Northeast Experiment Station

M. J. THOMPSON, M.S., Superintendent

Northwest Experiment Station

*A. A. DOWELL, M.S., Superintendent
†M. A. MCCALL, B.S.Agr., Assistant Horticulturist
O. M. KISER, B.S.Agr., Assistant Animal Husbandman
D. H. LAVOI, B.S.Agr., Assistant Animal Husbandman
R. S. DUNHAM, B.S.Agr., Assistant Agronomist
A. M. PILKEY, Assistant in Poultry Husbandry
E. R. CLARK, B.S.Agr., Pure Seed Specialist

* On leave, April 1 to June 30, 1930.
† On leave, September 1, 1928 to August 31, 1929.

Southeast Experiment Station

R. E. HODGSON, M.S., Superintendent

West Central Experiment Station

P. E. MILLER, M.Agr., Superintendent
P. S. JORDAN, B.S.Agr., Assistant Animal Husbandman
A. W. EDSON, B.S., Assistant Poultry Husbandman
*R. O. BRIDGFORD, B.S.Agr., Assistant Agronomist
J. A. ANDERSON, B.S.Agr., Assistant Horticulturist

* On leave September 1, 1929, to August 31, 1930.

UNIVERSITY OF MINNESOTA

AGRICULTURAL EXPERIMENT STATION

THIRTY-EIGHTH ANNUAL REPORT

JULY 1, 1929 TO JUNE 30, 1930

UNIVERSITY FARM, ST. PAUL

THIRTY-EIGHTH ANNUAL REPORT MINNESOTA AGRICULTURAL EXPERIMENT STATION

JULY 1, 1929 TO JUNE 30, 1930

FOREWORD

There appears to be no immediate prospect for relief from the agricultural depression. The economic distress has grown greater rather than less in the year just past. The low prices prevailing for most farm products and the consequently low incomes from farming are reflected in the efforts of farmers to increase their yields, to remove crop risks and to lower their operating expenses. The pressure upon the Experiment Station for information and assistance in meeting these exacting problems is continuously growing greater. The small increase in research funds arising from the maturing provisions of the Purnell Act has made it possible to expedite investigations under way. It has not, however, permitted expansion of the research program. An aggressive, comprehensive research program is highly essential at this time when rapid and radical readjustments are demanded in the interest of a more prosperous agriculture. The justification for state experiment stations lies in the inability of farmers, because of the small size of farm units, varied conditions of soil and climate, and the widespread economic forces involved, to solve their own problems. That the farmers of the state expect assistance from the station is indicated by the heavy flow of letters of inquiry for information on one phase or another of the farming business. It is indicated further by visits to the station of groups of farmers interested in the initiation of some line of investigation bearing on a common problem. Illustrative of such requests is one relating to studies of biennial sweet clover, both as to production and utilization. Another relates to improvement in quality of garden vegetables. Still others relate to studies of an as yet unnamed disease of small pigs that is causing serious losses; to large scale farming; to readjustments in the size of farm and of modern equipment for operating. The principal readjustment now in process relates to change in the size of farm units, the substitution of power machinery for human labor, the rehabilitation of labor so released, the control of commodity production to new forms of commodities produced for market, to a redirection of marketing processes and institutions, and to changes in levels of living. A long list of untouched research projects (something over 100 in number) has been accumulated which must await the com-

pletion of work under way or the provision of additional funds for the employment of a larger staff of workers.

The research work of the past, bearing for the greater part on biological problems, has yielded many discoveries of direct economic benefit to farmers. There is still much research in the biological field that should be vigorously prosecuted because of its relation to profitable farm operation. At the present time, it would seem important to emphasize research in the social sciences. There is reason to believe that reasearch in these lines may lead to just as large benefits to agriculture as have evolved from the biological researches of the past. Economic research is expensive. To gather suitable and adequate data for determining cause and effect in price movements, or for estimating future trends in production and consumption requires not only accurate sampling but comprehensive records and the inclusion of sufficient cyclical movements to give them a reasonable degree of validity. Studies of the movements of economic forces are not only time consuming but expensive. They require trained economists and facilities for travel and record taking. Sustained effort should be centered on gaining data at first hand on the economic phases relating to farms, to elevators, creameries, market places, and other centers where the movements of economic forces are reflected and measured. It is only on such data that the discovery of economic laws will be made and it is only on such laws that a body of knowledge will be developed that permits intelligent action in bringing about needed agricultural readjustments with the least possible friction and loss.

Research work of the Experiment Station during the past forty years has yielded much knowledge of intrinsic value to the agricultural industry. There is good reason to believe that continued research will yield equally well. The performance record of the Experiment Station is such as to warrant and to justify a largely expanded program of research and much greater public support.

CHANGES IN STAFF

Appointments

Agricultural Biochemistry

M. C. Markley, I. D. Jones, and H. P. Morris were appointed assistants.

Agricultural Engineering

L. W. Neubauer and L. H. Schoenleber were appointed assistants.

Agronomy and Plant Genetics

C. W. Doxtator, W. E. Haines, and LeRoy Powers were appointed assistants.

Dairy Husbandry

N. N. Allen, Jr., was appointed assistant dairy husbandman and superintendent of official testing to fill the vacancy caused by the resignation of W. H. Riddell.

G. H. Steele was appointed assistant.

Entomology and Economic Zoology

Filippo Silvestri, director of the agricultural experiment station and professor of general and agricultural zoology at Portici, Italy, was appointed entomologist for the spring quarter, and functioned as a visiting professor.

