

University of Minnesota

AGRICULTURAL EXPERIMENT STATION
THIRTY-SIXTH ANNUAL REPORT

JULY 1, 1927 TO JUNE 30, 1928



UNIVERSITY FARM, ST. PAUL
FEBRUARY 1929

LETTERS OF TRANSMITTAL

MINNEAPOLIS, MINN.,
July 1, 1928

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, 1928.

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

UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.,
July 1, 1928

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, 1928.

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

UNIVERSITY FARM, ST. PAUL, MINN.,
July 1, 1928

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President of the University of Minnesota.

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Respectfully,
W. C. COFFEY, Director

THIRTY-SIXTH ANNUAL REPORT MINNESOTA AGRICULTURAL EXPERIMENT STATION

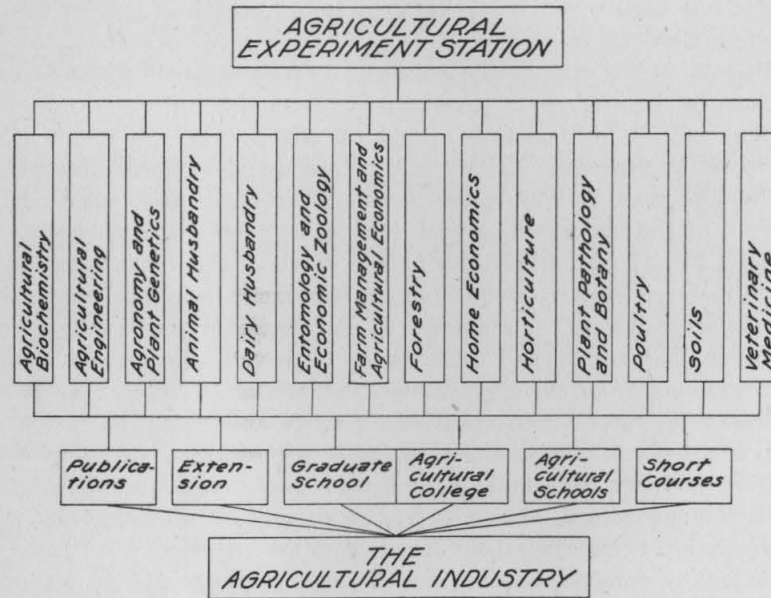
JULY 1, 1927 TO JUNE 30, 1928

FOREWORD

The year has been marked by increasing research activities. Emphasis has been given particularly to improvement in the quality of research with the result that there has been a ready acceptance of the findings of the station by the public and frequent applications of new methods and processes in agricultural production.

The official file contains a total of 202 projects on which work has been in progress. Of these, 175 are active, 14 were completed during the year, and 27 were allowed to lie dormant because of the absence of the leaders or for lack of adequate support. Nineteen new projects have been initiated during the year and the demand for additional research grows. Requests have been made by several specialized groups of producers for assistance in solving important and significant problems that are beyond their power to solve. Such requests have been received from the state canners' association, the vegetable growers' association, the co-operative creameries and milk producers, the crop improvement association, the implement dealers, the grain commission interests and millers, and from other organized groups in industrial agriculture, as well as from numerous individuals. Research problems are being constantly urged upon the experiment station staff by letter, by personal request, and through members of the extension staff.

Notwithstanding the fact that a total of \$521,751.08 was expended in experiment station research this year, it is impossible to undertake additional researches without additional financial support. The research work in hand, and most of it is important and well organized, can not be laid aside or suspended without loss. It must be finished before new work can be undertaken. New researches, except in emergencies, must therefore await the completion of the old or the provision of additional support funds. That additional public support should be given seems obvious. When it is recalled that the experiment station is the research laboratory for 188,000 farms, as well as for numerous groups in industrial agriculture, the support given is not over-liberal, being approximately one-tenth of one per cent of the gross sales value from Minnesota farms. As justification for such expenditures it may be pointed out that a recent examination of the achieve-



Organization of the Minnesota Agricultural Experiment Station and Means Through Which the Results of the Investigations Reach the Agricultural Industry.

ments of the experiment station researches indicates increased returns to Minnesota farms of approximately 46 million dollars annually through the application of the findings to agricultural production.

New truths come slowly. Sound principles and new agricultural knowledge can be developed only from extended research. While much has been learned about the growth and behavior of plants and animals that enter into farm production, the processes grow more complicated as agriculture becomes more intensified. New problems are constantly arising. A vast amount of research work is performed yearly by the state experiment stations, the United States Department of Agriculture, and other research agencies, yet many important problems that vitally affect agricultural production are still awaiting solution. Many hours of laboratory work and much patient investigation are performed annually, with numerous papers and discussions resulting therefrom. Much of this work is necessarily barren of results or of lasting value; for, as a recent writer¹ has pointed out, "A ton of rock must be mined and milled in order to secure an ounce of gold, . . . so, an immense amount of work must be done by the laboratory mills in order to recover a few grains of truth." Certainly this applies to agricultural research. While we often read of spectacular discoveries that are expected to revolutionize the agricultural world, the fact remains that real truths and sound principles are developed but slowly and with much patient effort. Experiment station workers are under the necessity of carefully examining much widely scattered literature before undertaking new researches in order to make sure that they are not working over a field that has already been well exhausted. It is in this way only that the quality of research may be still further advanced.

REORGANIZATION

Important and significant reorganizations were made at the close of the year. Farm Management, which has been a part of the Division of Farm Management, Agronomy, and Plant Genetics, was combined with Agricultural Economics in a Division of Farm Management and Agricultural Economics and transferred to the third floor of the new dairy building, Haecker Hall. Agronomy and Plant Genetics was constituted as a division and housed in the original experiment station building, referred to as the "Farm House," which was remodeled to provide adequate offices for the division. Partial research laboratory facilities and some class rooms were also provided, but the division as a whole still needs enlarged laboratories and additional class room space.

¹ N. B. Taylor, Department of Physiology, University of Toronto. In *Scientific Monthly*, November, 1928.

The Division of Agricultural Biochemistry occupied the new building provided under the name of "Plant Industry Building." The provision of this building has greatly enlarged the research facilities of the division for both experiment station work and graduate research. It provides, as well, additional class laboratories and rooms for instruction in the School and College. The building is 152 feet in length, with a maximum depth of 70 feet. It comprises three stories and a basement that is almost entirely above ground.

The provision for biochemistry in the new building left the old Agricultural Chemistry building available for the Division of Soils. The building was remodeled and re-equipped and now meets in fairly satisfactory manner the needs of this division for research laboratories and offices.

Another addition of importance to the facilities for research work is eight greenhouse units. These are to be used by the divisions of Agronomy and Plant Genetics and Plant Pathology and Botany in the researches covering inheritance, disease resistance, winter hardiness, and other phases of field crop propagation work.

As an additional measure in improving the experiment station organization, an experiment station office has been established on the second floor of the Administration Building. Dr. Andrew Boss, who for twenty-three years has been chief of the Division of Agronomy, Farm Management, and Plant Genetics, has been released from that responsibility and put definitely in charge of experiment station work as vice-director of the experiment station. He will give the major portion of his time to the direction of the experiment station, tho he will at the same time maintain research and teaching activities in the Division of Farm Management and Agricultural Economics.

CHANGES IN STAFF

Resignations

Agricultural Economics

J. D. Black, agricultural economist, resigned to accept a position as professor of agricultural economics at Harvard University.

T. G. Stitts, research assistant, resigned to accept a position in the United States Bureau of Economics as senior agricultural economist.

Animal Husbandry

H. W. Vaughan, assistant animal husbandman, resigned to accept the position of chief of the division of animal husbandry at Montana State College.

Dairy Husbandry

O. G. Schaefer, assistant dairy husbandman, resigned to accept a position as representative of the Dairy Farmer.

H. B. Richie, assistant in dairy husbandry, resigned to accept a position as bacteriologist with Swift and Company, at Chicago.

Farm Management, Agronomy, and Plant Genetics

F. L. Higgins, assistant in agronomy, resigned to devote his entire time to graduate study.

D. Curtis Mumford, assistant in farm organization, resigned at the end of the year to accept a position as associate economist in the United States Bureau of Agricultural Economics.

A. T. Hoverstad, assistant in farm management, resigned at the end of the year to take up farming.

Forestry

D. A. Kribs, assistant forester, resigned to take up graduate study at Yale University.

Horticulture

A. C. Hildreth, assistant horticulturist, resigned to accept the position of associate biologist at the University of Maine.

H. P. Traub, assistant horticulturist, resigned to accept the position of chief of the division of horticulture at the University of Texas.

Plant Pathology and Botany

A. W. Henry, assistant plant pathologist, resigned to accept a position as professor of plant pathology at the University of Alberta, Canada.

Poultry Husbandry

A. A. Hoberg, assistant in poultry husbandry, resigned to accept a commercial position.

Soils

G. B. Bodman, assistant in soils, resigned to accept a position as instructor in soil technology at the University of California.

Veterinary Medicine

R. E. Lubbehusen, assistant pathologist, resigned to accept a position as bacteriologist with the Pennsylvania Bureau of Animal Industry.

Appointments

Agricultural Economics

A. G. Black, G. B. Clarke, and O. J. Hall were appointed research assistants.

Dairy Husbandry

Henry Morrison was appointed assistant.

Entomology and Economic Zoology

R. A. Wardle was appointed associate entomologist for the year; L. W. Orr, L. B. Reed, and H. E. Gray were appointed assistants.

Farm Management, Agronomy, and Plant Genetics

H. K. Wilson was appointed assistant agronomist to fill the vacancy caused by the resignation of H. B. Sprague.

I. J. Johnson was appointed assistant in agronomy to fill the vacancy caused by the resignation of F. L. Higgins.

H. B. Pingrey and W. J. Roth were appointed assistants.

Forestry

L. W. Rees was appointed assistant forester to fill the vacancy caused by the resignation of D. A. Kribs.

Horticulture

A. E. Hutchins was appointed assistant.

Plant Pathology and Botany

C. S. Holton, W. F. Hanna, and G. Steinbauer were appointed assistants.

Soils

Constantin Nikiforoff was appointed assistant soils chemist to fill the vacancy caused by the resignation of G. B. Bodman.

Veterinary Medicine

R. Fenstermacher, was appointed assistant pathologist, to take charge of diagnosis work in co-operation with the State Livestock Sanitary Board.

Leave of Absence**Agricultural Biochemistry**

J. J. Willaman, plant chemist, was granted leave for the year to study in Europe on an International Education Board Fellowship.

Farm Management, Agronomy, and Plant Genetics

L. F. Garey, assistant in farm management, was granted leave for nine months to pursue graduate studies at Cornell University.

Home Economics

Lucy A. Studley, home economist, was granted leave for the year for study and research in Washington, D. C., and at the University of North Carolina.

Plant Pathology and Botany

J. G. Leach, assistant plant pathologist, was granted leave for the year for study in Europe on an International Education Board Fellowship.

R. B. Harvey, associate plant physiologist, was granted leave for the year for study in Europe on a Guggenheim Fellowship.

Veterinary Medicine

H. C. H. Kernkamp was granted leave for a year for study at Iowa State College of Agriculture and Mechanic Arts.

PUBLICATIONS

The following publications have been issued during the fiscal year 1927-28. These bulletins are available to those desiring to know the contents and are therefore not abstracted for the Annual Report.

Bulletins**Agricultural Experiment Station****General Series**

235. Field Studies on the Sources of Mold in Butter, by H. Macy and W. B. Combs, Division of Dairy Husbandry. 32 pages, edition of 6,000.

236. Retail Margins in Marketing Home-Grown Fruits and Vegetables, by W. C. Waite and H. B. Rowe, Division of Agricultural Economics. 32 pages, 7,500.

237. Rations for Baby Beeves and Selection of Calves for Baby Beef Production, by H. W. Vaughan, Division of Animal Husbandry. 52 pages, 10,000.

238. Forest Planting Experiments in Minnesota, by T. S. Hansen, Division of Forestry. 32 pages, 5,000.

239. Soybeans and Soybean Hay in the Dairy Ration, by O. G. Schaefer, Division of Dairy Husbandry. 16 pages, 10,000.

240. Family Living on Successful Minnesota Farms, by J. D. Black and C. C. Zimmerman, Division of Agricultural Economics. 28 pages, 7,000.

241. The Farm Woodlot of Southeastern Minnesota, by E. G. Cheyney and R. M. Brown, Division of Forestry. 28 pages, 7,500.

242. Parchment Paper as a Source of Mold in Butter, by H. Macy and G. M. Pulkrabek, Division of Dairy Husbandry. 24 pages, 7,500.

243. The Accuracy of Composite Cream Sampling, by W. B. Combs, L. M. Thurston, A. E. Groth, and S. T. Coulter, Division of Dairy Husbandry. 40 pages, 6,500.

244. Marketing Country Creamery Butter by a Co-operative Sales Agency, by H. B. Price, Division of Agricultural Economics. 48 pages, 10,000.

245. Marketing Locally Grown Raspberries in Minnesota, by H. B. Price, O. A. Negaard, Division of Agricultural Economics, and W. G. Brierley, Division of Horticulture. 24 pages, 6,500.

246. Factors Affecting Expenditures of Farm Family Incomes in Minnesota, by C. C. Zimmerman and J. D. Black, Division of Agricultural Economics. 32 pages, 7,500.

Reprints—

218. Feeding the Dairy Herd, by C. H. Eckles and O. G. Schaefer, Division of Dairy Husbandry. 48 pages, 25,000.

221. Tankage and Buttermilk as Protein Supplements for Growing Pigs, by E. F. Ferrin and M. A. McCarty, Division of Animal Husbandry. 12 pages, 5,000.

213. Feed Requirements and Cost of Gains of Spring and Fall Pigs, by E. F. Ferrin and M. A. McCarty, Division of Animal Husbandry. 20 pages, 5,000.

Technical Series

47. An analysis of the Cost of Tile Drainage Installation, by H. B. Roe, Division of Agricultural Engineering. 84 pages, 3,000.

48. Studies on the Carrion Beetle of Minnesota, Including New Species, by M. H. Hatch, Division of Entomology and Economic Zoology. 20 pages, 1,500.

49. A Comparison of the Toxicity to Insects of Chlorpicrin, Carbon Disulphide, and Carbon Tetrachloride, and Their Diffusion in a Column of Grain, by A. L. Strand, Division of Entomology and Economic Zoology. 68 pages, 1,500.

50. Heartrot of Aspen, with Special Reference to Forest Management in Minnesota, by Henry Schmitz, Division of Forestry; and L. W. R. Jackson, Division of Plant Pathology and Botany. 44 pages, 3,000.

51. Inheritance of Reaction to *Ustilago zeae* in Maize, by F. R. Immer, Division of Farm Management, Agronomy, and Plant Genetics. 64 pages, 1,500.

52. Experimental and Mathematical Analyses of Drain Tile Testing and New Test Bearings, by D. G. Miller and J. A. Wise, United States Department of Agriculture and Division of Agricultural Engineering. 66 pages, 2,000.

53. Regional and Seasonal Distribution of Moisture, Carbohydrates, Nitrogen, and Ash in 2-3 Year Portions of Apple Twigs, by H. P. Traub, Division of Horticulture. 64 pages, 1,500.

54. Length of Tracheids in Jack Pine in Relation to Their Position in the Vertical and Horizontal Axes of the Tree, by D. A. Kribs, Division of Forestry. 14 pages, 2,000.

55. The Agricultural Credit Situation in Minnesota, by B. M. Gile and J. D. Black. Division of Agricultural Economics. 98 pages, 2,000.

Annual Report Series

Thirty-fifth Annual Report of the Agricultural Experiment Station. 52 pages, 2,300.

Report of Northwest Experiment Station, Crookston, by A. A. Dowell, Superintendent. 60 pages, 2,000.

Report of the Northeast Experiment Station, Duluth, 1926 and 1927, by M. J. Thompson, Superintendent. 64 pages, 1,000.

Agricultural Extension Service

Special Series

113. Hay Making in Minnesota, by F. W. McGinnis, Division of Farm Management, Agronomy, and Plant Genetics. 12 pages, 7,500.

114. Efficient Operation of Local Elevators, by H. B. Price and H. B. Rowe, Division of Agricultural Economics. 20 pages, 10,000.

115. Machine Sheds, by H. B. White and M. G. Jacobson, Division of Agricultural Engineering. 12 pages, 10,000.

116. European Corn Borer, by A. G. Ruggles, Division of Entomology and Economic Zoology. 8 pages, 10,000.

117. Growing and Marketing Wool, by P. A. Anderson, Division of Animal Husbandry. 16 pages, 7,500.

118. Corn Growing, by A. C. Army, Division of Farm Management, Agronomy, and Plant Genetics. 20 pages, 10,000.

119. Hog Health Makes Wealth, by H. G. Zavoral, Division of Agricultural Extension. 12 pages, 10,000.

Reprints—

112. Profitable Dairying, by W. L. Cavert, Division of Agricultural Extension; and G. A. Pond, Division of Farm Management, Agronomy, and Plant Genetics. 16 pages, 7,500.

105. Colony Brooder Houses, by A. C. Smith, Division of Poultry Husbandry; Cora E. Cooke, Division of Agricultural Extension; and H. B. White, Division of Agricultural Engineering. 12 pages, 10,000.

103. Common Poultry Diseases, by W. L. Billings, Division of Agricultural Extension. 16 pages, 10,000.

98. Barns, by H. B. White and M. G. Jacobson, Division of Agricultural Engineering. 24 pages, 10,000.

85. Potato Growing, by F. A. Krantz, Division of Horticulture; A. G. Ruggles, Division of Entomology and Economic Zoology; J. G. Leach, Division of Plant Pathology and Botany; and H. B. White, Division of Agricultural Engineering. 24 pages, 10,000.

77. Farm Accounts, How Mr. Fairfield Kept Them, by W. L. Cavert, Division of Agricultural Extension. 12 pages, 10,000.

87. Sheep Raising in Minnesota, by P. A. Anderson, Division of Animal Husbandry. 20 pages, 10,000.

108. Raising Dairy Calves on Skimmilk, by T. W. Gullickson, Division of Dairy Husbandry. 8 pages, 10,000.

83. Care and Feeding of Chicks, by A. C. Smith, Division of Poultry Husbandry. 12 pages, 15,000.

Circular Series

25. Quack Grass Control, by A. C. Arny, Division of Farm Management, Agronomy, and Plant Genetics. 4 pages, 12,000.

26. Perennial Sow Thistle, by R. S. Dunham, Northwest Experiment Station, Crookston. 4 pages, 10,000.

27. Grain Mixtures for Dairy Feeding, by C. H. Eckles and O. G. Schaefer, Division of Dairy Husbandry. 8 pages, 10,000.

28. Eradicating Canada Thistles, by A. C. Arny, Division of Farm Management, Agronomy, and Plant Genetics. 4 pages, 10,000.

Reprints—

24. Prevent Smuts of Grains, by E. C. Stakman and H. A. Rodenhiser, Division of Plant Pathology and Botany. 4 pages, 20,000.

