University of Minnesota

AGRICULTURAL EXPERIMENT STATION

THIRTY-FOURTH ANNUAL REPORT

JULY 1, 1925 TO JUNE 30, 1926

UNIVERSITY FARM, ST. PAUL
APRIL 1927

LETTERS OF TRANSMITTAL

MINNEAPOLIS, MINN.,
JULY 1, 1926

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, 1926.

Respectfully,
FRED B. SNYDER,
President of the Board of Regents

UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.,
JULY 1, 1926

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, 1926.

Respectfully,
LOTUS D. COFFMAN,
President of the University of Minnesota

UNIVERSITY FARM, ST. PAUL, MINN.,
JULY 1, 1926

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Respectfully,
W. C. COFFEY, *Director*

THIRTY-FOURTH ANNUAL REPORT, MINNESOTA AGRICULTURAL EXPERIMENT STATION, JULY 1, 1925 TO JUNE 30, 1926.

W. C. COFFEY, Director

FOREWORD

The great contributions of an agricultural experiment station usually grow out of a well conceived, carefully planned, and intelligently conducted program of continuous research. The results of any one year which may deserve special recognition are somewhat like the lights which appear promiscuously on the switchboard of a perfectly co-ordinated telephone exchange. As with the lights, these results may seem, to the casual observer, to be the product of spasmodic effort, but they are not. They are born of the genius for painstaking planning, co-ordination, and attack; and the consummated achievements reported in a particular year are but a small expression of the total effort that brought them into being.

For the year covered by this report, 1925-26, it is evident that investigations in agricultural economics and rural sociology are beginning to bear fruit. Special mention should be made of accomplishments in Plant Pathology in isolating new strains and finding methods for controlling various plant diseases. Also in Plant Breeding, with Plant Pathology co-operating, progress was made in developing disease resistant varieties.

In Plant Physiology, methods of ripening fruits and vegetables were discovered which promise to be of economic significance.

There was progress in the Division of Veterinary Medicine in developing a better understanding of the conditions necessary to provide healthful surroundings for livestock; and the studies conducted by the Divisions of Biochemistry and Dairying on the mineral deficiency in the rations of farm animals promise to be of value to livestock raisers.

CHANGES IN STAFF

Resignations

Agricultural Biochemistry

Walter F. Hoffman, assistant biochemist, resigned to accept a position as director of research of the Northwest Paper Company of Cloquet, Minn.

Agricultural Economics

Holbrook Working, assistant economist, resigned to accept a position at the Food Research Institute, Stanford University, California. Edwin Gaumnitz, research assistant, resigned to accept a position as assistant professor of agricultural economics at Iowa State College.

Agricultural Engineering

E. J. Bullis, assistant in drainage, resigned to accept a position with the Portland Cement Association.

Agronomy and Farm Management

Fred Griffee, assistant plant breeder, resigned to accept a position as professor of plant breeding at the Oklahoma Agricultural and Mechanical College.

Bee Culture

G. C. Matthews, assistant apiculturist, resigned to enter private business.

Forestry

S. S. Burton, instructor in forestry, resigned to accept a position with the North Dakota School of Forestry.

Horticulture

J. S. Shoemaker, assistant in horticulture, resigned to accept a position at the Ohio Agricultural Experiment Station.

Plant Pathology and Botany

G. B. Sanford, assistant, resigned to accept a position as plant pathologist at the Dominion Laboratory of Plant Pathology, Saskatoon, Sask.

Appointments

Agricultural Biochemistry

W. F. Erb, special analyst, was appointed for the period October 1, 1925 to March 31, 1926.

Agricultural Economics

Arnold Hinrichs, Elmer Braun, Roy Ballinger, Gordon Ward, B. B. Derrick, Benjamin McCaul, and H. B. Rowe were appointed as research assistants.

Agronomy and Farm Management

F. J. Stevenson, assistant plant breeder, was appointed to fill the vacancy caused by the resignation of Fred Griffee; F. L. Higgins and D. Curtis Mumford were appointed as assistants.

Dairy Husbandry

H. B. Richie, assistant, was appointed to fill the vacancy caused by the resignation of H. C. Moore. S. T. Coulter, assistant, was appointed to fill the vacancy caused by the resignation of R. B. Becker.

Entomology and Economic Zoology

M. S. Johnson, economic zoologist, was appointed to continue the work in economic zoology; H. L. Sweetman, assistant, was appointed to fill the vacancy caused by the resignation of Walter Carter; H. L. Parten and William Robinson were appointed as assistants.

Forestry

Henry Schmitz, forester, was appointed as Chief of the Division of Forestry.

Plant Pathology and Botany

H. E. Parson and J. M. Wallace were appointed as assistants.

Leave of Absence

Agronomy and Farm Management

Andrew Boss was granted leave of absence for three months to assist in reorganizing the farm economics program of the Bureau of Agricultural Economics, United States Department of Agriculture.

Animal Husbandry

E. F. Ferrin was granted leave of absence for three months to study livestock production in the British Isles and Northwestern Europe.

Entomology and Economic Zoology

F. L. Washburn was granted leave of absence for the year to continue studies of insect life of the South Sea Islands. At the close of the year he was retired after 24 years of service to the state.

PUBLICATIONS

The following publications have been issued during the fiscal year.

Bulletins

Experiment Station Series

No. 220. Effect of Forest Fires on Land Clearing and Crop Production, by M. J. Thompson, Superintendent, Northeast Experiment Station. 24 pages, edition of 6000.

No. 221. Tankage and Buttermilk as Protein Supplements for Growing Pigs, by E. F. Ferrin and M. A. McCarty, Division of Animal Husbandry. 12 pages, 10,000.

No. 222. Blanching Celery, by R. B. Harvey, Division of Plant Pathology and Botany. 20 pages, 10,000.

No. 223. Composition of Creamery Butter and Its Control, by C. H. Eckles, J. R. Keithley, and W. B. Combs, Division of Dairy Husbandry. 32 pages, 9000.

No. 224. Management Problems of Farmers' Elevators, by H. B. Price and C. M. Arthur, Division of Agricultural Economics. 96 pages, 8000.

No. 225. Apple Pruning Investigations, by W. G. Brierley, Division of Horticulture. 24 pages, 5000.

No. 226. Recommended Varieties of Farm Crops for Minnesota, by A. C. Arny, Division of Agronomy and Farm Management. 32 pages, 10,000.

No. 227. Fuel from Pine Stumps, by M. J. Thompson, Superintendent, Northeast Experiment Station; and A. J. Schwantes, Division of Agricultural Engineering. 16 pages, 5000.

No. 228. Field Crop Variety Trials on the Coon Creek Peat Experimental Fields, 1919-25, by A. C. Arny and F. W. McGinnis, Division of Agronomy and Farm Management. 44 pages, 5000.

Reprint—

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

Annual Report Series

Thirty-second Annual Report of the Agricultural Experiment Station, Part IV. 32 pages, 5000.

Thirty-third Annual Report of the Agricultural Experiment Station. 48 pages, 2500.

Report of the Northwest Experiment Station, Crookston, 1925, by C. G. Selvig, Superintendent. 84 pages, 2000.

Report of the West Central Experiment Station, Morris, 1925, by P. E. Miller, Superintendent. 48 pages, 2000.

Report of the Northeast Experiment Station, Duluth, 1924 and 1925, by M. J. Thompson, Superintendent. 40 pages, 1200.

Technical Series

No. 28. Economic Aspects of Local Potato Warehouse Organization, by J. D. Black, B. A. Holt, and G. M. Peterson, Division of Agricultural Economics. 76 pages, 2000.

No. 29. Factors Affecting the Price of Minnesota Potatoes, by Holbrook Working, Division of Agricultural Economics. 40 pages, 3000.

No. 30. Control of Soil Heterogeneity and Use of the Probable Error Concept in Plant Breeding Studies, by H. K. Hayes, Division of Agronomy and Farm Management. 24 pages, 3000.

No. 31. A Study of a Disease of the Bones and Joints of Swine, by H. C. H. Kernkamp, Division of Veterinary Medicine. 48 pages, 3000.

No. 32. Plum Investigations, II. The Inheritance of Hardiness, by M. J. Dorsey and John Bushnell, formerly of the Division of Horticulture. 36 pages, 3000.

No. 33. A Genetic and Cytological Study of Dwarfing in Wheat and Oats, by C. H. Goulden, Division of Agronomy and Farm Management, 44 pages, 2000.

No. 34. The Relation of Temperature to Growth and Respiration in the Potato Plant, by John Bushnell, formerly of the Division of Horticulture. 32 pages, 2000.

No. 35. Physiologic Specialization in *P. graminis avenae,* by D. L. Bailey, Division of Plant Pathology and Botany. 24 pages, 1500.

Special Series
(Agricultural Extension Service)

No. 97. Land Clearing Practices in Minnesota, by M. J. Thompson, Superintendent, Northeast Experiment Station, Duluth. 12 pages, 10,000.

No. 98. Barns, by H. B. White and M. G. Jacobson, Division of Agricultural Engineering. 24 pages, 10,000.

No. 99. Alfalfa Insects, by W. Carter and A. G. Ruggles, Division of Entomology and Economic Zoology. 8 pages, 10,000.

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

No. 101. Rag Doll Test for Seed Corn, by R. F. Crim, Division of Agricultural Extension; and R. E. Hodgson, Superintendent, Southeast Experiment Station, Waseca. 20 pages, 20,000.

No. 102. Chlorpicrin, New Fumigant for Mill and Household Insects, by A. L. Strand, Division of Entomology and Economic Zoology. 20 pages, 8000.

No. 103. Common Poultry Diseases, by W. A. Billings, Division of Agricultural Extension. 16 pages, 10,000. (Reprinted from Farmers' Institute Annual, No. 38.)

No. 104. Alfalfa Aids Progress in Minnesota, by A. C. Arny, Division of Agronomy and Farm Management. 32 pages, 20,000.

No. 105. Colony Brooder Houses, by A. C. Smith, Division of Poultry Husbandry; and Cora E. Cooke, Division of Agricultural Extension. 12 pages, 10,000.

No. 106. Diseases of Head Lettuce in Minnesota, by J. G. Leach and H. G. Gilbert, Division of Plant Pathology and Botany. 12 pages, 5000.

No. 107. Liming for Alfalfa in Southeastern Minnesota, by F. J. Alway and C. O. Rost, Division of Soils. 32 pages, 10,000.

Reprints—

No. 28. Bovine Infectious Abortion of Cattle, by C. P. Fitch, W. L. Boyd, and R. E. Lubbehusen, Division of Veterinary Medicine. 36 pages, 5000.

No. 74. Care and Feeding of Swine, by E. F. Ferrin, Division of Animal Husbandry. 20 pages, 10,000.

No. 63. Tuberculosis of Poultry, by W. A. Billings, Division of Agricultural Extension. 20 pages, 10,000.

Circular Series
(Agricultural Extension Service)

Reprints—

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

No. 22. Treating Seed Potatoes with Hot Formaldehyde, by R. C. Rose, Division of Agricultural Extension. 4 pages, 10,000.

Boys' and Girls' Club Work

Garment Making Project, First Year, by Velma Slocum. 8 pages, 5000.

Garment Making Project, Second Year, by Velma Slocum. 12 pages, 5000.

Garment Making Project, Third Year, by Velma Slocum and Mildred Schench. 12 pages, 5000.

Organizing a 4-H Club, by A. J. Kittleson and others. 16 pages, 5000.

The Pig Club Project. 8 pages, 5000.

Reprint: The Dairy Club Calf, 8 pages, 10,000.

Radio Series

(Outlines of talks given over WCCO.)

No. 1. Poultry, by N. E. Chapman; No. 2. Dairy Farming, by L. V. Wilson; No. 3. Swine Raising, by H. G. Zavoral; No. 4. The Bee Industry, by F. Jager; No. 5. The Vegetable Garden, by F. A. Krantz, J. G. Leach, and John Walker; No. 6. The Flower Garden, by R. S. Mackintosh.

Miscellaneous

Catalog of Projects, 12 pages, 300.

The Country Bookshelf, 16 pages, 10,000.

Feeding the Dairy Herd Home-grown Feed for Profit, 8 pages, 10,000.

Docking and Castrating Lambs, reprinted, 12 pages, 5000.

Kindling the Hearth Fire (a rural drama), reprinted, 36 pages, 3000.

Extension Service News, monthly, 1800.

Among Ourselves, monthly, for the editors of the state, 750.

News Letter, weekly, 1100.

Abstracts of Journal Series Papers

Members of the experiment station staff are often called upon to prepare papers for presentation at meetings of groups of scientists or for publication in some one of the various scientific journals. Since these are in a measure reports of progress on specific research projects, brief abstracts of papers published in the scientific journals are made

a part of the annual report of the experiment station. The abstracts follow in the order of publication.

No. 412. "Brittle Straw and Other Abnormalities in Rye," by F. R. Davison, H. E. Brewbaker, and N. A. Thompson. In *Journal of Agricultural Research,* Vol. 28, No. 2, pp. 169-172 (April 12, 1924.)

Brittleness of straw, chlorophyll deficiency, male sterility, and crinkled awns were found as abnormalities in inbred strains of Minnesota No. 2 rye. Chemical analyses show a low percentage of crude fiber (14 per cent) and high pentosan 34 per cent) content in brittle straw compared with a crude fiber content of 32 per cent and pentosan content of 25 per cent on a dry-weight basis in healthy rye plants. Brittle plants have a high moisture content correlated with high pentosan content. The differences in starch, pectin, ash, and sugar content of normal and brittle rye plants are not great in amount. The greater thickness of cell wall in normal rye straw accounts in part for its greater strength as compared with brittle rye straw. The amount of lignin in normal rye straw greatly exceeds that in brittle straw.

No. 422. "Experiments with Inoculated Sulphur for Scab Control," by J. G. Leach and R. C. Rose. Abstract in *Phytopathology,* Vol. 14, p. 57 (1924).

Experiments have been conducted for two years at various points in Minnesota on a wide variety of soil types, including peat. The results obtained were very variable. In a few cases an appreciable reduction in the amount of scab was obtained, but in the majority of cases little or no control could be detected. In many places the application of inoculated sulphur decreased the yield without any appreciable reduction in the amount of scab. The particular type of soil on which the sulphur is applied appears to have a great deal to do with the effectiveness of the treatment.

No. 423. "Powdery Mildew of Raspberries," by J. G. Leach and J. L. Seal. Abstract in *Phytopathology,* Vol. 14, p. 61 (1924).

A powdery mildew affecting both red and black raspberries was very prevalent in Minnesota in 1923. It does not appear to be very destructive, altho heavy infection of young plants or young shoots may result in a distinct dwarfing. Affected leaves are usually more or less curled and wrinkled and are mottled with pale green or yellow blotches. Affected plants show considerable resemblance to mosaic or leaf curl, depending upon the degree of infection. The mycelium is confined almost entirely to the under surface of the leaves. On account of the normal white pubescence of the leaves, the mildew is often not recognized.

In view of the quarantines recently enacted by several states against mosaic, leaf curl, and blue stem of raspberries, which will necessitate extensive inspection and rogueing, these observations should be given publicity. This is particularly true because much of the inspection and rogueing will probably be done by men not especially trained in pathology.

No. 424. "Spraying vs. Dusting for Potatoes," by J. G. Leach. Abstract in *Phytopathology,* Vol. 14, p. 57 (1924).