J. D. Winter was appointed assistant entomologist without salary.

H. G. Ahrens was appointed assistant in bee culture to fill the vacancy caused by the resignation of James Thompson.

H. C. Donohoe, R. C. Hall, C. T. Schmidt, Erdman Braun, and Francis Munger were appointed assistants.

Farm Management and Agricultural Economics

E. C. Johnson was appointed associate economist to partially fill the vacancies caused by the resignations of A. G. Black and H. B. Price.

E. A. Johnson was appointed assistant.

Forestry

W. W. Chase was appointed assistant.

Horticulture

A. G. Tolaas was appointed assistant horticulturist without salary.

Ernest Angelo was appointed assistant.

Plant Pathology and Botany

I. L. Forbes, C. C. Allison, M. B. Moore, C. Christensen, and F. H. Kaufert were appointed assistants.

Veterinary Medicine

C. R. Donham was appointed assistant pathologist to fill the vacancy caused by the death of M. H. Reynolds.

W. L. Nilson was appointed assistant veterinarian to fill the vacancy caused by the resignation of E. A. Hewitt.

Resignations

Agricultural Engineering

Alvin Stinson, assistant, resigned to engage in farming.

G. F. Krogh, assistant in reclamation, resigned to accept a similar position in the United States Department of Agriculture.

Agronomy and Plant Genetics

H. E. Brewbaker, assistant plant geneticist, resigned to accept a position as associate agronomist in the United States Department of Agriculture, Office of Sugar Plants, with headquarters at Fort Collins, Colorado.

F. R. Immer, assistant plant geneticist, resigned to accept a position as associate agronomist in the United States Department of Agriculture, with headquarters at University Farm.

Animal Husbandry

M. A. McCarty, assistant animal husbandman, resigned to accept a position as associate animal husbandman at Pennsylvania State College.

Entomology and Economic Zoology

R. N. Chapman, entomologist, resigned to become director of the experiment station of the Hawaiian Pineapple Canners Association, of the University of Hawaii, Honolulu, Hawaii.

M. S. Johnson, assistant zoologist, resigned to accept a position as assistant professor of zoology at the University of Utah, Salt Lake City, Utah.

Farm Management and Agricultural Economics

A. G. Black, assistant agricultural economist, resigned to become head of the department of agricultural economics at the Iowa State College, Ames, Iowa.

Veterinary Medicine

E. A. Hewitt, assistant veterinarian, resigned to accept a position as associate professor of veterinary medicine at Iowa State College, Ames, Iowa.

North Central Experiment Station

O. I. Bergh, superintendent, resigned to pursue graduate study at the University of Wisconsin, Madison, Wisconsin.

Leaves

Agricultural Engineering

A. J. Schwantes, assistant agricultural engineer, was granted leave for three months to pursue graduate study at the University of Wisconsin.

Farm Management and Agricultural Economics

W. C. Waite, associate economist, was granted additional leave for the year to conduct research work for the United States Department of Agriculture, Bureau of Agricultural Economics, at Washington, D.C.

G. A. Sallee, research assistant, was granted leave for five months to pursue graduate study at Cornell University on a Social Science fellowship.

Home Economics

Wylle B. McNeal, home economist, was granted leave for eleven months for graduate study at Columbia University and for foreign travel.

Plant Pathology and Botany

E. C. Stakman, plant pathologist, was granted leave for one and one-half months to conduct research study for the Firestone Plantations Company in Liberia.

J. J. Christensen, assistant plant pathologist, was granted leave for nine months to accept a Guggenheim fellowship for research and travel in Europe.

Northwest Experiment Station

A. A. Dowell, superintendent, was granted leave for three months to pursue graduate study at the University of Minnesota.

West Central Experiment Station

R. O. Bridgford, assistant agronomist, was granted leave for one year to pursue graduate study.

PUBLICATIONS

A complete list of the publications issued during the year is given below. All publications are available for general distribution on request, except the papers published in the Scientific and Miscellaneous Journal Series. Brief abstracts of these papers are included.

General Bulletin Series

258. A study of breeding records of dairy herds. C. H. Eckles, Division of Dairy Husbandry. 16 pages, 7,000.

259. Common injurious mammals of Minnesota. M. S. Johnson, Division of Entomology and Economic Zoology. 68 pages, 12,000.

260. Double-crossed corn in Minnesota. H. K. Hayes, H. E. Brewbaker, and F. R. Immer, Division of Agronomy and Plant Genetics. 16 pages, 6,000.

261. Sweet clover hay for beef cattle—Fattening baby beeves and two-year-old steers. O. M. Kiser, Northwest Experiment Station, and W. H. Peters, Division of Animal Husbandry. 28 pages, 7,500.

262. Sources of power on Minnesota farms. W. L. Cavert, Division of Agricultural Extension. 72 pages, 5,000.

263. Reed canary grass for meadows and pastures. A. C. Arny, Division of Agronomy and Plant Genetics; R. E. Hodgson, Southeast Experiment Station; G. H. Nesom, Division of Soils. 28 pages, 5,000.

264. Small grain varieties in Minnesota. H. K. Wilson and A. C. Arny, Division of Agronomy and Plant Genetics. 84 pages, 5,000.

265. Alfalfa as a rotation crop. P. E. Miller and R. O. Bridgford, West Central Experiment Station. 20 pages, 5,000.

266. Cost of combine harvesting in Minnesota. G. A. Pond and L. B. Bassett, Division of Farm Management and Agricultural Economics. 32 pages, 5,000.

