties of flax, but it is not yet known how important this is in the development and maintenance of resistant strains of flax. *F. lini* probably belongs in the section *Elegans* of the form genus *Fusarium*.

No. 658. "Genetic Studies in Potatoes. II. The Inheritance of Red Cortical Color in Tubers," by F. A. Krantz. In *Proceedings of the Thirteenth Annual Meeting of Potato Association of America*, pp. 52-55 (December, 1926).

Inheritance studies on tuber color in potatoes have brought out the fact that the so-called skin colored varieties can be divided into two classes: I. Varieties which have the pigment located in the skin or periderm tissue, and, II. Varieties in which the pigment is located in the tissue beneath the skin. It is pointed out that both series contain all the known tuber colors and that they are very similar in their mode of inheritance. Triumph and McCormack are cited as examples of skin-colored varieties and Early Ohio as a cortical colored variety. Evidence obtained from selfs and crosses suggest the following genotypes for the three varieties: Triumph, DD Rr Aa; McCormick, Dd Rr Aa; Early Ohio, Ddc Rrc AcAc.

No. 661. "Rural Electrification in Europe," by E. A. Stewart. In *Agricultural Engineering*, Vol. 8 (5), pp. 105-108 (May, 1927).

A discussion of the differences between the United States and certain European countries in the use of electricity on farms and in rural communities. Tables are included giving the comparative percentage of farms electrified in different countries of Europe and a comparison of areas in Europe and the United States in which electricity is used. The comparative rates for electric service are also discussed, with statements concerning the types of rates in use in various countries. The consumption of electric current per farm is discussed, with comparisons of parts of the United States and European countries. The uses to which electric current is put are described and statements are given regarding the extent to which electric contrivances are developed.

No. 662. "The Green Bug in Minnesota," by A. G. Ruggles and F. M. Wadley. In *Journal of Economic Entomology*, Vol. 20, No. 2 (1927).

The green bug, *Toxoptera graminum* Rond., destroyed about 15 million bushels of oats in Minnesota in 1926. The cool, dry June was very favorable for the development of aphids.

Facts in the biology of the insect make it appear that the insect did not overwinter in Minnesota but was blown in by the wind.

No. 663. "Water Binding Capacity of Colloids. A Definite Factor in Winter Hardiness of Insects," by William Robinson. In *Journal of Economic Entomology*, Vol. 20, pp. 80-88 (1927).

It was found that under a falling temperature the hydrophilic, or water-loving, colloids of insect tissue will absorb or bind free water, and in direct proportion to the winter hardiness of the species of insect. The water thus bound ceases largely to function as ordinary water. The biological significance and the advantages to the species of having their free water changed into bound form upon the approach of winter is discussed; and the method of making the determinations is described. The mechanics of the absorption process is discussed. The suggestion is made that studies of winter hardiness of insects should be extended to include water-binding and water-holding capacity.

No. 664. "The Regional and Seasonal Distribution of Moisture and Food in 2-3 Year Apple Twigs," by H. P. Traub. In *Proceedings of the American Society for Horticultural Science*, 1926, pp. 127-131. College Park, Md. (1927).

The technic for the study of the seasonal distribution of moisture, carbohydrates, nitrogen, and ash in the complex tissues—periderm, cortex-phloem, outer xylem- and inner xylem-pith—of 2-3 year portions of apple twigs is briefly described. Wider application of the method is indicated.

No. 666. "Time of Cutting Wheat and Oats in Relation to Yield and Composition," by A. C. Arny and C. P. Sun. In *Journal of the American Society of Agronomy*, Vol. 19, No. 5 (May, 1927).

Cutting wheat and oats before they were mature resulted in reduction in yield when the harvested grain was cured in the shock. There was a tendency for

straw yields to be lower from the cutting made nine days early as compared with that made at maturity. Results over a period of years are necessary in order to come to conclusions regarding how immature grain can be cut without reduction in yield.

Lower weight per bushel resulted from premature cutting. There was not enough reduction in weight per bushel for wheat cut when the terminal spikelets were turning color and the kernels in them were in the hard dough stage (seven days early) and for oats cut when the kernels in the terminal spikelets were in the thick milk stage (seven days early) to make any change in the market grade as compared with the same grains cut at maturity.

That materials were not translocated to any extent from the straw to the grain after cutting, is indicated by lower yields per acre, lighter weights per bushel and per 1000 kernels of wheat and oats when cut at early stages of maturity and cured in the shock than when cut later.

Weights per 1000 kernels from the various cuttings were as great when dried rapidly in the oven as when cured slowly in the bag or shock. This is additional evidence that translocation of materials did not take place to an extent that would influence yield.

Hull percentages in oats cut at any stage were as high when dried rapidly in the oven as when cured slowly in the shock. This indicates that material stored temporarily in leaves and stems was not moved into the grain in large enough quantities to lower appreciably the percentage of hull.

No. 667. "Tile Spacing and Depth a Function of Soil and Crop Type," by H. B. Roe. In *Transactions of the American Society of Agricultural Engineers*, Vol. 20, pp. 244-246 (1926).

The importance of the problem of proper spacing and depth for tile drains in different soil types, the lack of definite information on the subject, and the need for research work thereon is shown. The pertinence of the question of rate of drop of the peak of the ground water curve under the influence of the governing tile lines is pointed out. The method of attack of the problem adopted is stated as a physical analysis of soils by sedimentation correlated with rate of drop of the ground water curve between tile lines, as an index of proper depth and spacing of these lines.

No. 671. "A Biochemical Survey of Bread Production," by C. H. Bailey. In *American Food Journal*, Vol. 22, pp. 128-130 (April, 1927).

The production of yeast-leavened bread of good quality involves the co-operation of the plant breeders, agronomists, millers, bakers, and biochemists. It appears that the properties of flour which adapt it to bread production involve not alone the concentration of certain constituents, notably the gluten proteins, but also the physical properties of these constituents as determined by their chemical and physical constitution and the influence of certain ions in their environment. The suitability of the dough solution as a medium for the metabolism of yeast is also of significance, and certain flour enzymes, notably diastase, contribute largely to the suitability of this medium.

No. 673. "A Study of Durum Wheats," by Herbert Vogel and C. H. Bailey. In *Cereal Chemistry*, Vol. 4, pp. 136-149 (1927).

The viscosity of acidulated suspensions of durum flours as measured in terms of "constant b" did not differ materially from similar properties of common or

vulgare wheat flours. Extensibility of durum patent flour doughs measured with the Chopin extensimeter was appreciably lower than that of vulgare patent flour doughs. A spectrophotometric analysis of the light reflected from the surface of durum flour showed that the highest scores were assigned to flours which absorbed more of the short wave lengths of light. The transmittancy of petroleum ether extracts of durum flours was likewise least in samples which had been assigned the highest scores, which scores were assumed to represent the relative value of these products to the macaroni manufacture.

No. 676. "The Preparation and Analysis of the Various Proteins of Wheat Flour with Special Reference to the Globulin, Albumin, and Proteose Fractions," by Walter F. Hoffman and Ross Aiken Gortner. In *Cereal Chemistry*, Vol. 4, pp. 221-229 (1927).

An attempt was made to isolate from a single sample of wheat flour all the proteins which had been reported to be present in wheat flour. No trace of the so-called "proteose" could be isolated. Only small amounts of a fraction corresponding to a "globulin" were isolated, and it is doubtful if a true "globulin" occurs in wheat flour. A hitherto undescribed "gum" was isolated but was not extensively studied. Sodium chloride (10 per cent) and potassium sulfate (5 per cent) extracts did not yield identical protein fractions so that this study indicates that certain data in the older literature will have to be revised and certain questions reopened.

No. 678. "The Relation of Selfed Lines of Corn to the F₁ Crosses. Between Them," by Gunnar Nilsson-Leissner. In *Journal of the American Society of Agronomy*, Vol. 19, pp. 440-454 (1927).

A study was made of the correlation of characters of selfed lines of corn which had been selfed for from 4 to 17 generations, and of F₁ crosses between them. The selfed lines include fourteen having dent and nine having flint origin. A separate study was made for the dent and flint groups. The average expressions of the following characters of the selfed lines—yield, length of ear, diameter of ear, number of kernel rows, and height of plant—were found to be strongly correlated with the same characters of the F₁ crosses. Some F₁ crosses yielded exceptionally well when the average production of the parent selfed lines was relatively low. The multiple correlation for yield of the F₁ crosses with the average of characters of vigor of the selfed lines—yield, length of ear, number of kernel rows, percentage of second ears, and height of plant—was +0.6687 for the dent cross, and +0.8240 for the flint.

No. 679. "Correlation of Loaf Volume with Peptizing Action of Salts on Wheat Flour Proteins," by Ross Aiken Gortner. In *Proceedings of the Society for Experimental Biology and Medicine*, Vol. 24, pp. 530-532 (1927).

High negative correlations were obtained between the amount of wheat flour peptized by a salt solution and the loaf volume of the bread baked from the original flours. In one instance the correlation was as high as $r = -0.925 \pm 0.028$. However, studies of only twelve samples of flour were reported in this publication, so the validity of the above correlations must be determined on a larger series. Work on such a series is already well advanced.

No. 680. "Growth of Plants in Artificial Light," by R. B. Harvey. In *Minnesota Horticulturist*, Vol 55, pp. 20-22 (January, 1927).

Using large bulbs and deep bowl reflectors, wheat, oats, barley, rye, flax, buckwheat, white sweet clover, peas, beans, lettuce, and several common weeds were grown from seed to seed in continuous artificial light. Tomatoes, red clover, alsike clover, squash, and silene bloomed but did not set seed. Potatoes produced tubers of good size, bloomed, but did not set seed. It is possible to grow plants and have them set seed in the winter, independent of sunlight, at no very great expense.

No. 681. "The Effect of Ethylene on the Enzymes of Pineapple," by L. O. Regeimbal and R. B. Harvey. In *Journal of the American Chemical Society*, Vol 49, p. 1117 (1927).

The authors found that ethylene not only hastened the maturity of pineapples but increased the direct reducing sugars and decreased the total sugars. The juice from treated fruit had a higher proteoclastic activity than the juice from the checks, as evidenced by the splitting of casein.

No. 682. "Effect of Phosphorus Deficient Rations on Blood Composition in Cattle," by L. S. Palmer and C. H. Eckles. In *Proceedings of the Society for Experimental Biology and Medicine*, Vol. 24, pp. 307-309 (1927).