22. Treating Seed Potatoes with Hot Formaldehyde, by R. C. Rose, Division of Agricultural Extension. 4 pages, 10,000.

14. Poisoning Pocket Gophers, by C. E. Mickel, Division of Entomology and Economic Zoology. 4 pages, 10,000.

Boys' and Girls' Club Work

Sheep Clubs. 8 pages, 6,000.

Reprints—

Garment Making, First Year, 12 pages, 15,000.

Garment Making, Second Year, 12 pages, 5,000.

Garment Making, Third Year, 12 pages, 5,000.

Bread Making, 12 pages, 10,000.

Club Manual and Secretary's Record Book. 32 pages, 10,000.

Team Demonstrations. 12 pages, 10,000.

Pamphlet Series

1. Second Annual Carload Baby Beef Contest, by W. E. Morris, Division of Agricultural Extension. 28 pages, 2,500.

2. Measuring the Progress of Extension Work, by M. C. Wilson, United States Department of Agriculture; and S. B. Cleland, Division of Agricultural Extension. 20 pages, 2,500.

3. Summary of Swine Feeding Experiments, by E. F. Ferrin, Division of Animal Husbandry. 12 pages, 5,000.

4. Trials of Soilvita, by P. R. McMiller, G. H. Nesom, and R. M. Pinckney, Division of Soils. 2 pages, 3,000.

Miscellaneous

Folders—

19. Crop Improvement Work at the Minnesota Agricultural Experiment Stations. 20 pages, 5,000.

20. Corn Growers Can Avert Seed Famine. 4 pages, 10,000.

21. Sanitation Plan for Poultry Improvement. 4 pages, 30,000.

22. Improved Varieties of Farm Crops for Minnesota. 12 pages, 5,000.

23. The Farmer, the Banker, the Extension Service. 4 pages, 7,500.

Catalog of Projects, 1927-28. 20 pages, 300.

Cow Testing Adds to Dairy Profits, by E. A. Hansen, C. C. Geddes, and R. Leighton. 20 pages, 3,000.

Talking Turkey, by W. L. Billings. 24 pages, 15,000.

Poultry Record Flocks in Minnesota, by Cora E. Cooke. 12 pages, 5,000.

Extension Service News, 1,750 monthly.

News Letter, 1,100 weekly.

Abstracts of Scientific Journal Series Papers

Papers bearing on the researches of the Agricultural Experiment Station prepared by members of its staff are regarded as reports of progress. As these are not available for general distribution, a list of the papers published during the year is appended and a brief abstract of each paper is given as a part of the Annual Report.

639. "A Study of the Inter-Relationship of the Carriers of Vitamins A and B as Affecting the Growth and Development of the Tissues and Organs of Young Animals," by Jessie E. Richardson, L. S. Palmer, and Cornelia Kennedy. In *American Journal of Physiology*, vol. 83, pp. 712-728 (January, 1928).

This was an attempt to determine the cause of a nutritive failure of rats fed presumably adequate diets, made up of highly purified materials, the failure manifesting itself in subnormal growth rate, sexual immaturity, and greasy hair and skin. It was determined that these abnormalities are not caused by too low a level of vitamins A and B, but appear to be due to faulty fat metabolism or utilization. The study seems to warrant the assumption that some compound is removed in the food purification that is essential for normal utilization of fat by the animal body.

653. "Biological and Taxonomic Investigations on the Mutillid Wasps (Hymenoptera, Mutillidae)," by Clarence E. Mickel. Bulletin 143 of the U. S. National Museum, pp. 1-351 (1928).

Part 1. Biology of the Mutillid wasps. This is a summary of all that is known regarding the biology of the Mutillidae, and an outline of the typical life history for the family. All known hosts of Mutillidae are given in tabular form,

68 hosts being listed for 39 species of mutillids; in each case the authority for the information is also given. The hosts are found principally in the Hymenoptera, but three species of Diptera are listed, and two species of Coleoptera. An investigation was carried out with *Dasymutilla bioculata* Cresson regarding the effect of the amount of food consumed by the larva on the size of the adult insect. It was found that when the mutillid *D. bioculata* Cresson parasitized *M. monodonta* Say the adult mutillids varied in size from 6 to 11 mm., but that when the mutillid parasitized *B. pruinosa* Fox they varied from 10.5 to 15.5 mm. It is pointed out that the mutillids are of economic importance on several counts owing to the severity of their sting; that several cases are on record of honey bees being attacked by them; and, probably most important, their activities as parasites of the tsetse fly in Africa. Information is given that indicates that the mutillid *D. bioculata* is able to endure higher temperatures than other insects that inhabit the same environment, and that their limitation in space (due to the lack of wings in the female) seems to be compensated by their increased endurance of high temperature. There is a summary regarding the information on sound-producing organs. No organs of hearing have been observed. A summary is given of the three cases of gynandromorphism known, and a description of a fourth case is included.

Part 2. Type species of the genera of the family Mutillidae. All the 100 genera of the family are listed, with original reference, the number of species originally included, the name of the genotype and the way in which it was designated, and the most important synonymy. A transcript of Reed's paper, in Spanish, in which *Neomutilla* was designated as a new genus is given.

Part 3. Monograph of the mutillid wasps of the genus *Dasymutilla* occurring in America north of Mexico—a taxonomic work based on 10,000 specimens. There is a summary of the biology of the genus, a discussion of the specific characters of the genus and also of its classification. The genus is divided into twenty subdivisions, designated as groups. There is a detailed history of the nomenclature and synonymy of the genus; *Bruesia* Ashmead and *Pycnomutilla* Ashmead are reduced to synonyms of *Dasymutilla*. One hundred forty-two species and varieties are treated. Keys to both females and males are included. In the discussion of each species is given: Complete historical synonymy; type locality; place where type is deposited; distribution by states (in the case of the more common species the distribution is shown in the map); a detailed list of the locality data of specimens studied arranged by states; and a statement regarding the diagnostic characters of the species and the range of variation.

Part 4. Annotated bibliography—a general bibliography of the family Mutillidae, thought by the author to be practically complete to 1926. In nearly all cases the original of each entry was examined. The material is annotated as follows. The material contained in the papers is classified into twelve classes and each is assigned a number: 1. Paper not seen by the author. 2. Important monographic work. 3. New genera described. 4. New species described. 5. Data regarding biology. 6. Key to genera. 7. Key to species. 8. General textbook account. 9. Faunal list. 10. Data on synonymy. 11. Bibliography. 12. Discussion on classification and phylogeny. Six hundred thirty-nine entries are included.

665. "The Nature of the Seed-Piece Transmission of Potato Blackleg," by J. G. Leach. In *Phytopathology*, vol. 17, pp. 155-159 (December, 1927).

Inoculation experiments and histological studies of tubers from plants with blackleg lead to the conclusion that blackleg may be systemic and perpetuated by

tubers and naturally infected by bacteria which enter through vascular bundles from decaying stolons. The bacteria remain relatively inactive in the vascular bundles, being excluded from the parenchyma by formation of a cork cylinder. When the starch has been removed by the sprout, the parenchyma is no longer able to form cork and is rapidly destroyed by the bacteria, which then spread into the stem. Artificial inoculation through the parenchyma appears relatively ineffective unless aided by some agency that inhibits cork formation.

668. "Report on Hydrogen-Ion Concentration of Flour," by C. H. Bailey. In *Journal of the Association of Official Agricultural Chemists*, vol. 10, pp. 469-473 (1928).

Collaborative studies of the H-ion concentration of buffer solutions and of flour extracts indicated as wide variations in the results with the former as with the latter. This indicates that there is nothing inherently wrong with the method outlined for the determination of the H-ion concentration of flour. The method was accordingly recommended to the Association of Official Agricultural Chemists for adoption as a tentative method, which action was approved by the subcommittee C and by the association (see J. Assocn. Off. Agr. Chem., vol. 10, p. 79).

670. "Portland Cements and Sulfate Waters," by Dalton G. Miller. In *The Bulletin of the Minnesota Federation of Architectural and Engineering Societies*, vol. XIII, pp. 11-17 (April, 1928).

Paper describes tests with 18 different brands of standard portland cements exposed in the laboratory to solutions of sodium and magnesium sulfate. Results show evidence of enough difference in resistance of different brands to indicate the necessity of special preliminary tests of cements for concrete to be exposed to sulfate-bearing waters and soils.

675. "Some Nitrogenous Constituents of Corn Pollen," by Carl G. Vinson. In *Journal of Agricultural Research*, vol. 35, pp. 261-278 (August, 1927).

A study of corn pollen showed that only a small part of the protein was soluble in water or in salt solutions. The greater fraction of the protein was soluble only in alkali solutions and possessed properties of a glutelin.

Arginine, adenine, lysine, tyrosine, and choline were identified in the nitrogenous residue from which the glutelin protein had been removed. A considerable amount of β hydroxy-glutamic acid was isolated but glutamic and aspartic acids were completely absent.

677. "Productivity of Peat Soil as Influenced by Height of the Ground Water Table," by H. B. Roe. In *Soil Science*, vol. 3, pp. 637-661 (1927).

This paper is based on two years of experimentation on a high-lime bog by the Divisions of Agricultural Engineering, Agronomy, and Horticulture, at the Minnesota station. The depth of ground water table was theoretically controlled on different plots at depths of 1, 2, 3, 4, and 5 feet. Settlement of the bog seemed practically complete before experimentation began, the total varying from 0.5 to 0.9 foot proportional to depth of the ground water table. Absolute control of

depth of water table was found impossible on account of varying rainfall and varying moisture demands of crops at different times in the growing season, the variation in height of peak of the ground water table ranging from 1 to 3 feet for these reasons, while the height of arch of the normal ground water curve above its lowest point ranged from 0.3 to 1.0 foot. Maximum heights of the ground water curves tended to occur from 1 to 3 days after heavy precipitation.

The general cropping plan included five standard field crops in replication and ten or more standard vegetable crops without replication, each in a strip of uniform width across all control plots.

Comparative yields of the same crop for the two years show the same general tendencies but also show noticeable disparities in actual size, most of which seemed capable of rational explanation because of (1) fluctuation of height of water table, and (2) temperature variation and frost occurrences peculiar to peat soils as influenced by rainfall and soil moisture conditions.

The temperature records indicated the following apparent facts:

1. A progressive rise in soil temperature from higher water levels to lower at any given depth of 0.8 foot or over.
2. A progressive rise forward through August from which time the progression reverses, at any given depth, for a given height of water table.
3. At a depth of 0.3 foot tendencies of soil temperature variations under (1) are reversed while those under (2) are maintained.
4. Tendencies of temperature variation of the subirrigation water follow the conditions stated under 3.

The influence of heavy or frequent rainfall seems to co-ordinate with temperature variations to increase the tendency toward untimely frosts.

Conclusions can not be final until further tests, but the following temporary suggestions for safe practice are offered:

1. In fixing the desirable average depth of water table, allowances must be made for
 - a. Maximum height of the peak of the ground water curve of from 0.5 to 1 foot above the normal water level over the tile lines.
 - b. Settlement of raw bog surface, under drainage and cultivation, of from 0.5 to 1 foot.
2. Most field crops do best with a final average depth of water table of about 3.5 feet.
3. Most vegetable crops have about the same requirement as that just given for field crops, but tuber crops, tomatoes, and celery seem to do best with the water table about 2.5 feet deep. Onions do best with the water table at about 4 feet.

686. "Inheritance of Winter Hardiness and Growth Habit in Crosses of Marquis with Minhardi and Minturki," by H. K. Hayes and O. S. Aamodt. In *Journal of Agricultural Research*, vol. 35, pp. 223-236 (August, 1927).

The inheritance of cold resistance and growth habit was studied in crosses of winter and spring wheats. Cold resistance and winter habit were correlated strongly in inheritance but the correlation was not absolute. Cold resistant types that are capable of heading when sown in spring are probably a result of the recombination of genetic factors for spring habit of growth obtained from Marquis with factors for cold resistance obtained from the winter-wheat parents, Minhardi and Minturki.

694. "The Mutillidae of Cuba (Hym.)," by C. E. Mickel. In *Psyche*, vol. 35, pp. 16-28 (March, 1928).

This is a review of all the Mutillid wasps known from Cuba. It is composed principally of material collected at Soledad, Cuba, in the vicinity of the Harvard Biological Station by Dr. George Salt. Nine species in four genera are recorded. Three of these species are described as new. There is a complete bibliography of the literature on the Mutillid wasps of Cuba and a list of six additional species of Mutillid wasps known to occur in the West Indies exclusive of Cuba.

699. "The Thermocouple Method of Determining Temperatures," by William Robinson. In *Annals of the Entomological Society of America*, vol. 20, pp. 513-521 (December, 1927).

The uses and advantages of the thermocouple method in entomology are discussed. The physical principles involved are briefly outlined. Detailed instructions are given for making thermocouples in the laboratory. The method of procedure in taking a reading is described, and certain precautions are suggested in the use of the apparatus.

700. "A New Species of Meloid Beetle, with a Key to the North American Species of the Genus *Leonidia* Cockerell," by C. E. Mickel. In *Entomological News*, vol. 39, pp. 38-41 (1928).

This paper describes a new species of blister beetle that was reared from the cells of the bee *Anthophora occidentalis* Cresson. This new species belongs to the genus *Leonidae* and a key to the known species of this genus is included in the paper, with figures of the important anatomical parts of each species.

702. "The Biotic Factors in the Environmental Resistance of *Anthophora occidentalis* Cress. (Hym.: Apidae; Dip., Coleop.)," by C. E. Mickel. In *Entomological News*, vol. 39, pp. 69-78 (March, 1928).

A discussion of an association of insects held together by the bee *Anthophora occidentalis* Cresson. Two hundred forty-nine cells of this insect, obtained at Colorado Springs, Colo., were held over winter for rearing. Information is given regarding the technic used. Ten species of insects were reared from these cells and compose the association discussed. It is pointed out that *A. occidentalis* offers an excellent opportunity for the investigation of the way in which biotic factors operate as environmental resistance, and suggestions are made as to possible ways in which each of the factors may operate, altho it is recognized that at present we have no definite knowledge regarding the function and importance of each factor. It is also suggested that the solution of problems of this kind would throw considerable light on similar problems involved in the biological control of injurious insect pests. The point is emphasized that studies of this kind are of primary importance in connection with the biological control of introduced insect pests and that such factors can be found to have definite mathematical values that would be useful in predicting the future performance of any particular host or parasite.

703. "Relation of Hydrophylic Colloids to Winter Hardiness of Insects," by William Robinson. In *Colloid Symposium Monograph*, vol. 5, pp. 199-218 (1928).

An investigation into the effect of low temperatures upon free and bound water relations of various hardy and non-hardy species. The method of making these determinations is described in detail. It was found that with the species used the percentage of water bound under a falling temperature was in direct proportion to their winter hardiness. The biological significance and advantages to the species of having the free water changed into the bound form upon the approach of winter is discussed.

704. "A Comparison of Selfed Lines of Corn and First Generation Crosses Between Them," by Louis Jorgenson and H. E. Brewbaker. In *Journal of the American Society of Agronomy*, vol. 19, pp. 819-830 (1927).

Studies are reported of ten selfed lines of Silver King in relation to F_1 crosses between them. Several characters of the parental lines were found to be correlated with the same characters of the F_1 crosses. Variability in yield of the crosses to the extent of 20 per cent was accounted for by certain measurable characters.

707. "Physico-Chemical Studies on Proteins III. Proteins and the Lyotropic Series," by R. A. Gortner, W. F. Hoffman, and W. B. Sinclair. In *Colloid Symposium Monograph*, vol. 5, pp. 179-198 (February, 1928); and *Kolloid Zeitschrift*, vol. 44, pp. 97-108 (1928).

A study was made of the peptizing effect of aqueous solutions of 21 inorganic salts on the proteins of wheat flour. Most of these salts were used in several concentrations, ranging from 0.5 N to 2.0 N. The following conclusions were reached: There is a pronounced lyotropic or Hofmeister series of anions arranging themselves in the order of increasing peptizing effect of $F < SO_4 < Cl < tartarate < Br < I$. There is a less pronounced, but still distinct, lyotropic series of cations, in order of increasing peptization of $Na < K < Li < Ba < Sr < Mg < Ca$. Hydrogen-ion concentration differences do not account for these lyotropic series. The lyotropic effects are due to the properties of the anion and cation of the salt and are observable and measurable even at constant hydrogen-ion concentration. The alkali halides all cause decreasing peptization with increased salt concentration. The halides of alkaline earths as a rule cause increased peptization with increasing salt concentration. This is particularly noticeable for $MgCl_2$, $MgBr_2$, $SrCl_2$ and $CaBr_2$ solutions. Our data show that protein "solubility" in neutral salt solutions is, in reality, protein peptization, and as such it is governed as to rate and extent by the nature of the particular anions or cations present in the salt solution. As globulins are defined as "proteins soluble in dilute solutions of salts of strong acids with strong bases" we wish to raise the questions, what salts? what dilutions? and lastly, what is a globulin? Our data show that N/1 solutions of KF extract an average of 13 per cent, KCl 23 per cent, BBr 37 per cent, and KI 64 per cent of protein from wheat flours. Which salt extracts the globulins? We do not believe that any salt used, in any one of the concentrations, extracts a chemical entity which should be designated by the term "globulin." "Peptization" by neutral salt solutions is not "hydrolysis," for there is no increase in free amino or carboxyl groups. It is pointed out that the colloid chemical viewpoint still affords the most satisfactory explanation for many of the properties of protein systems.

709. "Subsoil as a Factor in Drainage Design," by S. A. Norling. In *Agricultural Engineering*, vol. 8, pp. 311-320 (November, 1927).

This paper is based on three seasons' observations (1921-23) on the Albert Lea Farms, Hollandale, Minn., the area observed covering 15,000 acres, most of which was originally under water. The soil and subsoil varied from fine sandy loam, muck, and peat, shading into silty and clay loam underlain by coarse to medium fine sand to deep peat underlain by sandy loam, clay loam, and clay. Observations of the fluctuations of the ground water table were made by means of eight series of test wells on the different soil types extending across existing drains, except that in one case there was no drainage besides the open outlet ditches bordering the tract. On the other tracts the laterals varied from 160 feet to 850 feet apart and from $3\frac{1}{2}$ to 7 feet deep. Rainfall records were kept and carefully correlated with the fluctuation of the ground water under the influence of the drains. Apparent effects on field crops such as oats, rye, corn, potatoes, sugar beets, and various grass crops were also observed.

The records seemed to justify the following conclusions:

1. In areas where the main ditches extend through the finer, less pervious top soil into a sand subsoil from 4 to 7 feet below the surface, no lateral drainage is needed. Even irrigation systems may be desirable in dry seasons, and care should be taken not to cut the mains deep into the sand subsoil. Generally, main ditches 4 to 5 feet deep and 1,300 to 3,000 feet apart will suffice, the fineness and depth of the top soil being the major determining features.

2. In deep peat soils underlain by water-bearing sand, tile laterals 160 to 1,200 feet apart and 4 to 5 feet deep are desirable for best soil moisture conditions.

For practical application to drainage design, the whole paper should be carefully studied, but the following general suggestions will broadly serve as a safe guide:

1. The knowledge of soil texture and its relation to the flow of underground water is very important and must be given careful consideration in drainage design. A thoro soil survey is a necessary part of the basis for the drainage plans, as is also a study of soil moisture conditions existing previous to drainage.