Technical Bulletin Series

63. A new method for estimating the true fat content of buttermilk. W. E. Petersen and E. O. Herreid, Division of Dairy Husbandry. 16 pages, 3,000.

64. Some of the factors influencing the growth of molds in butter. Harold Macy, Division of Dairy Husbandry. 92 pages, 2,000.

65. Mutation and hybridization in *Ustilago zeae*. E. C. Stakman, J. J. Christensen, C. J. Eide, and Bjorn Peturson, Division of Plant Pathology and Botany. 116 pages, 2,000.

66. Identification of cultivated raspberries. J. D. Winter, Division of Horticulture. 16 pages, 2,000.

67. Studies on the nature of physiologic resistance to *Puccinia graminis tritici*. Walter Ezekiel, Division of Plant Pathology and Botany. 64 pages, 2,000.

Annual Report Series

Thirty-seventh Annual Report of the Agricultural Experiment Station. 60 pages, 2,200.

Agricultural Extension Service

Special Bulletin Series

125. Corn selection and germination tests. H. K. Wilson and R. F. Crim, Division of Agronomy and Plant Genetics. 8 pages, 10,000.

126. Hog cholera. H. C. H. Kernkamp, Division of Veterinary Medicine. 244 pages, 10,000.

127. Winter wheat varieties—importance and culture. R. E. Hodgson, Southeast Experiment Station; and H. K. Hayes, Division of Agronomy and Plant Genetics. 24 pages, 10,000.

128. Flax facts. A. C. Arny, Division of Agronomy and Plant Genetics. 32 pages, 40,000.

129. Utilization of sugar beet tops. C. H. Eckles, Division of Dairy Husbandry. 8 pages, 5,000.

130. Making the home lawn. L. E. Longley, Division of Horticulture. 12 pages, 10,000.

Reprints—

99. Common alfalfa insects. Walter Carter and A. G. Ruggles, Division of Entomology and Economic Zoology. 8 pages, 7,500.

105. Colony brooder houses. A. C. Smith, Division of Poultry Husbandry; Cora E. Cooke, Division of Agricultural Extension; H. B. White, Division of Agricultural Engineering. 4 pages, 10,000.

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

119. Hog health makes wealth. H. G. Zavoral, Division of Agricultural Extension. 12 pages, 10,000.

122. Honey, how to use it. Alice M. Child and Agnes Kolshorn, Division of Home Economics. 8 pages, 7,500.

123. Increasing the dairy income. E. A. Hanson, Division of Agricultural Extension, and O. G. Schaefer, Division of Dairy Husbandry. 12 pages, 10,000.

Circular Series

31. Barley stripe. E. C. Stakman and H. A. Rodenhiser, Division of Plant Pathology and Botany. 4 pages, 7,500.

32. Eradicating perennial weeds with chlorates. A. C. Arny, Division of Agronomy and Plant Genetics; R. O. Bridgford, West Central Experiment Station; R. S. Dunham, Northwest Experiment Station. 4 pages, 17,500.

Reprints—

9. Home orchard spray calendar. A. G. Ruggles, Division of Entomology and Economic Zoology, and R. C. Rose, Division of Agricultural Extension. 4 pages, 5,000.

25. Quack grass control. A. C. Arny, Division of Agronomy and Plant Genetics. 4 pages, 10,000.

28. Eradicating Canada thistle. A. C. Arny, Division of Agronomy and Plant Genetics. 4 pages, 10,000.

Boys' and Girls' Club Work

Reprints—

4. Garment-making project—First year. 10 pages, 10,000.

5. Garment-making project—Second year. 8 pages, 5,000.

11. Sheep club project. W. E. Morris, Division of Agricultural Extension. 8 pages, 5,000.

Pamphlet Series

10. Agricultural outlook in Minnesota for 1930. F. W. Peck. Division of Agricultural Extension. 8 pages, 6,000.

11. Report of 1929 Minnesota lamb production contest. W. E. Morris, Division of Agricultural Extension. 4 pages, 4,000.

13. Minnesota state-wide cow-testing association. H. R. Searles, Division of Agricultural Extension. 8 pages, 7,500.

Folder Series

22. Improved varieties of farm crops for Minnesota. 12 pages, 20,000.

25. The Banker—County Agent—Farmer. 4 pages, 5,000.

26. Vealing of calves in 1930. 4 pages, 12,000.

Miscellaneous

Field crops at Duluth. M. J. Thompson, Northeast Experiment Station. 24 pages, 1,000.

Catalog of Extension projects, 1930-1931. 24 pages, 500.

Extension Service News. Monthly, 1,850.

News Letter. Weekly, 1,200.

Familiar Talk. Quarterly, 300.

Crookston Series

3. Thirty years of weather in the Red River Valley. R. S. Dunham, Northwest Experiment Station. 12 pages, 2,000.

Scientific Journal Series

643. Progress in breeding new varieties of white potatoes. F. A. Krantz. *American Potato Journal* 6, No. 8:227-237. August, 1929.

A discussion of the breeding methods employed and the results obtained in potato breeding work.

818. A new cestode reared in the dog, *Multiceps packi* sp. nov. R. O. Christenson. *The Journal of Parasitology* XVI:44-53. 1929.