The investigations in progress regarding the dietary deficiency with cattle that occurs in parts of Minnesota and which has been shown to be a phosphorus deficiency, were extended to include analysis of the blood of affected animals. Cows showing the typical symptoms of a phosphorus-deficient ration have blood with a greatly reduced inorganic phosphorus content, in some cases as low as 20 per cent normal. The feeding of a phosphorus-bearing supplement quickly restores the normal phosphorus content.

No. 683. "Effect of Burning the Forest Floor upon the Productivity of Jack Pine Land," by F. J. Alway. In *Abstracts of the Proceedings of the First International Congress of Soil Science*, Commission IV, pp. 5-8 (June, 1927).

As the result of trials of various ordinary farm crops on land freshly cleared of *Pinus banksiana*, part of which had been prepared for the breaking plow without any use of fire and part with the most extreme burning, it is concluded that there is nothing in the forest floor under such trees that is toxic to farm crops and that the effect of burning the forest floor is without any beneficial effect upon the yields in the first crop season following the breaking.

No. 684. "Effect of Forest Fires upon the Composition and Productivity of the Soil," by F. J. Alway and C. O. Rost. In *Abstracts of the Proceedings of the First International Congress of Soil Science*, Commission IV, pp. 67-68 (June, 1927).

A study was made of burned-over areas following the exceptionally severe forest fire that occurred near Duluth on October 12, 1918. This, supported by later field observations and vegetation experiments, leads to the conclusion that the loss in productivity of the mineral soils traversed by forest fires is dependent

upon the extent of the destruction of the forest floor, and not upon changes in the underlying mineral soil.

No. 685. "Effect of Different Kinds and Amounts of Liming Materials upon the Hydrogen-Ion Concentration of the Soil," by C. O. Rost and Ernest A. Fieger. In *Abstracts of the Proceedings of the First International Congress of Soil Science*, Commission II, pp. 5-8 (June, 1927).

A study of the effect upon the hydrogen-ion concentration of the soil of six different forms of liming material used at different rates on eight experimental fields of the University of Minnesota is reported. The rates of application of the different materials varied from $\frac{1}{2}$ ton to 8 tons per acre. On sandy fields the results were more uniform than on those with fine-textured soils, but on all there was the same general effect. An increase in amount of any form of liming material was accompanied by a decrease in acidity. The lighter applications produced proportionally greater reductions than heavy ones, while the effectiveness of the materials was affected by their fineness, the coarsest form being least effective and the most finely divided the most effective. Four and a half years after the applications were made the effectiveness of the finer materials was found the same as after two years, while that of the coarse materials had increased.

No. 687. "Differentiation Between Acidity and Lime-Deficiency in the Case of Peat Soils," by F. J. Alway and I. J. Nygard. In *Abstracts of the Proceedings of the First International Congress of Soil Science*, Commission II, pp. 1-2 (June, 1927).

While all lime-deficient peat soils may be very acid, the converse is not always true, as on some very acid bogs the most lime-demanding crops such as sweet clover, grow well on the unlimed land and are not benefited by liming. This behavior is well brought out by studies reported from the two peat experimental fields of the University, near Milaca. On both, the peat varies in depth from 3 to 6 feet, is very strongly acid at all depths, and is underlaid by a very acid silty substratum. On one, almost all farm and garden crops fail, even after liberal fertilization with phosphate and potash, unless some form of lime has been applied, while on the other the most calciphile crops grow well on the unlimed land.

No. 688. "Electrodialysis in Studies of Soil Deficiencies," by C. O. Rost. In *Abstracts of the Proceedings of the First International Congress of Soil Science*, Commission II, pp. 104-107 (June, 1927).

The study reports the amount of lime and phosphoric acid removed by electrodialysis from soils whose response to lime and phosphate had been determined by a field experiment with alfalfa. From the soil showing the least response to liming the largest amount of lime was removed and generally larger amounts were removed from soils showing less response to liming. It was found that the amount of P_2O_5 removed from the soils showing no response to phosphate was greater on the average, but if one soil were omitted there was no significant difference between the responsive and non-responsive soils.

No. 689. "Effect of pH on Adsorption by Carbons," by S. M. Hauge and J. J. Willaman. In *Industrial and Engineering Chemistry*, Vol. 19, pp. 943-953 (1927).

The hydrogen-ion concentration of the medium greatly affects adsorption by decolorizing carbons. Proper control of hydrogen-ion concentration may afford a saving of as much as 75 per cent of the carbon usually employed. The various commercial carbons showed such different characteristics that they can not all be regarded as equally suitable for a specific decolorizing problem, neither can they be used interchangeably without pH control.

No. 690. "Physiological Specialization in *Tilletia levis* and *Tilletia tritici*," by H. A. Rodenhiser and E. C. Stakman. In *Phytopathology*, Vol. 17, pp. 247-253 (April, 1927).

Collections of *Tilletia levis* and *Tilletia tritici* were obtained from widely different localities and the degree of virulence with which they attack different varieties of wheat was studied. Both *T. levis* and *T. tritici* comprise distinct physiologic forms which can be recognized by the degree of their virulence on Kota and Marquis wheats and on Einkorn. It seems likely that still more forms, of both *T. levis* and *T. tritici*, could be distinguished if the proper differential hosts were found.

No. 691. "Phenomena Associated with the Destruction of the Chloroplasts in Tomato Mosaic," by Helen Sorokin. In *Phytopathology*, Vol. 17, pp. 363-379 (June, 1927).

A process of the actual dissolution of the protein of the chloroplast was observed in the chlorotic regions of the mosaic of tomato. Studies were made of living and fixed and stained material.

The normal chloroplasts are rather solid. The first indication of a pathological condition is the appearance of rapidly moving hyaline bodies within the chloroplasts. The movement of their bodies is possible only after liquefaction of the stroma of the chloroplasts has taken place. Therefore it is assumed that a proteolytic enzyme, possibly secreted by an organism, is present. An increased osmotic concentration results inside the chloroplast, and water is taken from the surrounding medium. Finally, the entire body of the chloroplast goes into solution and, if sufficient water is present, spherical transparent vesicles result. The sphere represents a "membrane" resulting from the digested chloroplast in which the digestion products and water are retained, the whole being surrounded by a surface film at the interface with water and containing moving bodies. The spheres give negative protein reactions, and are not soluble in alcohol, acetone, or acids. They can be fixed and stained by the methods used in the study of the inclusion of the animal virus diseases. We do not know whether or not the rapidly moving hyaline bodies are the "organisms" responsible for the destruction of the chloroplasts.

No. 692. "Detection of Sulfur-Deficiency of Soils by Means of Plants," by F. J. Alway. In *Abstracts of the Proceedings of the First International Congress of Soil Science*, Commission IV, pp. 78-79 (June, 1927).

The determination of the total sulfur content of alfalfa plants gives much promise of usefulness as a means of detecting the localities in which sulfur fertilizers are most likely to prove valuable, and even in the selection of particular fields. The common clovers and sweet clover may be similarly used, but none of these is as generally valuable as alfalfa as a trial crop in districts where fields

of the latter are common. The sulfur content was determined in samples of alfalfa from many plots on seven experimental fields, on which the relative response to sulfur fertilizers had already been ascertained. On the field in which alfalfa shows the greatest benefit from sulfur, the sulfur content of the entire tops varied from 0.09 to 0.11 per cent, while on five unresponsive fields it varied between 0.26 and 0.50 per cent. The use of the leaves alone for analysis is preferable in many cases, as they show a greater variation in sulfur content.

No. 693. "The Concentration of Glutenin and Other Proteins in Various Types of Wheat Flour," by Emily Grewe and C. H. Bailey. In *Cereal Chemistry*, Vol. 4, pp. 230-247 (May, 1927).

Flours milled from various types of wheat grown in the United States and Canada were examined to determine the variation in the gliadin-glutenin ratio, and it was found that among these flours of widely diverse origin and properties, the ratio was relatively constant. The correlation of the percentage of crude protein in these flours with the volume of loaf produced in experimental baking, was of the order of 0.7 ± 0.09 . Protein content accordingly appears to be of more service in ascertaining the baking strength of flour than is the gliadin-glutenin ratio, particularly when flours thus compared are not different in diastatic activity.

No. 695. "Agriculture Now," by J. D. Black. In *Journal of Agricultural Economics*, Vol. 9, No. 2, pp. 137-162 (April, 1927).

This paper is a plea for expansion of the fact-finding activities of public agencies dealing with agricultural problems. Only by securing true descriptions of conditions may intelligent programs for the future be developed.

The author examines in some detail the findings of various institutions that have presented studies of the welfare of farmers. A number of objections to these results are raised. The implication is that a new start needs to be made in finding out the condition of agriculture relative to other occupational groups.

No. 697. "Objectives and Methods in Rural Living Studies," by C. C. Zimmerman. In *Journal of Farm Economics*, Vol. IX, No. 2, pp. 223-238 (April, 1927).

This is a criticism of various concepts and methods in use in studies of rural living. An analysis of the purpose of these studies finds that "cost" of living and "standards" of living are not proper analytical terms because workers are primarily interested in the varying content of living behavior, whereas "costs" and "standards" are impossible to find and of little value. The conclusion is that no single measure of living content will suffice. A summary is given of the methods used in such studies in Minnesota.

No. 698. "Social Principles of Agricultural Co-operation," by C. C. Zimmerman. In *The Co-operative Marketing Journal*, Vol. 1, No. 6, pp. 162-164 (May, 1927).

This article summarizes some of the conclusions of Minnesota Technical Bulletin No. 45. It analyzes the relationship between attitudes favorable to co-operative marketing and other phenomena, such as co-operative experience, methods of promotion of co-operatives, methods of dealing with the membership (the use of legal coercion, education secrecy, and complexity of organization). Some principles of successful organization are proposed.

No. 706. "Maintenance Requirements for Calves, Tested by Live-B. M. Gile. In *Co-operative Marketing Journal*, Vol. 1, No. 7, pp. 187-191 (June, 1927).

Different methods of financing co-operative associations are discussed and special attention is given to the relative merits of stock and non-stock corporations. The principal conclusion in this connection is that the stock type of organization is generally preferable when relatively large amounts of fixed capital must be raised. Special mention is also made of financing crop advances and production loans, and of providing adequate reserve funds.

No. 705. "Maintenance Requirements for Calves, Tested by Live-Weight Method," by C. H. Eckles, T. W. Gullickson, and W. M. Neal. In *Journal of Dairy Science*, Vol. 10 (5), pp. 431-438 (1927).