2. The danger of excessive drainage on mineral areas where the surface soil is underlain by a coarse-textured subsoil must always be kept in mind.

3. Deep peat underlain by a water-bearing stratum is in no danger of drouth and can not be overdrained.

711. "A Preliminary Report of the Factors Controlling the Oviposition of May Beetles in Minnesota," by Harvey L. Sweetman. In *Journal of Economic Entomology*, vol. 20, pp. 783-794 (December, 1927).

May beetles, the adults of the white grubs, pay no attention to the kind of vegetation covering when they lay their eggs. They fly at random from their host plant and lay the eggs in ground that seems suitable to them. Wind seems to influence the nature of this flight in the morning, but regardless of the vegetation or of the elevation or of the type of soil, egg laying takes place in the immediate vicinity of the food plant. If the soil is soft enough to permit digging and sufficient moisture is present, the eggs are laid. If conditions are unfavorable, the beetle may delay egg laying for at least five days. In very dry soil, many eggs and young grubs probably are destroyed because of lack of moisture. In 1926 when most of this study of egg-laying was made, cultivated land such as is found

in corn fields seemed to be the condition necessary for these insects to lay their eggs in Minnesota. In small-grain and grass lands, however, the condition of the soil was such that eggs could not be laid. These observations directly contradict the prevailing opinion, that eggs are deposited only in sod land. The proximity of the feeding grounds of the beetles to the land to be planted is the important factor.

713. "Correlation Between Yielding Ability, Reaction to Certain Diseases, and Other Characters of Spring and Winter Wheats in Rod-Row Trials," by H. K. Hayes, O. S. Aamodt, and F. J. Stevenson. In *Journal of the American Society of Agronomy*, vol. 19, pp. 896-910 (October, 1927).

The influence of such characters as date of heading, height of plant, plumpness of grain, stem rust, and leaf rust on the yielding ability of varieties of wheat and the effect of these characters on one another was determined by partial correlations using the rod-row data of the spring and winter wheat varieties. A higher negative correlation was found between leaf rust and yield than between stem rust and yield in the spring wheats. This emphasizes the importance of breeding varieties resistant to leaf rust as well as to stem rust. A high correlation between percentage plumpness of grain and yield shows that selection on the basis of plumpness of grain, during the segregating generations of hybrids, when accurate yield data are not available is well worth while. Bearded selections produced plumper grain on the average than awnless ones.

714. "The Relation of Insects and Weather to the Development of Heart Rot of Celery," by J. G. Leach. In *Phytopathology*, vol. 17, pp. 663-667 (September, 1927).

Experiments proved that two species of dipterous insects, *Scaptomyza graminum* Fall. and *Elachiptera costata* Leow. are common agents of inoculation of celery heart rot, caused by *Bacillus carotovorus*. The writer suggests that these insects in all probability are also the chief agents of dissemination, as the adult flies commonly feed on the decaying tissues and have every opportunity to carry viable bacteria from diseased plants to the healthy leaves on which they deposit their eggs.

Observations of the writer for four years show that in the celery bogs near St. Paul, Minnesota, destructive outbreaks of heart rot occur only in hot, dry weather. This fact is explained by a study of the habits of the insects. In hot dry weather nearly all the eggs are deposited on the younger leaves near the heart of the celery plant. In rainy weather they are found on the outer leaves as frequently as on the inner leaves. Furthermore, in dry weather the young larvae soon find their way to the small heart leaves, which are always moist, while in rainy weather they may develop as well on the outer leaves. The influence of the weather, then, is not so much on the prevalence of soft rot as on the part of the plant that is attacked. In hot dry weather the heart leaves are attacked, the terminal bud is destroyed, and the plant is usually a total loss. During rainy weather the rot is confined to the older outer leaves and petioles. As these are discarded by the grower at harvest, no appreciable loss is felt.

717. "The Migration to Towns and Cities, III," by Carle C. Zimmerman. In *The American Journal of Sociology*, vol. XXXIII (September, 1927).

Migrants from cities to farms come primarily from the artisan class. Their economic ability, as shown by incomes and living expenditures, is about equivalent to that of native farmers. They are better educated than native farmers. Two-thirds of them take up farming because they intermarry with farm folks. A comparison of the net migration between cities and farms by economic and social groups gives the net law of rural-urban selection: the cities attract the extremes while farms attract the mean strata of society. This is merely a hypothesis.

718. "The Effect of Accumulated Carbon Dioxide on Plant Respiration," by J. J. Willaman and J. H. Beaumont. In *Plant Physiology*, vol. 3, pp. 45-59 (January, 1928).

The respiration of apple twigs at 0 degrees C., of potato tubers at about 22 degrees, and of wheat grain at 40 degrees has been studied from the standpoint of the effect of allowing the CO₂ to accumulate in the respiration chamber. Under such conditions the rate of CO₂ production continuously decreases with time. After the first 30 or 40 hours the relation is expressed by the formula

$$\frac{\text{CO}_2}{\log t - 0.566} = k$$

During the first 30 or 40 hours the rate is affected by a phenomenon that can be described as follows: When aspiration of the atmosphere surrounding the tissue is begun, after a period of accumulation of CO₂, the rate of respiration immediately assumes a far higher value than it had during the accumulation period. The magnitude of this value is possibly proportional to the amount of CO₂ previously accumulated. It is a matter of several hours before the rate attains a constant value. A possible explanation is that the accumulation of CO₂ in the tissues increases the hydrogen-ion concentration in the latter; that this brings the proteins of the protoplasm nearer to their isoelectric point and hence increases the permeability of the protoplasm and that this is responsible for an actual increase in rate of CO₂ production. The evidence in the literature on the pH of cell sap and on the isoelectric points of plant proteins bears out this view to a certain extent. Direct evidence in its favor was secured by passing LCl gas into a respiration chamber containing wheat grain. A duplicate of the CO₂ effect was obtained.

719. "Measurement of Hydrogen-Ion Concentration in the Control of Pulp and Paper Manufacture," by K. W. Franke and J. J. Willaman. In *Industrial and Engineering Chemistry*, vol. 20, p. 87 (January, 1928).

As many industries have found the measurement of hydrogen ions very useful in the control of factory practice, studies were undertaken of its possible uses in the manufacture of pulp and paper. The results allow the following conclusions: (1) The hydrogen electrode gives valuable information about many pulp mill liquors, but in sulfite solutions with a pH less than 7.0 the readings can not be taken as true pH values. (2) The quinhydrone electrode is untrustworthy in the presence of sulfites or other oxidizing or reducing compounds. It

is questionable on water, unless the latter is acid. (3) The most generally useful electrode in the pulp and paper mill is antimony. The best type is the ordinary pure stick preparation, of a radially crystalline structure. (4) The measurement of pH should prove especially useful in the control of the preparation of cooking liquors, in the addition of alum and size to the beaters, in water purification, and possibly in determining the end of the cooking process.

720. "Notes on Apparatus for Low Temperature Respiration Studies," by J. H. Beaumont, J. J. Willaman, and W. A. DeLong. In *Plant Physiology*, vol. II, pp. 487-495 (October, 1927).

A description of apparatus successfully used in low temperature respiration studies. A commercial ice cream cabinet provided a series of six chambers which, by a system of insulation and thermo controls, were maintained at uniform temperatures ranging from -10 degrees C. to +10 degrees C. Both the bead tower type of absorption apparatus and the coil tube absorption vessel were used in the operations. Details of the complete set-up are shown.

722. "The Fundamental Food Requirements for the Growth of the Rat. II. The Effect of Variations in the Proportion and Quality of Recognized Nutrients," by L. S. Palmer and Cornelia Kennedy. In *Journal of Biological Chemistry*, vol. 75, pp. 619-659 (December, 1927).

This paper presents some of the results of attempts to find a satisfactory solution of the failure of an apparently adequate diet of casein, salts (McCullum salt mixture 185), vitamins A and B, roughage (agar), and adequate energy to produce normal growth of rats when the animals are kept in screens to minimize coprophagy. The experiments presented include the addition of vitamins A, B, C, D, and E, singly and in various combinations. In other experiments qualitative and quantitative changes were made in the carbohydrate, protein, and mineral salts. Practically every experiment was repeated with different lots of rats, in different seasons of the year, and in different years. The dietary deficiencies manifested under these conditions do not appear to be those of a mineral salt or an amino acid nature, but are suggestive of vitamin-like factors.

723. "A Comparative Study of the Glutelins of the Cereal Grains," by Ralph K. Larmour. In *Journal of Agricultural Research*, vol. 35, pp. 1091-1120 (December, 1927).

Alkali-soluble proteins have been prepared from the cereal grains, *Triticum vulgare*, *T. durum*, *T. spelta*, *T. dicoccum*, *T. monococcum*, *Avena sativa*, *Hordeum vulgare*, *Secale cereale*, *Zea mays*, *Euchlaena mexicana (teosinte)*, and *Oryza sativa*.

Analyses for nitrogen distribution by the Van Slyke method revealed a well marked relationship between the various preparations, especially in respect to the basic nitrogen fraction.

Glutenin of wheat, *Triticum vulgare*, and oryzenin of rice, *Oryza sativa*, both well-defined glutelins, occupy positions at the extreme opposite limits of the class in respect to ammonia nitrogen (practically) and total basic nitrogen, and the corresponding values for the other proteins described fall within these limits. This is submitted as evidence that the preparations obtained belong to

a definite class of proteins, the glutelins, which is represented in all the cereal grains thus far studied.

724. "Enzymic Relations of Pectin," by J. J. Willaman. In *Minnesota Studies in Biological Sciences* No. 6, p. 334-341 (1927).

A review of the literature of the pectic enzyme. The view is taken that there are three of them: (1) Protopectinase is the enzyme that macerates plant tissue by dissolving the middle lamella; (2) pectase is an esterase that hydrolyzes soluble pectin with the formation of pectic acid, which forms a gelatinous Ca salt; (3) pectinase hydrolyzes pectin to its simple constituents.

725. The Effect of Variations in the Calcium, Magnesium, and Phosphorus Content of the Diet," by J. R. Haag and L. S. Palmer. In *Journal of Biological Chemistry*, vol. 76, pp. 367-389 (February, 1928).

The paper reports a series of experiments with rats fed diets varying in their proportion of Ca, Mg, and P. All the various combinations of so-called high and low levels of these elements were tested. The low levels of Ca, Mg, and P were respectively 0.48, 0.26, and 0.38 per cent of the dry matter of the ration in two series and 0.25, 0.07, and 0.18 in another series. The high levels of Ca, Mg, and P were respectively 2.3, 0.8, and 1.15 per cent of the rations. Growth of the animals was studied as well as Ca and P balances in 10-day balance trials. The general trend of the results shows that a more or less balanced condition of Ca, Mg, and P salts of the ration is essential to normal growth and functioning. High Mg proved to be a disturbing factor in both growth and Ca and P balances, the extent of this disturbance being conditioned by the intakes of Ca, P, and vitamins. The response of various groups of animals to certain vitamin levels points to even more important vitamin-mineral relationships than have heretofore been recognized.

726. "The Action of Sulphate Water on Concrete" by Dalton G. Miller. In *Public Roads*, vol. 8, pp. 203-212 (November, 1927).

Results of tests on 2x4-inch concrete and mortar cylinders immersed in the sulphate waters of Medicine Lake, South Dakota, for periods up to three and a half years, are compiled in this paper. The conclusions may be concisely summarized as follows: (1) Standard portland cements from different manufacturing plants vary greatly in resistance; (2) all cylinders of high alumina cements made very satisfactory showings except mortar cylinders mixed in the proportion 1:55; (3) specimens cured in steam at a temperature of 212 degrees F. continue to make excellent showings in all series; (4) cylinders cured in steam at a temperature of 212 degrees F. made equally favorable showings irrespective of brand of cement used in the mix; (5) as yet not enough evidence is at hand to show the relative effect of curing in steam at temperatures between 212 degrees and 285 degrees F.; (6) results, while indefinite, indicate that certain admixtures have some possibilities.

727. "The Agglutination Test as Applied in the Control of Bacillary White Diarrhea," by C. P. Fitch and R. E. Lubbehusen. In *Cornell Veterinarian*, vol. 18, pp. 19-25 (January, 1928).

The results of this work show that cloudy reactions in the agglutination test for bacillary white diarrhea can not be satisfactorily eliminated by starving the birds. Also if 0.5 per cent phenol is added, it increases the number of cloudy reactions. The agglutination titre of a given sample of serum may not be the same when the test is carried out in different laboratories. The work also showed that a careful study of the agglutination test is needed before it is officially adopted to control bacillary white diarrhea.

728. "The Fundamental Food Requirements for the Growth of the Rat. III. Yeast and Yeast Fractions as a Supplement to Synthetic Rations," by Cornelia Kennedy and L. S. Palmer. In *Journal of Biological Chemistry*, vol. 76, pp. 591-606 (March, 1928).

The diets that failed to promote normal growth, described in Paper 722, are made adequate by a supplement of whole dry yeast. This yeast is still adequate after thoro extraction with 85-90 per cent alcohol, or after it has been autoclaved, or after the Osborne and Wakeman vitamin fraction has been removed. The basal diets used contained vitamin B in the form of an alcohol extract of wheat embryo equivalent to 15 per cent ether-extracted wheat embryo. When the embryo extract is removed from the diet the whole yeast still makes it adequate for growth, but the autoclaved yeast fails to do so, likewise the Osborne and Wakeman vitamin fraction, the residue left after the preparation of this fraction, and a yeast extract concentrate supplied by the Harris Laboratories called Yeast Vitamin-Harris Powder. Bios, prepared from yeast by the method of Eddy, Kerr, and Williams, also fails as a growth-promoting supplement. It appears that yeast contains a growth-promoting factor similar in some respects to the vitamin B fraction discovered recently by several investigators but not identical with it.

729. "The Fundamental Food Requirements for the Growth of the Rat. IV. Coprophagy as a Factor in the Nutrition of the Rat," by Cornelia Kennedy and L. S. Palmer. In *Journal of Biological Chemistry*, vol. 76, pp. 607-622 (March, 1928).

Decline in weight in experimental rats fed the highly purified, presumably complete ration reported in Paper 722 was stopped and fair gains in weight were made by allowing the rats to consume their feces. The feces of rats on a mixed diet were no more potent. The growth-promoting factor in the feces is injured by prolonged mating, is soluble in alcohol, and is insoluble in ether. Commercial casein, purified merely by leaching with acid water contains the same factor found in the feces.

730. "Physiologic Specialization in *Puccinia coronata avenae*," by H. E. Parson. In *Phytopathology*, vol. 17, pp. 783-790 (November, 1927).

The writer demonstrated the existence of four and possibly five physiologic forms of *Puccinia coronata avenae*, which causes crown rust of oats, on the basis of their parasitic effect on four varieties of oats. It is probable that numerous additional physiologic forms could be demonstrated by using the proper combinations of differentials. The physiologic forms differ not only in their pathogenicity but apparently also in the readiness with which they produce telia. It will be

necessary to take into consideration the fact of physiologic specialization in breeding varieties of oats resistant to crown rust.

731. "The Effect of the Position of Roots Upon the Growth of Planted Trees," by E. G. Cheyney. In *Journal of Forestry*, vol. 25, pp. 1013-1015 (December, 1927).

The directions for the proper planting of a tree call for spreading the roots as nearly as possible in the same position they occupied before. About 90 per cent of all forest planting, however, involves the "slit" method, in which all the roots are compressed in a single plane and are often folded.

The rate of growth of northern white cedar and blue spruce planted with roots spread with white pine, was compared with that of similar plantings with balled roots planted by the 'slit' method. After four years the plants were dug up, inspected, and measured for height.

The ball into which the roots were rolled at the time of transplanting by the "slit" method could be plainly seen, but side roots had grown out from them so extensively that the roots varied little in appearance from those that had been spread out.

A difference of only 2.88 inches in height was found in favor of the spread roots. This seems insufficient to justify the increased planting costs involved in spreading the roots.

732. "A Mosaic Disease of Gladiolas," by Louise Dossdall. In *Phytopathology*, vol. 18, pp. 215-217 (February, 1928).

A new virus disease of gladiolas is described. The symptoms appear at all stages in the life of the plant—on the corm, the leaves, and the inflorescence. The virus is transmitted through the corm from one generation to the next. Plants eventually are killed. Infected corms seem to be quite warty and one method of controlling the disease is to plant only disease-free corms. It is suggested that sucking insects may transmit the virus from plant to plant in the field.

733. "A Modified Scale for the Pfund Color Grader for Use on Dark Sirups," by J. J. Willaman. In *Industrial and Engineering Chemistry*, vol. 20, pp. 701-704 (July, 1928).

In order to use the instrument on sirups that are too dark to register on the original scale, a new scale was devised, to be used with one, two, or three extra pieces of glass of the color of the original wedge. The original scale of 0 to 14 is thus extended to 15.7.

734. "Fellowships and Scholarships Available to Women in Home Economics," by Ethel L. Phelps. In *Journal of Home Economics*, vol. 20, pp. 328-332; 404-408 (May, June, 1928).

A survey of a group of departments of home economics and of some other institutions in which home economics women have worked shows a variety of opportunities open to women desiring to do graduate or research work.

735. "State Indexes of Price of Farm Products," by A. G. Black and Dorothea Kittredge. In *Journal of Farm Economics*, vol. X, pp. 312-330 (July, 1928).

A modification of Fisher's "Ideal" formula is used in constructing a monthly index of Minnesota farm prices from 1910 to 1926. This formula avoids inaccuracies arising from the use of constant weights. An index of income may be derived by multiplying the index prices by a similarly constructed index of quantities.

Seasonal variation in price that appears in the base period is removed by relating the price in the given month to the average price of the corresponding months of the base period. The base period is the average of 1924, 1925, and 1926.

736. "A Study of Probable Error Methods in Field Experiments," by H. K. Hayes and F. R. Immer. In *Scientific Agriculture*, vol. 8, pp. 345-352 (February, 1928).

Data from yields of small plots of the same variety of wheat were used. Conclusions drawn from separate probable errors calculated for each "variety" of four plots could have been erroneous in some instances because of the wide deviation of the yield of these varieties from expectation. Conclusions drawn from generalized probable errors did not suffer from this defect. A comparison was made of different methods of calculating a generalized probable error.

739. "The Relation of Phosphorus Deficiency to the Utilization of Feed," by C. H. Eckles and T. W. Gullickson. In *Proceedings of the American Society for Animal Production* (1927).

Extended studies have been previously reported regarding a dietary deficiency of cattle prevalent in parts of Minnesota and found to be due to a shortage of phosphorus. Further studies reported in this paper, to which 15 animals contributed, show that the low phosphorus ration has a decided effect upon the amount of feed required by the animal. When supplied in the form of a phosphorus-deficient ration, about 20 per cent more total digestible nutrients were required to maintain the animals at uniform weight or to support milk production.

740. "Experiments on the Control of Barley Stripe," by H. A. Rodenhiser. In *Phytopathology*, vol. 18, pp. 295-300 (March, 1928).