During studies on the larval cestodes of native wild rabbits a new species, *Multiceps packi,* was reared in the dog from a cyst occurring in the pericardial cavity of the Varying hare, *Lepus americanus phaenotus* Allen. A description is given of this species with notes and a key to other species of the genus in which the life cycle is known.

826. Inheritance of disease resistance in plants. H. K. Hayes. *American Naturalist* 64:15-36. 1930.

The development of disease-resistant varieties is being used extensively as a major method in the control of plant diseases. As illustrations of importance, there were cited varieties of wheat developed in the spring wheat area that are resistant to black stem rust, and varieties of flax that are resistant to wilt.

Because of physiologic forms of the organisms that cause disease, it is necessary to determine the genetic nature of these organisms. While new physiologic forms can be obtained by hybridization or by mutation, the genetic characters of the organisms that cause plant diseases appear to be as stable as the characters of higher plants.

With reaction to stem rust, instances were given in wheat crosses in which only a single differential factor was responsible for the character pair, resistance vs. susceptibility, while in other crosses multiple factors were involved. With reaction to the organism causing smut in corn and with the "spot blotch" disease in barley, the number and nature of factors involved were determined by studies of linkage relations with factors in known linkage groups. Two factors or groups of factors were determined for smut reaction; three groups of factors were isolated for the spot blotch disease in barley.

The development of disease-resistant varieties is one of the most valuable methods of utilizing genetic principles in the solving of agricultural problems.

827. Joannes Baptista Van Helmont. R. B. Harvey. *Plant Physiology* 4:543-546. 1929.

A biographical sketch with portraits collected from unusual sources.

830. The relation of stomatal behavior of stem rust resistance in wheat. Helen Hart. *Journal of Agricultural Research* 39:929-948. 1929.

A new kind of resistance to stem rust has been demonstrated, a "functional resistance," due to stomatal behavior. The stomata of wheat open gradually after sunrise and remain open for varying lengths of time during the day, but always are closed at night. Stomata of some varieties open very soon after sunrise and usually remain open most of the day. Stomata of other varieties open very slowly and remain open only a short time. Direct sunlight seems to be the most im-

portant simulus for the opening of stomata; temperature and moisture seem to be of secondary importance.

The critical period for stem rust infection is immediately after sunrise and while the plants are heavy with dew. The fungus enters the wheat plant if the stomata are open during most of the critical period, but if they are closed during that time the fungus is excluded. A variety of wheat is resistant to stem rust if its stomata open so slowly or so late that most of the rust inoculum is excluded and rendered ineffective.

There is a correlation between stomatal behavior and the stem-rust resistance of certain wheat varieties in the field at University Farm, St. Paul. Stomata of highly susceptible varieties open soon after sunrise while those of slightly less susceptible varieties open a little more slowly. In varieties that are highly resistant in the field, the stomata open very slowly and close again relatively early in the day.

838. Sulphur dusting for the prevention of stem rust of wheat. E. B. Lambert and E. C. Stakman. *Phytopathology* 19, No. 7:631-643. July, 1929.

Field experiments made at several places in Minnesota in 1925 and 1926 showed that stem rust of wheat can be controlled and yields increased by means of dusting with the proper kind of sulphur dust. The yield in 1926 was increased about 30 per cent at Crookston. Five commercial brands of dust were used in the experiments and Kolo dust proved to be most effective. The first application of dust should be made about the time the wheat is in blossom, and subsequent applications at five-day intervals. Ordinarily, three or more applications seem necessary to insure rust control, altho under certain conditions one or two may suffice. There is evidence that applications of less than 50 pounds per acre will be effective.

841. The effect of grafting on resistance and susceptibility of beans to *Colletotrichum lindemuthianum*. J. G. Leach. *Phytopathology* 19, No. 9:875-877. September, 1929.

Reciprocal grafts were made between two varieties of beans, one resistant and one susceptible to *Colletotrichum lindemuthianum*. When these were inoculated with the fungus, it was found that grafting had in no way modified the resistance or susceptibility of the stock or scion.

These experiments seem to indicate that, if resistance or susceptibility is due to a specific substance in the plant, this substance is not translocated from scion stock, or vice versa, or it is modified by the cells which receive it.

842. The construction of a psychrometer for small spaces. H. E. Gray. *Ecology* X, No. 3:355-358. July, 1929.

A type of small psychrometer is described which gives accurate readings in spaces too small to use a standard sling psychrometer. The device is of value in securing readings inside small cages and for general field work where it is desirable to secure readings at specific points on the plant, etc. Detailed directions are given for its assembly, operation and care.

843. Measuring the toxicity of insect fumigants. A. L. Strand. *Industrial and Engineering Chemistry*. Analytical Edition 2, No. 1:4. January, 1930.

The search for new materials useful as insect fumigants has progressed rapidly during the last few years. Much valuable information has been assembled and from this have come several compounds that are proving of economic importance. Altho the methods for determining the relative toxicities of chemical compounds have served very well for pointing out those of outstanding value, the use of many of the data for establishing the general principles underlying the study of the subject is questionable, because of the differences in these methods and the selection of criteria for the indication of toxicity.

It is shown that the greatest error in these methods arises from the attempt to determine *minimum* lethal concentrations.

A method for measuring relative values by comparing concentrations that kill 50 per cent of the test insects in a period of 5 hours has been investigated. These concentrations may be designated as the "5-hour median lethal concentrations." The method appears to have greater possibilities for accurate work on fumigants than those now in general use.