Comparative spraying and dusting experiments were conducted co-operatively by the Divisions of Plant Pathology and Entomology during 1922 and 1923, in which the following sprays and dusts were used.

Liquid bordeaux mixture (4-4-50) (1922 and 1923).
Liquid bordeaux mixture and Black Leaf 40 (1922 and 1923).
Liquid bordeaux mixture and Kayso (1923).
Liquid bordeaux mixture and sodium silicate (1923).
Dosch copper calcium arsenate dust (1922 and 1923).
Dosch copper calcium arsenate and nicotine dust (1922 and 1923).
Nictone dust (1922).
Niagara nicotine dust (1923).

The experiments were conducted on 1/10 or 1/12 acre replicated plots at University Farm in duplicate with Bliss Triumph and Green Mountain potatoes. All sprays were applied with a power sprayer, using three nozzles per row, and dusting was done with a power duster. All plots were sprayed or dusted four times.

The average increase in yield per acre over the check plots in 1922 (sprayed or dusted with arsenates only) was 57 bushels (34 per cent) for the sprayed plots and 20 bushels (12 per cent) for the dusted plots. In 1923 it was 19 bushels (9 per cent) for the sprayed plots and 6.5 bushels (3 per cent) for the dusted plots. In 1923 leaf-hoppers were not so numerous as in 1922 and appeared about a month later.

No. 425. "Minnesota Sunflower Diseases in 1923," by A. W. Henry and H. C. Gilbert. In *Phytopathology,* Vol. 14, p. 64 (1924).

Septoria helianthi Ell. and Kell. and *Puccinia helianthimollis* (Schw.) Jackson, together and separately, caused serious defoliation of *Helianthus annuus* L. in different sections of Minnesota this year, particularly on land which had borne several successive crops of sunflowers. One hundred per cent of the plants in such fields were commonly infected with both fungi. The damage was less severe where sunflowers were grown in rotation. Septoria leaf spot was frequently more destructive than rust. Both diseases first appeared on the cotyledons, but Septoria leaf spot spread rapidly during the early part of the summer while rust did not become abundant until later. Nineteen varieties of cultivated sunflowers were severely infected at St. Paul. A downy mildew also occurred on nine varieties of late-sown sunflowers at St. Paul, and was apparently responsible for severe stunting of from 10 to 90 per cent of the plants.

No. 426. "*Puccinia graminis poae* Erikss. and Henn. in the United States," by E. C. Stakman and M. N. Levine. Abstract in *Journal of Agricultural Research,* Vol. 28, pp. 541-548 (1924).

Puccinia graminis poae Erikss. and Henn. was definitely identified in the United States for the first time in 1923, altho the rust has been known for some time in Europe. The host range is narrow. The following species of Poa are susceptible: *Poa annua, P. compressa, P. fertilis, P. nemoralis, P. pratensis, P. triflora.* It has generally been considered that the rust is restricted to the genus Poa, but it can also infect barley very weakly. Morphologically, *P. graminis poae* is quite distinct from other varieties of *Puccinia graminis.* The teliospores, urediniospores, and aeciospores are even shorter than those of *P. graminis agrostis,* which were previously considered the shortest of all. It is not known just how widely distributed the rust may be; so far it has been found only near rusted barberry bushes in several of the Lake states.

No. 432. "Variation in Vigor of Sprouts from Quarters of Single Tubers," by John Bushnell. In *The Botanical Gazette,* Vol. 78, No. 2, pp. 233-236 (1924).

The vigor of the sprout was directly correlated with its position on the seed piece. Sprouts arising near the edge or at the top apparently were unable to draw upon the reserve foods of the tuber as successfully as sprouts more favorably located.

No. 434. "Forest Entomological Problems in the Lake States," by S. A. Graham. In *Journal of Forestry,* Vol. XXII, pp. 24-28 (1924).

This article summarizes the general forest insect situation in the Lake states and emphasizes the heavy losses in timber due to the ravages of the larch sawfly, the spruce budworm, and boring insects; and points out the danger of a jack pine sawfly outbreak. In spite of these serious problems, little is being done to protect the forests against these pests. Funds available for all forest insect work combined have amounted to less than $5000 annually.

An encouraging feature is the development of silvicultural methods of forest insect control that had arisen out of the application of ecological methods, and the rapid development of the spirit of co-operation and mutual helpfulness on the part of all agencies concerned with these problems.

No. 440. "The Effect of Temperature on the Potato Plant," by John Bushnell. In *Proceedings of the American Society for Horticultural Science,* pp. 307-310 (1923).

In this study of potato plants under approximately controlled conditions, humidity had no effect on the growth of the plants, but temperature had a striking effect. The maximum temperature at which Early Ohio potatoes produced tubers was between 20° and 23° C. At 23° C. and above, the failure to produce tubers is attributed to an increase in the rate of respiration, thus consuming the carbohydrates that at lower temperatures are stored in the tubers.

No. 441. "The Fruiting Habit of the Squash," by W. T. Tapley. In *Proceedings of the American Society for Horticultural Science,* pp. 312-319 (1923).

Five varieties of squash—Minnesota No. 23 Hubbard, Kitchenette, Quality, Delicious, and Banana—were under observation. Varieties differed in the number of pistillate blossoms produced per plant from 24.1 to 34.3. The percentage of pistillate blossoms which produced mature specimens varied from 5.5 in Banana to 43.7 in Kitchenette. Kitchenette and Quality set a large percentage of early blossoms; Minn. No. 23 Hubbard aborts a large number of early blossoms, while with Delicious the percentage of blossoms which set remains about the same throughout the season.

No. 463. "Effect of 'Service' upon Temperatures in Cattle," by E. A. Hewitt. In *Journal of the American Veterinary Medical Association,* Vol. LXV, N. S. 18, No. 6 (September, 1924).

The act of "service" serves as a nervous impulse which reflexly influences the heat regulatory mechanism. This heat regulatory mechanism may be con-

sidered as a sort of "thermostat" or thermo regulator, which is ordinarily set for the normal temperature, but may be deranged temporarily, causing a variation in temperature as a result of reflex or afferent impulses. This variation may be an increase or decrease in temperature. In the greater number of cases recorded the temperature was increased.

No. 465. "Cultivation of Crops on Peat or Muck Land," by G. R. B. Elliott. In *Journal of the American Peat Society,* Vol. 18, No. 2, pp. 25-36 (April, 1925).

Semi-official experiments conducted during the growing season of 1923 showed that the depth at which the ground water table is held has a marked influence on the yield and quality of crops grown on peat soil. On five separate plots the ground water table was held theoretically at depths from the surface of 1, 2, 3, 4, and 5 feet, respectively. The following general results seemed to be indicated:[1]

Hay crops were best and heaviest on upper levels.

Root crops were often heaviest on upper levels but were rough and of poor quality. Best quality and good yield were on lower levels.

Early potatoes were best with water level of 3 to 4 feet.

Late potatoes were best on deeper levels.

Corn stover was heaviest on deeper levels, but shelled grain was best on intermediate levels.

Beans and succulent crops were best and heaviest on deeper levels.

No. 470. "Possibilities and Limitations of Chlorpicrin as a Fumigant for Cereal Products," by R. N. Chapman and A. H. Johnson. In *Journal of Agricultural Research,* Vol. 31, No. 8, pp. 745-760 (October, 1925).

A survey of the literature on the toxicity of chlorpicrin to insects is followed by some toxicity experiments in which the granary weevil (*Calendra granaria* L.) was used. The high toxic action of the fumigant is demonstrated and in connection therewith the factors of time and temperature bear an inverse ratio to each other when the concentration of the gas varies from 1 gram to 125 grams per cubic meter. When the concentration is constant, the time required to kill bears a linear relationship to temperature, and this relationship continues down to 0° C. The necessity of building up a lethal concentration of the gas in a short time is emphasized. The greater part of the article deals with the effects of chlorpicrin on cereals which have been fumigated. When chlorpicrin is present in the flour, deleterious properties are noted in the bread baked from it. This is explained by the ability of the chlorpicrin to retard fermentation and to affect harmfully the physical condition of the gluten-forming proteins. When treated flours and cereals are exposed to the air for sufficient time, the chlorpicrin disappears.

No. 475. "Rust Resistance in Timothy," by H. D. Barker and H. K. Hayes. In *Phytopathology,* Vol. 14, No. 8, pp. 363-371 (1924).

[1] Note by the Administration: Subsequent investigations by other workers in the Minnesota Experiment Station do not support either the size or the location of yields reported in this paper.

Resistant clonal lines of timothy were resistant to rust collected from widely separated localities. Inoculation experiments on seedlings produced from self-fertilized clonal lines and from crosses between clonal lines, indicate that resistance or susceptibility in the selections of timothy studied is dependent upon a single differential factor pair. Resistance appears to be a dominant, and a close approximation to a 3:1 ratio was obtained in the progeny of self-fertilized resistant plants.

No. 479. "Correlated Inheritance of Botanical Characters in Barley, and Manner of Reaction to *Helminthosporium sativum,*" by Fred Griffee. In *Journal of Agricultural Research,* Vol. 30, No. 10, pp. 915-935 (1925).

A study was made of the mode of inheritance of certain characters in barley and their linkage relations. Each of the following character pairs is shown to differ by a single genetic factor: 2-rowed vs. 6-rowed, deficiens vs. 6-rowed, black vs. white glumes, early vs. late heading, rough vs. smooth awn, and intermediate-smooth vs. smooth awn. Resistance and susceptibility to *Helminthosporium sativum* are shown to be due to definite genetic factors. By studying the reaction of F_2 lines to this pathogene in relation to other characters, the inference is drawn that at least three factors are concerned in the production of resistance of the type possessed by Svanhals. One factor was linked with the factor for 2-rowed, one with the factor for rough awn, and one with the factor for white glumes. The factor for early heading was found to be linked with the factor for 6-rowed.

No. 483. "The Effect of Low Temperature on *Bruchus obtectus* Say, an Insect Affecting Seed," by Walter Carter. In *Journal of Agricultural Research,* Vol. 31, p. 165 (1925).

Determinations were made of the under-cooling and freezing points of larvae, pupae, and adults by the thermo-electric method. The under-cooling point was found to be slightly higher for each succeeding stage. Tables are given showing these determinations. In some instances the insects were pierced with the pointed thermocouple and in other cases the point was placed among a mass of the insects in a special glass container. The author states that in the latter case, when the insects were not injured they were able to withstand a lower temperature. It is claimed that there is a relation between the degree to which the insects are cooled and the extent of the rebound when the heat of crystallization is given off; the lower the under-cooling the lower the rebound due to increased loss of heat by radiation; that the rebound point is not necessarily the freezing point of the tissues. No relation could be found between rate of under-cooling and the under-cooling point. Weevils were placed in a refrigerator at various constant low temperatures in order to find the fatal temperature-time. It was noted that by lowering the temperature the fatal exposure was shortened. Charts are given showing some fatal time-temperature zones. Return to normal temperatures was followed by a period of partial activity called "arrested development," after which the insects died—usually before developing beyond the stage they were in at the time of exposure.

No. 484. "The Inheritance of Resistance to *Puccinia graminis* in Crosses Between Varieties of Durum Wheat," by J. B. Harrington. In *Scientific Agriculture,* Vol. V, No. 9, pp. 265-286 (May, 1925).

A study was made under greenhouse conditions of reaction to several physiologic forms of rust in durum crosses. Reaction to rust was found to be inherited in the same manner as other characters. Several factors were involved and environmental influences modified the expression of the rust reaction. A heavy rust epidemic was induced in the nursery by using several physiologic forms. Several selections were isolated which appeared as desirable agronomically as Kubanka 8 and Mindum, and which were as rust resistant as Pentad.

No. 491. "Carbohydrate Studies. I. The Relative Sweetness of Pure Sugars," by Alice Biester, Mildred Weigley Wood, and Cecile Stone Wahlin. In *American Journal of Physiology,* Vol. 73, pp. 387-396 (1925).

"II. The Relative Sweetness of Invert Sugar," by J. J. Willaman, Cecile Stone Wahlin, and Alice Biester. In *American Journal of Physiology,* Vol. 73, pp. 397-400 (1925).

Using a method which has been worked out for comparing the relative sweetness of different substances, and assigning to sucrose a rating of 100, lactose was found to have a value of 16.0; raffinose, 22.6; galactose, 32.1; rhamnose, 32.5; maltose, 32.5 (?); xylose, 40.0; dextrose, 74.3; invert sugar, 127.4-130.0; levulose, 173.3.

No. 498. "A Comparative Study of the Poison Apparatus of Certain Lepidopterous Larvae," by P. M. Gilmer. In *Annals of the Entomological Society of America,* Vol. 18, pp. 203-239 (1925).

The presence of poisonous properties among lepidopterous larvae is much more common than is ordinarily supposed, eight distinct families of the order being represented. The structures involved are of two types: (a) the hair type, (b) the spine type. The comparative study shows the gradual specialization of these types. The poison is the product of a special unicellular gland. It is probably not a protein but is in all probability adsorbed upon some proteir molecule or group of molecules which are normal constituents of the gland cell cytoplasm.

No. 502. "Factors Affecting the Development of *Melampsora lini* (Pers.) Desm.," by Helen Hart. Abstract in *Phytopathology,* Vol. 15, p. 53 (January, 1925). Published in full as Paper 586, in *Phytopathology,* Vol. 16, pp. 192-213.

Aeciospores and urediniospores of *Melampsora lini* (Pers.) Desm. germinate in distilled water at temperatures ranging from 0.5° to 27° C., the optimum being about 18° C. They germinate equally well in light and darkness. Host tissue did not stimulate germination appreciably. Teliospores require a rest period which could not be shortened artificially. Urediniospores may begin to germinate within an hour and a half, and only three hours in the moist chamber are required for infection. Uredinial germ tubes enter through the stomata of resistant as well as susceptible varieties. Under favorable conditions uredinia

are formed in about nine days. Light hastens their formation while darkness retards it. Uredinia are formed at temperatures ranging from 7° to 30° C. The effect of nutrients is indirect, intensity of infection being directly proportional to luxuriance of growth of the host. Rust from common flax infected *Linum rigidum* but not *L. lewisii,* while that from *L. lewisii* did not infect common flax. (Co-operative investigations between the U. S. Department of Agriculture, Bureau of Plant Industry, Office of Cereal Investigations, and the Minnesota Agricultural Experiment Station.)

No. 503. "The Control of Loose Smuts of Wheat and Barley, and Barley Stripe, by Uspulun, Semesan, and Germisan," by H. A. Rodenheiser and E. C. Stakman. In *Phytopathology,* Vol. 15, p. 51 (January, 1925).

Uspulun (0.25 per cent sol.), Semesan (0.3 per cent sol.), and Germisan (0.25 per cent sol.) controlled loose smuts of wheat and barley and barley stripe when the seed was soaked at 45° C. for one hour or longer. About 7 per cent of heads in control plots were smutted, while there was only a trace of smut in the treated plots. The percentage of plants affected with stripe was reduced from 13 to less than one per cent. Germisan also practically eliminated stripe when seed was soaked for three hours at ordinary temperatures. Shorter periods of immersion were not effective. Hot Germisan injured the seed slightly.

No. 506. "Records of Alberta *sphecoidea* with Descriptions of New Species of *Crabronidae,*" by Walter Carter. In *Canadian Entomologist,* Vol. 57, pp. 131-136 (1925).