Tests were made to check the accuracy of the Armsby figures for the maintenance requirement of calves. Animals receiving the amount prescribed by Armsby gained consistently about half a pound daily. From results with eleven animals in twenty-one maintenance periods the conclusion is drawn that the net energy necessary to maintain uniform weight in dairy calves in normal flesh is about 90 per cent of that set forth in Armsby's tables.

No. 706. "The Nature of the Combination Between Certain Acid Dyes and Proteins," by Ross Aiken Gortner. In *Journal of Biological Chemistry*, Vol. 74, pp. 409-413 (July, 1927).

It is suggested that the combination between certain acid dyes and proteins is due to the mutual precipitation of oppositely charged colloidal particles and not to the formation of a true chemical compound.

No. 710. "The Relation of Hydrogen-Ion Concentration of Dough to Baking Properties," by Emily Grewe and C. H. Bailey. In *Cereal Chemistry*, Vol. 4, pp. 261-270 (July, 1927).

Increasing the degree of acidity or hydrogen-ion concentration above that of the original flour appears to impair the physical properties of the dough in so far as its adaptability to bread making is concerned. The addition of alkali to the dough together with sufficient diastase to compensate for the reduced diastatic activity of alkaline doughs resulted in superior bread. Rate of change in diastatic activity with changing H-ion concentration was not uniform in all the flours, but was greatest in flours with high initial diastatic activity.

No. 712. "Notes on the Mechanism of Fermentation," by F. F. Nord. In *Science*, Vol. 65, pp. 474-477 (1927).

It is suggested that enzyme "activators" are in reality enzyme "protectors" and that no actual increase in enzyme activity above the normal occurs but rather that enzyme destruction is prevented, and thus the net amount of enzyme action within a given time is increased.

No. 715. "What Progress Are We Making as Cereal Chemists?" by C. H. Bailey. In *Cereal Chemistry*, Vol. 4, pp. 275-278 (July, 1927).

The development of cereal chemistry as a specialization in the field of applied biochemistry is traced. Emphasis is laid upon the significance now attached to

certain physical and physico-chemical properties of flour in their relation to baking strength. Progress made in the direction of standardizing analytical methods is believed to mark particularly the activities of the last decade. The statistical analysis of data accumulated in the development of new methods and in the study of the relation between certain variables is adding largely to the usefulness of these data.

EXPERIMENT STATION PROJECTS

1926-1927

Agricultural Biochemistry

- 101 Analytical Service (C. H. Bailey, G. S. Taylor, Roberto Oliver)
 Subproject: Analyses involving determination of moisture, protein, and crude fiber
 Subproject: Tests of wheat for milling and baking qualities
 Subproject: Feed analyses for division of animal husbandry
 Subproject: Miscellaneous analyses
- 102 Cereal and Flour Investigations (C. H. Bailey)
- 103 Investigation of Proposed Official Methods of Analysis (C. H. Bailey)
- 104 The Strength of Wheat Flour
 Subproject: Colloidal properties which may be involved in flour strength
 (a) The solubility of wheat flour proteins in various salt solutions (R. A. Gortner, W. B. Sinclair)
 (b) The relation between the peptizing action of salt solutions and flour strength (R. A. Gortner, C. H. Bailey, and technical assistants)
 (c) A gum as a constituent of wheat flour (R. A. Gortner, R. K. Larmour)
- Subproject: Other factors which may be involved in flour strength
 (a) Properties of durum wheat flours (C. H. Bailey, Herbert Vogel)
 (b) Protein fractions of flour and baking strength (C. H. Bailey, Emily Grewe, C. C. Fifield)
 (c) Diastatic activity in wheat flour (C. H. Bailey, Emily Grewe, Kathryn Tissue)
 (d) Effect of phosphates on the baking properties of flour (C. H. Bailey, R. A. Barackman)
 (e) Rancidity in baked products (C. H. Bailey, H. O. Triebold)
 (f) Checking or fracturing of baked cookies or biscuit (C. H. Bailey, J. A. Dunn)
 (g) Effect of dry skim milk on bread properties (C. H. Bailey, J. L. St. John)
- 201 The Biochemistry of Carotinoid Pigments in Animals (Dormant)
- 202 Chemical and Biological Studies in Animal Nutrition
 Subproject: The fundamental food requirements for animals (L. S. Palmer, Cornelia Kennedy)
 Subproject: The vitamin requirements of growing calves (L. S. Palmer, in co-operation with Dairy Husbandry)
 Subproject: A study of the nutritional requirements of certain insects (L. S. Palmer, Marion D. Sweetman, in co-operation with Division of Entomology and Economic Zoology)

- Subproject: The effect of dietary deficiencies on the oestrus cycle of the rat (L. S. Palmer, R. F. Light)
- 203 The Chemistry of Milk as a Colloidal System
 Subproject: The colloidal chemistry of rennin action and the coagulation and clotting phenomenon with rennin (L. S. Palmer, G. A. Richardson)
 Subproject: The churning phenomenon as an emulsion inversion (L. S. Palmer)
- 204 The Mineral Problems of Dairy Cattle in Minnesota (Joint project with Dairy Husbandry, No. 105) (L. S. Palmer, William Neal)
 Subproject: Effect of P and Ca supplements on mineral deficiency disease
 Subproject: Analysis of blood and bones
 Subproject: Growth and development of dairy calves on various planes of calcium and phosphorus
- 301 Chemical Studies on Forest Products (J. J. Willaman, R. A. Gortner, K. W. Franke, D. R. Briggs)
- 302 Comparative Studies on the Biochemistry of Normal and Abnormal Plants
 Subproject: Fermentation by *Fusarium lini* (J. J. Willaman, Mollie G. White)
 Subproject: Respiration of apple twigs in winter (Co-operative with Horticulture) (J. J. Willaman, J. H. Beaumont, W. A. DeLong)
 Subproject: Solution of carbon dioxide in tissues (J. J. Willaman, L. M. Greene)
 Subproject: Quality in potato tubers (Co-operative with Home Economics) (J. J. Willaman, Alice M. Child, Mary G. Lynch)
- 401 The Chemical and Physico-Chemical Properties of Plant Tissue Fluids (Dormant)
- 402 Chemical Studies of Pollen (Dormant) (R. A. Gortner, C. G. Vinson)
- 403 Protein Investigations
 Subproject: Proteins and the lyotropic series (R. A. Gortner, W. B. Sinclair)
 Subproject: The protein of wheat flour (R. A. Gortner, W. B. Sinclair)
 Subproject: Physico-chemical studies on derived proteins (R. A. Gortner, W. N. Sandstrom)
 Subproject: Electrical conductivity of protein compounds (R. A. Gortner, Harold M. Barnett)
 Subproject: The chemistry of glutelins from the cereal grains (R. A. Gortner, R. K. Larmour, Shevlin Fellow)
 Subproject: The basic amino acids of teosinte (R. A. Gortner, Lawrence Zeleny)
- #### Agricultural Economics
- 101 Agricultural Credit (J. D. Black, B. M. Gile)
 Subproject: The present agricultural credit situation in Minnesota (Completed)
 Subproject: Agricultural credit corporations
- 102 Elasticity of Supply of Farm Products (Dormant)
- 103 Farmers' Incomes in Minnesota (J. D. Black, W. C. Waite, D. Kittredge, A. Hinrichs)
- 104 Farmers' Marketing Attitudes (J. D. Black, Carle C. Zimmerman) (Completed)
- 105 Grain Dockage Investigations (Dormant)
- 106 Market Price Investigations (Dropped)
- 107 Market Price Quotations (Dormant)

- 108 Marketing of Farm Products (H. B. Price, A. Hinrichs, H. Rowe, W. Waite, T. Grinager)
 Subprojects: Problems of the Minnesota Co-operative Creameries Association
 Subproject: Organization and management problems of local creameries in Minnesota
 Subproject: Organization for selling livestock in the central market
 Subproject: Local concentration of livestock in Minnesota
 Subproject: Federation of local grain elevators
 Subproject: Margins on locally grown fruits and vegetables
 Subproject: Problems of the Lake Region Egg and Poultry Association
 Subproject: Co-operative marketing of honey
- 109 Market Organization Investigation (H. B. Price, H. Rowe)
- 110 Methods Employed by Private Agencies in Land Settlement (J. D. Black)
- 111 Methods of Land Valuation with Special Reference to Minnesota (J. D. Black, C. H. Hammar)
- 112 The Organization of Farmers' Supply Service (J. D. Black, H. B. Price, L. Myers, R. Froker)
- 113 Prices of Farm Products (J. D. Black, E. Working, W. Waite)
- 114 Taxation in Its Relation to Agriculture (J. D. Black, R. Ballinger)
 Subproject: The present agricultural situation in Minnesota
 Subproject: Comparative study of county and township expenditures in Minnesota
- 115 The Valuation of Agricultural and Forest Lands (J. D. Black, C. H. Hammar)
- 116 The Agricultural Surplus (W. Waite, G. Peterson)
- 117 A Study of Shifts in Agricultural Production in the Red River Valley of Minnesota (J. D. Black, B. Alvord)

Agricultural Engineering

- 101 Determination of the Relative Efficiency of Different Depths and Spacings of Drainage Lines (H. B. Roe, J. H. Neal, G. F. Krogh)
- 102 Drainage and Water Control Investigation on Peat Lands (H. B. Roe, J. H. Neal, G. F. Krogh)
- 103 Farm Building Ventilation (E. A. Stewart)
- 104 Farm Sewage Disposal (E. A. Stewart)
- 105 Heating and Ventilating of Homes (E. A. Stewart)
- 106 Hydro-Electric Plants (E. A. Stewart)
- 107 Investigation of Causes of Failure of Agricultural Drain Tile, the Means of Obviating Such Failures, and Mapping Areas where Extra Precautions are Necessary (Co-operative with U. S. Dept. of Agr., Bureau of Public Roads) (H. B. Roe, G. F. Krogh, P. W. Manson, for the University of Minnesota; D. G. Miller, P. G. McGrew, for the United States Department of Agriculture)
- 108 Investigations in Cost of Clearing Land (M. J. Thompson, A. J. Schwantes, J. J. McCurdy)
- 109 Investigations of Farm Tractors (J. B. Torrance)
 Subproject: Survey of factors governing successful tractor utilization
- 110 Investigations in Land Clearing Methods and Equipment (M. J. Thompson, A. J. Schwantes, B. H. Gustafson)
- 111 Investigation of Farm Buildings (H. B. White, M. G. Jacobson)