844. The use of acidulated mercuric chloride in disinfecting potato tubers for the control of Rhizoctonia. J. C. Leach. *Phytopathology* 19, No. 8:713-724. August, 1929.

A solution of mercuric chloride (1-500), acidulated by the addition of one per cent, by volume, of commercial hydrochloric acid, has been tested as a seed-tuber disinfectant in comparison with the standard mercuric-chloride method, the hot-formaldehyde method, and several other methods.

The data show that by using the acidulated solution as a 5-minute cold soak better results are obtained than by the hot-formaldehyde method, and virtually as good results as those secured by the standard mercuric-chloride 2-hour soak.

The simplicity and ease of application of the acidulated mercuric-chloride method give the method many advantages over methods now in use and justify its recommendation for extensive trials under field conditions.

Several of the organic-mercury treatments have been tested and all were found to be ineffective in reducing the amount of infection by *Rhizoctonia solani*.

846. The results of repeated testing by the agglutination method for the detection of bacillary white diarrhea in adult fowls. H. C. H. Kernkamp. *Cornell Veterinarian* 19:357-370. 1929.

The agglutination test was conducted on the blood of a large series of adult fowls at regular monthly intervals. In some cases this continued over a period of ten months. No agglutination occurred at any of the test periods in some birds; complete agglutination occurred at every test period in others, and in still others the results were very inconsistent. Birds that give such inconsistent results should be disposed of or treated as reactors and therefore as unhealthy ones. It has been shown, however, that in some birds that gave consistently positive reactions, no evidence of bacillary white diarrhea could be found. Similarly, some birds that gave a negative test consistently, when examined after death, were found to be affected by this disease. Few cases occurred.

848. The value of physiologic form surveys in the study of epidemiology of black stem rust. E. C. Stakman, M. N. Levine, and J. M. Wallace. *Scientific Agriculture* 10:707-720. 1930.

The results of the surveys thus far made show that the prevalence of physiologic forms of stem rust in certain regions may vary greatly from year to year. So far as these surveys bear on the question of the source of rust in the spring wheat region, the following conclusions are justified: In some years the same physiologic forms seem to predominate throughout the wheat-growing region of the Mississippi basin from Texas to the Canadian border. This was true in 1927 and in some previous years. In 1926, however, the form of wheat stem rust most prevalent in Texas did not make its appearance in the hard spring wheat area. Therefore, it is unlikely that there could have been an important south-to-north migration of rust that year. In 1928, on the other hand, the rust may have been blown northward, and probably was, but fortunately the physiologic forms then prevalent in the South could not infect the hard spring wheats.

849. The agricultural experiment station as a factor in agricultural improvement. Andrew Boss. *Boletin de la Union Pan Americana,* pages 139-158. February, 1929.

A brief description of experiment station organization in the United States with particular reference to the organization of the Minnesota station. A statement of the sources of financial support, estimates of expenditures and data concerning the physical plant are included. This is followed by a discussion of the results accomplished during the life of the experiment station with an estimate of the value of some of the findings in the development of agriculture in the state.

850. Effect of harvesting wheat and oats at different stages of maturity. H. K. Wilson and S. M. Raleigh. *Journal of the American Society of Agronomy* 21, No. 11:1057-1078. 1929.

Marquis wheat and Victory oats grown in replicated field plots were harvested at daily intervals from the time the seed was in the milk stage until maturity. Careful studies were made of the effect of the different methods of drying the plants after harvest and the relationship of black stem-rust to translocation and maturity.

Results indicated no advantage from premature harvesting of rust-infected wheat or oats. Yields increased from the time the grain was in the milk stage until shortly before maturity. Nitrogen percentage of wheat and oats decreased with maturity as carbohydrates increased. Nearly mature to mature wheat was decidely superior in milling and baking value.

851. The synthesis and secretion of milk fat. I. The time of milk and fat secretion. W. E. Petersen, L. S. Palmer, and C. H. Eckles. *American Journal of Physiology* 30:573-581. 1929.

A study of the postmortem milkings of the udders of six cows, slaughtered at the regular milking time, revealed that the milk drawn at a milking is in the udder at the beginning of milking and not largely secreted during the milking process, as has been commonly believed. The postmortem milks were normal except for lower fat content.

852. The synthesis and secretion of milk fat. II. An analytical study of the fat of the bovine mammary gland. W. E. Petersen, L. S. Palmer, and C. H. Eckles. *American Journal of Physiology* 30:582-590. 1929.

The ether extract of cows' udders, in various stages of lactation, was studied chemically and compared with body fat. Fat constituted up to 50 per cent of the dry matter of the lactating gland. Glands from non-lactating cows are much lower in fat content. The fat of the lactating gland is intermediate between butterfat and milk fat while the fat of the non-lactating gland is more nearly like body fat.

853. The synthesis and secretion of milk fat. III. A study of the activity of the perfused surviving gland, with special reference to the fat. W. E. Petersen, L. S. Palmer, and C. H. Eckles. *American Journal of Physiology* 30:592-599. 1929.

Perfusing surviving mammary glands with various solutions is shown to be feasible. Perfusion with a corn oil emulsion did not increase the fat content of the reaction but caused a material fat deposition in the gland cells. The volatile fatty acid content of the gland fat was increased through perfusion.

854. Linkage studies with "slashed" and "glossy$_1$" of the "Bn" linkage group in maize. H. E. Brewbaker. *Journal of Agricultural Research* 40, No. 10:939-950. 1930.