The paper contains records of *Sphecoid* wasps collected in the province of Alberta, Canada, and also descriptions of several new species of *Crabronidae,* an important family of the *Sphecoid* wasps.

No. 513. "Additional Notes on the prevalence of *Dioctophyme renale,* with Report of Three Unrecorded Cases," by W. A. Riley. Proc. Helminth. Soc. of Washington, *Journal of Parasitology,* Vol.11, p. 229 (June, 1925).

The supposedly rare Giant Kidney Worm of carnivores and man has now been reported for fifty North American dogs. Of the three cases here noted, one was from Arkansas and two from laboratories of the University of Minnesota. None of the cases in man reported for the United States are authentic.

No. 515. "A Note on Reports of Grouse Disease in Minnesota," by W. A. Riley. Proc. Helminth. Soc. of Washington. In *Journal of Parasitology,* Vol. 11, p. 229 (June, 1925).

In view of numerous reports that the grouse of northern Minnesota were dying from some parasitic infection, thirty birds found dead were examined. In every instance it was established that death resulted from bruises and broken bones due to injury or to gun shot. It is believed that the automobile is responsible for considerable loss. Ticks were found in only a small percentage and Coccidia only in light infections. Parasitic worms were remarkably scarce and could not be regarded as an important factor.

No. 517. "Two Dangerous Defoliators of Jack Pine," by S. A. Graham. In *Journal of Economic Entomology,* Vol. 18, No. 2, pp. 337-343 (April, 1925).

Jack pine, *Pinus banksiana,* once regarded a weed tree, is now becoming a valuable timber species. In the past this tree was considered almost immune to insect injury but recently it is suffering from the attack of several defoliators. This paper is a preliminary report of co-operative projects concerning two of these—the jack pine sawfly, *Neodiprion* n. sp., and the spruce budworm, *Archips fumiferana* on jack pine. The study is being conducted jointly by the Bureau of Entomology, United States Department of Agriculture, and the Minnesota Agricultural Experiment Station.

Climatic conditions influence the abundance of these defoliators but they are not of sufficient importance to explain the present outbreak. Neither is there evidence that the outbreak has been made possible by a lack of parasites and predators. As a result of lumbering and fires the quantity of jack pine forest has been tremendously increased, thus making food conditions especially favorable for jack pine insects. This appears to be a very important factor in making this outbreak possible.

Studies of control are still in progress and recommendations at the present time are purely provisional. Spraying with arsenate of lead is effective and is recommended for valuable trees. In forests, natural agencies and forest management must be relied upon for the control of these pests. Regulating the cut to favor other species is recommended, in order to produce a safer balance in the forest.

No. 518. "Inheritance in Wheat of Resistance to Black Stem Rust," by H. K. Hayes, E. C. Stakman, and O. S. Aamodt. In *Phytopathology,* Vol. 15, No. 7, pp. 371-387 (July, 1925).

Certain durum and emmer wheats are more generally resistant to the physiologic forms than any known varieties of the common group. The Marquis × Iumillo hybrid, II-15-44, was obtained from a cross of Iumillo durum and Marquis. So far as tested, it is rather rust resistant under field conditions, yields well, and is apparently not greatly inferior to Marquis in milling quality, altho more milling and baking tests are needed before final conclusions should be drawn. In a double cross (Marquis × Iumillo) × (Marquis × Kanred), the inheritance of two types of resistance was studied. The Marquis × Iumillo parent is resistant to many physiologic forms of stem rust under field conditions, but it is susceptible in the seedling stage in the greenhouse. The Marquis × Kanred parent is immune from 11 of the 21 physiologic forms found in the hard red spring wheat region in both the greenhouse and the field. The Marquis × Kanred type of immunity is dependent upon a single factor pair, while at least two factors are necessary to explain the resistance of the Marquis × Iumillo parent. The factors for resistance of the Marquis × Iumillo parent apparently are inherited independently of the factor for immunity of the Marquis × Kanred parent.

No. 524. "The Felled Tree as an Ecological Unit," by S. A. Graham. In *Ecology,* Vol. VI, pp. 397-411 (1925).

This paper presents data to show that the felled tree is a distinct ecological unit with a distinctly characteristic and well adapted population. There is a definite succession of organisms in a log as the chemical and physical character of the wood changes during the processes of disintegration and decay, beginning with xylophagous forms and concluding with an association of organisms characteristic of the duff strata of forest soils. Only the xylophagous stage is considered here.

The distribution of insects in logs is regulated by many factors, of which food, moisture, and temperature appear on the average most important. The effect of these factors is discussed in detail. A knowledge of the distribution and the factors regulating the distribution of insects in logs has important practical significance in the control of wood-boring insects. For instance, full shade reduces the amount of infestation of most wood-boring species and reduces the rate of development of all species. In some cases the localization of injury makes possible a considerable saving of high-grade material by intelligent sawing of logs.

No. 531. "A Note on a Method for Clarifying Cloudy Urines for Colorimetric Comparisons in the Phenolsulphonthalein Renal Function Test," by E. A. Hewitt. In *Journal of Laboratory and Clinical Medicine,* Vol. XI, No. 1 (October, 1925).

The suspended sulphates and phosphates which are contained in abundance in ox urine may be precipitated by the addition of one part by volume of a saturated solution of barium hydroxide to five parts of urine. In this manner cloudy urines may be clarified for colorimetric comparisons in renal function color tests.

No. 532. "Cost Rate Charges for Horse Work," by George A. Pond. In *Journal of Farm Economics,* Vol. VII, No. 3, pp. 369-373 (July, 1925).

A comparison is made on an individual farm between the "flat rate" and the "adjusted rate" method of charging horse labor to the individual enterprises. The "flat rate" is determined by dividing the total cost of maintaining the horses by the number of hours they work. The "adjusted rate" assumes that certain enterprises require large amounts of horse labor for a few days during rush seasons and that extra horses must be kept to handle the peak loads. The "adjusted rate" attempts to charge these enterprises with the total costs of the extra horses. The conclusion drawn from the sample cited was that the small difference in the charge between the two methods was not sufficient to justify the extra cost of computing by the "adjusted rate" method on diversified farms. On specialized crop farms the additional cost of the latter method might be justified.

No. 536. "Bjurfors Kronopark—A Swedish Forest School Demonstration Forest," by J. H. Allison. In *Journal of Forestry,* Vol. XXIII, No. 7-8, pp. 662-669 (July, August, 1925).

This is a description of a 16,223 acre Swedish second-growth forest, purchased by the Swedish government in 1894, as a Forest School demonstration forest, and of the results obtained in its management. At the time the purchase was made this forest was in a badly run-down condition. During the 30 years that have elapsed since, the volume of the timber has been greatly increased and its distribution between the different age classes has been markedly improved.

More than 1000 acres of swampy lands have been drained by means of open ditches, at a cost of $9611.36. A price of $6.91 per acre was originally paid for the tract. Operating expenses have been held within gross income. The per-acre gross income has risen from 40 cents in 1897 to $1.05 in 1910, and to $5.17 in 1920, while the per-acre net income has risen from 20 cents in 1897 to 42 cents in 1910, and to $3.00 in 1920.

No. 537. "Identification and Estimation of the Organic Acids Produced During Bread Dough and Cracker Dough Fermentation," by Arnold H. Johnson. Cereal Chemistry, Vol. II, pp. 345-364 (November, 1925).

Increase in acidity of doughs is due to carbon dioxide produced by yeast, acid phosphates produced by hydrolysis of phytin, and organic acids. Carbon dioxide of fermentation is largely responsible for increasing the H-ion concentration of bread doughs. In cracker doughs or sponges the acidity is due largely to lactic acid, altho a small quantity of acetic acid can be detected.

No. 538. "Genetic Studies in Potatoes. I. The Inheritance of Parti-Color and Suffused Tuber Color," by F. A. Krantz. In *Proceedings of the Potato Association of America,* pp. 32-37 (1925).

Three important commercial varieties of potatoes—Early Ohio, Triumph, and Red McCormick—have colored tubers. The mode of inheritance of tuber color in these three varieties forms the basis of this contribution.

No. 540. "Harvesting the Timber Crop on the Cloquet Forest Experiment Station," by T. S. Hansen. In *Lumber World Review,* Vol. XLIX, No. 2, p. 25 (July, 1925).

A short explanation and analysis of the cutting of timber during the 1924-26 period at the Cloquet Forest Experiment Station. The operation, which covered a 20-acre tract, involved the marketing of 68,000 board feet of logs at a net profit of $1158.46. This area was purchased in 1909 at a cost of $880. After the cutting, it was estimated that there was enough timber left on the tract to yield a net return of $1800.

No. 541. "Webster, a Common Wheat Highly Resistant to Black Stem Rust," by E. C. Stakman, M. N. Levine, and F. Griffee. In *Phytopathology,* Vol. 15, pp. 691-698 (November, 1925).

Webster, a recently named variety of *Triticum vulgare,* has been found to be resistant to 19 physiologic forms of *Puccinia graminis tritici.* It is resistant to 5 physiologic forms to which no other variety of common wheat is known to be resistant. The resistance appears to be due, at least partly, to morphologic characters. Webster is not a valuable wheat from an agronomic viewpoint, but probably will be valuable in breeding for rust resistance. It has 42 chromosomes, hence it is a true vulgare wheat.

No. 542. "Selection in Self-Fertilized Lines as a Means of Improving Timothy," by H. K. Hayes and S. E. Clarke. In *Scientific Agriculture,* Vol. V, No. 10, pp. 313-317 (June, 1925).

Selection in self-fertilized lines in timothy is a logical means of freeing the lines of undesirable recessive characters and of obtaining vigorous lines which excel in such important characters as yielding ability and disease resistance. The average seed-setting under conditions of controlled pollination appears to be an inherited character.

No. 543. "Natural Crossing in Oats," by Fred Griffee and H. K. Hayes. In *Journal of American Society of Agronomy,* Vol. 17, No. 9, pp. 545-549 (September, 1925).

Natural crossing in oats varied with the variety. The number of aberrant types, which resulted from natural crosses, ranged from 0.04 per cent in Victory to 1.4 per cent in Kanota. The actual amount of natural crossing is at least twice as great as indicated by the off-types which were observed. With the exception of Kanota, the frequency of natural crossing in oats at University Farm is less than has been observed previously with wheat.

No. 544. "Sulfur in Proteins. II. The Effect of Mild Alkaline Hydrolysis upon Hair," by W. F. Hoffman. In *Journal of Biological Chemistry,* Vol. 65, pp. 251-254 (August, 1925).

The treatment of hair with weak alkaline solutions for a relatively short period of time removes a large part of the sulphur from the protein. One per cent sodium carbonate solution for one hour removes as much as 25 per cent of the sulfur. It was impossible to isolate cystine from hair which had been so treated.

No. 545. "The Electrodialysis of Agar. A Method for the Preparation of the Free Agar Acid," by W. F. Hoffman and R. A. Gortner. In *Journal of Biological Chemistry,* Vol. 65, pp. 371-379 (September, 1925).

When agar was subjected to electrodialysis, all the inorganic constituents were removed except the silica. A study of the resulting product showed that agar is really a carbohydrate of a sulfonic acid. This is a relatively strong acid and forms salts with metals or organic bases. It is only the salts which forms the characteristic agar gels. The free acid will not set to a gel.

No. 546. "Pollen Development in the Apple with Special Reference to Chromosome Behavior," by James S. Shoemaker. In *The Botanical Gazette,* Vol. 81, No. 2, pp. 148-172 (April, 1926).

A cytological study of pollen development in the Stayman Winesap and Paragon varieties of the Winesap group of apples, in which pollen abortion is abundant, contrasted with development in the Delicious variety, in which a high percentage of normal pollen is produced. The irregular chromosome behavior in heterotypic division in Stayman Winesap resembles the behavior of chromosomes in other plants which are of known hybrid origin. This is the first description of chromosome behavior in the apple and it is of interest that irregularities typical of species hybrids are found.

No. 548. "The Colloid Chemistry of Rennet Coagulation," by L. S. Palmer and G. A. Richardson. *Third National Colloid Symposium Monograph,* pp. 112-144 (1925).

Following a review of colloid theories of rennin coagulation, experiments are described which lead to the following conclusions: (1) "Rennin exerts no detrimental effect on the protective action of lactalbumin during the period and at concn. in which milk is clotted." (2) Gelatin accelerates rather than retards rennin coagulation. (3) Lactalbumin exerts no influence on rennin coagulation of Ca caseinate. (4) Mother's milk coagulates with rennin on adding $CaCl_2$ to increase the sol. Ca 135 per cent. K caseinate inhibits coagulation of Ca caseinate unless much sol. Ca is present. Paracasein shows uniformly higher base- and acid-binding than casein. "It is obvious that rennin, acting on an incompletely formed Ca caseinate in colloidal dispersion at the pH of milk, converts it into a much less completely formed Ca paracaseinate, the chem. binding capacity of which for both base and acid is permanently altered. The nature of the mol. arrangement or surface change (since a substance in colloidal dispersion is altered) causing the increase in binding is not clear, but it is certainly not explained on the basis of simple mol. division or peptization . . . the instability of the highly unsatd. (with respect to base) paracaseinate is responsible for the greater sensitivity towards cations, and explains its coagulation." Tho both the action of the colloidal rennin on the caseinates and the clotting of the resulting paracaseinate are colloidal reactions, one does not yet know (1) the exact character of the colloidal Ca caseinate in milk, (2) the nature of the change in this colloid causing increased affinity for cations, (3) how the colloidal rennin enzyme produces this change. The casein colloids appear to be intermediate between suspensoids and true emulsoids. Gel formation depends on speed of pptn., and is followed by syneresis. Colloidal Ca phosphate mixed with paracasein forms a gel on addition of 0.5 per cent NaCl.

No. 549. "Relation Between the Gold Number of Gelatin and Its Value in the Ice Cream Mix," by H. C. Moore, W. B. Combs, and C. D. Dahle. In *Journal of Dairy Science,* Vol. VIII, pp. 500-514 (1924).

The gold number, often used by the chemist in measuring the protective property of colloids, was found to be of no value in the selection of gelatin for use in manufacturing ice cream. After studying the chief characteristics of six commercial gelatins, it was concluded that the effect of gelatin on the standing-up qualities or melting resistance, body and texture and flavor of the finished ice cream are the best indexes of the grade and amount of gelatin to use in the mix.

No. 550. "Potato Improvement by Selection in Self-fertilized Lines," by F. A. Krantz. In *American Potato Journal,* Vol. 2, No. 8, pp. 303-304 (1925).

A discussion of the potato breeding work at the Minnesota Agricultural Experiment Station, the method employed, the principles on which the method is based, and the progress of the work.

No. 551. "The Reaction of Selfed Lines and Crosses of Maize to *Ustilago zeae,*" by F. R. Immer and J. J. Christensen. In *Phytopathology,* Vol. 15, No. 11, pp. 699-707 (November, 1925).

The parent lines developed a uniform percentage of smut from year to year (1922-24 inclusive). The factors determining resistance or susceptibility to *Ustilago zeae* were transmitted in the same manner in both male and female gametes. Dominance of resistance or susceptibility to smut reaction was lacking. Further study is necessary before concluding how many genetic factors are involved.

No. 552. "The Statistical Determination of Demand Curves," by Holbrook Working. In *Quarterly Journal of Economics,* pp. 503-543 (August, 1925).