- 112 Land Clearing Investigations
 Subproject: Investigations in methods of stone removal (M. J. Thompson, A. J. Schwantes, B. H. Gustafson)
 Subproject: Investigations in power necessary for pulling stumps (M. J. Thompson, A. J. Schwantes)
 Subproject: Land clearing salvage—stone (M. J. Thompson, A. J. Schwantes)
 Subproject: Crop production following clearing of virgin land (M. J. Thompson, A. J. Schwantes, J. J. McCurdy)
 Subproject: Economic limitations of stump removal for pasture (M. J. Thompson, A. J. Schwantes, B. H. Gustafson)
- 113 Methods and Costs of Drainage Installation and Correlation of Land and Crop Values with Cost of Drainage
 Subproject: A study of the influence of tile drainage on soil temperature within the root zone of standard crops (H. B. Roe, J. H. Neal, G. F. Krogh)
- 114 The Utilization of Electricity in Agriculture (E. A. Stewart)
- 115 Wind-Power Electric Lighting Plants (E. A. Stewart)
- 116 Investigation of the Drainage Requirements of Swamp Forest Growth, of the Proper Type of Drainage System, and of the Methods and Costs of its Installation and Operation (Joint project with Forestry, No. 101) (Co-operative with Lake States Forest Experiment Station) (Raphael Zon, William Boss, H. B. Roe, A. J. Schwantes, B. H. Gustafson, Henry Schmitz, T. S. Hansen).
- 117 Investigations in Costs and Methods of Constructing Open Ditches with Explosives Under Varying Soil and Moisture Conditions (H. B. Roe, A. J. Schwantes)

Animal Husbandry

- 101 Baby Beef Feeding Trial (H. W. Vaughan, A. L. Harvey)
- 102 The Free-Choice Self-Feeder Method of Raising Beef Calves (Closed)
- 103 The Preparation of a Shelled Corn and Alfalfa Hay Ration for Fattening Yearling Steers (H. W. Vaughan, A. L. Harvey) (Closed)
- 104 A Comparison of Peatland and Upland Hays for Wintering Yearling Steers (H. W. Vaughan, A. L. Harvey) (Closed)
- 105 A Comparison of Alfalfa Hay and Peatland Timothy Hay Fed with Shelled Corn for Fattening Yearling Steers (H. W. Vaughan, A. L. Harvey)
- 201 The Cost and Advantages of Grinding Corn Fodder for Idle Horses (Joint project with Farm Management, Agronomy, and Plant Genetics No. 302) (W. H. Peters, L. B. Bassett) (Closed)
- 301 Studies in Wool and Other Animal Fibers (Co-operative with U. S. Dept. of Agr., Bureau of Animal Industry) (P. A. Anderson, for the University of Minnesota; E. W. Sheets, D. A. Spencer, J. I. Hardy)
 Subproject: Studies in the growth of wool
- 401 Swine Feeding Investigations (E. F. Ferrin, M. A. McCarty)
 Subproject: The value of ground rye fed with certain supplements as a ration for growing pigs
 Subproject: A comparison of protein supplements in rations for pigs following weaning
 Subproject: A comparison of the economy of full feeding and limited feeding of grain to growing pigs under dry lot and pasture conditions
 Subproject: Methods of watering pigs

- Subproject: A study of the cost of production and quality of the product from lard-type and from bacon-type hogs
- Subproject: A study of the production of Wiltshire sides from hogs of the lard and the bacon breeds
- Subproject: The feeding value of oats
- Subproject: The comparative value of corn and oats for growing pigs

Bee Culture

- 101 Bee Disease Inspection (James W. Thompson)
- 102 Investigations in Queen Breeding and Raising (Francis Jager)
- 103 Management of Bees (Francis Jager)
- 104 Bee and Honey Survey of Minnesota (James W. Thompson)
- 105 Studies in Pollen (Francis Jager)

Dairy Husbandry

- 101 Factors Influencing the Vitamin Content of Milk (Dormant) (Dropped)
- 102 Feeding Tests with Crops New to Minnesota (O. G. Schaefer)
- 103 Food Requirements for Cattle (C. H. Eckles, T. W. Gullickson)
- Subproject: The energy requirement for growth
- Subproject: The maintenance requirement of growing cattle
- Subproject: The relation of vitamins to the growth of dairy cattle and to milk production
- Subproject: The deficiencies of milk as an exclusive diet for calves
- 104 The Immediate Influence of Various Feeds upon the Quantity and Quality of Milk (W. E. Petersen)
- 105 The Mineral Problems of Dairy Cattle in Minnesota (Joint project with Agricultural Biochemistry, No. 204) (C. H. Eckles, T. W. Gullickson)
- Subproject: Effect of P and Ca supplements on mineral deficiency disease
- Subproject: Analysis of blood and bones
- Subproject: Growth and development of dairy calves on various planes of calcium and phosphorus
- 201 The Accuracy of Methods of Making Composite Samples in Minnesota Creameries (W. B. Combs, L. M. Thurston, A. E. Groth, S. T. Coulter)
- 202 Factors Influencing the Composition and Market Qualities of Butter (H. Macy, L. M. Thurston, W. B. Combs, A. E. Groth, H. B. Richey, S. T. Coulter, Geo. M. Pulkrabek)
- Subproject: Moldiness in butter
- Subproject: Cheesy flavors in butter
- 203 Ice Cream Studies (Dormant)
- 204 Increasing the Production of Dairy Cows by Better Feeding (O. G. Schaefer)
- 205 The Loss of Fat in Churning Sweet Cream and Methods for Its Control (W. B. Combs, L. M. Thurston, A. E. Groth, S. T. Coulter)
- Subproject: Methods of testing buttermilk
- Subproject: Methods for reducing the loss of fat in sweet cream buttermilk
- 206 Powdered Milk Studies (Dormant) (Closed)

Entomology and Economic Zoology

- 101 Alfalfa Weevil (Dormant)
- 102 Biologic and Taxonomic Studies on the Mutillidae (Hymenoptera) (C. E. Mickel)
- 103 The Bronze Birch Borer (*Agrilus anxius*) (Dormant)
- 104 Cucumber Insects (Dormant)

- 105 Economic Status of Fur-Bearing Animals of Minnesota (M. S. Johnson)
- Subproject: The status of fur-farming in Minnesota
- 106 Effect of Physical Factors upon Insects in Freshly Cut Logs (S. A. Graham)
- 107 The Endoparasites of Man and Domesticated Animals (Dormant)
- 109 Grasshopper Control (Dormant)
- 110 Greenhouse Insects (A. G. Ruggles, H. L. Parten)
- 111 Insect Collection (C. E. Mickel)
- Subproject: Insect collection, University Farm
- Subproject: Insect collection, Itasca Park
- 112 Insect Defoliators of Forest Trees (S. A. Graham)
- Subproject: Jack pine sawfly
- Subproject: The spruce budworm on jack pine
- Subproject: Spruce budworm on spruce and fir
- 113 Insectary Work (A. G. Ruggles, T. L. Aamodt)
- 114 Insects Infesting Stored Food Products (Dormant)
- Subproject: Measure for protecting flour and other cereals from insect attack
- Subproject: The protection of dried fruit from insects
- 115 Insects of Orchard with Best Means of Combating (Dormant)
- Subproject: Plant lice
- Subproject: Apple maggot
- 116 Insecticides (A. G. Ruggles)
- Subproject: Orchard spraying (Dormant)
- Subproject: Potato spraying (Co-operative with Plant Pathology and Botany)
- 117 Jack Pine Insects (Included as part of No. 112)
- 118 Life History and Injury of the Potato Leaf-Hopper *Empoasca mali* (Dormant)
- 119 The Parasites and Symbionts of Insects (Dormant)
- 120 The Productivity of Minnesota Lakes in Fish and Fish Food (M. S. Johnson)
- Subproject: Classification of Minnesota lakes by physical characters
- 121 Soil Insects, "White Grubs" (A. G. Ruggles, H. L. Sweetman)
- 122 A Study of Derris and Related Insecticides for the Control of External Parasites of Domesticated Animals (O. C. McBride)
- 123 A Study of the Hookworms of the Dog and the Domesticated Fox (Dormant)
- 124 A Study of the Rôle of Temperature and Humidity in the Development and Control of Insects in Flour and Other Cereal Products and in Cereals While in Storage (Wm. Robinson)
- Subproject: Study of temperatures of grain in storage when left undisturbed and when run during cold weather. Effect of chilled grain upon mortality of grain weevils.
- Subproject: Continuation of experiments on low temperature and moisture as factors in the ecology of grain weevils
- Subproject: Continuation of moisture determination of insects by electric method
- 125 A Study of the Tabanidae or Horseflies of Minnesota (Dormant)
- 126 Use of Chlorpicrin Either Alone or in Combination with Paradichlorobenzene or Carbon Tetrachloride for Fumigating Grain in Elevators (A. L. Strand)
- 127 Field Crop Insects (A. G. Ruggles, F. M. Wadley)
- Farm Management, Agronomy, and Plant Genetics**
- 101 Cost Accounting Investigations on Minnesota Farms (G. A. Pond, A. T. Hoverstad, G. A. Sallee, F. H. Tomlinson, W. J. Roth, Bess M. Miller)
- Subproject: Detailed farm records and accounts in Pine County, Minnesota