The mode of inheritance and linkage relations of a seedling and plant character designated as "slashed" is reported. The character appears as long thin striae on each leaf of the plant. Such thin areas generally break through the leaf and give it a characteristic slashed or cut appearance. The character was found in Minnesota No. 13 inbred lines and was shown to be inherited as a simple recessive character. Slashed plants are much weaker than normal plants and in some crosses there appeared to be an elimination of the recessive types giving too few slashed for a 3:1 ratio. This was found to occur particularly in crosses where another weak recessive was segregating and in several crosses the double recessive class was lacking in numbers.

"Slashed" was found to be independent of inheritance of characters in seven out of the eight linkage groups in maize known at the time the study was made. It was found linked with the "Bn" group. The independence of the "Bn" group from others was further verified by F_2 linkage studies of gl_1 in relation to factors in six of the other groups.

Linkage studies of "slashed" with "glossy$_1$", ramose and brown aleurone, when considered in relation to published data, indicated the order of the genes to be *ra-gl*$_1$ — *sl-Bn.*

856. The role of molasses in cookie-making. Eva F. Stephens and Alice M. Child. *Food Industries* 2, No. 5:203-206. 1930.

As the result of experimental work, it was found that high-grade molasses produced molasses cookies of better color, flavor, and aroma than medium or low grades. The amount of sodium bicarbonate used definitely affected the quality of cookies produced. The most desirable texture was obtained in cookies with pH values between 7.5 and 8.4, the range given when 3 grams of molasses was used. The flavor of cookies of this range of pH values was also best. The cookies baked at 475° F. (246° C.) for 5 minutes were most desirable. Cookie

doughs kept in a refrigerator at 40° F. (4.4° C.) for 24 hours were more easily handled. The optimum time for standing would depend upon the size of the mix.

858. Physico-chemical studies on proteins. IV. A comparative study of the acid and alkali binding of native and deaminized proteins. W. M. Sandstrom. *Journal of Physical Chemistry* 34, No. 5:1071-1101. May, 1930.

Edestin, arachin, and globulin of the cantaloupe seed were prepared and analyzed for their nitrogen distribution by the method of Van Slyke. Edestin, arachin, casein, fibrin, and durumin were deaminized and the resulting products analyzed by determining their nitrogen distribution. The free amino group of lysine is attached by the nitrous acid with the result that the lysine fraction is lost to the phosphotungstic acid fraction. Probably histidine and cystine are slightly altered by the treatment with nitrous acid. Varying concentrations of acid and alkali were added to the proteins and the potentiometric determinations of the hydrogen-ion concentrations were made on the system at equilibrium. From a preliminary inspection of the curves resulting when the quantity of acid or alkali bound was plotted as a function of equilibrium concentrations, it appeared that our proteins behaved very similarly to the prolamines previously studied in this laboratory. With the exception of edestin, the quantity of acid bound by the proteins is roughly proportional to the lysine content of the proteins. It is postulated that some basic group other than the ϵ-amino group of lysine must be responsible for the acid-binding capacity of edestin. For all five proteins studied, the acid-binding capacity is greatly decreased when the proteins are deaminized. The quantities of sodium hydroxide bound at pH= 10.5 by the native proteins and their deaminized products were compared, and it was found that in four of the five cases more alkali was needed to bring the deaminized protein to that hydroxyl-ion concentration than was required for the untreated protein. From the data beyond the range of pH 2.5 and 10.5 the constants, log *a* and *b*, were calculated from the logarithmic values. The constants for the globulins and the group of deaminized proteins differ among themselves but are very similar to the values obtained in this laboratory for the prolamines, except that the values for *b*, the slope of the line, for the globulins are uniformly lower than those for the prolamines. As in the case of the prolamines, this latter type of binding can not be accounted for on the basis of primary valences, and since the empirically derived Freundlich adsorption isothern can be made to fit the data, we conclude that in these regions we are dealing with typical adsorption phenomena.

859. The isolation of *Salmonella pullorum* from the liver, heart's blood, and yolk of young chickens. H. C. H. Kernkamp. *Poultry Science* 9(1):13-18. 1929.

A series of 400 young chickens is included in this study. Cultures were made from the liver, heart's blood, and unabsorbed yolk in each case. *S. pullorum* was obtained from one or more of the tissues mentioned in every case. In chicks up to three weeks of age, *S. pullorum* was isolated from the liver in 92 per cent, yolk in 73 per cent, and heart's blood in 66 per cent. Chicks ranging from three to eight weeks of age yielded the organism from the liver in 76 per cent of the cases, heart's blood in 50 per cent, and yolk in 39 per cent. The importance

of careful and more complete examinations of older chicks for the presence of *S. pullorum* is emphasized.

860. Further studies of the role of vitamin C in the nutrition of calves. L. M. Thurston, L. S. Palmer, and C. H. Eckles. Journal of Dairy Sciene XII, No. 5:394-404. September, 1929.

This is a second report dealing with the vitamin C requirement of the growing calf. Vitamin C was demonstrated in the liver of calves fed for one year on a ration capable of producing scurvy in guinea pigs within 30 days.

Heifers fed from birth on a scorbutic diet secrete appreciable quantities of vitamin C in their milk. The absence of vitamin C from the diet apparently does not interfere with reproduction in cattle.

862. Toxicity of sodium chlorate ($NaClO_3$) for cattle. C. P. Fitch, W. L. Boyd, and E. A. Hewitt. *Cornell Veterinarian* 19:373-375. 1929.