Solutions of Uspulum, Germisan, Semesan, and formaldehyde used at different temperatures and for different periods of soak, and ten dust fungicides were tested for their effectiveness in controlling barley stripe. The effectiveness of the liquid fungicides depended on the temperature of the solution and the period of soak. Uspulum and Semesan were the most satisfactory of the liquid fungicides.

The Du Pont dusts K-1-A and K-1-B eliminated stripe entirely, while Du Pont dust No. 12, S.A.F. dust No. 225, and Wa Wa dust were almost as effective. Coppercarb and Kolo dust were ineffective in controlling stripe.

741. "Heterothallism in *Ustilago zaeae*," by E. C. Stakman and J. J. Christensen. In *Phytopathology*, vol. 17, pp. 827-834 (December, 1927).

It was found that the corn smut fungus, *Ustilago zaeae*, comprises strains of different sex. The fusion of two strains of opposite sex apparently is prerequisite to the development of corn smut. When corn was inoculated with monosporidial cultures, no smut galls were formed. However, when it was inoculated with

strains of opposite sex, normal infection resulted. This suggests that new physiologic forms are being produced by hybridization. As sectors are formed in certain unisexual strains, it is probable that new forms are arising by mutation also.

742. "Physiologic Specialization in *Puccinia sorghi*," by E. C. Stakman, J. J. Christensen, and H. E. Brewbaker. In *Phytopathology*, vol. 18, pp. 345-354 (April, 1928).

Corn rust, *Puccinia sorghi* Schw., has not hitherto been destructive to corn in the upper Mississippi Valley. From 1923 to 1925 it caused considerable damage, however, to certain inbred lines of corn grown in the plant breeding plots at University Farm, St. Paul. Rust notes were taken on the reaction of 170 selfed lines to smut and rust. There was a wide range of susceptibility and resistance, and all combinations of susceptibility and resistance to the two diseases appeared. Seven physiologic forms of *P. sorghi* were recognized by their parasitic behavior on eight selfed lines of corn.

Corn rust could become a destructive disease on certain newly developed lines of corn. Susceptible lines, therefore, should be eliminated.

743. "Correlated Studies in Oats of the Inheritance of Reaction to Stem Rust and Smuts of Other Differential Characters," by H. K. Hayes, Fred Griffiee, F. J. Stevenson, and A. P. Lunden. In *Journal of Agricultural Research*, vol. 36, pp. 437-457 (March, 1928).

The mode of inheritance and the linkage relationships in oats of the differential characters black vs. white grain, stem rust resistance vs. susceptibility, smut reaction, weak vs. strong awns, and few vs. many hairs on the rachilla that supports the second kernel of the spikelet are given. Black vs. white glumes and resistance vs. susceptibility to rust gave approximately 3 : 1 segregations with black dominant over white and rust resistance dominant over susceptibility. Few vs. many hairs on the rachilla which supports the second kernel of the spikelet gave approximately a 3 : 1 ratio of few to many hairs in the F_2 . The breeding behavior of number and strength of awns could not be explained on any simple genetic basis. The genetic factors for smut reaction were not determined accurately, but a possible explanation was suggested.

There was apparently a very loose linkage between the genetic factors for hairs on the rachilla and for glume color. No correlation between rust reaction and awn development or rust reaction and smut reaction could be demonstrated by the test used.

The coefficient of contingency and the double X^2 test were used in several cases to show the possible occurrence of linkage.

745. "The Determination of the Zeta—Potential on Cellulose—A Method," by David R. Briggs. In *Journal of Physical Chemistry*, vol. 32, pp. 641-675 (May, 1928).

A method is described for the determination of zeta-potentials on colloid materials of such nature as cellulose, by means of the "streaming potential" measurements.

A review of the literature and development of the "streaming potential" equation, together with the assumptions contained therein, is given.

Considerations are offered which indicate that measurements of the specific conductivity of the liquid in the diaphragm, which may vary widely from that of

the liquid in bulk, may be made with a high degree of accuracy. The values for zeta resulting from the use of this value for the specific conductivity in the "streaming potential" equation, are to be regarded as absolute (not simply comparative) so far as the assumptions relative to the other functions in the equation will allow.

Results indicate that zeta varies with the source and history of a sample of cellulose. An approximate value of zeta for two samples of a rag pulp and for a wood pulp are given. These values are 0.0214, 0.0161, and 0.0083 volts, respectively.

746. "Water Conservation in Insects," by William Robinson. In *Journal of Economic Entomology*, vol. 21 (1928).

The rôle of water in the physiology of insects is briefly discussed. A study is made of the range in the total water content of various insects, and a correlation made between water content of insects and their food. The value of metabolic water of insects is discussed. A brief statement is made of the colloidal mechanism with which the cactus conserves its water supply; and some experiments are described in which it is shown that insects living under low water conditions have a mechanism for conserving their water supply similar to that of the cactus.

747. "Response and Adaptation of Insects to External Stimuli," by Wm. Robinson. In *Annals of the Entomological Society of America*, vol. 21 (September, 1928).

The general effect of collidal activity upon insect physiology is briefly mentioned. Two series of experiments upon various species of insects are described in which low temperature and water supply are the stimuli. The response to temperature showed adsorption of water to be in direct proportion to winter hardiness of the species. When water was available it was found that insects are able to hold water in reserve on the surface of their colloids like the cactus, and that it is in direct proportion to the percentage of water in their food. The sources, importance, and function of water in insect physiology are briefly discussed.

748. "The Roots of Flax Plants," by A. C. Army and I. J. Johnson. In *Journal of the American Society of Agronomy*, vol. 20, pp. 373-380. (April, 1928).

The root systems of several varieties of flax were studied at 22, 44, 58, and 94 days from seeding. The flax varieties were mature 94 days from seeding. At University Farm, plants of Winona (a wilt-resistant variety developed at University Farm) 22 days from planting were 7 inches high and had tap roots with a penetration of 21 inches and numerous main branches near the surface with a spread of 10.5 inches. At 44 days the plants were 24 inches tall and beginning to bloom. The tap root had penetrated to a depth of 37 inches; the main branches had reached a spread of one foot and some of these had turned down and penetrated to a depth of 2 feet. At full bloom (58 days from planting) the main branches had increased their depth of penetration to between 2.5 and 3 feet and the tap root had increased in length to 3.5 feet. At maturity the tap root had penetrated the soil to a depth of 4 feet and the main branches to a depth of 3.5 feet.

At Crookston the main side branches did not turn down to any extent and remained largely in the surface foot.

749. "Completed Experiments to Determine Whether Avian Tuberculosis Can Be Transmitted Through the Eggs of Tuberculous Fowls," by C. P. Fitch and R. E. Lubbehusen. In *Journal of the American Veterinary Medical Association*, n.s. vol. 25, pp. 636-649 (February, 1928).

This represents work done to determine whether avian tuberculosis can be transmitted through the eggs of tuberculous birds. A flock of tuberculous birds was maintained. Eggs were obtained for hatching from these diseased birds. They were incubated and hatched. Two thousand eggs were set from 88 tuberculous birds. Six hundred and ninety-seven chicks were hatched. None of these showed any evidence of tuberculosis. Eggs were artificially infected by injecting with tubercle bacilli. It was found that the presence of tubercle bacilli in eggs markedly interfered with their fertility. Tuberculous chicks were produced from artificially infected eggs. More than 30 per cent of the tuberculous birds failed to produce eggs. As a result of this study and that previously reported, we must view the danger of the transmission of tuberculosis through naturally infected eggs as of little practical consequence.

750. "Insects as Test Animals in Vitamin Research. I. Vitamin Requirements of the Flour Beetle, *Tribolium confusum* Duval," by Marion Devoe Sweetman and Leroy S. Palmer. In *Journal of Biological Chemistry*, vol. 77, pp. 33-52 (April, 1928).

It was found possible to determine the vitamin requirements of this insect by using purified or otherwise modified rations, using essentially the same procedure followed with rats. The insect can be reared on a purified ration of protein, dextrin, salts, with a small supplement of yeast or wheat germ or their alcoholic extracts. Fat accelerates the growth rate but does not need to contain vitamin A. The vitamin requirement of this insect is similar to vitamin B in distribution and is, at least in part, identical with the purified products of the Osborne and Wakeman, and Levene and van der Hoeven purification processes. *Tribolium* is sensitive qualitatively to as low as 0.5 per cent of a source of the vitamin and apparently makes a quantitative response to its additions over a certain range. Using the insect as test animal, it was found that hand dissected portions (embryo, embryo end of endosperm, endosperm, distal end) of wheat, corn, oats, barley, and rice all contain some of the growth promoting factor required. Wheat contains the factor concentrated in the embryo and adjacent portion of endosperm, but corn endosperm carries the factor in as high concentration as in the embryo.

751. "Effect of Delayed Harvesting on Quality of Wheat," by A. F. Bracken and C. H. Bailey. In *Cereal Chemistry*, vol. 5, pp. 128-145 (March, 1928).

Kernels of Kanred wheat harvested at 10-day intervals after ripening progressively increased in volume and decreased in density. Wheat kernels initially low in density and in protein content changed more in density and volume than wheat of higher density and protein content. Opaqueness of wetted and dried

wheat kernels results from the checking or cracking of the kernel. Such checks or cracks contribute to increased fracturing of such kernels when threshed. Titratable acidity and H-ion concentration showed no alternative as a result of delayed harvesting. The same was true of diastatic activity, and of the dimensions of the epithelial cells of the scutellum. No chemical evidence of appreciable proteolysis could be found in the late-harvested grain, and baking qualities were not modified in the series under observation.

752. "The Use of Ethylene Gas in Ripening Fruits and Vegetables," by L. O. Regeimbal. (Title changed by printer to "Ripening Fruits and Vegetables with Gas.") In *Wisconsin Horticulture*, vol. 18, pp. 93-94 (January, 1928).

Ethylene in a concentration of one part of gas to 1000 parts of air will hasten the maturity of tomatoes, melons, and bananas, and will blanch celery. Rooms must be well constructed in order to retain the gas. Humidity, as a rule, must be high, but for melons it should be between 65 and 70 per cent in order to check the growth of surface molds. Detailed directions are given for using the gas.

754. "A Study of the Proteoclastic Activity of Flour," by Andrew Cairns and C. H. Bailey. In *Cereal Chemistry*, vol. 5, pp. 79-104 (March, 1928).

The Sorenson formol titration method proved to be superior to the seven other methods applied to the study of proteolysis in aqueous flour suspensions. Degree of refinement, as measured in terms of the ash content of flour, was correlated with rate of proteolysis. Flour milled from sprouted wheat undergoes more rapid proteolysis when suspended in water than normal flour, but the inclusion of from 1 to 3 per cent of sprouted wheat in mixture with normal wheat has little effect upon rate of proteolysis in the resulting flour. Decreases in the viscosity of incubated flour suspensions are associated with increases in products of proteolysis, but the former is not a satisfactory procedure for quantitative studies because of the variability of results.

756. "Studies of the Effect on Their Bread Making Properties of Extracting Flours with Ether," by Arnold H. Johnson. In *Cereal Chemistry*, vol. 5, pp. 169-180 (May, 1928).

Bread superior in color, texture, and volume to bread from natural flour was produced from ether-extracted flour. Low-grade flours were affected more than patent flours. The absorption, wet and dry gluten content, and viscosity of acidulated suspensions was not altered by extracting flours with ether. Diastatic activity apparently increased as a result of such extraction.

757. "The Relation of Temperature During the Growing Season in the Spring Wheat Area of the United States to the Occurrence of Stem Rust Epidemics," by E. C. Stakman and E. B. Lambert. In *Phytopathology*, vol. 18, pp. 369-374 (April, 1928).

A study was made of the effect of weather on the development of rust epidemics from 1904 to 1925, inclusive, in Minnesota, North Dakota, and South Dakota.

An analysis was made of the weather conditions for the entire period, and it was evident from the results that there is a tendency for destructive epidemics to develop during warm growing seasons and for relatively little rust to develop during cool seasons.

The development of epidemics depends on many inter-related factors; consequently it is possible for epidemics to develop during cool seasons, and for hot seasons to be relatively free from rust.

Low precipitation has a tendency to prevent the development of epidemics regardless of the temperature.

758. "Comparative Studies of Winter Hardiness in Wheat," by John H. Martin. In *Journal of Agricultural Research*, vol. 35, pp. 493-535 (1927).

The studies presented are concerned only with low temperatures and not with killing due to winter drouth, soil blowing, heaving, or smothering by ice.

Hardy wheats are characterized by a low moisture content of the tissues, a high percentage of total solids in the juice, a high freezing-point depression or osmotic concentration of the juice when the plants are actively growing, a high percentage of bound water in the juice, a low rate of respiration at low temperatures, and frequently by a long period of vegetative growth.

The most important character influencing hardiness is the ability to build up a high imbibition pressure of the cell colloids during hardening.

Swedish (Minnesota No. 2) rye, which is more hardy than any wheat, has a high moisture content, a low percentage of total solids, and a low freezing-point depression like nonhardy wheats, but it has a lower rate of respiration at low temperatures and a greater imbibition pressure than the hardiest wheats.

During the hardening of wheats there is a decrease in moisture content and an increase in total solids in the sap, freezing-point depression of the sap, and imbibition pressure of the cell colloids, as measured by the ability of the tissues to hold sap against the forces of freezing and pressure.

In the tissues of a given variety, the quantity of juice expressed is positively correlated with the moisture content. The percentage of total solids and the freezing-point depression of the juice are negatively correlated with moisture content and the quantity of juice expressed from the tissues. The quantity of juice retained after pressing is positively correlated with moisture content in unfrozen tissues, but not significantly so in frozen tissues.

The moisture content, sap concentration, imbibition pressure, and hardiness of wheat and rye plants fluctuate widely during the fall and winter, and differences between varieties do not exist at all times.

The freezing of plants at controlled temperatures, followed by a determination of the extent of killing, appears to be the most feasible laboratory method for measuring hardiness.

A sudden exposure of wheat and rye plants from the greenhouse to a temperature of -10 degrees C. for 24 hours will kill the hardiest varieties. Any variety of winter wheat will withstand a temperature of -5 degrees C. for the same period. Hardening is necessary to protect wheat against the much lower temperatures than -10 degrees C. that occur in northern wheat-growing areas. The hardier the variety the more it can harden.

The crown is the most hardy portion of the wheat plant above the soil surface. Young leaves are more hardy than old leaves, and the bases of leaves are more hardy than the tips.

The genetic factors involved in the inheritance of hardness have not been determined, but most F_3 strains are intermediate between the parents in hardness. Accurate measures of hardness in the field are difficult because of the variations both in the plants and in weather conditions.

759. "The Effect of Height of Ground Water Table on the Development of Truck Crops on Peat Land," by H. P. Traub and C. E. Steinbauer. In *Proceedings of the American Society for Horticultural Science*, pp. 49-53 (1927).

A brief preliminary report on the effect of height of ground water table on the height, weight, and chemical composition of truck crops on peat lands. The optimum levels are given for the more important truck crops as ascertained from experiments covering the seasons of 1924-27 on two series of controlled plots, one located in northern Minnesota and one in central Minnesota.

760. "Summer Frost Prevention on Northern Peat Lands by Raising the Ground Water Table," by H. P. Traub and C. E. Steinbauer. In *Proceedings of the American Society for Horticultural Science*, pp. 54-60 (1927).

A preliminary report of the effect of height of ground water table on soil and air temperatures during summer frost periods on two peat bogs in Minnesota. Its effect on crop production is illustrated by showing the behavior of tomatoes on the different ground water levels.

761. "The Quantitative Analysis of Environmental Factors," by Royal N. Chapman. In *Ecology*, vol. IX, pp. 111-122 (April, 1928).

This paper is based upon the results of a series of experiments with the confused flour beetle, *Tribolium confusum*. It was found that the populations of beetles came to the point of saturation and remained stationary when all environmental conditions remained constant. The concentration of beetles per gram of flour was independent of the initial population and the total size of the environment.

The number of progeny from a single pair of individuals was also found to be proportional to the size of the environment.

After a state of equilibrium has been attained, large numbers of eggs continue to be laid only to be consumed by the larvae and adults. If the environment is expanded by the addition of more flour, these eggs hatch and the population rises to a new point of saturation.

These findings substantiate the hypothesis with regard to biotic potential and environmental resistance and thus pave the way for the measurement of the effect of various environmental factors in terms of their effect upon the population of insects.

762. "Glossy Seedlings in Maize," by H. K. Hayes and H. E. Brewbaker. In *American Naturalist*, vol. 62, pp. 228-235 (May-June, 1928).

In addition to the glossy seedling located in linkage group, Bn-sl-gl₁-ra, two new glossy seedlings have been discovered. The three glossies are designated as gl₁, gl₂, and gl₃. Intercrosses of any two glossies give ratios of 9 normal to 7

glossy in F_2 . Preliminary studies of linkage relations show gl₂ and flinty-floury to be linked with a recombination value of about 30.

763. "Group Management for Farmers' Elevators," by H. Bruce Price. In *American Co-operation*, vol. 1, pp. 172-185 (1927).

This paper points out some of the chief weaknesses of elevators when operating independently and suggests some of the ways in which a central federation of farmers' elevators may give assistance. Emphasis is placed upon the service such federations may give to elevator companies—information on market prices, financing, organization, and operations. The author points out that the gains from these services would probably in the long run equal, if they did not exceed, the gains of selling co-operatively in the central market.

765. "Biochemistry of Plant Diseases. X. Fermentation of Pentoses by *Fusarium lini*," by Mollie G. White and J. J. Willaman. In *The Biochemical Journal*, vol. XXII, pp. 583-591 (1928).

When *Fusarium lini* is grown on xylose, arabinose, or rhamnose, the main products of metabolism are mycelium, CO₂, ethyl alcohol, and a small amount of organic substance precipitated by lead. From 95 to 99 per cent of the carbon can be accounted for in these products, making it rather unlikely that there is any other product of major importance.

Of these three pentoses, xylose is utilized most efficiently for alcohol production and arabinose for growth. Rhamnose is utilized very poorly for either.

During the course of growth in a culture the ratio of CO₂ to ethyl alcohol is constantly shifting, owing to the consumption of alcohol by the fungus.

766. "Biochemistry of Plant Diseases. XI. *Fusarium lini* and the Pyruvic Acid Theory of Alcoholic Fermentation," by Mollie G. White and J. J. Willaman. In *The Biochemical Journal*, vol. XXII, pp. 592-595 (1928).

The fungus can utilize all of the intermediate compounds involved in the pyruvic acid theory of alcoholic fermentation, namely, hydroxymethylglyoxal, pyruvic acid, and acetaldehyde. The substance first named was used instead of methylglyoxal. The following comparison is now possible between this fungus and yeast in regard to the above theory: Methylglyoxal has not been tried on the fungus, it is not utilized by yeast. Its hydroxy-derivative is not used by yeast (Nord, 1927), but it is by the fungus. Glycerol is utilized only by the fungus. Pyruvic acid is utilized by both, but much more readily for growth by *F. lini*. Acetaldehyde is available for both, and is detectable in the medium when both organisms are grown on hexoses. Ethyl alcohol is produced by both, and is readily utilized by the fungus for growth, but not by the yeast. Although these results do not constitute proof of the pyruvic acid theory for this fungus, nevertheless there seems to be a rather close analogy between the mechanism of alcohol fermentation in yeast and in *F. lini*.