- 102 A Study of the Organization of Farms in the Red River Valley (A. T. Hoverstad, D. C. Mumford, G. A. Sallee, C. O. Ruud, Hilda A. Kiehne)
- 201 Co-operative Trials of Farm Crops at the Branch Stations (A. C. Arny, H. B. Sprague, R. E. Hodgson, R. O. Bridgford, R. S. Dunham, O. I. Bergh, M. J. Thompson)
- 202 Crop Rotation Investigations (A. C. Arny, F. W. McGinnis, F. L. Higgins)
 Subproject: Field C rotations
 Subproject: Field T rotations
 Subproject: Alternate and continuous cropping
 Subproject: Effect of crops on those that follow
- 203 Forage Crop Investigations (A. C. Arny, F. W. McGinnis, J. W. Nelson, F. L. Higgins)
- 204 Investigations in the Growing of Small Grains (H. B. Sprague, A. C. Arny, F. W. McGinnis)
- 205 Studies in the Classification of Farm Crops (A. C. Arny, H. B. Sprague, A. C. Dillman)
- 301 Comparison of Fence Posts (L. B. Bassett)
- 302 The Cost and Advantages of Grinding Corn Fodder for Idle Horses (Joint project with Animal Husbandry No. 201) (Closed)
- 303 A Study of the Physical Organization of Farms (Dormant)
 Subproject: The farm layout
 Subproject: The farmstead arrangement
- 304 Types of Farming and Production Areas in Minnesota (L. F. Garey, Andrew Boss, V. J. Olson)
- 305 Hay Stack and Mow Measurement (Co-operative with U. S. Dept. of Agr., Bureau of Agricultural Economics) (Andrew Boss, A. T. Hoverstad, for the Minnesota Agricultural Experiment Station; W. A. Wheeler, H. R. Tolley, for the United States Department of Agriculture)
- 401 Breeding of Miscellaneous Field Crops (H. K. Hayes, F. J. Stevenson, Fred Hull, S. E. Clark, V. Nielsen)
 Subproject: To determine the value of selection in self-fertilized lines as a means of improving red clover
 Subproject: The mode of pollination of grasses and the effects of self-fertilization
 Subproject: Improvement of sweet clover
- 402 Corn Breeding Investigations (H. K. Hayes, H. E. Brewbaker, F. R. Immer, Fred Hull, J. H. Lefforge, R. E. Hodgson, R. S. Dunham, R. O. Bridgford, Alma Schweppe, G. Nilsson-Leissner, V. Nielsen, and L. Jorgenson)
 Subproject: A study of the inheritance of certain characters in corn
 Subproject: Improvement of corn through inbreeding and subsequent cross-breeding
 Subproject: Corn improvement at Waseca
 Subproject: The production of improved varieties of corn for northern Minnesota
 Subproject: The production of improved varieties of corn for west central Minnesota
- 403 The Development of Disease Resistant Varieties of Farm Crops (Co-operative with Plant Pathology and Botany No. 104) (H. K. Hayes, E. C. Stakman, O. S. Aamodt, F. J. Stevenson, H. E. Brewbaker, F. R. Immer, S. E. Clarke, G. Proytchoff, G. Nilsson-Leissner)

- Subproject: The development of rust-resistant varieties of wheat (Co-operative with U.S. Dept. of Agr.)
- Subproject: The genetics of biologic forms of *P. graminis*
- Subproject: The development of varieties of wheat resistant to bunt
- Subproject: The development of varieties of oats resistant to black stem rust
- Subproject: The development of varieties of corn resistant to root and stalk rots
- Subproject: The development of pure lines of corn resistant to smut
- Subproject: The development of desirable agronomic types of barley resistant to *Helminthosporium sativum*
- Subproject: Resistance of wheat varieties to wheat scab
- Subproject: Varietal resistance of wheat, barley, rye, and oats to root and culm rots
- Subproject: The production of high-yielding rust-resistant timothy
- Subproject: Flax wilt (Co-operative with U. S. Dept. of Agr.)
- Subproject: The development of varieties of flax resistant to rust (Co-operative with U. S. Dept. of Agr.)
- 404 The Development of Improved Sorts of Corn (H. K. Hayes, H. E. Brewbaker)
 Subproject: The determination of characters of selfed lines which are of importance for breeding purposes
 Subproject: Utilization of selfed lines in producing improved sorts
- 405 Inheritance Studies with Small Grains (H. K. Hayes, F. J. Stevenson)
 Subproject: Effects of selection in pure lines and the inheritance of characters of small grains
 Subproject: The chromosome number of different farm crops and their near relatives
- 406 Investigations in Cereal Breeding (H. K. Hayes, F. J. Stevenson, H. E. Brewbaker, S. E. Clarke, F. R. Immer, Lee Alexander, A. Schweppe, and Branch station agronomists)
 Subproject: To produce hardy winter wheats of high yielding ability and high milling quality which contain other desirable agronomic characters
 Subproject: To produce improved varieties of spring wheat
 Subproject: To produce improved varieties of oats
 Subproject: To produce improved varieties of barley
 Subproject: To isolate pure forms of rye by continuous selection; to study improvement of rye by selection in self-fertilized lines; and to obtain improved varieties for Minnesota
 Subproject: To determine the best methods of technic in plant breeding
 Subproject: Tests of new varieties in rod rows
- 501 Co-operative Seed Production and Distribution (A. D. Haedecke)

Forestry

- 101 Investigation of the Drainage Requirements of Swamp Forest Growth, of the Proper Type of Drainage System, and of the Methods and Costs of Its Installation and Operation (Joint project with Agricultural Engineering No. 116) (Co-operative with U. S. Dept. of Agr., Forest Service) (Raphael Zon, Wm. Boss, H. B. Roe, A. J. Schwantes, B. H. Gustafson, Henry Schmitz, T. S. Hansen)
- 102 Management of the Cloquet Forest (T. S. Hansen)

- 103 Pathology of Aspen in Relation to Its Management and Utilization (H. Schmitz, R. M. Brown, Lyle Jackson) (Closed)
- 104 Possibilities of Cut-over Lands in Minnesota (T. S. Hansen)
- 105 Preservative Treatment of Fence Posts—Zumbra Heights, University Farm (Henry Schmitz, J. H. Allison)
- 106 Studies of Forest Planting (T. S. Hansen)
- 107 Thinning of Jack and Norway Pine (Dormant)
- 108 Volume, Growth, and Yield Studies of Birch and Aspen in Northern Minnesota (R. Zon, S. R. Gevorkiantz)
- 109 Windbreak Planting Investigations (E. G. Cheyney, R. M. Brown)
- 110 Studies in Yield and Volume (J. H. Allison)
- 111 Working Plan for the Cloquet Forest Area (J. H. Allison, T. S. Hansen)
- 112 Woodlot Study (E. G. Cheyney, R. M. Brown) (Closed)

Home Economics

- 101 A Quantitative and Qualitative Study of Farm Homes in Minnesota with Emphasis on the Influence of the Farms on the Management of the Home and the Life of the Family (Lucy A. Studley)
Subproject: A study of approximately 100 farm homes in Cottonwood and Steele Counties
- 102 The Relation of Diet to Blood Formation and Regeneration (Jane M. Leichsenring)
Subproject: The influence of the vitamins on the rate of blood regeneration
- 103 A Study of the Cooking of Pork Products (Alice M. Child)
Subproject: A study of bacon
Subproject: A study of ham
Subproject: A study of pork roasts
Subproject: A comparison of quality and losses in bacon, ham, and pork (loin) roasts from three breeds of hogs—Duroc Jersey, Poland China, and Yorkshire

Horticulture

- 101 Study of Ornamental Varieties and Their Uses (C. E. Cary)
- 102 Turf Construction and Maintenance (C. E. Cary)
- 201 Hardiness Studies in Fruit Breeding (J. H. Beaumont, W. H. Alderman, A. C. Hildreth, W. A. De Long, A. N. Wilcox, H. P. Traub)
- 202 Sterility Studies in Fruit Breeding (J. H. Beaumont, W. H. Alderman, A. N. Wilcox)
- 203 A Study of the Inheritance of Characters in Fruits (J. H. Beaumont, W. H. Alderman, A. N. Wilcox, F. E. Haralson)
- 301 Blueberry Culture (W. G. Brierley, A. C. Hildreth)
- 302 Co-operative Orchard Management (W. G. Brierley, A. C. Hildreth)
- 303 Cost of Producing Fruits (Dormant)
- 304 Fruit Variety Studies (W. G. Brierley and W. H. Alderman)
- 305 Nut Culture in Minnesota (W. G. Brierley)
- 306 Nature of Winter Injury Arising From Fall Planting of Apple Trees in Minnesota (A. C. Hildreth, W. G. Brierley)
- 401 Anatomy and Taxonomy of the Parsnip, Winter Radish, Spinach, Rutabaga, Salsify, and Celeriac (H. P. Traub, B. I. Burrell)
- 402 Vegetable Breeding and Selection (F. A. Krantz, H. P. Traub)
- 403 Effect of Differential Water Table on the Development of Vegetable Crop Plants on Peat Lands (H. P. Traub, F. A. Krantz)

- 404 Hardening-off Process in Vegetable Crop Plants (H. P. Traub)
- 405 Isolation of Strains of Girasole, Dahlia, and Chicory with Relative High Inulin and Inulide Content (H. P. Traub)
- 406 Nutrition Studies in Vegetable Crop Plants (H. P. Traub, F. A. Krantz)
- 407 Onion Culture on Peat and Mineral Lands (H. P. Traub, F. A. Krantz)
- 408 Potato Breeding (F. A. Krantz)
Subproject: A study of the relative productivity of certified seed stocks and of the factors affecting the production of good seed stock (Completed)
Subproject: Potato breeding methods
Subproject: Inheritance in the potato
- 409 Storage of Girasole Tubers (H. P. Traub)
- 410 Storage of Husk Tomato in the Dehydrated Condition (H. P. Traub)
- 411 Summer Frost Prevention on Peat and Muck Lands (H. P. Traub, F. A. Krantz)
- 412 Vegetable Experiments on Peat Land (F. A. Krantz, B. I. Burrell, H. P. Traub, W. H. Alderman)

Plant Pathology and Botany

- 101 Cereal and Forage Crop Diseases (E. C. Stakman, J. J. Christensen, A. W. Henry, C. V. Kightlinger, H. A. Rodenhiser, Chih Tu)
Subproject: Imperfects on cereals
Subproject: Smut treatments
Subproject: Scab of cereals
Subproject: Ergot of cereals
Subproject: Black chaff of wheat
Subproject: Smuts of sorghum
- 102 The Control of Weeds by Cyanamid (E. C. Stakman, W. C. Broadfoot, H. H. Flor, L. W. R. Jackson) (Closed)
- 103 Dendropathological Work (E. C. Stakman, Lyle Jackson, Ralph Lindgren)
Subproject: Miscellaneous Itasca Park experiments
Subproject: The rotting of posts and poles
Subproject: Relation of environment to damping off
Subproject: Pathology of aspen in relation to the management and utilization of species in Minnesota (Co-operative with Forestry)
Subproject: White pine blister rust
Subproject: Effect of the degree of rot on the mechanical properties of Norway pine, spruce, birch, and poplar (Co-operative with Forestry)
- 104 The Development of Disease-Resistant Varieties of Farm Crops (Joint project with Farm Management, Agronomy, and Plant Genetics No. 403) (E. C. Stakman, J. J. Christensen, A. W. Henry, P. D. Peterson, H. A. Rodenhiser, C. V. Kightlinger, Chih Tu, for the Division of Plant Pathology; O. S. Aamodt, M. N. Levine, for the U. S. Dept. of Agr., Bureau of Plant Industry)
Subproject: The development of rust-resistant varieties of wheat
Subproject: The genetics of biologic forms of *Puccinia graminis*
Subproject: The development of smut-resistant grain
Subproject: The development of varieties of oats resistant to black stem rust
Subproject: The development of varieties of corn resistant to root and stalk rot