This paper examines typical statistical studies of relations between the price of commodities and quantities demanded, for the purpose of providing a more adequate and accurate basis for interpreting the results of such studies.

It is shown that a few statistical studies bear on the demand relationship usually discussed in the economic texts, the relation between the price of a commodity and the quantity entering into consumption; but that most of the published studies have to do with a relation between price and quantity held for future sale by "speculators," a "speculators' demand" that has been little discussed.

Consumers' demand is essentially a rate, a quantity per unit of time; but speculators' demand is not a rate. The two types of demand may be very different in character. In particular, the speculators' demand is subject to more variation from time to time owing to a variety of factors not affecting consumers' demands.

The elasticity of demand, whether consumers' or speculators', is shown to depend partly upon the point within the market area from which the price quotations are obtained.

A third type of demand, that involved in the immediate determination of actual current market prices, seems incapable of satisfactory statistical treatment.

Statistical demand curves, as usually determined, may differ widely from the true demand curve. The curve which provides the best statistical basis for estimating quantity from price usually has a considerably steeper slope than that which provides the best statistical basis for estimating price from quantity, yet in the absence of special knowledge of the conditions, each has an equal claim to be considered the true demand curve. The problem of determining the true demand curve from statistical data is examined and a basis is provided for approximating its position and slope where adequate data are available.

No. 553. "The Rôle of the Antiscorbutic Vitamin in the Nutrition of Calves," by L. M. Thurston, C. H. Eckles, and L. S. Palmer. In *Journal of Dairy Science,* Vol. IX, pp. 37-49 (1926).

Calves in one group were kept from birth to one year of age, in another group to two years of age, on rations essentially free from the antiscorbutic vitamin. Guinea pigs receiving the same ration died with scurvy within 20 days. The eight calves all grew at a rate considerably above normal. It is concluded that calves do not require vitamin C in quantities that can be measured by the present method of testing food materials for their antiscorbutic potency by

feeding to guinea pigs. Under practical conditions, even when poor feeding practices are followed, there is little, if any, reason to believe that the well being of the calf will be affected by a shortage of vitamin C.

No. 560. "Studies on the Pathogenicity and Physiology of *Helminthosporium gramineum* Rab.," by Thorvaldur Johnson. In *Phytopathology,* Vol. 15, No. 12, pp. 797-804 (December, 1925).

Helminthosporium gramineum consists of at least two physiologic forms which can be recognized by their reaction to temperature. Attempts to induce *H. gramineum* to produce conidia on artificial media were unsuccessful. Low soil temperatures were found to favor infection of barley by the organism under controlled experimental conditions. It has been shown that artificial infection is possible through inoculation of germinating barley seed. By removing the hulls it is possible to obtain a high percentage of infection in susceptible varieties.

No. 561. "Biochemistry of Plant Diseases. V. Relation Between Susceptibility to Brown Rot in Plums and Physical and Chemical Properties," by J. J. Willaman, N. C. Pervier, and H. O. Triebold. In *Botanical Gazette,* Vol. 80, pp. 121-144 (October, 1925).

Various chemical and physical factors were investigated in the attempt to elucidate the factors which cause susceptibility or resistance of plum varieties to the brown rot organism.

The firmness of the flesh and the toughness of the skin appear to be directly related to resistance; accordingly, in this particular instance, resistance to disease appears to be governed by physical structure rather than chemical composition.

No. 562. "The Action of Sulphate Water on Concrete," by D. G. Miller. In *Public Roads,* Vol. 6, pp. 174-179 (October, 1925).

A report of tests of 2x4 inch portland cement mortar and concrete cylinders after one year in Medicine Lake, So. Dak.

No. 563. "An Alcohol-Soluble Protein Isolated from Polished Rice," by W. F. Hoffman. In *Journal of Biologic Chemistry,* Vol. 66, pp. 501-504 (December, 1925).

Rice is the only common cereal grain from which an alcohol-soluble protein had not been previously reported. Certain workers had reported that it contained no alcohol-soluble proteins. By a modified technic it was possible to isolate a small amount of such a protein, the description and analysis of which are given in this paper.

No. 564. "A Report of Experimental Work on the Bull as a Factor in the Spread of Infectious Abortion," by R. E. Lubbehusen and C. P. Fitch. In *Journal of the American Veterinary Medical Association,* Vol. LXVIII, n.s. 21, No. 4 (January, 1926).

Experiments were carried out by the artificial infection of bulls with the Bang organism, and it was found that bulls are not readily infected through the natural channels of infection, namely, per os or by way of the urethra.

Many bulls giving a positive reaction to the serologic tests for infectious abortion do not harbor *Bact. abortus* Bang in the genital organs.

Repeated examinations of the semen of bulls known to harbor the organism in the genitalia (the result of artificial infection) failed to show the presence of *Bact. abortus* Bang.

No. 566. "Physiologic Specialization and Mutation in *Helminthosporium sativum,*" by J. J. Christensen. Abstract in *Phytopathology,* Vol. 15, pp. 785-796 (December, 1925).

Helminthosporium sativum is a group species consisting of many physiologic forms. At least thirty-seven can be recognized readily on culture media. The writer observed at least fifty forms, and there are indications of the existence of numerous others. Many of the physiologic forms have quite different parasitic capabilities on wheat and barley. Some forms are extremely virulent, others are moderately virulent, and still others are but weak parasites.

Mutations occur frequently on culture media. Some forms mutate much more often than others. The mutants observed differed from the parents in rate of growth, color, zonation, amount of aerial mycelium, and pathogenicity. Relatively weak forms may produce very virulent mutants, and vice versa. The mutants, which arise as sectors, suggest that the mechanism is somewhat analogous to bud mutation in higher plants.

No. 567. "A Test of Indolinones as Agents for Prevention and Cure of Polyneuritis," by R. A. Gortner, L. S. Palmer, and Selmer J. Dahl. In *Proceedings of the Society for Experimental Biology and Medicine,* Vol. XXII, pp. 231-233 (1925).

The behavior of beta-methyl and beta-propyl indolinones, both as protectors against and cures for polyneuritis in pigeons was studied. Neither was able to protect the birds against loss of weight in a polished rice diet or against the incidence of polyneuritis. Beta-methyl indolinone was found to have a slight curative effect. Thyroxin, an indolinone-like compared, also failed to protect against loss of weight on a polished rice diet and gave no conclusive evidence of relieving polyneuritis. Pilocarpine hydrochloride also had no preventive antineuritic properties.

No. 568. Peroxidase as a Factor in Butter Deterioration," by L. S. Palmer and M. M. Miller. In *Journal of Dairy Science,* Vol. IX, pp. 272-275 (1926).

The extent to which peroxidase, the most abundant and most potent oxidizing ferment normal to milk, contributes to the deterioration of butter has not been settled. An effort was made to throw light on this question by the addition of a concentrated peroxidase preparation from horseradish roots to both sweet and ripened cream and observing the keeping quality of butter made therefrom in the usual manner. Examination of the butter at 115-, 180-, and 335-day intervals after storage at room temperature and 0° C., revealed no deterioration detectable by increase in organic and amino acids in the aqueous phase of the butter; or by the Kreis test, or amount of oxidized fatty acids in the fat. The aqueous phase of the butter still contained large quantities of peroxidase after 335 days as revealed by the guaiac, paraphenelendiamine, and pyrogallol reagents.

No. 570. "Present-Day Problems of Corn Breeding," by H. K. Hayes. In *Journal of American Society of Agronomy,* Vol. 18, No. 4, pp. 344-363 (April, 1926).

The modern method of corn breeding has resulted from the development of a sensible genetic interpretation of the results of selfing and crossing in naturally cross-pollinated species, and in these studies the work with corn has played an important rôle. Perhaps of equal importance is the fact that adapted varieties can not, as a rule, be further improved by the use of earlier methods. In order to accomplish the desired results, extensive studies must be made and it must be appreciated that breeding cross-pollinated plants by some system of controlled pollination can not be carried out without considerable effort. Summarized data which were presented proved the practical value of modern methods of breeding.

No. 571. "Physico-Chemical Factors Influencing Cream Rising. I. Viscosity," by L. S. Palmer and E. O. Anderson. In *Journal of Dairy Science,* Vol. IX, pp. 1-14 (1926).

The two outstanding factors involved in determining the volume of cream rising as a definite layer on a given lot of milk are (a) the rapidity and completeness with which the fat globules rise, (b) the volume occupied by the risen globules. A study of the relation of viscosity of raw milk of a uniform (standardized) fat content to these two factors shows that there is a direct relation between viscosity, temperature of creaming, content of plasma solids, more exhaustive creaming, and larger cream volumes. When the temperature was constant, higher plasma solids gave higher viscosity, more exhaustive creaming, and larger cream volumes. When the plasma solid content of the milk was constant, lower temperatures also gave more exhaustive creaming and larger cream volume. The detrimental effect of pasteurizing the milk on subsequent cream rising at various temperatures was not found to be related primarily to the effect of heat on viscosity. Altho pasteurizing the milk permanently lowers the viscosity, the effects on creaming are much greater than can be accounted for by the decreased viscosity. It is shown that the detrimental effect of pasteurization on cream rising is accompanied by less exhaustive creaming and closer packing of the fat globules in the cream layer.

No. 572. "Inheritance of Immunity from *Melampsora lini,*" by A. W. Henry. Abstract in *Phytopathology,* Vol. 16, p. 87 (1926).

Crosses were made between immune and susceptible varieties of *Linum usitatissimum.* Three immune parents were used: a selection from a lot of commercial Argentine flax; Bombay, C. I. 42; and Ottawa, 770B. The F_1 plants of all crosses were immune. The segregation in the F_2 of a cross between the Argentine selection and Saginaw, a susceptible fiber variety, approximated a ratio of 15 immune plants to 1 susceptible plant. The F_2 of a cross between Bombay and Winona, a susceptible seed flax, showed a simple monohybrid segregation. Apparently there was a single factor difference between immunity and susceptibility in a cross between Ottawa 770B and Saginaw. The former has white flowers and yellow seeds, and the latter blue flowers and brown seeds. Blue flowers and brown seeds were dominant, and a ratio of 3 blue-flowered, brown-seeded plants to 1 white-flowered, yellow-seeded plant was obtained in the F_2. These characters apparently were inherited independently of immunity from rust,

so that in the F_2 a segregation approximating a 9:3:3:1 ratio was obtained. (Co-operative investigation by the Minnesota Agricultural Experiment Station and the Offices of Cereal Disease Investigations and Fiber Plant Investigations, U. S. Department of Agriculture.)

No. 575. "Physiologic Specialization of *Ustilago zeae* and *Puccinia sorghi* and Their Relation to Corn Improvement," by E. C. Stakman and J. J. Christensen. Abstract in *Phytopathology,* Vol. 16, p. 64 (January, 1926).

Ustilago zeae is one of the destructive pathogenes of corn. Apparently the only method of appreciably reducing losses is the production of resistant lines. However, there is circumstantial as well as direct evidence that there are several physiologic forms of the organism. This fact is likely to complicate the problem of developing resistant varieties. *Puccinia sorghi* is not considered a destructive pathogene. However, in 1925, on certain selfed lines of corn in the Plant Breeding plots at the University of Minnesota, the rust was so virulent as to do considerable damage. It is possible, therefore, that corn rust may become an important factor in corn production if susceptible sorts are commonly grown. It would probably be relatively easy, however, to obtain resistant sorts, as some lines of a given variety are extremely resistant while others are extremely susceptible to the rust. The rust situation is also complicated by the fact that there are several physiologic forms. The writers have been able to recognize at least three, and possibly five, by their action on eight selfed lines of corn. A very virulent form was collected in Oklahoma, Kansas, Nebraska, and New Hampshire, while a less virulent one was obtained from several localities in Minnesota, and a very weak one from Texas. There is no correlation between rust resistance and smut resistance of selfed lines. (Co-operative investigations by the section of plant pathology and the section of plant breeding.)

No. 576. "Effect of Sulfur Dust on the Development of Black Stem Rust of Wheat in a Natural Epidemic," by E. B. Lambert and E. C. Stakman. Abstract in *Phytopathology,* Vol. 16, p. 64 (January, 1926).

In several localities in Minnesota, in 1925, wheat was dusted with precipitated sulfur at the rate of about thirty pounds per acre, in order to determine the effect on the development of black stem rust. There was a heavy natural epidemic at most of the places where experiments were made. The results support statements, emanating from Cornell University, that sulfur dust will control rust under certain conditions. The time of application is one of the most critical factors. Dusting must not be begun too late or discontinued too early. In some experiments, one application practically controlled the rust in spite of the heavy natural epidemic; but in others, five applications had practically no effect, altho the first was made before there was any appreciable amount of rust in the field. Apparently, the sulfur is not effective very long after it has been dusted on the plants—it must be applied just before a spore shower. It does not seem to inhibit the development of uredinia after plants are once infected. In the hard red spring wheat region, in years when there is a heavy epidemic, it would be necessary to begin dusting when the grain is in flower, or even earlier, and continue until the hard dough stage. This would require five or six applications. It would be necessary to begin at exactly the right time and to continue long

enough. The determination of these times constitutes a real difficulty. No two seasons are alike and it is doubtful whether the proper time could be predicted with even approximate accuracy in any given season. (Co-operative investigations by the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, and the Minnesota Agricultural Experiment Station.)

No. 577. "Physiologic Specialization of *Fusarium lini* Bolley, by W. C. Broadfoot and E. C. Stakman. Abstract in *Phytopathology,* Vol. 16, p. 84 (January, 1926).

Fusarium lini consists of several physiologic forms. At least eight can be distinguished by their parasitic action on the following varieties of flax: Primost, Minn. 25 (C. I. 177); Winona, Minn. 182 (C. I. 179); N. D. 3080 (C. I. 275); N. D. 40013 (C. I. 241). Six of the forms differ greatly from each other in virulence. Two of them are about equally virulent, except that one consistently causes loss of chlorophyll above the cotyledons in all varieties of flax inoculated. It also causes loss of chlorophyll in seedlings of barley, oats, and rye. The cultural characteristics of some forms differ from those of others, but this is not a safe criterion for the determination of all forms. Neither can the forms be differentiated by rate of growth at different temperatures. There are differences in size and septation of spores of different forms grown under the same conditions, but there also are similar differences when the individual forms are grown under different conditions. Therefore the forms can not be differentiated by spore morphology. Some of these forms heavily infect certain resistant varieties of flax, but it is not yet known how important this fact is in controlling flax wilt by immunization.

No. 578. "The Rôle of Vitamin A in the Nutrition of Calves," by I. R. Jones, C. H. Eckles, and L. S. Palmer. In *Journal of Dairy Science,* Vol. IX, pp. 119-139 (1926).

Calves were fed from birth on rations deficient in vitamin A but adequate in other respects. The ration used was oxidized skimmilk powder, white corn, and dried beet pulp. Comparison was made with a check group receiving the same ration with the addition of cod liver oil as a source of vitamin A. All feeds used were tested for vitamin A content by experiments with rats. The results were positive. Calves on a ration free from vitamin A showed characteristic symptoms within two months and survived only to the age of about three months. Wheat straw was found to contain a fair amount of the vitamin in question.

No. 579. "Method for a Graphic Record of Texture, Volume, and Contour of Cake," by Alice M. Child and Daisy I. Purdy. In *Cereal Chemistry,* Vol. III, pp. 57-60 (January, 1926).