767. "Lipins and Sterols as Sources of Error in the Estimation of Fat in Buttermilk," by L. M. Thurston and W. E. Petersen. In *Journal of Dairy Science*, vol. II, pp. 270-283 (July, 1928).

It is shown that the lecithin and sterols of buttermilk are extracted with the fat in the official Roese-Gottlieb method of estimating the percentage fat content of buttermilk. The authors use this fact as proof that the official method is inaccurate for the testing of buttermilk. In trials with synthetic milk, containing known quantities of lecithin and fat, the Babcock method was found to yield more accurate results than either the Roese-Gottlieb or the American Association methods. The Babcock results were uniformly too low when milks containing not more than 0.3 per cent fat were tested. The Babcock method is recommended as the most reliable one known at present.

769. "Quantitative Results in the Prediction of Insect Abundance on the Basis of Biotic Potential and Environmental Resistance," by Royal N. Chapman. In *Journal of Economic Entomology*, vol. 21, pp. 349-352 (April, 1928).

A plea for the use of quantitative methods in attempts to predict insect abundance with an example drawn from experience with the European corn borer.

771. "The Adaptation of Medium Red Clover Strains," by A. C. Arny. In *Journal of the American Society of Agronomy*, vol. 20, pp. 557-568 (June, 1928).

Tests of winter-killing and yields during the seasons 1922-23 and 1926-27 of one or more strains of red clover from seed secured from the main clover seed producing sections of North and South America and Europe show that seed produced in France, Italy, and Chile is of no value for planting in Minnesota. Seed produced in western and central continental Europe yielded 81.4 per cent of the yields of northern grown native strains. Central-, southern-, and western-grown native strains yielded 92.2 per cent of the yields of northern grown native strains.

Results with the native strains indicate that the source of the original seed is an important consideration. Plants from winter-hardy strains grown under milder climatic conditions produced seed that in turn produced stands practically as cold resistant as those from seed grown continuously in the north.

774. "Determination of Losses Due to Smut Infections in Selfed Lines of Corn," by F. R. Immer and J. J. Christensen. In *Phytopathology*, vol. 18, pp. 599-602. (July, 1928).

A study was made to determine the effect of smut galls of different sizes and from different locations on the plants in reducing yields in selfed lines of corn. Large smut galls above the ears reduced the yield of infected plants by 94 per cent. Infections below the ears did not reduce yields as much as those above the ears. Losses due to smut were directly proportional to the size of the smut galls.

775. "Influence of Environmental Factors on the Seasonal Prevalence of Corn Smut," by F. R. Immer and J. J. Christensen. In *Phytopathology*, vol. 18, pp. 589-598 (July, 1928).

Dry weather conditions, as expressed by a low number of days of precipitation and a high percentage of sunshine, were found conducive to the prevalence of

smut. Temperature was not so important a factor as either number of days of precipitation or percentage of sunshine.

Corn seedlings proved very susceptible when hypodermically inoculated, yet seedling infection with gall formation seldom occurs in the field. The specific reason for this is not known.

A correlation of $+0.40 \pm 0.10$ was found between natural infection in a smut epidemic and artificial infection of the same strains of corn by hypodermic inoculation with a mixture of eight physiologic forms of smut.

776. "The Family Budget as a Tool for Sociological Analysis," by Carle C. Zimmerman. In *The American Journal of Sociology*, vol. XXXIII (May, 1928).

This study discusses the use of budgetary analyses by the rural sociologists for the purpose of grasping and understanding some of the chief effects of urbanization or ruralization upon the behavior of social groups. Studies of budgetary behavior have been carried on with profit for more than two hundred and fifty years, yet much is still to be done. The works of Engel and LePlay suggest that an understanding of many effects of urbanization upon social behavior may be grasped through the use of budgetary analyses. Studies made by the Minnesota Agricultural Experiment Station suggest that the organization of the rural budget is primarily about the land and real property. On the other hand, urbanization increases the organization of the budget about the individual and adds to the number of choices and decisions that must be made. Further, a summary of some characteristics of living or budgetary behavior indicates that the value of such studies is increased by the use of intercorrelations of many fields of behavior. This means that the sociologists have an opportunity and an obligation in making such studies. Some principles or social laws not ordinarily given in such studies are suggested. The footnotes include a bibliography of the more important studies and a reference to the chief articles on methodology in this field.

777. "Construction and Installation of a Toluol-Mercury Thermostat," by Wm. Robinson. In *Annals of the Entomological Society of America*, vol. 21 (1928).

The functions of the thermostat and how it operates are discussed. Detailed instructions are given for its construction. The function of an electric relay are mentioned and directions are given for installation of all parts of the apparatus.

778. "The Perpetually Frozen Subsoil of Siberia," by Constantin Nikiforoff. In *Soil Science*, vol. 26, pp. 61-81 (July, 1928).

Perpetually frozen subsoil is found on more than 3,500,000 square miles in the northern and eastern parts of Siberia. In some places the frozen layer has a thickness of more than 500 feet. The temperature within this never rises above the freezing point and is lowest not far from the surface, below which it rises gradually with increasing depth. Two hypotheses have been advanced in explanation of the origin of the perpetually frozen subsoil. According to one it is an inheritance from the great cold of the glacial period; according to the other it is a consequence of the contemporary climate. Perpetually frozen subsoil has been reported from several places in northern Canada and probably is very extensive in Alaska and the districts of Yukon, Mackenzie, and Franklin. On the basis of the meteorological records the author suggests a probable southern boundary in North America. Owing to the underlying perpetually frozen subsoil, various peculiar

physical processes have been found to occur in the annually thawing surface layers of the soil and some of these play an important rôle in all kinds of constructional work and have much significance for the successful development of agriculture in that region.

779. "Resistance of Portland Cement Concrete to the Action of Sulfate Waters as Influenced by the Cement," by Dalton G. Miller. In *Proceedings of the American Society for Testing Materials*, vol. 28, Part II (1928).

The paper describes tests to determine the resistance of concrete, made from 30 portland cements, to the action of sulfate waters including a solution of sodium sulfate, a solution of magnesium sulfate, and natural alkaline waters of Medicine Lake, South Dakota. The tests show that standard portland cements may vary greatly in resistance to sulfate waters; under the same exposure conditions the more resistant cements have outlived those of less resistance by as much as eight times.

Portland cements that have failed quickly in the laboratory in solutions of sodium sulfate have ordinarily displayed low resistance in the field to the action of mixed salts. The most desirable cements for concrete exposed to the action of sulfate waters are those that prove most resistant to the action of both pure salts and mixed salts.

The standard physical tests and chemical analyses of portland cements give no indication of resistance to sulfate waters. Geological differences of raw materials may possibly be a factor.

The paper outlines an accelerated test by submerging standard cement briquets for 6 months in 1 per cent solutions of sodium and magnesium sulfates. Until a better accelerated test is developed, this is recommended for determining the resistance of portland cements to the action of sulfate waters.

780. "The Inter-relationship of Certain Physico-Chemical Constants of Plant Saps," by R. A. Gortner and Rachel Rude. In *Proceedings of the Society for Experimental Biology and Medicine*, vol. 25, pp. 630-635 (May, 1928).

A statistical study of certain physico-chemical constants of plant saps. The outstanding observation is that bound water values are not correlated with osmotic pressure, total solids in the sap, the water content of the leaves, or the percentage of total water that can be expressed from the leaves. As this is the case, bound water determinations should be made in any thoro study of plant saps by physico-chemical methods.

782. "A Streaming Potential Method of Measuring Electrokinetic Potentials on Proteins," by David R. Briggs. In *Journal of the American Chemical Society*, vol. 50, pp. 2358-2363 (June, 1928).

An extremely accurate and rapid method is described for determining the electrokinetic potential on proteins. By means of this technic it is possible to determine the isoelectric point of proteins within ± 0.01 pH.

787. "Some Applications of Spectrophotometric Methods to Baking Problems," by Eva L. Stephens, Alice M. Child, and C. H. Bailey. In *Cereal Chemistry*, vol. 5, pp. 256-268 (July, 1928).

The spectrophotometer was employed in studying the effect of several variables upon the color of cookies. Color of the molasses used in such cookies is correlated with the color of the cookies, dark, low-grade molasses producing a correspondingly dark cookie. Dosage of sodium bicarbonate used in the dough formula exerted a substantial effect upon the color of the cookie. In general, the cookies became progressively darker as the degree of alkalinity increased.

PROJECTS

Agricultural Biochemistry

- 101 Analytical Service (C. H. Bailey, G. S. Taylor, C. C. Fifield, M. E. Gunderson)
 Subproject: Nitrogen analyses for section of farm crops
 Subproject: Tests of wheat for milling and baking qualities
 Subproject: Feed analyses for Division of Animal Husbandry
 Subproject: Miscellaneous analyses
- 102 Cereal and Flour Investigations (Co-operative with Utah Experiment Station—Nephi substation) (C. H. Bailey)
- 103 Investigation of Proposed Official Methods of Analysis (C. H. Bailey)
- 104 The Strength of Wheat Flour (Adams)
 Subproject: Colloidal properties which may be involved in flour strength
 (a) The solubility of wheat flour proteins in various salt solutions (R. A. Gortner, W. B. Sinclair)
 (b) The relation between the peptizing action of salt solutions and flour strength (R. A. Gortner, C. H. Bailey, C. C. Fifield, Rachel Rude)
 (c) A gum as a constituent of wheat flour (Dormant)
 (d) A study of the properties of wheat flour as produced by different milling systems (R. A. Gortner, T. A. Pascoe, R. C. Sherwood)
 Subproject: Other factors which may be involved in flour strength
 (a) Diastatic activity and baking strength (C. H. Bailey, Emily Grewe)
 (b) Relation of the ether-soluble fraction of flour to baking strength (A. H. Johnson)
 (c) Proteoclastic activity of wheat flours (C. H. Bailey, Andrew Cairns)
 (d) Power input as a measure of the plasticity of wheat flour doughs (C. H. Bailey, C. C. Fifield)
- 105 Biochemistry of Milling and Baking (Purnell)
 (a) The correlation of the ash content of wheat with the ash content of flour (C. H. Bailey, R. C. Sherwood)
 (b) Checking or fracturing of baked cookies or biscuits (C. H. Bailey, J. A. Dunn) (Completed)
 (c) Spectrophotometric analysis of the color of cookies (C. H. Bailey, Eva Stephens)
 (d) Effect of phosphates on the baking qualities of flour (C. H. Bailey, C. B. Gustafson)

- (e) Rancidity in baking products (C. H. Bailey, H. O. Triebold)
- (f) Citrate investigations (C. H. Bailey, R. H. Harris)
- (g) Effect of dry skim milk on bread properties (C. H. Bailey, T. A. Pascoe) (Informal co-operation with State Experimental Mill)
- 201 The Biochemistry of Carotinoid Pigments in Animals (L. S. Palmer)
- 202 Chemical and Biological Studies in Animal Nutrition
- (a) The fundamental food requirements for animals (L. S. Palmer, Cornelia Kennedy)
- (b) A study of the nutritional requirements of certain insects (L. S. Palmer, Marion D. Sweetman)
- 203 The Chemistry of Milk as a Colloidal System (Adams) (L. S. Palmer, G. A. Richardson)
- 204 The Mineral Problems of Dairy Cattle in Minnesota (Joint project with Division of Dairy Husbandry No. 105) (Purnell) (L. S. Palmer, W. M. Neal)
- Subproject: The cause of mineral deficiency in Minnesota
- Subproject: The relation of phosphorus intake to the utilization of feed
- Subproject: Analysis of blood and bones from animals receiving phosphorus-deficient ration
- Subproject: The mineral requirement for growth
- 301 Chemical Studies of Forest Products
- (a) The zeta potential of cellulose (R. A. Gortner, D. R. Briggs) (Completed)
- (b) The effect of electrolytes on the zeta potential of cellulose (R. A. Gortner, D. R. Briggs)
- (c) The sizing process (R. A. Gortner, Samuel R. Olsen) (Completed)
- (d) Surface conductance (R. A. Gortner, D. R. Briggs)
- (e) The effect of wood-rotting fungi on the chemical composition of wood (Co-operative with Forestry) (Henry Schmitz, K. W. Franke)
- 302 Comparative Studies on the Biochemistry of Normal and Abnormal Plants (Adams) (Co-operative with Waconia Sorghum Mills)
- (a) Fermentation by *Fusarium lini* (J. J. Willaman, Mollie G. White) (Completed)
- (b) Respiration of apple twigs in winter (Co-operative with Horticulture) (J. J. Willaman, J. H. Beaumont, W. A. DeLong)
- (c) Hydrogen-ion concentration as a factor in the quality of sorghum sirup (J. J. Willaman, Stephen S. Easter)
- (d) A study of pectin and its enzyme relations (J. J. Willaman)
- 401 The Chemical and Physico-Chemical Properties of Plant Tissue Fluids (R. A. Gortner, Rachel Rude, I. D. Jones)
- 402 Chemical Studies of Pollen (Dormant)
- 403 Protein Investigations
- (a) Proteins and the lyotropic series (R. A. Gortner, W. B. Sinclair) (Completed)
- (b) The proteins of wheat flour (R. A. Gortner, W. B. Sinclair)

- (c) Physico-chemical studies on derived proteins (R. A. Gortner, W. M. Sandstrom)
- (d) Electrical conductivity of protein compounds (R. A. Gortner, Harold M. Barnett) (Dormant)
- (e) The glutelins of cereal grains (R. A. Gortner, R. K. Larmour) (Completed)
- (f) The basic amino acids of teosinte (R. A. Gortner, Lawrence Zeleny) (Dormant)
- (g) The alkali binding of casein (R. A. Gortner)
- (h) Electrokinetic properties of proteins (R. A. Gortner and D. R. Briggs)

Agricultural Economics

- 101 Agricultural Credit (Purnell) (A. G. Black, V. D. Gilman, Percy Lowe, G. B. Clarke)
- Subproject: The present agricultural credit situation in Minnesota (Revived)
- Subproject: The organization and business practices of agricultural credit corporations
- 102 Elasticity of Supply of Farm Products (Dormant)
- 103 Farmers' Incomes in Minnesota (A. G. Black, D. D. Kittredge)
- 105 Grain Dockage Investigations (Dormant) (Closed)
- 107 Market Price Quotations (D. D. Kittredge)
- 108 Marketing of Farm Products (H. B. Price, W. C. Waite, A. F. Hinrichs, Torstein Grinager, T. G. Stitts, Ole Negaard) (Purnell)
- Subproject: Problems of the Minnesota Co-operative Creameries Association
- Subproject: Organization and management problems of local creameries in Minnesota (Dormant)
- Subproject: Organization for selling livestock in central market
- Subproject: Local concentration of livestock in Minnesota (Dormant)
- Subproject: Federation of local grain elevators (Dormant)
- Subproject: Margins on locally grown fruits and vegetables (Dormant)
- Subproject: Problems of the Lake Region Egg and Poultry Association
- Subproject: Co-operative marketing of honey (Co-operative with U. S. Dept. of Agr., Bureau of Agricultural Economics)
- Subproject: Organization and management problems of farmers' elevators (Co-operative with U. S. Dept. of Agr., Bureau of Agricultural Economics)
- Subproject: Marketing of small fruits (Co-operative with Division of Horticulture)
- 109 Market Organization Investigations (H. B. Price, A. F. Hinrichs)
- 110 Methods Employed by Private Agencies in Land Settlement (J. D. Black) (Co-operative with U. S. Dept. of Agr., Bureau of Agricultural Economics) (Closed)
- 111 Methods of Land Valuation with Special Reference to Minnesota (Dormant)
- 112 Organization of the Farmers' Supply Service (H. B. Price, J. D. Black, Rudolph Froker) (Co-operative with U. S. Dept. of Agr., Bureau of Agricultural Economics)
- 113 Prices of Farm Products (W. C. Waite, E. J. Working, D. D. Kittredge, G. B. Clarke, O. J. Hall, T. G. Stitts, B. A. Holt) (Purnell) (Co-operative with U. S. Dept. of Agr., Bureau of Agricultural Economics)
- 114 Taxation in Relation to Agriculture (Purnell) (J. D. Black) (Closed)
- Subproject: The present agricultural taxation situation in Minnesota

- Subproject: Comparative study of county and township expenditures in Minnesota
- 115 The Valuation of Agricultural and Forest Lands (Purnell) (Co-operative with U. S. Dept. of Agr., Bureau of Agricultural Economics) (Dormant)
- 116 The Agricultural Surplus (Dormant)
- 117 Study of Shifts in Agricultural Production in the Red River Valley (Purnell) (Co-operative with U. S. Dept. of Agr., Bureau of Agricultural Economics) (Dormant)
- 118 Settler Turnover in Minnesota (Joint project with Agricultural Engineering 118; co-operative with U. S. Dept. of Agr., Bureau of Agricultural Economics) (G. B. Clarke) (New)

Agricultural Engineering

- 101 Determination of the Relative Efficiency of Different Depths and Spacings of Tile Drains in Four Typical Minnesota Soils (Revised) (H. B. Roe, J. H. Neal, G. F. Krogh, B. C. Colby)
- 102 Drainage and Water Control on Peat Lands (Co-operative with Division of Farm Management, Agronomy, and Plant Genetics and Division of Horticulture (H. B. Roe, J. H. Neal, G. F. Krogh, B. C. Colby)
- 103 Farm Building Ventilation (E. A. Stewart, Julius Romness)
- 104 Farm Sewage Disposal (Co-operative with Division of Agricultural Extension (E. A. Stewart, A. G. Tyler, J. M. Larson)
- 105 Heating and Ventilating of Homes (E. A. Stewart, A. G. Tyler)
- 106 Hydro-Electric Plants (E. A. Stewart, A. G. Tyler)
- 107 Investigation of Causes of Failure of Agricultural Drain Tile, the Means of Obviating Such Failures, and Mapping Areas Where Extra Precautions Are Necessary (Co-operative with Minnesota State Dept. of Agr., Division of Drainage, and U. S. Dept. of Agr., Bureau of Public Roads (H. B. Roe, for the University of Minnesota; P. W. Manson, for the State Dept. of Agr.; D. G. Miller, P. C. McGrew, for the U. S. Dept. of Agr.)
- 108 Investigations in Cost of Clearing Land (M. J. Thompson, A. J. Schwantes, B. H. Gustafson, J. J. McCurdy)
- 109 Investigations of Farm Tractors (J. B. Torrance) (Dormant) (Closed)
Subproject: Survey of factors governing successful tractor utilization
- 110 Investigations in Land Clearing Methods and Equipment (M. J. Thompson, B. H. Gustafson) (Dormant)
- 111 Investigations of Farm Buildings (H. B. White, M. G. Jacobson)
- 112 Land Clearing Investigations
Subproject: Investigations of methods of stone removal (M. J. Thompson, A. J. Schwantes, B. H. Gustafson)
Subproject: Investigations in power necessary for pulling stumps (M. J. Thompson, A. J. Schwantes)
Subproject: Land clearing salvage—stone (M. J. Thompson, B. H. Gustafson)
Subproject: Crop production following clearing of virgin land (M. J. Thompson, B. H. Gustafson, J. J. McCurdy)
Subproject: Economic limitations of stump removal for pasture (M. J. Thompson, B. H. Gustafson)
Subproject: Relation of fire in clearing to spotted crop production the following year (M. J. Thompson, B. H. Gustafson)