- Subproject: The development of desirable agronomic types of barley resistant to *Helminthosporium sativum*
- Subproject: The resistance of wheat varieties to wheat scab
- Subproject: Varietal resistance of wheat, barley, rye, and oats to root and culm rots
- Subproject: The production of high-yielding rust-resistant timothy
- Subproject: Flax wilt
- Subproject: The development of varieties of flax resistant to rust
- 105 Diseases of Ornamental Plants (Louise Dossdall)
- 106 The Effect of Ammo-Phos on the Development of Plant Diseases (E. C. Stakman, W. C. Broadfoot, H. H. Flor, L. W. R. Jackson) (Closed)
- 107 The Effect of Cyanamid on the Development of Plant Diseases (E. C. Stakman, W. C. Broadfoot, H. H. Flor, L. W. R. Jackson) (Closed)
- 108 Fruit Diseases (E. C. Stakman, P. D. Peterson, H. W. Johnson)
- Subproject: Experimental apple spraying (Co-operative with Entomology and Economic Zoology)
- Subproject: Experimental plum spraying
- Subproject: Diseases of small fruits and methods of control
- Subproject: Biology of *Sclerotinia spp.*
- Subproject: Raspberry mosaic (Co-operative with Entomology and Economic Zoology)
- 109 Minnesota Mushrooms (Louise Dossdall)
- 110 Plant Disease Survey (Louise Dossdall)
- 111 Rusts of Cereals (Co-operative with U. S. Dept. of Agr., Office of Cereal Investigations) (E. C. Stakman, J. G. Leach, J. J. Christensen, A. W. Henry, Helen Hart, C. V. Kightlinger, J. M. Wallace, Chih Tu, H. E. Parson, for the University of Minnesota; M. N. Levine, O. S. Aamodt, E. B. Lambert, L. W. Melander, R. U. Cotter, for the U.S. Dept. of Agr.)
- Subproject: Nature of resistance
- Subproject: Biologic specialization in cereal rusts
- Subproject: Epidemiology of cereal rusts
- Subproject: Barberry eradication
- Subproject: Dusting to control cereal rust
- 112 The Microflora of Moldy Silage and Hay (Revived) (In co-operation with Agricultural Biochemistry and Veterinary Medicine) (J. J. Willaman, C. P. Fitch, P. D. Peterson)
- 113 Diseases of Canning Crops (E. C. Stakman, J. G. Leach, H. H. Thornberry, C. G. Anderson)
- 114 Pathological Changes Occurring in Storage and Ripening of Fruits and Vegetables Under Varying Conditions (E. C. Stakman, P. D. Peterson)
- 201 Effect of Low Temperature on Plants (R. B. Harvey, L. O. Regeimbal, E. T. Erickson)
- 202 Hollow Heart of Potatoes (R. B. Harvey) (Dormant) (Dropped)
- 203 Investigations on Respiratory Enzymes (R. B. Harvey, L. O. Regeimbal)
- 204 Light Relations of Forest Reproduction (R. B. Harvey, L. O. Regeimbal)
- 205 Physiological Changes Occurring in the Storage and Ripening of Fruits and Vegetables Under Varying Conditions (R. B. Harvey, L. O. Regeimbal)
- 206 Physiology of Reproduction (R. B. Harvey) (Dormant)
- 207 Physiology of Seed Germination (R. B. Harvey, G. A. Vacha, E. T. Erickson)

- 208 Garden Truck Diseases (J. G. Leach, H. E. Parson)
- Subproject: Bean bacteriosis and anthracnose
- Subproject: Potato diseases
- Subproject: Miscellaneous truck crop diseases
- Subproject: The relation of dipterous insects to the spread and development of soft rot of vegetables
- 209 Studies in Plant Metabolism and Growth (R. B. Harvey, L. O. Regeimbal, E. T. Erickson)
- Subproject: Effect of length of illumination period and light intensity upon growth and reproduction
- Subproject: Effect of increased CO₂ supply upon plant growth and reproduction
- Subproject: Salt nutrition
- Subproject: Effect of nightly illumination on control of seedling diseases
- 301 Seed Studies (A. H. Larson)
- Subproject: Weed seed cases
- Subproject: Seed testing survey
- Subproject: Germination of lettuce seed
- 302 Weeds (A. H. Larson, E. T. Erickson)
- Subproject: Perennial sow thistle

Poultry Husbandry

- 101 The Determination of the Efficiency of Different Forms of Liquid Milk as a Substitute for the Mash Customarily Fed (A. C. Smith, A. A. Hoberg)
- Subproject: To determine the adaptability and practicability of feeding liquid milk to young chicks during the brooding age
- Subproject: To determine the amount of milk chicks will consume when water and the customary mixed fine feeds of mashes are absolutely withheld
- Subproject: To determine the relative efficiency of (a) sweet whole milk, (b) sweet skim milk, (c) sour skim milk, (d) buttermilk as measured by the economic standards named in the first subproject:
- Subproject: To determine the effect of above rations on maturity, size, and production of pullets
- 102 Effect upon Mortality, Growth, and Feather Development of Feeding Leghorn Chicks Different Amounts of Different Animal Foods (A. C. Smith, A. A. Hoberg) (Closed)
- 103 The Raising of Young Turkeys by Artificial Methods (Co-operative with Veterinary Medicine) (A. C. Smith, A. A. Hoberg) (Closed)
- Subproject: Artificial hatching
- Subproject: Artificial brooding
- Subproject: Feeding
- Subproject: Costs per pound of gain

Soils

- 101 Agricultural Value of Marl (Dormant) (Closed)
- 102 Fertilizer Experiments (F. J. Alway, G. H. Nesom, Wm. Methley)
- 103 Hydrogen-ion Concentration of Soils (C. O. Rost)
- 104 Land Classification (F. J. Alway, P. R. McMiller)
- 105 Movement of Water in Soils (F. J. Alway, J. H. Ellis)

- 106 Peat Soils (F. J. Alway, G. H. Nesom, W. Methley)
 107 Sandy Soils (F. J. Alway, G. H. Nesom, W. Methley)
 108 Soils of the Low-Lime Area (F. J. Alway, C. O. Rost)
 109 Soil Survey (F. J. Alway, P. R. McMiller, G. B. Bodman)
 110 Soils of the Red Drift (F. J. Alway, G. B. Bodman)

Veterinary Medicine

- 101 The Chemistry of the Blood and Urine of Animals Affected with Specific and Obscure Diseases (E. A. Hewitt)
 102 Contagious Abortion of Mares and Pyaemic Arthritis of Foals (W. L. Boyd, C. P. Fitch) (Dormant)
 103 Diseases of Poultry (C. P. Fitch, H. C. H. Kernkamp, R. E. Lubbehusen, Edith Cavilla)
 Subproject: Tuberculosis
 Subproject: Bacillary white diarrhea
 Subproject: Enterohepatitis
 104 Infectious Abortion and Other Diseases of the Reproductive Organs of Cattle (C. P. Fitch, W. L. Boyd, R. E. Lubbehusen, Edith Cavilla)
 Subproject: The pathology and treatment of sterility
 Subproject: Serological tests in their relation to bovine infectious abortion
 Subproject: Bacterial flora of the vagina and uterus of the cow (Dormant)
 Subproject: Infectious white scours and calf pneumonia (Dormant)
 Subproject: The function of the corpus luteum
 Subproject: Production of artificial immunity
 Subproject: Effect of pituitrin on delayed parturition, expulsion of the fetal membranes, and subinvolution of the uterus
 Subproject: Channels of infection in bovine infectious abortion
 Subproject: Biological requirements of *Bact. abortus* Bang.
 Subproject: Elimination of *Bact. abortus* through excretions and secretions
 Subproject: The clean and the infected herd
 105 Investigation of Obscure Diseases (C. P. Fitch, W. L. Boyd, H. C. H. Kernkamp, E. A. Hewitt, Edith Cavilla, R. E. Lubbehusen)
 Subproject: The investigation of obscure diseases in the state, with special reference to infectious diseases
 Subproject: The investigation and treatment of diseases affecting University Farm animals
 106 State Regulatory Work (M. H. Reynolds)
 107 Tuberculin Tests (M. H. Reynolds)
 Subproject: Relative accuracy of the several tests
 Subproject: Relative desirability of the several combinations of these tests
 Subproject: Different responses to the several tests in relation to extent of lesions, activity, and virulence
 Subproject: Significance of slight and atypical reactions
 Subproject: Tuberculin hypersensitiveness in nontuberculous cattle

General

- 101 Rural Living in Minnesota (C. C. Zimmerman, L. Myers)
 Subproject: A study of the distribution of cash income of farmers
 Subproject: The objectives of rural living studies

FINANCIAL STATEMENT

The Minnesota Agricultural Experiment Station in Account with the
 United States Department of Agriculture

1926-1927

	Dr.		
To receipts from the Treasurer of the United States in accordance with the appropriations for the fiscal year ending June 30, 1927, under the Act of Congress approved March 2, 1887.....			\$15,000.00
	Cr.		
By salaries		\$15,000.00	
			<hr/>
Total Hatch Fund.....		\$15,000.00	\$15,000.00
	Dr.		
To receipts from the Treasurer of the United States in accordance with the appropriations for the fiscal year ending June 30, 1927, under the Act of Congress approved March 16, 1906.....			\$15,000.00
	Cr.		
By salaries		\$15,000.00	
			<hr/>
Total Adams Fund.....		\$15,000.00	\$15,000.00
	Dr.		
To receipts from the Treasurer of the United States in accordance with the appropriations for the fiscal year ending June 30, 1927, under the Act of Congress approved February 24, 1925.....			\$30,000.00
	Cr.		
By salaries		\$22,813.31	
By travel, supplies, equipment.....		7,186.69	
Total Purnell Fund.....		\$30,000.00	\$30,000.00

Supplementary Statement

Receipts from sources other than the United States for the year ending June 30, 1927:

State appropriations	\$241,922.96
Special appropriations	30,000.00
Fees	54,267.00
Sales	127,555.19
	<hr/>
Total	\$453,745.15