A standard and score card for judging cake are given. Also a definite method for making a print of a slice of cake or bread. The prints are of value in keeping a record of volume, texture, and contour of cake.

No. 580. "A Balanced Cost Schedule for Tile Trenching," by H. B. Roe. In *Agricultural Engineering,* Vol. VII, pp. 1-21 (January, 1926).

This schedule is based on a man-hour labor unit. It was developed from data obtained from the construction of eighteen farm tile drainage systems from

1908 to 1921 inclusive. The work unit established is *the lifting of one cubic foot of earth through a vertical distance of one foot.* The character of digging is grouped in three classes: easy, average, and hard. A schedule is established for each of these classes, in the form of both tables and curves. These schedules give the time in man hours required to dig 100 linear feet of trench for drain tile from 4- to 24-inch, inclusive, and for depths of trench of from 3 feet to 12 feet. A practically complete discussion is offered covering the source and reliability of the data and of the methods and formulas used in computing the schedules.

It is pointed out that the principles on which the schedules are based makes them independent of economic conditions and wholly dependent on the efficiency of labor. Hence they are applicable at all times independent of the money value of labor. The paper closes with a carefully worked out illustration of the way in which the schedules may be applied.

No. 581. "The Relation of Soil Temperature and Soil Moisture to the Development of Head Smut of Sorghum, by J. J. Christensen. In *Phytopathology,* Vol. 16, pp. 353-357 (May, 1926).

A study was made, under controlled conditions, of the effect of soil moisture and temperature on the development of head smut of sorghum. Seedlings of sorghum became infected in dry soil at temperatures ranging from 16° to 36° C. The optimum soil temperature for infection was 28° C. The minimum, and probably the maximum, fluctuates with the percentage of moisture in the soil. High soil moisture materially reduced the percentage of smutted plants at all temperatures and also narrowed the thermal range for infection.

No. 582. "Blanching Celery on a Commercial Scale with Ethylene," by R. B. Harvey. In *Minnesota Horticulturist,* Vol. 54, pp. 209-211 (1926).

This is a report before the vegetable section of the Minnesota Horticultural Society of the year's experience in the use of ethylene for blanching celery. It answers several questions on the expense, practicability, and results of the process.

No. 583. "The Relation of the Seed Corn Maggot (*Phorbia fusciceps* Zett.) to the Spread and Development of Potato Blackleg in Minnesota," by J. G. Leach. In *Phytopathology,* Vol. 16, pp. 149-176 (1926).

The seed-corn maggot (*Phorbia fusciceps* Zett.) is an agent of dissemination, inoculation, and hibernation of bacteria capable of causing potato blackleg. Bacteria are constantly associated with the insect and are necessary for the normal development of the larvae. Bacteria do not occur inside the eggs, but are common on the surface. Virulent pathogenic bacteria are found in the puparia and emerge with the adult. Pathogenic bacteria are also common in the intestinal tract and excrement of adult flies. Eggs are deposited in the soil on or near healthy seed-pieces or sprouts. On hatching, the maggots burrow into the seed-piece and inoculate it with bacteria which spread into the stem, causing blackleg. The insect has been responsible for outbreaks of blackleg in fields planted with carefully treated seed from fields known to have been free from blackleg. Control measures have not been devised.

No. 584. "A New Species of *Dasymutilla* from Cuba," by Clarence E. Mickel. In *Entomologische Mitteilung,* Vol. 15, pp. 197, 198 (1926).

A new species of *Mutillid* wasp from Cuba of the genus *Dasymutilla* is described.

No. 585. "Physico-Chemical Factors Influencing Cream Rising. II. Relation of Plasma Colloids to Pasteurization Effect," by L. S. Palmer, J. C. Hening, and E. O. Anderson. In *Journal of Dairy Science,* Vol. IX, pp. 171-191 (1926).

Among the various theories which have been advanced to explain the detrimental effect of pasteurization on cream rising and cream layers are (a) that heat disintegrates natural clusters of fat globules which bring about normal creaming and (b) that a coagulation of lactalbumin hinders the rise of the fat globules. This paper reports studies with various synthetic milks of a uniform fat content prepared by adding high test cream to a natural or specially prepared plasma. In one series the plasma was either raw or pasteurized skimmilk and the cream was either raw or from pasteurized whole milk. Detrimental effects on creaming were observed only in tests in which the skimmilk was pasteurized. No relation was found between fat globule clustering and either exhaustive cream rising or satisfactory cream layers. In the next series the plasma was either raw or dialyzed skimmilk (essentially free from lactose and soluble salts), the "milk" having a specific gravity of 1.01-1.02; or the dialyzed plasma was restored to a nearly normal specific gravity with lactose. Cream rising was not optimum in any case; but cream volumes were not abnormal even in the low-density milks, altho the cream lines were not distinct. Pasteurization effects were variable, but in general detrimental, pointing to the plasma colloids as the chief factors governing cream rising. In the next series the plasma was calcium caseinate dispersions having either the pH of milk or containing 5 per cent lactose. Cream layers were uniformly very poor and pasteurization uniformly detrimental, in this series. Cream lines were very indistinct. In the last series the plasma was either acid whey or cheese whey. Acid whey was neutralized and clarified. When the pH of these synthetic milks was normal, pasteurization gave more exhaustive creaming and larger cream volumes in sharp contrast to natural or casein milks in which pasteurization caused less exhaustive creaming and closer packing of the fat in the cream layers. Neither of the theories explaining pasteurization effects mentioned above are supported by any of the experiments reported in this paper.

No. 587. "A Study of the Value of Whole Milk and Milk Sediment for the Isolation of *Bacterium abortus* Bang," by C. P. Fitch and R. E. Lubbehusen. In *The Cornell Veterinarian,* Vol. 16, pp. 46-53 (January, 1926).

Comparative studies were made of the use of whole milk and milk sediment for the isolation of the Bang organism. The presence of the organism was determined by guinea pig inoculation. It was found sometimes by one method and sometimes by the other as follows:

Bact. abortus was isolated from whole milk in 29.7 per cent and from milk sediment in 43.2 per cent of the samples showing evidence of infection. If either method is to be used to the exclusion of the other, the injection of milk sediment is to be preferred as being more efficient.

No. 588. "Concentration of Carbonates in Two Minnesota Soil Types," by Paul R. McMiller. In *Soil Science,* Vol. XXII, pp. 75-82 (July, 1926).

In two important soil types occurring in western Minnesota, gray zones of very pronounced carbonate accumulation were studied. In these zones, which occur at depths of from 12 to 27 inches below the surface and are from 12 to 36 inches in thickness, the carbonate content ranges from 25 to 45 per cent; while in the material below it varies between 9 and 21 per cent and in the overlying layers only from 0.5 to 3 per cent. The carbonate content of the different sections in the profiles of these soil types shows no direct relation to the texture.

No. 589. "Preliminary Experiments on the Use of Chlorpicrin as an Insect Fumigant in Flour and Cereal Mills," by A. L. Strand. In *Journal of Economic Entomology,* Vol. 19, pp. 504-510 (June, 1926).

The first successful use of a highly toxic gas solely within the milling machinery of flour and cereal mills is reported. The paper deals chiefly with the development of a method by which this can be accomplished. The system finally employed consists in directing an atomizing sprayer filled with the required amount of fumigant into each elevator head. All the atomizers are then connected to a central tube which leads to a tank of compressed air or oxygen to furnish pressure for their operation. Five pounds of chlorpicrin and an equal volume of carbon tetrachloride are used per 1000 cubic feet of space within the machinery to be treated, that is, in the elevator legs and conveyors, together with the grinders, sifters, etc., connected thereto. The fumigant is applied while the machinery is in operation but after it has been allowed to run itself empty of most of the stock. By this method of fumigation, employed at frequent intervals, the insects in flour and cereal mills can be kept to minimum numbers, the cleaning of plugged spouts and elevators eliminated, and the intervals between general fumigations of the entire mill greatly increased.

No. 590. "Use of Leaf Characters in Identification of Plum Varieties," by W. H. Alderman and J. S. Shoemaker. In *Proceedings of the American Society for Horticultural Science,* pp. 264-269 (1925).

A key based on leaf characters is presented for the identification of the plum varieties commonly grown in Minnesota. As the varieties have been derived from at least five species and their hybrids, there is a marked variability in foliage. This variability has been used to advantage in the key.

No. 591. "Toxic Relation of Other Crops to Tomatoes," by W. H. Alderman and J. A. Middleton. In *Proceedings of the American Society for Horticultural Science,* pp. 307-308 (1925).

An attempt was made to repeat the work of Bedford and Pickering under controlled conditions, using tomato plants grown in boxes in the greenhouse, and pruned to a single stem. With ten common cover crop plants grown in special pans to prevent the mingling of the roots, and the tomato plants receiving water only through these pans, there was not the slightest indication of any deleterious effect of the surface crops on the tomato plants.

No. 592. "Use of Plant Characters in Identification of Red Raspberry Varieties," by J. D. Winter. In *Proceedings of the American Society for Horticultural Science,* pp. 261-264 (1925).

A study of raspberries under Minnesota conditions has shown that certain plant characters are relatively constant for a given variety under varying conditions of growth. Varieties, therefore, may be identified with certainty at any time during the growing season without reference to the fruit. The principal characters of importance for identification purposes were found to be the abundance, color, and structure of the prickles on the cane and on the petiole of the leaf; the number of leaflets to each petiole; the relative intensity or value of color of the foliage; the relative height of the cane and whether the cane is conspicuously glaucous or otherwise. A preliminary key to fifteen varieties of red raspberries has been prepared, based on characters exclusive of the fruit.

No. 593. "A Record System for Fruit Breeding Work," by A. N. Wilcox. In *Proceedings of the American Society for Horticultural Science,* pp. 269-271 (1925).

The method of keeping breeding records at the Minnesota Fruit Breeding Farm is described, with particular attention to the numbering system devised by the author. The system is arranged to provide a means of quickly tracing the breeding history of a plant; to prevent confusion and mistakes involved in changing or copying numbers; and to permit the use of brief, easily made, permanent labels stamped in zinc.

No. 594. "Development of New Fruits," by W. H. Alderman and J. H. Beaumont. In *Biennial Report of the Kansas State Horticultural Society,* 1924-25, pp. 92-96.

A discussion of plant breeding methods, their implication, and application to the development of new fruits. A summary of the progress in developing fruit varieties and methods applicable for future work are given.

No. 595. "Hydrogenated Vegetable Oil as a Source of Vitamine E," by Cornelia Kennedy and L. S. Palmer. In *American Journal of Physiology,* Vol. LXXVI, pp. 316-319 (1926).

Three generations of young were obtained on Evans and Bishop's sterility diet consisting of casein 18 grams, cornstarch 54 grams, milk fat 9 grams, salts 4 grams, and yeast 0.4 to 0.6 gram daily, by replacing the lard with an equal amount of hydrogenated cotton-seed oil (crisco). Great difficulty was experienced in rearing the young. It is inferred from these observations that hydrogenation does not destroy the fertility factor, vitamin E, present in vegetable oils.

No. 596. "Detailed Cost Studies," by Andrew Boss. In *Journal of Farm Economics,* Vol. VIII, No. 1, pp. 126-136 (January, 1926).

The modern concept of the function of detailed cost studies is that they should serve as a source for basic unit data covering all phases of the farm business that will serve in determining (1) the profits from the farm business as a whole with a fair allocation of sources of profits; (2) results that may reasonably be expected from different enterprise combinations; (3) approximate estimates of consequences likely to result from changes in the type of organization in an area or region; (4) the most profitable enterprises or the enterprises making the largest returns for the resources used; (5) in some cases the most effective and profitable farm practices within the enterprise, and (6) always a large number of illustrations of organization and practices that make for efficiency.

The data thus gathered from statistical routes by institutions connected with agricultural colleges are providing a great deal of subject matter for use in the classes in farm management and farm economics in colleges and schools. Aside from specific and local values that these studies may have, their major values are reflected in a much larger way. They may be made the basis for defining profitable production areas of the principal crops and livestock products. They give the basis for selecting enterprises for large areas and determining which combinations will be most advisable. Data tables built up from the accumulating records will become valuable sources for calculating and estimating the probabilities of costs and profits at any given time and place.

No. 597. "High Aluminum Cements and Sulphate Waters," by D. G. Miller. In *Concrete,* Vol. 28, pp. 24-31 (1926).

Paper is based on tests of 2x4-inch concrete and mortar cylinders in which two brands of French and one brand of American high alumina cements were used. Cylinders were exposed in the laboratory to solutions of sodium and magnesium and in the field to the natural sulphate waters of Medicine Lake, So. Dak.

No. 598. "Unusual Pathologic Processes in Swine," by H. C. H. Kernkamp. In *Veterinary Alumni Quarterly,* Vol. 13, No. 4, pp. 112-116 (March, 1926).

Three unusual disease conditions are described. In one case the gall bladder and bile ducts of the liver were packed full of sand and small gravel. There was 4.93 pounds of this foreign material in the organ. This is a trifle more than the normal weight of the liver. The second case represented an anomalous sexual condition, wherein a pig with normal external male sex organs, had internally a large uterus-like structure that was filled with a clear fluid. The third was that of a kidney of a mature hog in which certain embryologic stages of renal development had persisted, thus causing a peculiar lobular kidney.

No. 600. "Results of Commercial Applications of Ethylene for Blanching Celery," by R. B. Harvey. In *Market Growers Journal,* Vol. 38 pp. 237-238 (1926).

This paper gives results of the use of ethylene on blanching carlots of celery. Reports of co-operators are quoted. Reports of failures in blanching are explained as due to not fulfilling the conditions of temperature (65° F.) or gas concentration (one part of ethylene per 1000 parts of air). The ethylene was found to have no effect in either retarding or accelerating rots in the celery.

No. 602. "Control of Diastatic Activity in Wheat Flour. I. Production of Diastatic Flour and Effect of Large Dosages," by R. C. Sherwood and C. H. Bailey. In *Cereal Chemistry,* Vol. III, pp. 107-136 (March, 1926).

Germinated wheat constituted a convenient source of flour high in diastatic activity. Conditions involved in germinating the wheat were of importance.

Wheat germinated for three days was most suitable and 20 per cent or less added to the normal wheat yielded flour which baked into bread superior to that when 40 per cent or more of the germinated wheat was used. No appreciable increases in non-protein nitrogen, H-ion concentration, titratable acidity, or other criteria of unsoundness in flour could be detected when 5 per cent of wheat sprouted under control for three days was included in the wheat mixture.

—"II. Experiments with Flour Milled on a Commercial Scale." In *Cereal Chemistry,* Vol. III, pp. 163-182 (May, 1926).

Wheats which yielded flour low in diastatic activity but were otherwise normal could not be converted into as high quality bread as when the deficiency in diastase was supplemented by the addition of highly diastatic material. Wheat sprouted under control for three days was used as a source of diastase. With wheat low in diastatic activity, this was doubled by the addition of 3 per cent of sprouted wheat. The flour milled from the mixture baked into superior bread, and was as sound and kept as well in storage as the control, or ungerminated, wheat flour.

No. 603. "Preliminary Report of Experimental Work in the Control of Bovine Infectious Abortion," by C. P. Fitch, W. L. Boyd, and R. E. Lubbehusen. In *Journal of the American Veterinary Medical Association,* Vol. LXIX, n.s. 22, No. 3 (June, 1926).