- 113 A Study of the Influence of Tile Drainage on Soil Temperatures Within the Root Zone of Standard Crops (formerly subproject under project entitled "Methods and Costs of Drainage Installation and Correlation of Land and Crop Values with Cost of Drainage") (Co-operative with U. S. Dept. of Agr., Bureau of Public Roads) (H. B. Roe, J. H. Neal, G. F. Krogh, B. C. Colby, Mrs. Hans Oftedal)
- 114 The Utilization of Electricity in Agriculture (Joint project with Home Economics No. 106; co-operative with the Division of Farm Management, Agronomy, and Plant Genetics and the Minnesota Committee on the Relation of Electricity to Agriculture) (E. A. Stewart, A. G. Tyler, Julius Romness, J. M. Larson, W. J. Roth, Florence Kelley, Ruth Sager, Alice M. Child)
- 115 Wind Power Electric Lighting Plants (E. A. Stewart, A. G. Tyler)
- 116 Investigations of the Drainage Requirements of Swamp Forest Growth, of the Proper Type of Drainage System, and of the Methods and Costs of Its Installation and Operation (Joint project with Forestry No. 101; co-operative with Division of Soils and U. S. Dept. of Agr. Forest Service) (Dormant)
- 117 Investigations in Costs and Methods of Constructing Open Ditches with Explosives Under Varying Soil and Moisture Conditions (Dormant) (Closed)
- 118 Settler Turnover in Minnesota (Joint Project with Agricultural Economics No. 118) (New)

Animal Husbandry

- 101 Baby Beef Feeding Trial (Dormant) (Closed)
- 105 A Comparison of Alfalfa Hay and Peat Land Timothy Hay Fed with Shelled Corn for Fattening Yearling Steers (Co-operative with Division of Agricultural Biochemistry and Division of Soils) (W. H. Vaughan) (Closed)
- 106 Fattening Yearling Steers (W. H. Peters, S. G. Denner)
- 301 Studies in Wool and Other Animal Fibers (Co-operative with U. S. Dept. of Agr., Bureau of Animal Industry) (P. A. Anderson, for the University of Minnesota; E. W. Sheets, D. A. Spencer, J. I. Hardy, for the U. S. Dept. of Agr.)
Subproject: Studies in the growth of wool
- 401 Swine Feeding Investigations (E. F. Ferrin, M. A. McCarty)
Subproject: The value of ground rye fed with certain supplements as a ration for growing pigs
Subproject: A comparison of protein supplements in rations for pigs following weaning
Subproject: A comparison of the economy of full feeding and limited feeding of grain to growing pigs under dry lot and pasture conditions (Closed)
Subproject: A study of the cost of production and quality of the product from lard-type and from bacon-type hogs
Subproject: A study of the production of Wiltshire sides from hogs of the lard and bacon breeds
Subproject: The feeding value of oats
Subproject: The comparative value of corn and oats for growing pigs
Subproject: A comparison of protein supplements (New)

Subproject: A study of the nutritive requirements of growing swine by means of a comparison of the leading feeding standards

Bee Culture

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

Dairy Husbandry

- 102 Feeding Tests with Crops New to Minnesota (Co-operative with Division of Farm Management, Agronomy, and Plant Genetics) (O. G. Schaefer)
- 103 Food Requirements for Cattle (Co-operative with Division of Agricultural Biochemistry) (C. H. Eckles, T. W. Gullickson)
 - Subproject: The energy requirement for growth
 - Subproject: The maintenance requirement for growing cattle (Completed)
 - Subproject: The relation of vitamins to the growth of dairy cattle and to milk production (Completed)
 - Subproject: The deficiencies of milk as an exclusive diet for calves
- 104 The Immediate Influence of Various Feeds upon the Quantity and Quality of Milk (W. E. Petersen)
- 105 The Mineral Problems of Dairy Cattle in Minnesota (Purnell) (Joint project with Agricultural Biochemistry No. 204) (C. H. Eckles, T. W. Gullickson)
 - Subproject: The cause of mineral deficiency in rations of cattle in western Minnesota
 - Subproject: The relation of low phosphorus intake to the utilization of feed
 - Subproject: Analysis of blood and bones from animals receiving a phosphorus deficient ration
 - Subproject: The mineral requirements for the growth of cattle
- 201 The Accuracy of Methods of Making Composite Samples in Minnesota Creameries (W. B. Combs, L. M. Thurston, A. E. Groth, S. T. Coulter) (Completed)
- 202 Factors Influencing the Composition and Market Qualities of Butter (Purnell) (H. Macy, W. B. Combs, L. M. Thurston, A. E. Groth, H. B. Richie, S. T. Coulter, H. Morrison, W. J. Hansen)
 - Subproject: Moldiness in butter
 - Subproject: Cheesy flavors in butter
 - Subproject: The cause and prevention of crumbly butter
 - Subproject: Distribution of salt in butter
- 203 Ice Cream Studies (W. B. Combs, L. M. Thurston)
 - Subproject: Powdered skimmilks in ice cream
- 204 Increasing the Production of Dairy Cows by Better Feeding (Co-operative with Agricultural Extension) (Closed)
- 205 The Loss of Fat in Churning Sweet Cream and Methods for Its Control (Co-operative with State Creamery) (W. B. Combs, L. M. Thurston, A. E. Groth, S. T. Coulter, W. E. Petersen)
 - Subproject: Methods of testing buttermilk
 - Subproject: Factors influencing the loss of fat in buttermilk

- 207 The Feed Requirements and the Cost of Keeping Dairy Herd Sires (Co-operative with Division of Farm Management, Agronomy, and Plant Genetics) (O. G. Schaefer) (New)
- 208 French Weed as a Possible Source of Injury to the Market Qualities of Dairy Products (C. H. Eckles, Paul Derby) (New)
- 209 The Value of the Proven Sire in Building up a Dairy Herd (O. G. Schaefer, W. E. Peterson) (New)

Entomology and Economic Zoology

- 101 Alfalfa Weevil (Dormant)
- 102 Biologic and Taxonomic Studies on the Mutillidae (Hymenoptera) (C. E. Mickel)
- 103 The Bronze Birch-Borer, *Agrilus bilineatus* (Co-operative with U. S. Dept. of Agr., Bureau of Entomology; University of Michigan; Lake States Forest Experiment Station) (S. A. Graham, A. Peterson)
- 104 Cucumber Insects (Dormant)
- 105 Economic Status of Fur-Bearing Animals in Minnesota (M. S. Johnson)
 - Subproject: The status of fur-farming in Minnesota
 - Subproject: Common injurious mammals in Minnesota
- 106 Effect of Physical Factors upon Insects in Freshly Cut Logs (Co-operative with U. S. Dept. of Agr., Bureau of Entomology; Lake States Forest Experiment Station; and University of Michigan) (S. A. Graham) (Closed)
- 107 The Endoparasites of Man and Domesticated Animals (Co-operative with U. S. Dept. of Agr., Bureau of Animal Industry; Division of Veterinary Medicine; Swift and Company; and fox farmers in Minnesota) (W. A. Riley, R. O. Christenson)
 - Subproject: The sources of infection of domesticated foxes by tapeworms
- 108 Flukes of the Genus *Collyriclum* as Parasites of Poultry (W. A. Riley)
- 109 Grasshopper Control (Dormant)
- 110 Greenhouse Insects (A. G. Ruggles, H. L. Parten)
- 111. Insect Collection (Co-operative with Division of Forestry) (C. E. Mickel, L. B. Reed)
 - Subproject: Insect collection, University Farm
 - Subproject: Insect collection, Itasca Park
- 112 Insect Defoliators of Forest Trees (Co-operative with U. S. Dept. of Agr., Bureau of Entomology and Forest Service; and Michigan Experiment Station) (S. A. Graham)
 - Subproject: The jack-pine sawfly
 - Subproject: The spruce budworm on jack pine
 - Subproject: The spruce budworm on spruce and fir
 - Subproject: The larch sawfly
- 113 Insectary Work (A. G. Ruggles)
- 114 Insects Infesting Stored Food Products (R. N. Chapman)
 - Subproject: Measures for protecting flour and other cereal products from insects
 - Subproject: The protection of dried fruit from insects
- 115 Insects of Orchard with Best Means of Combating (Dormant)
 - Subproject: Plant lice
 - Subproject: Apple maggot
- 116 Insecticides (Co-operative with Division of Plant Pathology and Botany) (A. G. Ruggles, H. L. Parten)

- Subproject: Orchard spraying (Dormant)
 Subproject: Potato spraying
 Subproject: Scale insect control
- 118 Life History and Injury of the Potato Leaf Hopper *Empoasca mali* (Co-operative with Division of Plant Pathology and Botany) (Dormant)
- 119 The Parasites and Symbionts of Insects (Dormant)
- 120 The Productivity of Minnesota Lakes in Fish and Fish Foods (M. S. Johnson)
 Subproject: Classification of Minnesota lakes by physical characters
- 121 Soil Insects (A. G. Ruggles, G. A. Mail)
- 122 A Study of Derris and Related Insecticides for the Control of External Parasites of Domesticated Animals (Dormant) (Closed)
- 123 A Study of the Hookworms of the Dog and the Domesticated Fox (W. A. Riley)
- 124 A Study of the Rôle of Temperature and Humidity in the Development and Control of Insects in Flour and Other Cereal Products and in Cereals While in Storage (Adams) (R. N. Chapman, Wm. Robinson)
 Subproject: Study of temperatures of grain in storage when left undisturbed and when run during cold weather. Effect of chilled grain upon mortality of grain weevils
 Subproject: Continuation of experiments on low temperature and moisture as factors in the ecology of grain weevils
 Subproject: Continuation of moisture determination of insects by electric method
- 125 A Study of the Tabanidae, or Horseflies, of Minnesota (W. A. Riley, C. B. Philip)
- 126 Use of Chlorpicrin Either Alone or in Combination with Paradichlorobenzene or Carbon Tetrachloride for Fumigating Grain in Elevators (A. L. Strand)
- 127 Field Crop Insects (A. G. Ruggles, F. M. Wadley)
- 128 Effect of Temperature and Humidity on Wintering of Bees (R. N. Chapman)
- 129 A Study of the Rôle of Temperature and Moisture in the Physiology of Insects (Wm. Robinson)

Farm Management, Agronomy, and Plant Genetics

- 101 Cost Accounting Investigations on Minnesota Farms (Co-operative with U. S. Dept. of Agr., Bureau of Agricultural Economics) (G. A. Pond, F. H. Tomlinson, G. A. Sallee)
 Subproject: Detailed farm records and accounts in Pine County, Minnesota (Completed)
- 102 A Study of the Organization of Farms in the Red River Valley (Purnell) (Co-operative with Division of Animal Husbandry and Division of Dairy Husbandry, and with the U. S. Dept. of Agr., Bureau of Agricultural Economics) (G. A. Pond, A. Boss, D. C. Mumford, C. O. Ruud)
- 103 An Accounting Study of the Factors Affecting the Incomes of Dairy Farms (Co-operative with Division of Agricultural Extension and with the U. S. Dept. of Agr., Bureau of Agricultural Economics) (G. A. Pond, A. T. Hoverstad, R. C. Bevan) (New)
- 201 Comparative Trials of Farm Crops at the Branch Stations (Co-operative with superintendents and agronomists at the branch stations) (A. C.

- Arny, H. K. Wilson, S. M. Raleigh, I. J. Johnson, R. E. Hodgson, R. O. Bridgford, R. S. Dunham, O. I. Bergh, M. J. Thompson)
- 202 Crop Rotation Investigations (Co-operative with Division of Plant Pathology and Botany, Division of Entomology and Economic Zoology, Division of Soils, and the branch stations) (A. C. Arny, F. L. Higgins, D. U. Harvey)
 Subproject: Field C rotations
 Subproject: Field T rotations
 Subproject: Alternate and continuous cropping (Completed)
 Subproject: The effect of crops on those that follow
- 203 Forage and Pasture Crop Investigations (formerly "Forage Crop Investigations") (A. C. Arny, J. W. Nelson, F. L. Higgins, I. J. Johnson, D. U. Harvey)
 Subproject: Comparative yields of soybeans and pole beans grown with Minnesota No. 13 corn
 Subproject: Time, rate, and method of seeding forage crops
 Subproject: Variety trials of forage crops
 Subproject: The relation of time of cutting of forage crops to yield and quality of the product and to the maintenance of satisfactory stands
- 204 Investigations in the Growing of Small Grains (Co-operative with Flax Development committee) (A. C. Arny, H. K. Wilson, S. M. Raleigh, I. J. Johnson)
 Subproject: Varietal tests of small grains at University Farm
 Subproject: Nutrient requirements of standard recommended varieties
 Subproject: Lodging of small grains
 Subproject: Dates of harvest of small grains
 Subproject: Rates and dates of seeding small grains
- 205 Studies in the Classification of Farm Crops (Co-operative with Flax Development Committee) (A. C. Arny, H. K. Wilson, A. C. Dillman)
- 206 Methods of Eradicating Perennial Weeds (Co-operative with Division of Plant Pathology and Botany and the Northwest Experiment Station) (A. C. Arny, R. S. Dunham, A. H. Larson, J. W. Nelson) (New)
 Subproject: Eradicating perennial weeds with chemicals
 Subproject: Effect of frequent cutting on the vigor of perennial weeds
 Subproject: Amounts of reserve foods in the underground parts of these weeds at different stages of development
- 301 Comparison of Fence Posts (L. B. Bassett)
- 303 A Study of the Physical Organization of Farms (L. B. Bassett)
 Subproject: The farm layout
 Subproject: The farmstead arrangement
- 304 Types of Farming and Production Areas in Minnesota (L. F. Garey)
- 305 Hay Stack and Mow Measurement Investigations (Co-operative with U. S. Dept. of Agr., Bureau of Agricultural Economics) (A. T. Hoverstad, G. A. Sallee)
- 401 Breeding of Miscellaneous Field Crops (H. K. Hayes, F. R. Immer, F. J. Stevenson)
 Subproject: To determine the value of selection in self-fertilized lines as a means of improving red clover
 Subproject: The mode of pollination of grasses and the effects of self-fertilization
 Subproject: Improvement of sweet clover

- 402 Corn Breeding Investigations (Co-operative with the Northwest, Southeast, and West Central experiment stations, and with the Minnesota Valley Canning Company) (H. K. Hayes, H. E. Brewbaker, F. R. Immer, H. L. Thomas, R. E. Hodgson, R. S. Dunham, R. O. Bridgford, C. L. Alexander)
 Subproject: A study of the inheritance of certain characters in corn
 Subproject: Improvement of corn through inbreeding and subsequent cross-breeding
 Subproject: Corn improvement at Waseca
 Subproject: The production of improved varieties of corn for northern Minnesota
 Subproject: The production of improved varieties of corn for west central Minnesota
- 403 The Development of Disease Resistant Varieties of Farm Crops (Joint project with Plant Pathology and Botany No. 104; co-operative with the U. S. Dept. of Agr., Bureau of Plant Industry) (H. K. Hayes, F. J. Stevenson, H. E. Brewbaker, F. R. Immer, for the Division of Farm Management, Agronomy, and Plant Genetics; E. C. Stakman, for the Division of Plant Pathology and Botany; O. S. Aamodt, for the U. S. Dept. of Agr.)
 Subproject: The development of rust-resistant varieties of wheat (Co-operative with U. S. Dept. of Agr.)
 Subproject: The genetics of biologic forms of *P. graminis* (Dormant)
 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 types of barley resistant to "spot blotch"
 Subproject: Resistance of wheat varieties to wheat scab
 Subproject: Varietal resistance of wheat, barley, rye, and oats to root and culm rots
 Subproject: The production of high-yielding, rust-resistant timothy
 Subproject: Flax wilt (Co-operative with U. S. Dept. of Agr.)
 Subproject: Development of varieties of flax resistant to rust (Co-operative with U. S. Dept. of Agr.)
- 404 The Development of Improved Sorts of Corn (Purnell) (Co-operative with Division of Plant Pathology and Botany and the Southeast Experiment Station) (H. K. Hayes, H. E. Brewbaker, H. L. Thomas)
 Subproject: The determination of characters of selfed lines which are of importance for breeding purposes
 Subproject: Utilization of selfed lines in production of improved sorts
- 405 Inheritance Studies with Small Grains (Adams) (Informal Co-operation with U. S. Dept. of Agr., Bureau of Plant Industry; co-operative with Division of Plant Pathology and Botany) (H. K. Hayes, F. J. Stevenson)
 Subproject: Inheritance of characters in small grains
 Subproject: Cytologic and genetic study of species crosses
- 406 Investigations in Cereal Breeding (Co-operative with the U. S. Dept. of Agr., Bureau of Plant Industry and with branch stations) (H. K. Hayes, F. J. Stevenson, H. E. Brewbaker, F. R. Immer, C. L. Alexander, and branch station agronomists)

- Subproject: To produce hardy winter wheats of high yielding ability and high milling quality and which contain other desirable characters
 Subproject: To produce improved varieties of spring wheat
 Subproject: To produce improved varieties of oats
 Subproject: To produce improved varieties of barley
 Subproject: To produce vigorous selfed strains by selection in artificially self-fertilized lines and to synthesize such lines to produce new and better varieties of rye.
 Subproject: To determine the best methods of technic in plant breeding
 Subproject: Tests of new varieties in rod rows
- 501 Co-operative Seed Production and Distribution (Co-operative with Minnesota Crop Improvement Association and farmers) (A. D. Haedecke)

Forestry

- 101 Investigation of the Drainage Requirements of Swamp Forest Growth, of the Proper Type of Drainage System, and of the Methods and Costs of Its Installation and Operation (Joint project with Agricultural Engineering No. 116; co-operative with the U. S. Dept. of Agr. Forest Service) (Raphael Zon, for the U. S. Dept. of Agr.; Wm. Boss, H. B. Roe, A. J. Schwantes, B. H. Gustafson, for the Division of Agricultural Engineering; Henry Schmitz and T. S. Hansen, for the Division of Forestry) (Dormant)
- 102 Management of the Cloquet Forest (T. S. Hansen)
- 104 Possibilities of Cut-Over Lands (T. S. Hansen)
- 105 Preservative Treatment of Fence Posts (Co-operative with the U. S. Dept. of Agr. Forest Service) (J. H. Allison, H. Schmitz)
- 106 Studies of Forest Planting (T. S. Hansen)
- 107 Thinning of Jack and Norway Pine (Co-operative with the U. S. Dept. of Agr. Forest Service) (T. S. Hansen)
- 108 Volume, Growth, and Yield Studies of Birch and Aspen in Northern Minnesota (Co-operative with U. S. Dept. of Agr. Forest Service) (Raphael Zon, S. R. Gevorkiantz)
- 109 Windbreak Planting Investigations (E. G. Cheyney)
- 110 Studies in Yield and Volume (Co-operative with St. Paul Waterworks and North Central Experiment Station) (J. H. Allison, R. M. Brown)
- 111 Working Plan for the Cloquet Forest Area (Co-operative with the U. S. Dept. of Agr. Forest Service) (J. H. Allison, Ernest George)
- 113 Black Spruce Volume Study (Co-operative with U. S. Dept. of Agr. Forest Service) (R. M. Brown) (New)
- 114 A Study of the Economic Management of the Farm Woodlot (Purnell) (J. H. Allison, T. S. Hansen) (New)
- 115 Relation Between Specific Gravity and Pulp Wood in Partially Decayed Aspen Wood (Co-operative with Division of Agricultural Biochemistry) (Henry Schmitz) (New)