Expenditures, Central Experiment Station and Branch Stations, 1926-1927

	University Farm	Crookston	Morris	Grand Rapids	Duluth	Waseca	Zumbra Heights	Albert Lea	Total
Salaries and labor.....	\$235,080.59	\$23,577.57	\$22,449.98	\$7,529.67	\$9,921.72	\$8,234.61	\$8,164.38	\$2,399.97	\$317,358.49
Stationery and office supplies.....	2,406.44	453.61	303.83	259.53	74.04	52.98	36.45	.....	3,586.88
Scientific supplies, consumable.....	5,002.50	26.58	104.75	10.03	45.18	52.20	.....	.....	5,241.24
Feeding stuffs	12,493.42	3,185.18	2,337.44	1,871.89	1,870.29	1,269.45	137.61	.....	23,165.28
Sundry supplies	17,481.94	2,491.79	2,694.18	907.97	1,559.70	2,539.44	1,213.50	224.38	29,112.90
Fertilizers .....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Communication service	3,450.73	321.54	329.30	132.39	128.34	108.75	56.43	21.12	4,548.60
Travel expense	13,069.38	946.78	756.81	428.83	391.23	272.97	117.60	202.53	16,186.13
Transportation of things.....	1,113.86	409.74	292.48	236.71	248.61	135.00	61.32	.....	2,497.72
Publications	3,196.55	421.65	259.24	96.05	6.03	9.96	8.13	1.17	3,998.78
Heat, light, water, power.....	10,408.49	2,322.12	2,201.62	1,008.59	307.47	548.58	1,261.83	.....	18,058.70
Furniture, fixtures, furnishings.....	3,773.24	1,163.45	863.84	421.09	42.48	29.58	.....	.....	6,293.68
Library	3,018.64	266.37	51.09	278.38	.....	.....	.....	.....	3,614.48
Scientific equipment	3,081.61	7.43	.....	3.21	.....	.....	.....	.....	3,092.25
Livestock	4,226.81	1,129.95	1,252.41	66.67	681.57	48.75	.....	.....	7,406.16
Tools, machinery, appliances.....	1,698.09	906.06	934.01	496.12	95.22	475.05	684.24	1,654.08	6,942.87
Buildings and land.....	75.12†	533.48	-639.80*	.....	290.55	235.14	.....	.....	495.09
Contingent expenses	780.11	-138.85*	554.83	362.11	160.83	220.83	190.62	15.42	2,145.90
Total	\$320,358.12	\$38,024.45	\$34,746.01	\$14,109.24	\$15,823.26	\$14,233.29	\$11,932.11	\$4,518.67	\$453,745.15

* Credit charge due to adjustments in accounting.

† Does not include \$94,411.87 spent on new plant industry building.

EXPERIMENT STATION STAFF

The Board of Regents

The Hon. Fred B. Snyder, Minneapolis	-	-	-	-	-	-	-	-	1928
The President of the Board	-	-	-	-	-	-	-	-	-
Lorus D. Coffman, Minneapolis	-	-	-	-	-	-	-	-	Ex Officio
The President of the University	-	-	-	-	-	-	-	-	-
The Hon. Theodore Christanson, St. Paul	-	-	-	-	-	-	-	-	Ex Officio
The Governor of the State	-	-	-	-	-	-	-	-	-
The Hon. J. M. McConnell, St. Paul	-	-	-	-	-	-	-	-	Ex Officio
The Commissioner of Education	-	-	-	-	-	-	-	-	-
The Hon. W. J. Mayo, Rochester	-	-	-	-	-	-	-	-	1931
The Hon. Bess M. Wilson, Redwood Falls	-	-	-	-	-	-	-	-	1931
The Hon. George H. Partridge, Minneapolis	-	-	-	-	-	-	-	-	1932
The Hon. Earl Boeckmann, St. Paul	-	-	-	-	-	-	-	-	1933
The Hon. John G. Williams, Duluth	-	-	-	-	-	-	-	-	1933
The Hon. A. D. Wilson, Guthrie	-	-	-	-	-	-	-	-	1928
The Hon. Julius A. Collier, Shakopee	-	-	-	-	-	-	-	-	1928
The Hon. J. E. G. Sundberg, Kennedy	-	-	-	-	-	-	-	-	1929
The Hon. Samuel Lewison, Canby	-	-	-	-	-	-	-	-	1933

The Agricultural Committee

The Hon. J. E. G. Sundberg, Chairman	The Hon. Bess M. Wilson
The Hon. J. G. Williams	The Hon. Samuel Lewison
The Hon. J. M. McConnell	President L. D. Coffman
The Hon. A. D. Wilson	

Administrative Officers

W. C. COFFEY, M. S., L.L.D., Director
 ANDREW BOSS, D.Sc., Vice-Director
 F. W. PECK, M.S., Director of Agricultural Extension and Farmers' Institutes
 *C. G. SELVIG, M.A., Superintendent, Northwest Experiment Station, Crookston
 †A. A. DOWELL, M.S., Superintendent, Northwest Experiment Station, Crookston
 P. E. MILLER, M.Agr., Superintendent, West Central Experiment Station, Morris
 O. I. BERGH, B.S.Agr., Superintendent, North Central Experiment Station, Grand Rapids
 M. J. THOMPSON, M.S., Superintendent, Northeast Experiment Station, Duluth
 R. E. HODGSON, B.S. in Agr., Superintendent, Southeast Experiment Station, Waseca
 F. E. HARALSON, Assistant Superintendent, Fruit Breeding Farm, Zumbra Heights, (P. O. Excelsior)
 RAPHAEL ZON, F.E., Director, Forest Experiment Station, Cloquet
 W. P. KIRKWOOD, M.A., Editor, and Chief, Division of Publications
 ALICE MCFEELY, Assistant Editor of Bulletins
 HARRIET W. SEWALL, B.A., Librarian
 ‡T. J. HORTON, Photographer
 R. A. GORTNER, Ph.D., Chief, Division of Agricultural Biochemistry
 §J. D. BLACK, Ph.D., Chief, Division of Agricultural Economics
 WILLIAM BOSS, Chief, Division of Agricultural Engineering
 W. H. PETERS, M.Agr., Chief, Division of Animal Husbandry
 FRANCIS JAGER, Chief, Division of Bee Culture
 C. H. ECKLES, M.S., D.Sc., Chief, Division of Dairy Husbandry
 ||R. N. CHAPMAN, Ph.D., Chief, Division of Entomology and Economic Zoology
 ANDREW BOSS, D.Sc., Chief, Division of Farm Management, Agronomy, and Plant Genetics
 H. SCHMITZ, Ph.D., Chief, Division of Forestry
 ||W. H. ALDERMAN, B.S.A., Chief, Division of Horticulture
 E. M. FREEMAN, Ph.D., Chief, Division of Plant Pathology and Botany
 A. C. SMITH, B.S., Chief, Division of Poultry Husbandry
 F. J. ALWAY, Ph.D., Chief, Division of Soils
 C. P. FITCH, M.S., D.V.M., Chief, Division of Veterinary Medicine

* Resigned March 5, 1927.

† Appointed April 15, 1927.

‡ Resigned October 1, 1926.

§ On leave, February 19 to June 30, 1927.

|| On sabbatical leave, 1926-27.

Division of Agricultural Biochemistry

ROSS AIKEN GORTNER, Ph.D., Agricultural Biochemist

Section of Proteins and Colloids

ROSS AIKEN GORTNER, Ph.D., Agricultural Biochemist
 WALTON B. SINCLAIR, M.S., Assistant Biochemist
 W. MARTIN SANDSTROM, M.S., Assistant

Section of Cereal Technology and Analytical Service

C. H. BAILEY, Ph.D., Associate Agricultural Biochemist
 G. S. TAYLOR, B.A., Analyst
 ROBERTO OLIVER, B.A., Special Analyst
 *H. O. TRIEBOLD, M.S., Strietmann Fellow
 †J. A. DUNN, M.S., Strietmann Fellow
 KATHRYN TISSUE, M.S., Fleischmann Fellow
 ‡J. L. ST. JOHN, M.S., American Dry Milk Institute Fellow
 R. A. BARACKMAN, B.A., Phosphate Manufacturers' Fellow

Section of Plant Chemistry

J. J. WILLAMAN, Ph.D., Plant Chemist
 K. W. FRANKE, M.S., Assistant
 D. R. BRIGGS, M.S., Assistant
 S. R. OLSEN, B.S., Cloquet Wood Products Fellow

Section of Nutrition and Dairy Chemistry

L. S. PALMER, Ph.D., Dairy Chemist
 CORNELIA KENNEDY, Ph.D., Assistant Agricultural Biochemist
 W. M. NEAL, M.S., Research Assistant
 OLE MYLAND, Animal Caretaker

Division of Agricultural Economics

§J. D. BLACK, Ph.D., Agricultural Economist
 H. BRUCE PRICE, Ph.D., Associate Economist
 WARREN C. WAITE, Ph.D., Assistant Economist
 ||ELMER J. WORKING, M.S., Assistant Economist
 BUDD A. HOLT, M.A., Research Assistant
 B. M. GILE, B.S., Research Assistant
 ¶MRS. DOROTHEA KITTREDGE, M.A., Assistant Economist
 ARNOLD HINRICH, B.S., Research Assistant
 ¶LAWRENCE MYERS, M.S., Research Assistant
 HAROLD B. ROWE, B.S., Research Assistant
 T. G. STITTS, Ph.D., Research Assistant

Division of Agricultural Engineering

WILLIAM BOSS, Agricultural Engineer

Section of Farm Mechanics

J. B. TORRANCE, B.S. in Agr., Assistant Agricultural Engineer
 J. G. DENT, Assistant in Farm Mechanics

† Resigned September, 1926.

‡ Appointed February 16, 1927.

§ Resigned September, 1926.

¶ On leave, February to June 30, 1927.

|| Appointed January 1, 1927.

¶ Appointed September, 1926.