Two experimental herds were established in December, 1923. One herd is infected with contagious abortion and the other is free of this disease, as demonstrated by the blood tests. These herds are cared for by the same men and are not separated by more than 75 feet. One animal only has become infected in a period of 30 months in the clean herd. The experiments to date indicate that it is feasible to keep a clean herd and an infected herd on the same premises and cared for by the same men.

No. 604. "Sulphate Content of the Leaf-Tissue Fluids of Egyptian and Upland Cotton," by J. Arthur Harris, Clara T. Hoffman, and Walter F. Hoffman. In *Journal of Agricultural Research,* Vol. 31, pp. 653-661 (October, 1925).

The Upland and Egyptian varieties of cotton were found to differ significantly in sulphate content. This factor apparently is related to the ability of these cottons to adapt themselves to certain soil environments. (Part of the extensive investigation carried out by Dr. Harris, Head of the Department of Botany of the University, under joint co-operation of the University and the United States Department of Agriculture.)

No. 605. "A Chemical Study of Cystine from Kidney Stones," by R. A. Gortner and W. F. Hoffman. In *Proceedings of the Society for Experimental Biology and Medicine,* Vol. 23, pp. 691-693 (1926).

Samples of cystine from kidney stones were compared with other samples prepared from protein (human hair) and with inactive cystine prepared by holding protein cystine with 20 per cent hydrochloric acid for 48 hours. It was found that all three forms showed characteristic properties in certain tests. The cystine from kidney stones showed the highest optical activity (a specific rotation of $-242.6°$) of any cystine preparation reported in the literature.

No. 607. "Solving the Problem of Ripening Tropical Fruit in the North," by R. B. Harvey. In *The Chicago Packer,* Vol. 48, p. 16 (1926).

This article recommends the use of ethylene particularly for ripening the ordinary and the Cavendish banana. Instructions for the use of the ethylene process are given, also the time for ripening and the advantageous results which may be expected. A suggestion is given for the application of this process to the ripening of melons, tomatoes, and other fruits which must be shipped in a firm green condition.

No. 608. "The Ripening of Fruits by Ethylene Gas," by R. B. Harvey. In *The Minnesota Horticulturist,* Vol. 54, p. 140 (1926).

This paper summarizes for the use of horticulturists the experiments and commercial trials of ethylene in ripening tomatoes, bananas, and other fruits. It suggests the use of ethylene in ripening such fruits as melons when caught by frost.

No. 610. "A Conductivity Cell for Continuous Measurements of Respiratory Rate," by R. B. Harvey and L. O. Regeimbal. In *Plant Physiology,* Vol. 1, pp. 205-206 (1926).

This is a technical article giving instructions for the construction and use of a conductivity cell which has been found of value in the determination of sudden changes in the production of carbon dioxide by respiration from tissues when treated with ethylene to hasten ripening.

No. 611. "Biochemistry of Plant Diseases. VII. Correlation Between Skin Texture and Flesh Texture in Plum Varieties," by J. J. Willaman. In *Proceedings of the Society for Experimental Biology and Medicine,* Vol. 23, pp. 680-681 (1926).

Skin texture and flesh texture vary together. This relationship holds for the different plum varieties, for different seasons, and for different stages of ripeness.

No. 612. "Canning Qualities of Strawberry Varieties," by W. G. Brierley and Alice M. Child. In *The Minnesota Horticulturist,* Vol. 54, pp. 129-133 (May, 1926).

Canning studies made in 1924 and 1925 showed that there was practically no difference between berries canned by pressure cooker, water bath, and open kettle methods. The canned berries were held three months in a cool, dark storage and then judged as to condition, color, quality, etc. Varieties considered superior for canning purposes included, among others, Easypicker and Premier, two of the standard commercial varieties for Minnesota. Varieties considered poor for canning included Nokomis and Minnehaha, which are widely grown commercially in Minnesota. Dunlap, Gibson, and Marshall, while ranked as good canning varieties, were not equal to the best. While it can not be said that all smooth, firm, dark-red berries with red flesh were good canning varieties, it was obvious that light colored, soft varieties canned poorly.

No. 618. "Some Factors Affecting the Pathogenicity of *Actinomyces scabies,*" by G. B. Sanford. Abstract in *Phytopathology,* Vol. 16, pp. 525-547 (August, 1926).

A study was made of the effect of temperature, moisture, aeration, and substrate reaction on the growth, fructification, and germination of *Actinomyces scabies,* the potato scab pathogene. The effect of turning under green rye on the development of scab, soil reaction, and the soil flora was also studied. There is evidence that abundant soil moisture during the first thirty or forty days in the development of tubers reduces the amount of scab, probably by reducing the rapidity and abundance of spore formation. It is suggested that turning under such green crops as rye promotes the development of a soil flora which, for various reasons, is anti-biotic to *A. scabies.*

No. 619. "Ripening with Ethylene Gas," by R. B. Harvey. In *Canadian Horticulturist,* Vol. 49, p. 136 (1926).

The use of ethylene as a ripener of fruits and vegetables has been tried on a commercial scale sufficiently to recommend its use to the general trade. Instructions for making commercial installations are given. Also data are given on time required to ripen different varieties of fruits and vegetables. Care must be taken to maintain proper temperature and humidity in order to secure a proper ripening. A concentration of one part of ethylene to 1000 parts of air can be used for ripening a great variety of fruits. The use of ethylene is recommended to ripen tomatoes and other fruits which are nearly mature before the market price drops or after frosts.

No. 620. "Using Electricity to Make it Earn Dividends," by E. A. Stewart. In *Bulletin of Committee on Relation of Electricity to Agriculture,* Vol. II, No. 7, pp. 5-18 (May, 1926).

This paper gives some of the results of the work carried on at Red Wing, Minn., over two years. The proper conditions for giving rural electric service are emphasized—adequate voltage regulation, complete wiring of the farmstead and buildings, and a large amount of electrical equipment. The cost of rural lines should be financed by the utility so the farmer may use his money for equipment. Results show that a farmer can use electricity profitably for feed grinding, husking and shredding corn, threshing, milking, pumping water, hoisting hay, refrigeration, incubation, brooding, and lighting. Tables of data on energy consumption for different uses show that a farmer can use enough electricity that his price per KWH will be very moderate, even tho adequate fixed charges are made by the utility. The effect of light on egg production is shown graphically and indicates that substantial increases in income can be secured at very low cost for electric light.

EXPERIMENT STATION PROJECTS
1925-1926

Agricultural Biochemistry

Cereal and Flour Investigations (C. H. Bailey)

The Strength of Wheat Flour

- Subproject: Colloidal properties which may be involved in flour strength (R. A. Gortner, W. F. Hoffman)
- Subproject: Other factors which may be involved in flour strength (C. H. Bailey, Herbert Vogel, R. A. Gortner, Emily Grewe, R. C. Sherwood, R. A. Barackman, H. C. Triebold, J. L. St. John)

Investigations of Proposed Official Methods of Analysis (C. H. Bailey)

Comparative Studies on the Biochemistry of Normal and Abnormal Plants (J. J. Willaman, J. H. Beaumont, C. P. Fitch, P. D. Peterson, Alice M. Child)

Analytical Service (C. H. Bailey, G. S. Taylor, W. F. Erb)

Protein Investigations

- Subproject: The proteins of wheat flour (R. A. Gortner, W. F. Hoffman)
- Subproject: The basic amino acids of teosinte (R. A. Gortner, Lawrence Seleny)
- Subproject: Physico-chemical studies on derived proteins (R. A. Gortner and W. M. Sandstrom)
- Subproject: The electrical conductivity of protein compounds (R. A. Gortner, W. F. Hoffman, H. M. Barnett)
- Subproject: A chemical study of cystine from kidney stones (R. A. Gortner, W. F. Hoffman)
- Subproject: The chemistry of the flutelins from cereal grains (R. A. Gortner, R. K. Larmour)
- Subproject: The alcohol-soluble protein of rice (W. F. Hoffman) (Completed)
- Subproject: The composition of the "ammonia" in the Kjeldahl method (R. A. Gortner, W. F. Hoffman)

Chemical Studies of Pollen (R. A. Gortner, C. G. Vinson)

Chemical and Biological Studies in Animal Nutrition

- Subproject: Indolinones in polyneuritis (L. S. Palmer, R. A. Gortner, S. J. Dahl)
- Subproject: The vitamin requirements of growing calves (L. S. Palmer, in co-operation with C. H. Eckles, L. M. Thurston, I. R. Jones, S. I. Bechdel of the Division of Dairy Husbandry)
- Subproject: The antagonism of mineral ions in animal nutrition (L. S. Palmer, J. R. Haag)
- Subproject: A study of mineral deficiency disease among cattle (L. S. Palmer; and C. H. Eckles, T. W. Gullickson of the Division of Dairy Husbandry)
- Subproject: The anti-rachitic value of mother's milk (Cornelia Kennedy, L. S. Palmer)
- Subproject: Studies on the existence of a fertility vitamin necessary for normal reproduction of rats (Cornelia Kennedy and L. S. Palmer)
- Subproject: The fundamental food requirements for animals (L. S. Palmer, Cornelia Kennedy)

Subproject: The inter-relation of carriers of vitamins A and B as affecting growth and tissue change in young animals (L. S. Palmer, Cornelia Kennedy, Jessie E. Richardson)

The Chemistry of Milk as a Colloidal System (L. S. Palmer, Otto Johnson, G. A. Richardson, G. O. Larson)

The Biochemistry of Carotinoid Pigments in Animals (Dormant)

The Chemical and Physico-Chemical Properties of Plant Tissue Fluids (W. F. Hoffman, T. A. Pascoe, R. A. Gortner)

Chemical Studies on Forest Products (J. J. Willaman, W. F. Hoffman, K. W. Franke, D. R. Briggs)

Subproject: Determination of sodium thiosulfate

Subproject: Dialysis of blank liquor

Subproject: Colloidal aspects of beater action on wood fiber

Subproject: Relation of alum to the pH in the beater

Subproject: Determination of hydrogen ions in pulp and paper manufacture

Subproject: Microscopic study of the pulping process

Agricultural Economics

Methods Employed by Private Agencies in Land Settlement (J. D. Black)

Methods of Land Valuation with Especial Reference to Minnesota (J. D. Black)

Investigation of Forces Determining Prices of Farm Products (J. D. Black)

Relation of Changes in General Price Level to Prices of Farm Products (J. D. Black)

Market Price Investigations (Dormant)

Market Price Quotations (J. D. Black)

Elasticity of Supply of Farm Products (J. D. Black)

Farmers' Incomes in Minnesota (J. D. Black)

Market Organization Investigations (J. D. Black)

Farmers' Co-operative Movement in Minnesota (J. D. Black)

Organization of Farmers' Supply Service (J. D. Black)

Farmers' Marketing Attitudes (J. D. Black)

Grain Dockage Investigations (Dormant)

Agricultural Credit (J. D. Black, B. M. Gile)

Subproject: The present agricultural credit situation in Minnesota

Prices of Farm Products (J. D. Black, T. G. Stitts, B. Holt, P. Slagsvold, H. Working)

Taxation in Its Relation to Agriculture (J. D. Black, R. Ballinger, O. Negaard)

Subproject: The present agricultural taxation situation in Minnesota

Marketing of Farm Products (H. B. Price, J. D. Black, E. W. Gaumnitz, B. A. Holt)

Subproject: Problems of the Minnesota Co-operative Creameries Association

Subproject: Organization and management problems of local creameries in Minnesota

Subproject: Organization for selling livestock in Central Livestock Market

Subproject: Local concentration of livestock in Minnesota

Subproject: Federation of local grain elevators

Subproject: Margins on locally grown fruits and vegetables

Market Business Practice (J. D. Black)

Agricultural Engineering

Methods and Costs of Drainage Installation and Correlation of Land and Crop Values with Cost of Drainage (H. B. Roe)

Drainage and Water Control Investigation on Peat Lands (H. B. Roe, J. H. Neal, G. F. Krogh)

Determination of the Relative Efficiency of Different Depths and Spacings of Drainage Lines (H. B. Roe, J. H. Neal, G. F. Krogh)

Investigation of Causes of Failure of Agricultural Drain Tile, the Means of Obviating Such Failures, and Mapping Areas Where Extra Precautions Are Necessary (H. B. Roe, G. F. Krogh)

Investigation of Farm Buildings (H. B. White, M. G. Jacobson)

Investigations in Cost of Clearing Land (M. J. Thompson, A. J. Schwantes, J. J. McCurdy)

Investigations in Land Clearing Methods and Equipment (M. J. Thompson, A. J. Schwantes)

Heating and Ventilating of Homes (E. A. Stewart, A. G. Tyler)

Hydro-Electric Plants (E. A. Stewart, A. G. Tyler)

Farm Building Ventilation (E. A. Stewart, Julius Romness)

Wind Power Electric Lighting Plants (E. A. Stewart, A. G. Tyler)

Farm Sewage Disposal (E. A. Stewart, Julius Romness, A. G. Tyler)

Investigation of Farm Tractors (J. B. Torrance)

Subproject: Survey of factors governing successful tractor utilization

Land Clearing Investigations (M. J. Thompson, A. J. Schwantes, J. J. McCurdy)

Subproject: Investigations in methods of stone removal

Subproject: Investigations in plowing under brush

Subproject: Investigations in power necessary for pulling stumps

Subproject: Investigations in utilization of stump wood for fuel

Subproject: Land clearing salvage—stone

Subproject: Crop production following clearing of virgin land

Subproject: Economic limitations of stump removal for pasture

Utilization of Electricity in Agriculture (E. A. Stewart, A. G. Tyler, Julius Romness, L. F. Garey, Florence Connolly)

Agronomy and Farm Management

Breeding of Miscellaneous Field Crops (H. K. Hayes, Fred Griffee, F. J. Stevenson, S. E. Clarke)

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

Investigations in Cereal Breeding (H. K. Hayes, Fred Griffee, F. J. Stevenson, H. E. Brewbaker, S. E. Clarke, Lee Alexander, Alma Schweppe)

Subproject: To produce hardy winter wheats of high yielding ability

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 the 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
Corn Breeding Investigations (H. K. Hayes, S. E. Clarke, R. E. Hodgson, R. S. Dunham, R. O. Bridgford, Alma Schweppe, G. Nilsson-Leissner, V. Nielsen, L. Jorgenson)
Inheritance Studies with Small Grains (H. K. Hayes, Fred Griffee, F. J. Stevenson)
Subproject: Effects of selection in pure lines and the inheritance of characters
Subproject: The chromosome number of different farm crops and their near relatives, the cytology of maturation in ovule and pollen grain, and the cause of sterility
The Development of Disease Resistant Varieties of Farm Crops (H. K. Hayes, E. C. Stakman, O. S. Aamodt, Fred Griffee, H. E. Brewbaker, F. J. Stevenson, F. R. Immer, S. E. Clarke
Subproject: The development of rust resistant varieties of wheat
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
Subproject: Development of varieties of flax resistant to rust
Development of Improved Sorts of Corn (H. K. Hayes, H. E. Brewbaker)
Crop Rotation Investigations (A. C. Arny, J. H. Lefforge)
Forage Crop Investigations (A. C. Arny, F. W. McGinnis, F. H. Steinmetz, F. L. Higgins)
Subproject: Comparison of distance apart to plant corn and soybeans and sunflowers, and stage of maturity to cut for silage purposes
Subproject: Time, rate, and method of seeding alfalfa, sweet clover, sudan grass, millets, Canada field peas for pasture and hay
Subproject: Variety trials of various forage crops and roots
Subproject: Various legumes and grasses grown alone and in mixture for hay, pasture, and effect on following crops
Investigations in the Growing of Small Grains (A. C. Arny, F. W. McGinnis, Ching Po Sun)
Comparative Trials of Farm Crops at the Branch Stations (A. C. Arny)
Studies in the Classification of Farm Crops (A. C. Arny, J. H. Lefforge, A. C. Dillman)
Co-operative Seed Production and Distribution (A. D. Haedecke)
Cost Accounting Investigations on Minnesota Farms (G. A. Pond, Rex Truman, A. T. Hoverstad, Bess M. Miller, Mrs. W. E. Kiehne, C. O. Ruud, F. H. Tomlinson, G. A. Sallee)