Home Economics

- 101 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 (Co-operative with the Division of Farm Management, Agronomy, and Plant Genetics) (Dormant)

- 102 The Relation of Diet to Blood Formation and Regeneration (Purnell) (Jane M. Leichsenring, Alice Biester)
Subproject: The influence of vitamins on the rate of blood regeneration
Subproject: The distribution of nitrogenous constituents of the blood during blood formation and regeneration
- 103 A Study of the Cooking of Pork Products (Purnell) (Co-operative with Division of Animal Husbandry and Institute of American Meat Packers) (Alice M. Child)
Subproject: Factors influencing shrinkage in cooked ham
Subproject: Comparing pork shoulder roasts cooked at different temperatures
Subproject: To secure a quality test for the over-cooking of bacon
Subproject: To secure a grading chart for judging bacon in quality test
- 104 Factors Affecting the Selection, Care, and Wearing Qualities of Textile Materials (Purnell) (Ethel L. Phelps, Eunice Thompson) (New)
Subproject: A study of fiber quality and physical properties in relation to cost of staple wool materials
- 105 A Study of Bound and Free Water in Meat (Alice M. Child, Amy Macomber, Florence C. Kelley) (New)
- 106 The Utilization of Electricity in Agriculture (Joint project with Division of Agricultural Engineering No. 114) (New)
Subproject: Cooking by electrically heated ranges and appliances

Horticulture

- 101 A Study of Ornamental Varieties and Their Uses (C. E. Cary)
- 102 Turf Construction and Maintenance (Co-operative with the U. S. Golf Association) (C. E. Cary)
- 201 Hardiness Studies in Fruit Breeding (Adams) (Co-operative with Division of Plant Pathology and Botany and Division of Soils) (J. H. Beaumont, A. C. Hildreth, W. H. Alderman, W. A. DeLong, A. N. Wilcox, H. P. Traub)
- 202 Sterility Studies in Fruit Breeding (Adams) (Co-operative with Division of Plant Pathology and Botany) (J. H. Beaumont, W. H. Alderman, A. N. Wilcox, F. A. Krantz)
- 203 A Study of the Inheritance of Characters in Fruits (J. H. Beaumont, A. N. Wilcox, W. H. Alderman, F. E. Haralson)
- 301 Blueberry Culture (W. G. Brierley, W. H. Alderman, A. N. Wilcox)
- 302 Co-operative Orchard Management (Combined with No. 304)
- 303 Cost of Producing Fruits (Dormant)
- 304 Fruit Variety Studies (W. G. Brierley, W. H. Alderman, Fred Rohner)
Subproject: Adaptability and value of different varieties of fruits for canning, preserving, and other home uses (In co-operation with the Division of Home Economics, the North Central, Northeast, and Northwest branch stations, and between 30 and 40 trial stations)
- 305 Nut Culture in Minnesota (W. G. Brierley)
- 306 Nature of the Injury Arising from Fall Planting of Apple Trees in Minnesota (Dormant)
- 307 Pruning Studies (W. G. Brierley) (New)
Subproject: The effect of height of pruning upon the performance of the Latham red raspberry
Subproject: The effect of tree vigor on the rate of healing of wounds in the apple

- 401 Description, Classification, and Standardization of Truck Crops (Formerly "Anatomy and Taxonomy of the Parsnip, Winter Radish, Spinach, Rutabaga, Salsify, and Celeriac") (H. P. Traub, C. J. B. Thor, E. S. Miller, L. Zeleny, F. P. Hall)
- 402 Vegetable Breeding and Selection (F. A. Krantz, W. H. Alderman, A. E. Hutchins, H. P. Traub)
Subproject: Pea breeding
Subproject: Tomato breeding
Subproject: Head lettuce breeding (Co-operative with Northeast Experiment Station)
Subproject: Onion breeding (Co-operative with Northeast Experiment Station)
Subproject: Melon breeding
Subproject: Radish breeding
Subproject: Cabbage breeding (Co-operative with Division of Plant Pathology and Botany)
Subproject: Celery breeding (Co-operative with Division of Plant Pathology and Botany)
Subproject: Carrot breeding
Subproject: Tests of varieties and strains of vegetables
- 403 Effect of Differential Water Table on the Development of Vegetable Crop Plants on Peat Lands (Co-operative with Division of Agricultural Engineering and the St. Louis County Club) (H. P. Traub, F. A. Krantz, W. H. Alderman)
- 404 Hardening-Off Process in Vegetable Crop Plants (Co-operative with Division of Agricultural Biochemistry) (H. P. Traub, C. J. B. Thor, L. Zeleny)
- 405 Isolation of Strains of Girasole, Dahlia, and Chicory with Relatively High Inulin and Inulide Content (Co-operative with Division of Agricultural Biochemistry) (H. P. Traub, F. A. Krantz, C. J. B. Thor)
- 406 Nutrition Studies in Vegetable Crop Plants (Co-operative with St. Louis County Club) (Dormant)
- 407 Onion Culture on Peat and on Mineral Lands (Co-operative with St. Louis County Club) (H. P. Traub, F. A. Krantz)
- 408 Potato Breeding (F. A. Krantz, A. E. Hutchins)
Subproject: Potato breeding methods
Subproject: Inheritance in the potato
- 409 Storage of Girasole Tubers (Co-operative with the Division of Plant Pathology and Botany) (H. P. Traub, C. J. B. Thor) (Closed)
- 410 Storage of Husk Tomato in the Dehydrated Condition (H. P. Traub) (Closed)
- 411 Summer Frost Prevention on Peat and Muck Lands (Co-operative with Division of Agricultural Engineering and the St. Louis County Club) (H. P. Traub, F. A. Krantz, W. H. Alderman)
- 412 Vegetable Experiments on Peat Land (Co-operative with St. Louis County Club) (F. A. Krantz, H. P. Traub, W. H. Alderman)
Subproject: Nutrition of vegetable crops
Subproject: Head lettuce experiments

Plant Pathology and Botany

- 101 Cereal and Forage Crop Diseases (E. C. Stakman, J. J. Christensen, H. A. Rodenhiser, C. S. Holton)

- Subproject: Imperfects on cereals
 Subproject: Smut treatments
 Subproject: Scab of cereals
 Subproject: Ergot of cereals (Dormant)
 Subproject: Sunflower rust (Dormant)
 Subproject: Black chaff of wheat
 Subproject: Diseases of flax (Dormant)
 Subproject: Smuts of sorghum (Co-operative with Division of Agricultural Biochemistry)
- 103 Dendropathological Work (Co-operative with U. S. Dept. of Agr. Forest Service) (E. C. Stakman, Ralph Lindgren)
 Subproject: Miscellaneous Itasca Park experiments
 Subproject: The rotting of posts and poles (Co-operative with Page and Hill Pole Company)
 Subproject: Relation of environment to damping off
 Subproject: Pathology of aspen in relation to the management and utilization of this species in Minnesota (Co-operative with Division of Forestry)
 Subproject: White pine blister rust
 Subproject: The effect of the degree of rot on the mechanical properties of Norway pine, spruce, birch, and poplar (Co-operative with Division of Forestry)
- 104 The Development of Disease Resistant Varieties of Farm Crops (Joint project with Farm Management, Agronomy, and Plant Genetics No. 104; co-operative with U. S. Dept. of Agr., Bureau of Plant Industry) (E. C. Stakman, J. J. Christensen, H. A. Rodenhiser, P. D. Peterson, C. S. Holton, Chih Tu, for the Division of Plant Pathology and Botany; M. N. Levine, O. S. Aamodt, for the U. S. Dept. of Agr.)
 Subproject: The development of rust resistant varieties of wheat
 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 stalk and root 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
- 105 Diseases of Ornamental Varieties (Louise Dosdall)
- 108 Fruit Diseases (Co-operative with the Division of Entomology and Economic Zoology) (E. C. Stakman, P. D. Peterson)
 Subproject: Experimental apple spraying (Dormant)
 Subproject: Experimental plum spraying (Dormant)
 Subproject: Diseases of small fruits and methods of control
 Subproject: Biology of *Sclerotinia spp.* (Dormant)
 Subproject: Raspberry mosaic (Co-operative with Division of Entomology and Economic Zoology)

- 109 Minnesota Mushrooms (Louise Dosdall)
- 110 Plant Disease Survey (Louise Dosdall)
- 111 Rusts of Cereals (Adams) (Co-operative with U. S. Dept. of Agr., Office of Cereal Investigations) (E. C. Stakman, H. W. Johnson, Helen Hart, H. E. Parson, W. C. Broadfoot, J. M. Wallace, for the University of Minnesota; M. N. Levine, O. S. Aamodt, E. B. Lambert, L. W. Melander, R. U. Cotter, for the U. S. Dept. of Agr.)
 Subproject: Nature of resistance
 Subproject: Biologic specialization in cereal rusts
 Subproject: Epidemiology of cereal rust
 Subproject: Barberry eradication
 Subproject: Dusting to control cereal rust (Niagara Sprayer Company Fellowship)
- 112 The Microflora of Moldy Silage and Hay (Co-operative with Division of Veterinary Medicine and Division of Agricultural Biochemistry) (C. P. Fitch, J. J. Willaman, P. D. Peterson)
- 113 Diseases of Canning Crops (Co-operative with Minnesota Cannery Association) (E. C. Stakman, J. G. Leach, H. H. Thornberry, C. G. Anderson)
 Subproject: Diseases of canning peas
 Subproject: Diseases of sweet corn
- 114 Pathological Changes Occurring in Storage and Ripening of Fruits and Vegetables Under Varying Conditions (E. C. Stakman, P. D. Peterson, H. W. Johnson)
 Subproject: Pathological changes occurring in fruits and vegetables in storage (Dormant)
 Subproject: The effect of temperature and humidity on the development of storage rots
 Subproject: The length of holding storage in relation to pathological changes in fruits (Dormant)
- 115 Physiologic Specialization of Smuts of Cereals (E. C. Stakman, J. J. Christensen, H. A. Rodenhiser, C. S. Holton, W. Hanna, R. Bamberg) (Purnell) (New)
- 116 Garden Truck Diseases (formerly No. 208) (J. G. Leach, E. C. Stakman, H. W. Johnson)
 Subproject: Bean bacteriosis and anthracnose
 Subproject: Potato diseases
 Subproject: Miscellaneous truck crop diseases
 Subproject: The relation of dipterous insects to the spread and development of soft rot of vegetables
- 201 Effect of Low Temperature on Plants (Co-operative with Division of Farm Management, Agronomy and Plant Genetics) (R. B. Harvey, L. O. Regeimbal, E. T. Erickson)
- 203 Investigations on Respiratory Enzymes (R. B. Harvey, L. O. Regeimbal)
- 204 Light Relations of Forest Reproduction (Co-operative with U. S. Dept. of Agr. Forest Service) (R. B. Harvey, L. O. Regeimbal)
 Vegetables Under Varying Conditions (Co-operative with Division of Horticulture) (R. B. Harvey, L. O. Regeimbal)
- 206 Physiology of Reproduction (Dormant)
- 207 Physiology of Seed Germination (Co-operative with Division of Farm Management, Agronomy, and Plant Genetics) (R. B. Harvey, L. O. Regeimbal, A. H. Larson, E. T. Erickson, G. P. Steinbauer)
- 208 Garden Truck Diseases (Number changed to 116)

- 209 Studies in Plant Metabolism and Growth (Co-operative with Division of Farm Management, Agronomy, and Plant Genetics) (R. B. Harvey, L. O. Regeimbal, E. T. Erickson, G. P. Steinbauer)
- 301 Seed Studies (Co-operative with State Seed Laboratory) (A. H. Larson, E. T. Erickson, G. P. Steinbauer)
 Subproject: Weed seed cases
 Subproject: Germination of lettuce seed
 Subproject: Seed testing survey
- 302 Weeds (A. H. Larson, E. T. Erickson)
 Subproject: Perennial sow thistle

Poultry Husbandry

- 101 The Determination of the Efficiency of Different Forms of Liquid Milk as a Substitute for the Mash Customarily Fed (A. C. Smith, A. A. Hoberg (Closed))
- 104 Determination of the Most Effectual Methods of Feeding Milk to Laying Hens (Dormant)
- 105 Investigation of the Feeding and Care of Young Chicks (A. C. Smith, A. A. Hoberg) (New)
 Subproject: To determine the value of sweet skim milk fed as a beverage *ad libitum* as supplementary nutrition to the basal all-mash ration already rich in animal protein derived from meat and bonemeal
 Subproject: To determine the comparative value of an all-grain ration and an all-mash ration when both are supplemented by skim milk as a beverage *ad libitum*
 Subproject: To determine the value of the combined mash and grain ration with sweet milk as compared with both the all-mash and the all-grain rations
 Subproject: To determine the most desirable age to begin feeding baby chicks

Soils

- 102 Fertilizer Experiments (F. J. Alway, G. H. Nesom, P. R. McMiller, Wm. Methley)
- 103 Hydrogen-Ion Concentration of Soils (C. O. Rost)
- 104 Land Classification (Co-operative with U. S. Dept. of Agr.) (F. J. Alway)
- 105 Movement of Water in Soils (Adams) (F. J. Alway)
- 106 Peat Soils (F. J. Alway, G. H. Nesom, I. J. Nygard, A. Libby)
- 107 Sandy Soils (F. J. Alway, G. H. Nesom, Wm. Methley)
- 108 Soils of the Low-Lime Area (F. J. Alway, G. B. Bodman, C. Nikiforoff)
- 109 Soil Survey (Co-operative with U. S. Dept. of Agr.) (F. J. Alway, P. R. McMiller, G. B. Bodman, A. Libby)
- 110 Soils of the Red Drift (F. J. Alway, G. B. Bodman, A. Libby)

Veterinary Medicine

- 101 The Chemistry of the Blood and Urine of Animals Affected with Specific and Obscure Diseases (E. A. Hewitt)
 Subproject: The physiology and chemistry of the blood and urine of normal animals
 Subproject: The physiology and chemistry of the blood and urine of animals affected with specific and obscure diseases

- 102 Contagious Abortion of Mares and Pyaemic Arthritis of Foals (Dormant)
- 103 Diseases of Poultry (Informal co-operation with Division of Poultry Husbandry) (C. P. Fitch, R. E. Lubbehusen, H. C. H. Kernkamp)
 Subproject: Tuberculosis
 Subproject: Bacillary white diarrhea (Included as project No. 109)
 Subproject: Entero-hepatitis (Dormant)
- 104 Infectious Abortion and Other Diseases of the Reproductive Organs of Cattle (Adams) (C. P. Fitch, W. L. Boyd, R. E. Lubbehusen, E. Cavilla)
 Subproject: Pathology and treatment of sterility
 Subproject: Serologic tests in their relation to bovine infectious abortion
 Subproject: Bacterial flora of the vagina and uterus of the cow (Dormant)
 Subproject: Infectious white scours and calf pneumonia (Dormant)
 Subproject: The function of the *corpus luteum*
 Subproject: Production of artificial immunity
 Subproject: Effect of pituitrin on delayed parturition, expulsion of the fetal membranes, and subinvolution of the uterus
 Subproject: Channels of infection in bovine infectious abortion (Dormant)
 Subproject: Biological requirements of *Bact. abortus* Bang.
 Subproject: Elimination of *Bact. abortus* through excretions and secretions (Dormant)
 Subproject: The clean and the infected herd
- 105 Investigation of Obscure Diseases (Co-operative with State Livestock Sanitary Board) (C. P. Fitch, R. Fenstermacher, W. L. Boyd, E. A. Hewitt, M. H. Reynolds)
 Subproject: The investigation of obscure diseases in the state with special reference to infectious diseases
 Subproject: The investigation and treatment of diseases affecting University Farm animals
- 106 State Regulatory Work (M. H. Reynolds)
- 107 Tuberculin Tests (M. H. Reynolds)
 Subproject: Relative accuracy of the several tests
 Subproject: Relative desirability of the several combinations of these tests
 Subproject: Different responses to the several tests in relation to extent of lesions, activity, and virulence
 Subproject: Significance of slight and atypical reactions
 Subproject: Tuberculin hypersensitiveness in non-tuberculous cattle
- 109 Bacillary White Diarrhea (Purnell) (Informal co-operation with Division of Poultry Husbandry) (C. P. Fitch, R. Fenstermacher) (New)
 Subproject: The relation of nutrition, care, and other factors incident to bacillary white diarrhea
 Subproject: Means of diagnosis (1) agglutination test, (2) complement fixation test, (3) pullorin
 Subproject: Location of the germ in the body of the individual
 Subproject: Comparison between *Salmonella pullorum*, *Salmonella sanguinaria*, *Salmonella aertrycke*

General

- 101 Rural Living in Minnesota (Purnell) (C. C. Zimmerman, D. C. Dvoracek)
 Subproject: A study of the distribution of cash income of farmers
 Subproject: Farm housing in Minnesota

FINANCIAL STATEMENT

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

1927-1928

Dr.
To receipts from the Treasurer of the United States in accordance with the appropriations for the fiscal year ending June 30, 1928, under the Act of Congress approved March 2, 1887..... \$15,000.00

Cr.
By salaries \$15,000.00
Total Hatch Fund \$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, 1928, under the Act of Congress approved March 16, 1906..... \$15,000.00

Cr.
By salaries \$15,000.00
Total Adams Fund \$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, 1928, under the Act of Congress approved February 24, 1925..... \$40,000.00

Cr.
By salaries \$32,777.08
By travel, supplies, equipment 7,222.92
Total Purnell Fund \$40,000.00

Supplementary Statement

Receipts from sources other than the United States for the year ending June 30, 1928:
State appropriations (General University Support) \$284,019.93
Special state appropriations 34,950.00
Private and corporate sources 19,868.73
Sales and miscellaneous 112,912.42