The results of experiments to determine the toxicity of sodium chlorate for cattle were reported. These indicate clearly the toxicity of sodium chlorate for this group of animals, when administered in the crystal form. Four hundred grams were given to one animal and 180 grams to another. In both instances, severe symptoms were produced. One animal aborted. It could not be definitely proved that sodium chlorate was the cause of the abortion.

863. Sulfur in proteins. IV. The effect of alkalies upon cystine. R. A. Gortner and W. B. Sinclair. *Journal of Biological Chemistry* 83, No. 3:681-696. September, 1929.

Boiling cystine with 1 or 5 per cent Na_2CO_3 solution decomposes about one-half the cystine in 24 hours. In a 6.5 per cent solution of $Ba(OH)_2.8H_2O$ approximately 50 per cent of the cystine is destroyed in 1 hour of boiling, the N being liberated as NH_3 and the S as sulfide S. After 24 hours there still remains approximately 15 per cent of the bound amino N and an equivalent amount of bound S. With 20 per cent NaOH or KOH, 83 per cent of the original N is still present as α-amino N after boiling for 24 hours. These solutions cause rapid and complete removal of the S. Rapid deamination is produced by 6 per cent $Sr(OH)_2$ solution and a 5 per cent suspension of $Ca(OH)_2$. With the latter, the deamination reaches 92 per cent in 12 hours. The rate and extent of deamination does not appear to be a function of the OH-ion concentration of the alkaline solution. "There appears to be an intimate relationship between the deamination mechanism and the rate at which S is removed. It is suggested that deamination of cystine in alkaline solution may be associated with an oxidation-reduction mechanism and that when all, or nearly all, of the S has been removed then the α-amino groups which still remain become relatively stable. Cystine, or some organic compound having essentially the same N:S ration as cystine, still persists in the solution after 24 hours of boiling with 6.5 per cent $Ba(OH)_2$ solution. It is suggested that this 'compound' may be another 'isomeric' form of cystine, differentiated from it by the fact that it is extremely soluble in H_2O, so soluble, in fact, as to be hygroscopic." Attempts were made to isolate pure organic compounds from the decomposition products, but there is a great complexity of compounds produced which contain

"loosely-bound" organic S even after boiling cyctine with $Ba(OH)_2$ solution for 24 hours. *l*-cystine and *i*-cystine are decomposed at the same rate and to the same extent.

864. Observations on excessive abundance of the midge, *Chironomus plumosus,* at Lake Pepin. M. S. Johnson and Francis Munger. *Ecology* 11 (1):110-126. January, 1930.

The midge, *Chironomus plumosus,* occurs along the shores of Lake Pepin in spring and again in summer in such numbers as to be a serious pest. It has become evident there within the last ten or twelve years, largely replacing mayflies, which were formerly abundant. Some of the samples of mud taken from the lake bottom showed larvae of this species in excess of 7,000 per square yard, a figure much greater than has been reported from other lakes. The samples showed a seasonal change in size and number of larvae. Apparently, this midge has two generations a year. Several kinds of fish of the diminished fish population eat extensively of the larvae, but do not prevent the adults from becoming excessively abundant. There is evidence that the lake water is not seriously polluted, but the great abundance of the midge larvae seems to result from the enrichment of the lake bottom by pollution brought by the Mississippi River from the Twin Cities.

865. Relation of the storage temperature to freezing injury in vegetables. R. B. Harvey. *The Minnesota Horticulturist* 57, No. 9:261-268. October, 1929.

Storage at low temperatures prevents injury from freezing in certain vegetables. Hardiness is gained and lost in a few days of storage. The evidence of ice formation can be used to prove injury from freezing.

866. Factors affecting color in sorghum sirup. J. J. Willaman and S. S. Easter. *Industrial and Engineering Chemistry* 21, No. 11:1138-1145. November, 1929.

The Pfund color grader is a highly satisfactory instrument for evaluating the color of sorghum sirup. The colored glass wedge of one of these instruments has been calibrated against a spectrophotometer. A reference table of this calibration is given. The Biley hydrogen electrode is very satisfactory and dependable for measuring the pH of sorghum juice up to a density of about 55° Brix. Five samples of sorghum sirup showed a straight-line relation between log of concentration (in degrees Brix) and color value. A reference table has been constructed for predicting the increase in color of sorghum juice due to concentration alone, and by means of it color formation during the process of evaporation may be detected. The pigments of sorghum juice do not change color from acid to alkaline, but they change in intensity linearly with the pH. When diluted sorghum sirup is heated at various pH's, color and acids are produced. The amount of color is proportional to the temperature, but it is independent of the initial pH. This is largely due to the decrease in pH with its concomitant decrease in color intensity. When glucose solutions are heated in the same manner, there is some increase in color and a decrease in pH. As in sorghum, the color formation is proportional to the temperature and independent of the initial pH. Invert sirup behaves quite differently, owing to the fructose. There is a very great increase in color, and this increase is greater

the greater the pH. Probably most color production in sorghum sirup is due to the fructose present. In factory practices, the most important factors in color production are the degree of inversion of the sucrose and the length of time and the temperature at which the juice is held, assuming that the reaction never becomes alkaline.

867. Culinary quality in potatoes. Alice M. Child and J. J. Willaman. *The American Potato Journal* 6, No. 9:259-266. September, 1929.