Study of the Organization of Farms in the Red River Valley (G. A. Pond, D. C. Mumford, O. M. Fuller, C. O. Ruud, Mrs. W. E. Kiehne)
Subproject: Detailed farm records and accounts in Polk County, Minn.
Detailed Farm Records and Accounts in Pine County, Minn. (G. A. Pond)
Comparison of Fence Posts (L. B. Bassett)
A Study of the Physical Organization of Farms (L. B. Bassett)
Subproject: The farm layout
Subproject: The farmstead arrangement
A Study of Farm Organization and Practices on Livestock Farms (L. F. Garey)
Hay Standardization (F. H. Steinmetz)
Subproject: Palatability tests of wild hay
Types of Farming and Production Areas in Minnesota (L. F. Garey, V. J. Olson)
The Cost and Advantages of Grinding Corn Fodder for Idle Horses (W. H. Peters, L. B. Bassett)
Dairying as a Supplementary Enterprise on General Farms (A. Boss, G. A. Pond, R. S. Kifer)

Animal Husbandry

Baby Beef Feeding Trial (H. W. Vaughan, A. L. Harvey)
Swine Feeding Investigations (E. F. Ferrin, M. A. McCarty)
Subproject: The value of tankage and skimmilk as protein supplements for young pigs at weaning time
Subproject: The value of ground rye fed with certain supplements as a ration for growing pigs
Subproject: Marl as a source of calcium for swine
Subproject: A comparison of protein supplements in rations for pigs following weaning
Subproject: Fattening feeder pigs
Subproject: A comparison of the economy of full feeding and limited feeding of grains to growing pigs under dry lot and pasture conditions
Subproject: The comparative values of alfalfa, sweet clover, and rape pastures for pork production
Subproject: Methods of watering pigs
Subproject: A study of the cost of production and quality of product from lard type and from bacon type hogs
Subproject: A study of the production of Wiltshire sides from hogs of the lard and bacon breeds
Studies in Wool and Other Animal Fibers (P. A. Anderson, E. W. Sheets, D. A. Spencer, J. I. Hardy)
Subproject: Studies in the growth of wool
Free-Choice Self-Feeder Method of Raising Beef Calves (H. W. Vaughan, A. L. Harvey, H. A. Carsberg)
Cost and Advantages of Grinding Corn Fodder for Idle Horses (W. H. Peters, L. B. Bassett)

Bee Culture

Investigations in Queen Breeding and Raising (F. Jager)
Subproject: Demonstrating the possibility of commercial queen raising in Minnesota, its conditions, possibilities, and cost
Subproject: Investigations into the controlled mating of queen bees

Subproject: Research into possibilities of Carniolan bees for Minnesota
Subproject: A study of the laying capacity of queen bees
Management of Bees (F. Jager, G. C. Mathews, J. W. Thompson)
Subproject: Model apiary
Subproject: Summer and winter results of bees in different localities
Subproject: Studies in imported pound packages and nuclei for commercial production of honey
Subproject: Influence of sizes and types of hives on honey production and production of brood
Subproject: The influence of various kinds of natural and artificial foods in successful wintering of bees
Studies in Pollen (F. Jager)
Subproject: A study of pollen substitutes
Subproject: A study of gathering, and storing natural pollen through winter for spring use of bees
Subproject: A study of actual benefit derived from bees as pollinators of plants
Bee Disease Inspection (J. W. Thompson)

Dairy Husbandry

Factors Influencing the Market Quality of Minnesota Butter (H. Macy, W. B. Combs, L. W. Thurston, H. B. Richie, S. T. Coulter)
Subproject: Moldiness in butter
Subproject: Cheesy flavors in butter
Food Requirements of Growing Dairy Cattle (C. H. Eckles, T. W. Gullickson)
Subproject: The energy requirements 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
Ice Cream Studies (W. B. Combs, H. Bele)
Subproject: Factors influencing the viscosity and the relation of viscosity to the yield and quality of ice cream
Subproject: The relation between the gold number of gelatine and the protectiveness afforded ice cream
Increasing the Production of Dairy Cows by Better Feeding (O. G. Schaefer)
Factors Influencing the Vitamin Content of Milk (C. H. Eckles) (Dormant)
The Immediate Influence of Various Feeds Upon the Quantity and Quality of Milk (W. E. Petersen)
Subproject: Immediate influence of feeds high in oil content upon the fat percentage and quality of milk
Powdered Milk Studies (H. Macy)
Subproject: Bacteriological studies of powdered milk
Feeding Tests with Crops New to Minnesota (O. G. Schaefer)
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
Accuracy of the Methods of Making Composite Samples in Minnesota Creameries (W. B. Combs, L. M. Thurston, A. E. Groth, S. T. Coulter)

Mineral Problems of Dairy Cattle in Minnesota (C. H. Eckles, T. W. Gullickson)

Entomology and Economic Zoology

Nutritional Requirements of Certain Insects (*Tribolium confusum* Duval) (R. A. Gortner, R. N. Chapman) (closed)
The Parasites and Symbionts of Insects (W. A. Riley) (Dormant)
Insect Collection (C. E. Mickel)
Subproject: Insect collection, University Farm
Subproject: Insect collection, Itasca Park
Insecticides (A. G. Ruggles)
Subproject: Orchard spraying
Subproject: Potato spraying
Endoparasites of Man and Domesticated Animals (Dormant)
Insects Infesting Stored Food Products (R. N. Chapman)
Subproject: Measures for protecting flour and other cereal products from insects
Alfalfa Weevil (Dormant)
Insect Defoliators of Forest Trees (S. A. Graham)
Subproject: Jack pine sawfly
Subproject: The spruce budworm on Jack pine
Subproject: The spruce budworm, *Tortrix fumiferano*, on spruce and balsam fir
Subproject: The larch sawfly
A Study of Derris and Related Insecticides for the Control of External Parasites of Domesticated Animals (O. C. McBride)
Grasshopper Control (Dormant)
Insects of Orchard with Best Method of Combating (A. G. Ruggles)
Subproject: Plant lice
Subproject: Apple maggot
Insectary Work (A. G. Ruggles, T. L. Aamodt)
Life History and Injury of the Potato Leaf-Hopper (Dormant)
Use of Chlorpicrin Either Alone or in Combination with Paradichlorobenzene or Carbon Tetrachloride for Fumigating Grain in Elevators (A. L. Strand)
Effect of Physical Factors Upon Insects in Freshly Cut Logs (S. A. Graham)
A Study of the Rôle of Temperature and Humidity in the Development of Insects in Flour and Other Cereal Products (R. N. Chapman)
Effect of Temperature and Humidity on Wintering of Bees (R. N. Chapman) (Completed)
Spruce Budworm, *Tortrix fumiferana* (R. N. Chapman) (Discontinued)
Flukes of the Genus Collyriclum as Parasites of Poultry (Dormant)
A Study of the *Tabanidae*, or Horse-Flies, of Minnesota (C. B. Philip)
A Study of the Hookworms of the Dog and the Domesticated Fox (Dormant)
Greenhouse Insects (A. G. Ruggles)
Cucumber Insects (A. G. Ruggles)
Economic Status of Certain Field Vertebrates in Minnesota (M. S. Johnson) (Closed)
Soil Insects—"White grubs" (R. N. Chapman, A. G. Ruggles)

Forestry

Possibilities of Cut-Over Lands in Minnesota (Including "Qualitative and Quantitative Survey of Cut-Over Lands" and "Retardation of Natural Production and Yield Due to Fire") (T. S. Hansen)
Windbreak Planting Investigations (E. G. Cheyney) (Dormant)
Studies of Methods of Cutting in Norway Pine (T. S. Hansen) (Dropped)
Effect of Structure, Time of Cutting, and Methods of Seasoning of White Cedar on the Penetration of Preservatives (J. P. Wentling) (Dropped)
Wood Collection (J. P. Wentling) (Dropped)
Silvicultural Studies in Itasca Park (J. P. Wentling) (Dropped)
Studies in Minnesota Woods (J. P. Wentling) (Dropped)
Working Plan for Itasca Park (J. H. Allison) (Abandoned)
Studies of Forest Plantings (T. S. Hansen)
Working Plan for the Cloquet Forest Experiment Station Area (T. S. Hansen, J. H. Allison)
Blueberry Culture (T. S. Hansen) (Dropped)
Preservative Treatment of Fence Posts (J. H. Allison)
Forest Trees of Minnesota (J. P. Wentling)
Studies in Yield and Volume (J. H. Allison)
Studies in White Pine Blister Rust Control (E. G. Cheyney) (Dropped)
A Forest Survey of Minnesota (E. G. Cheyney)
Woodlot Study (E. G. Cheyney)
Volume Study of White Spruce (T. S. Hansen)
Thinning of Jack and Norway Pine (T. S. Hansen)
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 (R. Zon, T. S. Hansen) (Formerly "Effect of Water Level in Swamps Upon Tree Growth")
Volume, Growth, and Yield Studies of Birch and Aspen in Northern Minnesota (T. S. Hansen)
Demonstration Windbreak Plantations (S. S. Burton)

General

Rural Living in Minnesota (C. C. Zimmerman, G. W. Sprague, C. B. Howe)

Home Economics

A Quantitative and Qualitative Study of Farm Homes in Minnesota with Emphasis on the Influence of the Farm upon the Management of the Home and the Life of the Family (Lucy A. Studley)
  Subproject: A study of approximately 100 farm homes in the counties of Cottonwood and Steele
The Relation of Diet to Blood Formation and Regeneration (Jane M. Leichsenring)
  Subproject: The influence of the vitamins on the rate of blood regeneration
A Study of the Best Methods of Preparing Pork Products (Alice M. Child)
  Subproject: A study to determine the best methods of preparing ham, pork roast, bacon, and a standard for judging the cooked product

Horticulture

A Study of the Inheritance of Characters in Fruits (W. H. Alderman, J. H. Beaumont, A. N. Wilcox, F. E. Haralson)
Hardiness Studies in Fruit Breeding (W. H. Alderman, J. H. Beaumont, A. C. Hildreth, A. N. Wilcox)
Sterility Studies in Fruit Breeding (W. H. Alderman, J. H. Beaumont, A. N. Wilcox)
Vegetable Breeding and Selection (F. A. Krantz, B. I. Burrell, H. P. Traub)
Blueberry Culture (W. G. Brierley, W. H. Alderman, A .C. Hildreth)
Vegetable Experiments on Peat Land (F. A. Krantz, B. I. Burrell, H. P. Traub, W. H. Alderman)
Co-operative Orchard Management (W. G. Brierley, W. H. Alderman, A. C. Hildreth)
Fruit Variety Studies (W. G. Brierley, W. H. Alderman)
Cost of Producing Fruits (W. G. Brierley) (Postponed)
Nut Culture in Minnesota (W. G. Brierley)
Potato Breeding (F. A. Krantz, W. H. Alderman)
  Subproject: A test of varieties and seedlings
  Subproject: Sexual breeding
Turf Construction and Maintenance (C. E. Cary)
A Study of Ornamental Varieties and Their Uses (C. E. Cary)

Plant Pathology and Botany

Plant Disease Survey (Louise Dosdall, J. J. Christensen, A. W. Henry, J. G. Leach, R. M. Nelson, E. C. Stakman, P. D. Peterson)
Rusts of Cereals (E. C. Stakman, J. J. Christensen, J. H. Craigie, F. J. Greeney, Helen Hart, A. W. Henry, T. Johnson, J. G. Leach, H. E. Pearson, L. A. Schaal, J. M. Wallace, O. S. Aamodt, R. U. Cotter, E. B. Lambert, M. N. Levine, L. W. Melander)
  Subproject: Nature of resistance
  Subproject: Physiologic specialization of *Puccinia graminis tritici*
  Subproject: Epidemiology of cereal rusts
  Subproject: Barberry eradication
  Subproject: Dusting to control cereal rusts
Cereal and Forage Crop Diseases (E. C. Stakman, J. J. Christensen, A. W. Henry, H. A. Rodenhiser, T. Johnson)
  Subproject: Imperfects on cereals and roots
  Subproject: Smut treatments
  Subproject: Scab of cereals
  Subproject: Ergot of cereals
  Subproject: Sunflower rust
  Subproject: Black chaff of wheat
  Subproject: Miscellaneous diseases of sunflowers
  Subproject: Miscellaneous diseases of flax
  Subproject: Sorghum smut
Garden Truck Diseases (J. G. Leach, H. E. Parson, G. B. Sanford, R. B. Harvey)
  Subproject: Bean bacteriosis and anthracnose (dormant)
  Subproject: Potato diseases
  Subproject: Miscellaneous truck crop diseases

Subproject: The relation of dipterous insects to the spread and development of soft rot of vegetables
Fruit Diseases (E. C. Stakman, P. D. Peterson)
Subproject: Experimental apple spraying
Subproject: Experimental plum spraying
Subproject: Diseases of small fruits and methods of control
Subproject: Biology of *Sclerotinia spp.* (Discontinued)
Subproject: Raspberry mosaic
Dendropathological Work (E. C. Stakman, L. Jackson, R. Lindgren, R. Nelson, W. Peel)
Subproject: Miscellaneous Itasca experiments
Subproject: The rotting of posts and poles
Subproject: Relation of environment to damping-off
Seed Studies (A. H. Larson, Ruby Ure Crouley)
Subproject: Germination of lettuce seed
Subproject: Seed testing survey
Subproject: Weed seed cases
Weeds (A. H. Larson, Ruby Ure Crouley)
Subproject: Perennial sow thistle
Minnesota Mushrooms (Louise Dosdall)
Studies in Plant Metabolism and Growth (R. B. Harvey)
Subproject: Effect of length of illumination period and light intensity upon growth and reproduction
Subproject: Effect of increased CO_2 supply upon plant growth and reproduction
Subproject: Salt nutrition
Subproject: Effect of nightly illumination on control of seedling diseases
Investigations on Respiratory Enzymes (R. B. Harvey, L. O. Regeimbal, G. A. Vacha)
Physiology of Seed Germination (R. B. Harvey, G. A. Vacha)
Effect of Low Temperature on Plants (R. B. Harvey, L. O. Regeimbal, G. A. Vacha)
Subproject: Varietal differences in frost resistance of crop plants
Subproject: Physiological factors concerned in frost injury
Subproject: Desiccation in the frozen condition as a cause of injury
Subproject: Killing of seeds and seedlings of forest trees and horticultural plants by low temperature
Physiology of Reproduction (R. B. Harvey, L. O. Regeimbal) (Dormant)
Development of Disease-Resistant Varieties of Farm Crops (E. C. Stakman, H. K. Hayes, J. J. Christensen, A. W. Henry, P. D. Peterson, H. A. Rodenhiser, O. S. Aamodt, M. N. Levine)
Subproject: Breeding of spring wheat for resistance to black stem rust
Subproject: The genetics of biologic forms of *Puccinia graminis*
Subproject: The development of smut-resistant varieties of small grains
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: 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
Effect of Cyanimid on the Development of Plant Diseases (E. C. Stakman, W. C. Broadfoot, H. H. Flor)
Effect of Amo-Phos on the Development of Plant Diseases (E. C. Stakman, W. C. Broadfoot, H. H. Flor)
Control of Weeds by Cyanamid (E. C. Stakman, W. C. Broadfoot, H. H. Flor)
Diseases of Ornamental Plants (Louise Dosdall)
Physiology of Blanching Fruits and Vegetables (R. B. Harvey)
Hollow Heart of Potatoes (R. B. Harvey) (Discontinued)