Total receipts \$521,751.08

Experiment Station Expenditures, 1927-1928

| | University Farm | Crookston | Morris | Grand Rapids | Duluth | Waseca | Zumbra Heights | Albert Lea | Total |
|---------------------------------------|-----------------|-------------|-------------|--------------|-------------|-------------|----------------|------------|--------------|
| Salaries and labor | \$239,434.27 | \$23,279.30 | \$22,103.18 | \$8,140.71 | \$9,198.27 | \$7,717.47 | \$8,845.51 | \$2,438.70 | \$321,157.41 |
| Stationery and office supplies..... | 2,112.19 | 332.16 | 229.45 | 132.81 | 31.69 | 65.22 | 30.54 | ..... | 2,934.06 |
| Scientific supplies | 7,826.88 | 333.98 | 508.59 | 297.65 | 145.44 | 146.16 | 99.34 | 62.11 | 9,420.15 |
| Feeding stuffs | 11,834.09 | 2,760.25 | 2,554.56 | 1,820.18 | 1,690.56 | 1,797.78 | 179.25 | ..... | 22,636.67 |
| Sundry supplies | 6,636.58 | 1,637.29 | 2,190.09 | 1,233.77 | 1,522.23 | 1,223.28 | 1,221.96 | 27.82 | 15,693.02 |
| Fertilizers | 838.26 | 13.82 | 15.85 | 24.18 | 20.19 | 25.26 | 248.25 | ..... | 1,185.81 |
| Communication service | 3,228.49 | 308.36 | 248.35 | 116.91 | 124.26 | 73.80 | 56.47 | 7.50 | 4,164.14 |
| Travel expense | 9,801.46 | 363.03 | 282.32 | 120.23 | 171.90 | 75.18 | 46.80 | 50.67 | 10,881.59 |
| Transportation of things..... | 2,190.38 | 465.80 | 577.59 | 211.19 | 90.69 | 140.71 | 41.07 | 27.27 | 3,744.70 |
| Publications | 16,747.98 | 644.57 | 207.00 | 105.44 | 262.83 | 1.02 | 4.65 | 5.25 | 17,978.74 |
| Heat, light, water, power..... | 11,697.66 | 1,810.89 | 2,502.35 | 1,073.86 | 315.40 | 671.67 | 478.26 | ..... | 18,550.09 |
| Furniture, furnishings, fixtures | 4,364.19 | 118.40 | 42.61 | 530.58 | 3.18 | 7.50 | 33.62 | ..... | 5,100.08 |
| Library | 989.53 | 244.50 | 117.60 | 181.97 | ..... | ..... | ..... | ..... | 1,533.60 |
| Scientific equipment | 6,351.42 | ..... | 2.30 | 16.22 | ..... | ..... | ..... | 148.84 | 6,518.78 |
| Livestock | 3,758.18 | 536.66 | 2,089.85 | 405.00 | 142.58 | 529.26 | ..... | ..... | 8,061.53 |
| Tools, machinery, appliances | 8,933.53 | 215.97 | 604.66 | 943.83 | 203.65 | 140.33 | 781.30 | 234.00 | 12,057.27 |
| Buildings and lands | 54,348.76 | 444.55 | 582.10 | 651.43 | 716.07 | 766.20 | 47.22 | ..... | 57,556.33 |
| Contingent | 1,121.68 | 403.99 | 526.45 | 276.58 | 42.91 | 160.83 | 31.44 | 13.23 | 2,577.11 |
| Total | \$392,215.53 | \$33,913.52 | \$35,384.90 | \$16,282.54 | \$15,281.85 | \$13,541.67 | \$12,115.68 | \$3,015.39 | \$521,751.08 |

EXPERIMENT STATION STAFF

The Board of Regents

| | | | | | | | | |
|---|---|---|---|---|---|---|---|-------------------|
| The Hon. FRED B. SNYDER, Minneapolis | - | - | - | - | - | - | - | 1934 |
| The President of the Board | | | | | | | | |
| LOTUS D. COFFMAN, Minneapolis | - | - | - | - | - | - | - | <i>Ex Officio</i> |
| The Chancellor of the University | | | | | | | | |
| The Hon. THEODORE CHRISTIANSON, St. Paul | - | - | - | - | - | - | - | <i>Ex Officio</i> |
| The Governor of the State | | | | | | | | |
| The Hon. J. M. McCONNELL, St. Paul | - | - | - | - | - | - | - | <i>Ex Officio</i> |
| The Commissioner of Education | | | | | | | | |
| The Hon. W. J. MAYO, Rochester | - | - | - | - | - | - | - | 1931 |
| The Hon. BESS M. WILSON, Redwood Falls | - | - | - | - | - | - | - | 1931 |
| The Hon. GEORGE H. PARTRIDGE, Minneapolis | - | - | - | - | - | - | - | 1932 |
| The Hon. EGIL BOECKMANN, St. Paul | - | - | - | - | - | - | - | 1933 |
| The Hon. JOHN G. WILLIAMS, Duluth | - | - | - | - | - | - | - | 1933 |
| The Hon. SAMUEL LEWISON, Canby | - | - | - | - | - | - | - | 1933 |
| The Hon. A. D. WILSON, Guthrie | - | - | - | - | - | - | - | 1934 |
| The Hon. JULIUS A. COLLIER, Shakopee | - | - | - | - | - | - | - | 1934 |
| The Hon. J. E. G. SUNDBERG, Kennedy | - | - | - | - | - | - | - | 1929 |

The Agricultural Committee

| | |
|--------------------------------------|--------------------------|
| The Hon. J. E. G. SUNDBERG, Chairman | The Hon. BESS M. WILSON |
| The Hon. J. G. WILLIAMS | The Hon. SAMUEL LEWISON |
| The Hon. J. M. McCONNELL | Chancellor L. D. COFFMAN |
| The Hon. A. D. WILSON | |

Administrative Officers

| |
|--|
| W. C. COFFEY, M.S., LL.D., Director |
| ANDREW BOSS, D.Sc., Vice-Director |
| F. W. PECK, M.S., Director of Agricultural Extension and Farmers' Institutes |
| A. A. DOWELL, M.S., Superintendent, Northwest Experiment Station, Crookston |
| P. E. MILLER, M.Agr., Superintendent, West Central Experiment Station, Morris |
| O. I. BERGH, B.S.Agr., Superintendent, North Central Experiment Station, Grand Rapids |
| M. J. THOMPSON, M.S., Superintendent, Northeast Experiment Station, Duluth |
| R. E. HODGSON, B.S. in Agr., Superintendent, Southeast Experiment Station, Waseca |
| F. E. HARALSON, Assistant Superintendent, Fruit Breeding Farm, Zumbra Heights, (P. O. Excelsior) |
| RAPHAEL ZON, F.E., Director, Forest Experiment Station, Cloquet |
| W. P. KIRKWOOD, M.A., Editor and Chief, Division of Publications |
| ALICE McFEELY, Assistant Editor of Bulletins |
| HARRIET W. SEWALL, B.A., Librarian |
| R. A. GORTNER, Ph.D., Chief, Division of Agricultural Biochemistry |
| *J. D. BLACK, Ph.D., Chief, Division of Agricultural Economics |
| WILLIAM BOSS, Chief, Division of Agricultural Engineering |
| W. H. PETERS, M.Agr., Chief, Division of Animal Husbandry |
| FRANCIS JAGER, Chief, Division of Bee Culture |
| C. H. ECKLES, M.S., D.Sc., Chief, Division of Dairy Husbandry |
| R. N. CHAPMAN, Ph.D., Chief, Division of Entomology and Economic Zoology |
| ANDREW BOSS, D.Sc., Chief, Division of Farm Management, Agronomy, and Plant Genetics |
| H. SCHMITZ, Ph.D., Chief, Division of Forestry |
| W. H. ALDERMAN, B.S.A., Chief, Division of Horticulture |
| E. M. FREEMAN, Ph.D., Chief, Division of Plant Pathology and Botany |
| A. C. SMITH, B.S., Chief, Division of Poultry Husbandry |
| F. J. ALWAY, Ph.D., Chief, Division of Soils |
| C. P. FITCH, M.S., D.V.M., Chief, Division of Veterinary Medicine |

* Resigned September, 1927.

Division of Agricultural Biochemistry

ROSS AIKEN GORTNER, Ph.D., Agricultural Biochemist

Section of Proteins and Colloids

ROSS AIKEN GORTNER, Ph.D., Agricultural Biochemist

WALTON B. SINCLAIR, M.S., Assistant Biochemist

W. MARTIN SANDSTROM, M.S., Assistant

RACHEL RUDE, A.B., Assistant

Section of Cereal Technology and Analytical Service

C. H. BAILEY, Ph.D., Associate Agricultural Biochemist

G. S. TAYLOR, B.A., Analyst

ROBERTO OLIVER, B.A., Special Analyst

*J. A. DUNN, M.S., Strietmann Fellow

C. B. GUSTAFSON, B.S., Phosphate Manufacturers' Fellow

†JOHN W. READ, M.S., Strietmann Fellow

RAE H. HARRIS, M.S., Pfizer & Company, Inc., Citrate Fellow

‡C. C. FIFIELD, B.A., Research Assistant

Section of Plant Chemistry

§J. J. WILLAMAN, Ph.D., Plant Chemist

K. W. FRANKE, M.S., Assistant

||S. R. OLSEN, B.S., Cloquet Wood Products Fellow

¶S. I. ARONOVSKY, Ch.E., Cloquet Wood Products Fellow

**STEPHEN S. EASTER, B.S., Waconia Sorghum Mills Fellow

Section of Nutrition and Dairy Chemistry

L. S. PALMER, Ph.D., Dairy Chemist

CORNELIA KENNEDY, Ph.D., Assistant Agricultural Biochemist

W. M. NEAL, M.S., Research Assistant

OLE MYDLAND, Animal Caretaker*

* Resigned May 31, 1928.

† Appointed June 1, 1928.

‡ Appointed August 1, 1927.

§ On sabbatical leave, October 1, 1927 to October 1, 1928.

|| Resigned October 1, 1927.

¶ Appointed October 1, 1927.

** Resigned April 30, 1928.

Division of Agricultural Economics

*J. D. BLACK, Ph.D., Agricultural Economist

H. BRUCE PRICE, Ph.D., Agricultural Economist

WARREN C. WAITE, Ph.D., Associate Economist

ELMER J. WORKING, M.S., Associate Economist

BUDD A. HOLT, M.A., Assistant Economist

MRS. DOROTHEA D. KITTREDGE, Assistant Economist

A. G. BLACK, Ph.D., Research Assistant

ARNOLD F. HINRICH, B.S., Research Assistant

†GEORGE B. CLARKE, B.A., Research Assistant

‡ORVILLE J. HALL, B.S., Research Assistant

§T. G. Stitts, Ph.D., Research Assistant

* Resigned September, 1927.

† Appointed September 16, 1927.

‡ Appointed October 15, 1927.

§ Resigned October 15, 1927.

Division of Agricultural Engineering

WILLIAM BOSS, Agricultural Engineer

Section of Farm Machinery

A. J. SCHWANTES, B.S. in Agr., Assistant Agricultural Engineer

J. B. TORRANCE, B.S. in Agr., Assistant Agricultural Engineer

J. G. DENT, Assistant in Farm Mechanics

Section of Farm Buildings

H. B. WHITE, B.S. in Agr., Assistant Agricultural Engineer

M. G. JACOBSON, Assistant in Farm Structures

Section of Drainage

H. B. ROE, B.S. in Engr., Associate Agricultural Engineer

J. H. NEAL, B.S. in A.E., Assistant Agricultural Engineer

G. F. KROGH, Assistant in Drainage

D. G. MILLER, C.E., Drainage Engineer. U.S. Dept. of Agr., B.P.R.

P. C. MCGREW, B.S. in C.E., Assistant Drainage Engineer, U.S. Dept. of Agr., B.P.R.

P. W. MANSON, B.S. in C.E., Assistant in Drainage

Section of Land Clearing

M. J. THOMPSON, M.S., Associate, Land Clearing

B. H. GUSTAFSON, B.S. in Agr., Assistant Agricultural Engineer

Section of Agricultural Physics

E. A. STEWART, B.Pd., B.S., Associate Agricultural Physicist

A. G. TYLER, Assistant Agricultural Physicist

JULIUS ROMNESS, B.S., Assistant Agricultural Physicist

FLORENCE E. KELLEY, B.S. in H.E., Assistant

Division of Animal Husbandry

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

Section of Horse Husbandry

*H. W. VAUGHAN, M.S., Assistant Animal Husbandman

A. L. HARVEY, M.S., Assistant Animal Husbandman

Section of Beef Cattle Husbandry

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

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

Section of Animal Breeding

* Resigned September 16, 1927.

Division of Bee Culture

FRANCES JAGER, Apiculturist

JAMES M. THOMPSON, B.S., Assistant

Division of Dairy Husbandry

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

Section of Dairy Products

W. B. COMBS, M.S., Dairy Husbandman

L. M. THURSTON, Ph.D., 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, Ph.D., Assistant Dairy Husbandman

Section of Dairy Bacteriology

H. MACY, B.S., Assistant Bacteriologist

HENRY MORRISON, Assistant in Dairy Husbandry

* Resigned June 30, 1928.

† Transferred to Experimental Creamery, May 16, 1928.

‡ Resigned April 1, 1928.

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

R. A. WARDLE, M.S., Associate Entomologist

W. ROBINSON, Ph.D., Assistant Entomologist

C. E. MICKEL, Ph.D., Assistant Entomologist

M. S. JOHNSON, Ph.D., Assistant Zoologist

A. L. STRAND, Ph.D., Assistant Entomologist

H. L. PARTEN, B.S., Assistant in Entomology—Extension Entomologist

F. M. WADLEY, Ph.D., Research Assistant

NORDAHL PETERSON, B.A., Assistant in Parasitology

THEO. A. OLSON, B.S., Assistant

*L. W. ORR, Assistant in Forest Entomology

†G. A. MAIL, B.S., Assistant in Entomology

*L. B. REED, B.S., Assistant in Entomology

*H. E. GRAY, B.A., Assistant in Entomology

‡S. L. LOEWEN, B.S., Assistant

* Appointed September 15, 1927.

† Resigned March 16, 1928.

‡ Appointed January 1, 1928.

Division of Farm Management, Agronomy, and Plant Genetics

ANDREW BOSS, D.Sc., Agriculturist

Section of Farm Management

ANDREW BOSS, D.Sc., Agriculturist

GEORGE A. POND, Ph.D., Associate Agriculturist

L. B. BASSETT, Associate Agriculturist

*L. F. GAREY, M.A., Assistant in Farm Management

A. T. HOVERSTAD, B.S., Assistant in Farm Management

D. CURTIS MUMFORD, B.S., Assistant in Farm Management

G. A. SALLEE, B.S., Assistant in Farm Management

†W. J. ROTH, M.S., Assistant in Farm Management

†H. B. PINGREY, B.S., Assistant in Farm Management

Section of Farm Crops

A. C. ARNY, M.S., Associate Agronomist

H. K. WILSON, Ph.D., Assistant Agronomist

‡F. L. HIGGINS, M.S., Graduate Assistant

§L. J. JOHNSON, Assistant Agronomist

S. M. RALEIGH, B.S., Assistant

Section of Co-operative Seed Production and Distribution

ANDREW BOSS, D.Sc., Agriculturist

R. F. CRIM, B.S., Extension Specialist in Agronomy

A. D. HAEDECKE, Assistant in Agronomy

Section of Plant Genetics

H. K. HAYES, D.Sc., Plant Geneticist

F. J. STEVENSON, M.S., Assistant Plant Geneticist

H. E. BREWBAKER, Ph.D., Assistant Plant Geneticist

H. L. THOMAS, B.S., Research Fellow

* On sabbatical leave October 1, 1927 to June 30, 1928.

† Appointed October 1, 1927.

‡ Resigned January 1, 1928.

§ Appointed January 1, 1928.

Division of Forestry

HENRY SCHMITZ, Ph.D., Forester

E. G. CHEYNEY, A.B., Associate Forester

J. P. WENTLING, M.A., Associate Forester

J. H. ALLISON, M.F., Associate Forester

RAPHAEL ZON, F.E., Director Forest Experiment Station, Cloquet

T. S. HANSEN, M.F., Assistant Forester

*D. A. KRIBS, B.S., Assistant Forester

R. M. BROWN, M.S., Assistant Forester

†LOUIS W. REES, B.S., Assistant Forester

* Resigned September 1, 1927.

† Appointed September 1, 1927.

Division of Home Economics

WYLLE B. MCNEAL, M.A., Home Economist

ALICE BIESTER, A.M., Home Economist

ALICE M. CHILD, M.A., Home Economist

JANE M. LEICHSENRING, Ph.D., Home Economist

ETHEL L. PHELPS, M.S., Home Economist

*LUCY A. STUDLEY, M.A., Home Economist

* On sabbatical leave, 1927-28.

Division of Horticulture

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

Section of Pomology

W. G. BRIERLEY, M.S., Associate Horticulturist

*A. C. HILDRETH, Ph.D., Assistant Horticulturist

Section of Fruit Breeding

J. H. BEAUMONT, Ph.D., Assistant Horticulturist

A. N. WILCOX, M.S., Assistant Horticulturist

Section of Vegetable Gardening

F. A. KRANTZ, Ph.D., Assistant Horticulturist

†H. P. TRAUB, Ph.D., Assistant Horticulturist

‡A. E. HUTCHINS, B.S., Assistant in Horticulture

Section of Floriculture and Landscape Gardening

C. E. CARY, B.S., Assistant Horticulturist

L. SANDO (Florist), Assistant in Horticulture

F. E. HARALSON, Assistant Superintendent, State Fruit Breeding Farm

* Resigned August 19, 1927.

† Resigned May 1, 1928.

‡ Appointed January 15, 1928.

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

*HELEN HART, M.A., Assistant Plant Pathologist

H. E. PARSON, B.S., Assistant in Plant Pathology

*J. M. WALLACE, M.S., Assistant in Plant Pathology

R. M. LINDGREN, B.S., Assistant in Plant Pathology

H. W. JOHNSON, M.S., Assistant in Plant Pathology

§C. S. HOLTON, B.S., Assistant in Plant Pathology

§WM. F. HANNA, M.S., Assistant in Plant Pathology

WM. BROADFOOT, M.S., Fellow, Niagara Sprayer Company

C. G. ANDERSON, B.S., Fellow, Minnesota Cannery Association

||H. H. THORNBERRY, M.S., Fellow, Minnesota Cannery Association

*Detailed by the Office of Cereal Crops and Diseases, U. S. Dept. of Agriculture,
for co-operative work*

O. S. AAMODT, Ph.D., Associate Pathologist

M. N. LEVINE, Ph.D., Associate Pathologist

E. B. LAMBERT, Ph.D., Assistant Pathologist

R. U. COTTER, M.S., Assistant Pathologist

Section of Plant Physiology

¶R. B. HARVEY, Ph.D., Associate Plant Physiologist

L. O. REGEIMBAL, M.S., Assistant in Plant Physiology

E. T. ERICKSON, B.S., Assistant in Plant Physiology

**G. P. STEINBAUER, M.S., Assistant in Plant Physiology

Section of Agricultural Botany

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

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

† On sabbatical leave from August 16, 1927.

‡ On leave from July 1 to September 30; Resigned October 1, 1927.

§ Appointed October 1, 1927.

|| Resigned April 16, 1928.

¶ On sabbatical leave from August 1, 1927.

** Appointed August 1, 1927.

Division of Poultry Husbandry

A. C. SMITH, B.S., Poultry Husbandman

*A. A. HOBERG, B.S., Assistant in Poultry Husbandry

* Resigned April, 1928.

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

*CONSTANTIN NIKIFOROFF, Ph.D., 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

* Appointed November 1, 1927.

† Resigned November 1, 1927.

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

‡R. FENSTERMACHER, D.V.M., Assistant Pathologist

* On sabbatical leave, October 1, 1927 to October 1, 1928.

† Resigned March 15, 1928.

‡ Appointed January, 1928.

General

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