Section of Farm Buildings

H. B. WHITE, B.S. in Agr., Assistant Agricultural Engineer
M. G. JACOBSON, Assistant in Farm Structures

Section of Drainage

H. B. ROE, B.S. in Engr., Associate Agricultural Engineer
J. H. NEAL, B.S. in A.E., Assistant Agricultural Engineer
G. F. KROGH, Assistant in Drainage
D. G. MILLER, C.E., Drainage Engineer, U.S.D.A., B.P.R.
P. C. MCGREW, B.S. in C.E., Assistant Drainage Engineer, U.S.D.A., B.P.R.
*P. C. MANSON, B.S. in C.E., Assistant in Drainage

Section of Land Clearing

M. J. THOMPSON, M.S., Assistant, Land Clearing
A. J. SCHWANTES, B.S. in Agr., Assistant Agricultural Engineer
B. H. GUSTAFSON, B.S. in Agr., Assistant Agricultural Engineer

Section of Agricultural Physics

E. A. STEWART, B.Pd., B.S., Associate Agricultural Physicist
A. G. TYLER, Assistant Agricultural Physicist
JULIUS ROMNESS, B.S., Assistant Agricultural Physicist
†FLORENCE C. KELLEY, B.S. in H.E., Assistant

Division of Animal Husbandry

W. H. PETERS, M.Agr., Animal Husbandman

Section of Horse Husbandry

W. H. PETERS, M.Agr., Animal Husbandman

Section of Beef Cattle Husbandry

H. W. VAUGHAN, M.S., Assistant Animal Husbandman
A. L. HARVEY, M.S., Assistant in Beef Cattle Husbandry

Section of Swine Husbandry

E. F. FERRIN, M.Agr., Assistant Animal Husbandman
M. A. McCARTY, M.S., Assistant in Swine Husbandry

Section of Animal Husbandry and Meats

P. A. ANDERSON, B.S., Assistant Animal Husbandman

Division of Bee Culture

FRANCIS JAGER, Apiculturist
JAMES M. THOMPSON, B.S., Assistant

Division of Dairy Husbandry

C. H. ECKLES, M.S., D.Sc., Dairy Husbandman

Section of Dairy Products

W. B. COMBS, M.S., Dairy Husbandman
L. M. THURSTON, B.S., Assistant in Dairy Husbandry
H. B. RICHIE, B.S., Assistant in Dairy Husbandry
S. T. COULTER, B.S., Assistant in Dairy Husbandry
GEORGE PULKRABEK, B.S., Assistant in Dairy Husbandry

* Appointed August 1, 1926.

† Appointed September 15, 1926.

Section of Dairy Production

C. H. ECKLES, M.S., D.Sc., Dairy Husbandman
O. G. SCHAEFER, M.S., Assistant Dairy Husbandman
T. W. GULLICKSON, M.S., Assistant Dairy Husbandman
W. E. PETERSEN, M.S., Assistant Dairy Husbandman

Section of Dairy Bacteriology

H. MACY, B.S., Assistant Bacteriologist

Division of Entomology and Economic Zoology

*R. N. CHAPMAN, Ph.D., Entomologist, Stored Food Products Insect Investigations
W. A. RILEY, Ph.D., Entomologist and Parasitologist
A. G. RUGGLES, M.A., Entomologist
M. S. JOHNSON, Ph.D., Economic Zoologist
†W. C. COOK, Ph.D., Associate Entomologist
‡S. A. GRAHAM, Ph.D., Assistant Entomologist, Forest Insect Investigations
C. E. MICKEL, Ph.D., Assistant Entomologist, Extension
W. ROBINSON, Ph.D., Assistant Entomologist
A. L. STRAND, M.S., Research Assistant
§G. M. STIRRETT, M.S., Assistant in Entomology
||A. L. GIBSON, B.S., Assistant in Entomology
¶NORDAHL PETERSON, B.A., Assistant in Parasitology
G. A. MAIL, B.S., Assistant in Entomology
**F. M. WADLEY, M.S., Research Assistant
††H. L. SWEETMAN, M.S., Assistant in Entomology
H. L. PARTEN, B. S., Assistant in Entomology

Division of Farm Management, Agronomy, and Plant Genetics

ANDREW BOSS, D.Sc., Agriculturist

Section of Farm Management

ANDREW BOSS, D.Sc., Agriculturist
‡‡G. A. POND, Ph.D., Associate Agriculturist
L. B. BASSETT, Associate Agriculturist
L. F. GAREY, M.A., Assistant in Farm Management
A. T. HOVERSTAD, B.S., Assistant in Farm Management
D. CURTIS MUMFORD, M.S., Assistant in Farm Organization

Section of Farm Crops

A. C. ARNY, M.S., Associate Agronomist
§§F. W. MCGINNIS, M.S., Assistant Agronomist
H. B. SPRAGUE, Ph.D., Assistant Agronomist
F. L. HIGGINS, M.S., Graduate Assistant
H. M. TYSDALE, M.S., Graduate Assistant

* On sabbatical leave, 1926-27.

† Appointed July 1, 1926. Resigned June 30, 1927.

‡ Resigned June 30, 1927.

§ Resigned September 1, 1926.

|| Appointed December 1, 1926. Resigned June 15, 1927.

¶ Appointed September 15, 1926.

** Appointed July 15, 1926.

†† Resigned April 1, 1927.

‡‡ On leave, Nov. 1, 1926, to June 30, 1927.

§§ Resigned February 1, 1927.

Section of Co-operative Seed Production and Distribution

ANDREW BOSS, D.Sc., Agriculturist
 R. F. CRIM, B.S., Extension Specialist in Agronomy
 A. D. HAEDECKE, Assistant in Agronomy

Section of Plant Genetics

H. K. HAYES, D.Sc., Plant Geneticist
 F. J. STEVENSON, M.S., Assistant Plant Geneticist
 H. E. BREWBAKER, Ph.D., Assistant Plant Geneticist
 J. H. LEFFORGE, B.S., Assistant in Agronomy

Division of Forestry

HENRY SCHMITZ, Ph.D., Forester
 E. G. CHEYNEY, A.B., Associate Forester
 J. P. WENTLING, M.A., Associate Forester
 J. H. ALLISON, M.F., Associate Forester
 RAPHAEL ZON, F.E., Director, Forest Experiment Station, Cloquet
 T. S. HANSEN, M.F., Assistant Forester at Cloquet
 D. A. KRIBS, B.S., Assistant Forester
 *R. M. BROWN, M.S., Assistant Forester

Division of Home Economics

WYLLE B. MCNEAL, M.A., Home Economist
 ALICE M. CHILD, M.A., Assistant Home Economist
 JANE M. LEICHSENRING, Ph.D., Assistant Home Economist
 LUCY STUDLEY, M.A., Assistant Home Economist

Division of Horticulture

†W. H. ALDERMAN, B.S.A., Horticulturist

Section of Pomology

W. G. BRIERLEY, M.S., Associate Horticulturist
 A. C. HILDRETH, Ph.D., Assistant Horticulturist

Section of Fruit Breeding

J. H. BEAUMONT, Ph.D., Assistant Horticulturist
 A. N. WILCOX, M.S., Assistant Horticulturist

Section of Vegetable Gardening

F. A. KRANTZ, Ph.D., Assistant Horticulturist
 ‡B. I. BURRELL, B.S., Assistant Horticulturist
 H. P. TRAUB, Ph.D., Assistant Horticulturist

Section of Floriculture and Landscape Gardening

C. E. CARY, B.S., Assistant Horticulturist
 §J. H. BERGEN, B.S., Assistant Horticulturist
 L. SANDO (Florist), Assistant in Horticulture

Fruit Breeding Farm

†W. H. ALDERMAN, B.S.A., Superintendent
 F. E. HARALSON, Assistant Superintendent

* Appointed January 1, 1927.

† On sabbatical leave, 1926-27.

‡ Resigned April 1, 1927.

§ Appointed August 16, 1926.

Division of Plant Pathology and Botany

E. M. FREEMAN, Ph.D., Plant Pathologist and Botanist

Section of Plant Pathology

*E. C. STAKMAN, Ph.D., Plant Pathologist
 J. G. LEACH, Ph.D., Assistant Plant Pathologist
 *†A. W. HENRY, Ph.D., Assistant Plant Pathologist
 *‡C. V. KIGHTLINGER, Ph.D., Assistant Plant Pathologist
 *J. J. CHRISTENSEN, Ph.D., Assistant Plant Pathologist
 LOUISE DOSDALL, Ph.D., Mycologist
 P. D. PETERSON, M.S., Assistant in Plant Pathology
 H. A. RODENHISER, M.S., Assistant in Plant Pathology
 *HELEN HART, M.A., Assistant Plant Pathologist
 H. E. PARSON, B.S., Assistant in Plant Pathology
 *J. M. WALLACE, M. S., Assistant in Plant Pathology
 §LYLE W. JACKSON, M.S., Assistant in Plant Pathology (American Cynamid Company Fellow)
 ||R. M. LINDGREN, B.S., Assistant in Plant Pathology
 ¶CHI TU, B.S., Assistant in Plant Pathology
 HOWARD W. JOHNSON, M.S., Assistant in Plant Pathology
 WM. BROADFOOT, M.S., Assistant in Plant Pathology (American Cyanamid Company Fellow)
 **H. H. FLOR, M.S., (American Cyanamid Fellow)
 C. GEORGE ANDERSON, B.S. (Minnesota Cannery Association Fellow)
 HALBERT H. THORNBERRY, M.S., (Minnesota Cannery Association Fellow)

Detailed by the Office of Cereal Investigations, United States Department of Agriculture, for Co-operative Work

O. S. AAMODT, Ph.D., Pathologist
 M. N. LEVINE, Ph.D., Pathologist
 E. B. LAMBERT, Ph.D., Assistant Pathologist

Section of Plant Physiology

R. B. HARVEY, Ph.D., Associate Plant Physiologist
 L. O. REGEIMBAL, M.S., Assistant in Plant Physiology
 ††G. A. VACHA, B.S., Assistant in Plant Physiology
 †††E. T. ERICKSON, B.S., Assistant in Plant Physiology

Section of Agricultural Botany

A. H. LARSON, B.S., Seed Analyst

* Co-operating with the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.

† On leave, October 1, 1926, to June 30, 1927.

‡ October 1, 1926, to June 6, 1927.

** Appointed November 1, 1926.

§ Resigned April 15, 1927.

|| Appointed October 1, 1926.

¶ Resigned October, 1926.

** Resigned September, 1926.

†† Resigned October, 1926.

Division of Poultry Husbandry

- A. C. SMITH, B.S., Poultry Husbandman
A. A. HOBERG, B.S., Assistant in Poultry Husbandry

Division of Soils

- F. J. ALWAY Ph.D., Soils Chemist
C. O. ROST, Ph.D., Associate Soils Chemist
P. R. McMILLER, M.S., Assistant Soils Chemist
G. H. NESOM, B.Sc., Assistant in Soils
G. B. BODMAN, M.S., Assistant
R. M. PINCKNEY, Ph.D., Assistant
WILLIAM METHLEY, Assistant

Division of Veterinary Medicine

- C. P. FITCH, M.S., D.V.M., Animal Pathologist and Bacteriologist
M. H. REYNOLDS, M.D., D.V.M., Veterinarian
W. L. BOYD, D.V.S., Assistant Veterinarian
H. C. H. KERNKAMP, D.V.M., Assistant Veterinarian
EARL A. HEWITT, B.S., D.V.M., Assistant Veterinarian
R. E. LUBBEHUSEN, B.S., D.V.M., Assistant Pathologist

General

- C. C. ZIMMERMAN, Ph.D., Rural Sociologist; Special Investigator in Rural Sociology