Poultry

The Raising of Young Turkeys by Artificial Methods (A. C. Smith, A. A. Hoberg, M. Peebles)
Subproject: Artificial hatching
Subproject: Artificial brooding
Subproject: Feeding poults artificially brooded
Subproject: Feeding poults after the brooding age, in confinement
Effect upon Mortality, Growth, and Feather Development of Feeding Leghorn Chicks Different Amounts of Different Animal Foods (A. C. Smith, A. A. Hoberg)
Subproject: Effect of a combination of meat scraps and dried buttermilk in varying proportions

Soils

Fertilizer Experiments (F. J. Alway, W. M. Methley, G. H. Nesom, R. M. Pinckney)
Soil Survey (F. J. Alway, P. R. McMiller, G. B. Bodman, R. M. Pinckney)
Movement of Water in Soils (F. J. Alway, R. M. Pinckney)
Peat Soils (F. J. Alway, G. H. Nesom, I. Nygard)
Sandy Soils (F. J. Alway, G. H. Nesom)
Hydrogen-ion Concentration of Soils (C. O. Rost)
Soils of the Low-Lime Area (F. J. Alway, C. O. Rost)
Land Classification (F. J. Alway, P. R. McMiller)
Agricultural Value of Marl (F. J. Alway, G. H. Nesom, Wm. Methley)
Soils of the Red Drift (F. J. Alway, G. B. Bodman)

Veterinary Medicine

Infectious Abortion and Other Diseases of the Reproductive Organs of Cattle (C. P. Fitch, W. L. Boyd, R. E. Lubbehusen, Margaret Sichler)
Subproject: Pathology and bacteriology of sterility
Subproject: Serological tests in their relation to bovine infectious abortion
Subproject: Bacterial flora of the vagina and uterus of the cow
Subproject: Infectious white scours and calf pneumonia
Subproject: Function of the *corpus luteum*
Subproject: Production of artificial immunity
Subproject: Effects of pituitrin on delayed parturition, expulsion of the fetal membranes, and subinvolution of the uterus

Subproject: Channels of infection in bovine infectious abortion
Subproject: Elimination of *Bact. abortus* through excretions and secretions
Subproject: Biological requirements of *Bact. abortus* Bang.
Subproject: The clean and infected herd
Contagious Abortion of Mares and Pyaemic Arthritis of Foals (W. L. Boyd, C. P. Fitch) (Dormant)
Investigation of Obscure Diseases (C. P. Fitch, W. L. Boyd, H. C. H. Kernkamp, R. E. Lubbehusen, E. A. Hewitt, Margaret Sichler)
Subproject: Investigation of obscure diseases in the state, with special reference to infectious diseases
Subproject: Investigation and treatment of diseases affecting University Farm animals
State Regulartory Work (M. H. Reynolds)
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 non-tuberculous cattle
Diseases of Poultry (C. P. Fitch, H. C. H. Kernkamp, R. E. Lubbehusen, Margaret Sichler)
Subproject: To determine the feasibility of applying the tuberculin test in the control and suppression of tuberculosis in poultry
Subproject: To study entero-hepatitis in turkeys and to determine the efficiency of certain drugs and biological agents as preventives and curatives
Application of the Benzoate Renal Function Test to Nephritis in Cattle (E. A. Hewitt) (Closed)
Chemistry of the Blood and Urine of Animals Affected with Specific and Obscure Diseases (E. A. Hewitt)
Studies in Digestion in Herbivora (E. A. Hewitt) (closed)

FINANCIAL STATEMENT

The Minnesota Agricultural Experiment Station in Account with the United States Appropriations, 1925-1926

Dr.		
To receipts from the Treasurer of the United States in accordance with the appropriations for the fiscal year ending June 30, 1926, under the Act of Congress approved March 2, 1887		$15,000.00
Cr.		
By salaries	$15,000.00	
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, 1926, under the Act of Congress approved March 16, 1906		$15,000.00
Cr.		
By salaries	15,000.00	
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, 1926, under the Act of Congress approved February 24, 1925		20,000.00
Cr.		
By salaries	16,506.16	
By travel, supplies, equipment	3,493.84	
Total Purnell Fund	$20,000.00	$20,000.00

Supplementary Statement

Receipts from sources other than the United States for the year ending June 30, 1926:		
State appropriations	$241,504.39	
Special appropriations	30,000.00	
Fees	99,311.46	
Sales	83,460.64	
Miscellaneous	2,249.97	
Total		$456,526.46

Expenditures, Central Station and Substations, 1925-26

	University Farm	Crookston	Morris	Grand Rapids	Duluth	Waseca	Zumbra Heights	Albert Lea	Total
Salaries	$223,567.90	$23,473.15	$20,837.56	$7,454.22	$8,940.30	$6,966.09	$7,223.28	$2,238.75	$300,701.25
Labor	4,738.16	142.15	536.29	31.85	58.20	226.11	70.26	.....	5,803.02
Stationery and office supplies	6,472.40	826.74	607.82	110.82	215.31	22.62	23.13	.....	8,278.84
Scientific supplies	920.86	.....	8.31	.....	.....	.....	.....	.....	929.17
Feeding stuffs	11,794.92	2,372.58	1,779.98	2,563.38	1,530.78	671.37	48.75	.....	20,761.76
Sundry supplies	36,416.72	2,545.78	2,526.03	1,327.32	1,924.32	1,927.23	493.86	.....	47,161.26
Fertilizers	554.67	.....	51.00	.....	6.75	.....	12.90	.....	625.32
Communication service	1,939.97	146.24	86.03	80.10	.....	9.57	54.72	.....	2,316.63
Travel	9,618.03	673.09	299.93	75.64	149.46	39.09	.....	.....	10,855.24
Freight and express	2,040.98	239.45	169.79	258.84	3.36	.....	.51	.....	2,712.93
Publications	1,397.06	53.17	1.18	.....	.....	.....	.....	.....	1,451.41
Power, heat, light, and water	12,853.64	1,682.28	2,041.89	906.78	128.31	281.28	815.58	.....	18,709.76
Furniture and fixtures	5,130.02	1,563.59	2,999.61	383.70	552.30	94.74	189.75	.....	10,913.71
Library	1,459.28	364.40	199.45	4.00	.....	.....	.....	.....	2,027.13
Scientific equipment	5,406.70	40.89	185.50	7.10	.....	.....	.....	.....	5,640.19
Livestock	2,792.88	696.08	180.00	11.50	40.50	.....	.....	.....	3,720.96
Tools, machinery, appliances	1,055.98	1,529.85	356.42	43.22	1,080.69	600.00	32.37	.....	4,698.53
Buildings and lands	8,039.82	852.73	326.80	.....	.....	.....	.....	.....	9,219.35
Total	$336,199.99	$37,202.17	$33,193.59	$13,258.47	$14,630.28	$10,838.10	$8,965.11	$2,238.75	$456,526.46

EXPERIMENT STATION STAFF

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The Hon. Fred B. Snyder, Minneapolis	- - - - -	1928
The President of the Board		
Lotus D. Coffman, Minneapolis	- - - - -	*Ex Officio*
The President of the University		
The Hon. Theodore Christianson, St. Paul	- - - - -	*Ex Officio*
The Governor of the State		
The Hon. J. M. McConnell, St. Paul	- - - - -	*Ex Officio*
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The Hon. W. J. Mayo, Rochester	- - - - -	1931
The Hon. Bess M. Wilson, Redwood Falls	- - - - -	1931
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The Hon. J. E. G. Sundberg, Kennedy	- - - - -	1929

The Agricultural Committee

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The Hon. Alice R. Warren	The Hon. Bess M. Wilson
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W. C. COFFEY, M.S., Director
ANDREW BOSS, Vice-Director
F. W. PECK, M.S., Director of Agricultural Extension and Farmers' Institutes
C. G. SELVIG, M.A., 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
ANDREW BOSS, Chief, Division of Agronomy and Farm Management
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
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

* On leave July 1, 1925, to January 1, 1926.

Division of Agricultural Biochemistry

ROSS AIKEN GORTNER, Ph.D., Agricultural Biochemist

Section of Proteins and Colloids

ROSS AIKEN GORTNER, Ph.D., Agricultural Biochemist
*WALTER F. HOFFMAN, Ph.D., 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
†W. F. ERB, Special Analyst
H. O. TRIEBOLD, B.S., Strietmann Fellow
EMILY GREWE, M.A., 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., Cloquet Wood Products Fellow
D. R. BRIGGS, M.S., Cloquet Wood Products Fellow

Section of Nutrition and Dairy Chemistry

L. S. PALMER, Ph.D., Dalry Chemist
CORNELIA KENNEDY, Ph.D., Assistant Agricultural Biochemist
CORNELIA KENNEDY, Ph.D., Assistant Agricultural Biochemist
J. ROY HAAG, M.S., Assistant
OLE MYDLAND, Animal Caretaker

Division of Agricultural Economics

J. D. BLACK, Ph.D., Agricultural Economist
H. B. PRICE, Ph.D., Assistant Economist
‡HOLBROOK WORKING, Ph.D., Assistant Economist
B. A. HOLT, M.A., Research Assistant
*EDWIN GAUMNITZ, M.A., Research Assistant
B. M. GILE, B.S., Research Assistant
C. M. HOWE, M.A., Research Assistant
§ARNOLD HINRICHS, B.S., Research Assistant
ELMER BRAUN, B.S., Research Assistant
ROY BALLINGER, M.A., Research Assistant
GORDON WARD, B.S., Research Assistant
B. B. DERRICK, B.S., Research Assistant
BENJAMIN MCCAUL, B.S., Research Assistant
H. B. ROWE, B.S., Research Assistant

* Resigned April, 1926.
† Part time, October 1, 1925 to March 31, 1926.
‡ Resigned September, 1925.
§ Appointed April, 1926.

Division of Agricultural Engineering

WILLIAM BOSS, Agricultural Engineer

Section of Farm Mechanics

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

Section of Farm Buildings

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

Section of Drainage

H. B. ROE, B.S. in Engr., Associate Agricultural Engineer, Drainage
J. H. NEAL, B.S. in A.E., Assistant Agricultural Engineer, Drainage
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., Junior Drainage Engineer, U.S.D.A., B.P.R.
*E. J. BULLIS, 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, Land Clearing

Section of Agricultural Physics

E. A. STEWART, B.Pd., B.S., Assistant Agricultural Physicist, Agricultural Physics
A. G. TYLER, Assistant Agricultural Physicist
JULIUS ROMNESS, B.S., Assistant Agricultural Physicist

Division of Agronomy and Farm Management

ANDREW BOSS, Agriculturist

Section of Plant Breeding

H. K. HAYES, D.Sc., Plant Breeder
†FRED GRIFFEE, Ph.D., Assistant Plant Breeder
H. E. BREWBAKER, M.S., Assistant Plant Breeder
‡F. J. STEVENSON, M.S., Assistant Plant Breeder

Section of Farm Crops

A. C. ARNY, M.S., Associate Agronomist
F. W. MCGINNIS, M.S., Assistant Agronomist
F. H. STEINMETZ, M.S., Assistant Agronomist
F. L. HIGGINS, M.S., Graduate Assistant
J. H. LEFFORGE, B.S., Assistant in Agronomy

Section of Co-operative Seed Production and Distribution

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

Section of Cost Accounting

G. A. POND, M.S., Associate Agriculturist
A. T. HOVERSTAD, B.S.. Assistant

Section of Farm Organization

ANDREW BOSS, Agriculturist
L. B. BASSETT, Associate Agriculturist
L. F. GAREY, M.A., Assistant in Farm Management
§D. CURTIS MUMFORD, B.S., Assistant in Farm Organization

* Resigned March, 1926.
† Resigned September 1, 1925.
‡ Appointed November 1, 1925.
§ Appointed September 25, 1925.

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 Sheep Husbandry and Meats

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

Division of Bee Culture

FRANCIS JAGER, Apiculturist
*G. C. MATTHEWS, Assistant 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

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
‡F. L. WASHBURN, Economic Zoologist
§M. S. JOHNSON, Ph.D., Economic Zoologist
S. A. GRAHAM, Ph.D., Assistant Entomologist, Forest Insect Investigations
CLARENCE E. MICKEL, Ph.D., Assistant Entomologist, Extension
A. L. STRAND, B.S., Research Assistant
G. M. STIRRETT, M.S., Assistant in Entomology
C. B. PHILIP, B.S., Assistant in Parasitology
H. L. SWEETMAN, M.S., Assistant in Entomology
||WM. ROBINSON, M.S., Assistant in Entomology
||H. L. PARTEN, B.S., Assistant in Entomology

* Resigned October, 1925.
† Appointed August 1, 1925.
‡ On leave, 1925-26. Retired July 1, 1926.
§ Appointed July 1, 1925.
|| Appointed September 1, 1925.

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
T. S. Hansen, M.F., Assistant Forester at Cloquet
*E. E. Probstfield, M.F., Assistant Forester at Cloquet
D. A. Kribs, B.S., Assistant
†S. S. Burton, B.S., Assistant
*A. M. Koroleff, Assistant

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, B.S., 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
Basil I. Burrell, B.S., Assistant Horticulturist
H. P. Traub, M.S., Assistant Horticulturist

Section of Floriculture and Landscape Gardening

Clarence E. Cary, B.S. in Agr., Assistant Horticulturist
L. Sando, Florist
F. E. Haralson, Assistant Superintendent, State Fruit Breeding Farm

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
‡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
R. M. Nelson, Assistant Plant Pathologist
‡Helen Hart, M.A., Assistant Plant Pathologist

* New appointment.
† Resigned September, 1925.
‡ Co-operating with the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.

Wm. Broadfoot, M.S., Assistant in Plant Pathology (American Cyanamid Co. Fellow)
H. H. Flor, M.S., Assistant in Plant Pathology (American Cyanamid Co. Fellow)

Detailed by the Office of Cereal Investigations, U. S. Department of Agriculture for Co-operative Work

O. S. Aamodt, M.S., Pathologist
M. N. Levine, Ph.D., Pathologist
E. B. Lambert, M.S., Agent

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 (From Oct. 1, 1925 to June 30, 1926)

Section of Seed Laboratory

A. H. Larson, B.S., Seed Analyst
Ruby Ure Crouley, Assistant Seed Analyst

Division of Poultry Husbandry

A. C. Smith, B.S., Poultry Husbandman
Alvie 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
Margaret Sichler, B.S., Technician

General

C. C. Zimmerman, M.S., Rural Sociologist; Special Investigator in Rural Sociology