Grading charts are presented that have been used successfully in judging boiled and baked potatoes. Inexperienced judges used them without any difficulty. Potatoes that show high quality for boiling will probably show it for baking, if any tendency to sluff be ignored. Higher dry matter tends to be accompanied by better texture and by better flavor, at least within the group studied, which was rather low in dry matter.

868. Influence of shape on the chemical composition of potato tubers. J. J. Willaman and Alice M. Child. *Plant Physiology* 4, No. 3:385-392. July, 1929.

When the shape ratios of Early Ohio potato tubers are compared among themselves, it is found that there is a marked positive correlation between length-width and length-depth, and between length-depth and width-depth, but no relation between length-width and width-depth. Thus, the length is the dominating dimension. It is also the dominating dimension when the shape ratios are compared with the size of tubers, indicating that as the tubers grow in size it is largely because of increased length. The nitrogen content of the tubers is governed more by the depth than by any other dimension. The smaller tubers tend to have a higher nitrogen content than the larger. These conclusions hold whether the comparisons are made within a variety, or among samples of tubers from several varieties. If a variety of potato of high protein content be sought, it is believed that it will more likely be found in one having moderate sized tubers of spheroidal shape.

869. A comparative test of tomatoes. A. E. Hutchins. *Minnesota Horticulturist* 57, No. 7:202-206. July, 1929.

A comparative list of new strains and introductions with standard varieties of tomatoes. Report consists of yields of individual pickings, cumulative yields, and relative market desirability of the different types.

870. Atmospheric electricity during sand storms. R. A. Gortner. *Science* 70, No. 1805:118-119. August, 1929.

It is suggested that the static electricity, which is so evident during sand storms and which causes radio disturbances and unrest in animals and human beings, may be due to the electrical charges at the sand-air interface, and that theories developed in colloid chemistry may afford a solution of atmospheric electricity problems.

871. Protein content of reed canary grass in peat soils. F. J. Alway and G. H. Nesom. *Journal of Agricultural Research* 40:297-320. February, 1930.

Previous determinations of the crude protein content of this grass, about 30 in all, made in Europe and America, are assembled and determinations reported on upward of 150 samples of grass grown on peat soils in Minnesota. On part of these the determination was made on the separated culm, blade, sheaf, and panicle. In the entire grass the protein content ranged from 6.6 to 25.2 per cent. It was highest in the blade, 15.5 to 26.9 per cent, and lowest in the culm, 2.8 to 11.9 per cent. The protein content of the hay was found to be much influenced by the supply of available nitrogen in the soil as well as by the stage of maturity and consequent proportion of culm and sheaf. A higher protein content is favored by early mowing, thin stands, nitrogen fertilization, and conditions favoring rapid nitrification in the soil. In the aftermath the protein was less variable and, in general, much higher than in the first cutting.

872. A note on Lambert's mosaic in the fowl. F. B. Hutt. *Journal of Heredity* XX, No. 7:323-324. July, 1929.

A case recently reported in which a fowl was found to be yellow-skinned on one side of the body and white-skinned on the other is compared with a similar case, previously reported, in which the same color differences between the two sides were accompanied, in addition, by marked differences in size. It is pointed out that such differences are to be expected in cases where mosaics have arisen from nondisjunction of chromosomes and are not to be expected where the abnormality is the result of a factor mutation in a somatic cell. The two cases discussed afford, therefore, a means of distinguishing between animal mosaics arising from nondisjunction of chromosomes and those arising from gene mutations where either phenomenon has occurred at an early stage in ontogeny.

873. Time and temperature factors in hardening plants. R. B. Harvey. *American Journal of Botany* XVII, No. 3:212-217. March, 1930.

The hardiness of cabbages was determined after exposure to various continous hardening treatments and after alternation between high and low temperatures. The threshold value for producing hardiness in Early Jersey Wakefield cabbage was found at about +5° C. Alternate equal exposures, 12 hours at 0° and 12 hours at 10°, and 12 hours at 20°, produce greater hardiness than exposure continuously at the average of these temperature exposures: 5° C. in the first, and 10° in the second case. The effect of short exposure, 1 to 4 hours per day, at 0° C., overbalances the effect of longer exposures, 23 to 20 hours per day, at 10° and 20° C.

It is suggested that hardiness in plants is a cold shock response.

874. Normal variations in the inorganic phosphorus of the blood of dairy cattle. L. S. Palmer, W. S. Cunningham, and C. H. Eckles. *Journal of Dairy Science* 13, No. 3:174-195. May, 1930.

The inorganic blood phosphate in individual cattle may vary markedly from day to day even when the blood is drawn under apparently identical conditions. The inorganic blood phosphate in individual cattle may vary considerably from hour to hour, altho the data available on this point are very limited. Exercise causes marked changes in blood phosphate of cattle. There is first a definite rise, which is followed by a marked fall which persists for several hours. Feeding has a small but significant effect on the inorganic phosphate in cattle blood. The value rises within the first hour and apparently does not return to normal until after about three hours. Normal water drinking by cattle has no significant effect on blood phosphate. So far as the factors studied are concerned, the procedure indicated for securing normal samples of blood from cattle is to have the animal at rest in its stanchion for several hours and draw the blood before feeding, with the least possible physical disturbance of the animal. Water should be allowed *ad libitum*. Parturition causes a decrease in the inorganic blood phosphorus which may amount to as much as 3.2 mgm. per 100 cc. of plasma. The decrease sets in on the day before calving, the lowest point of decrease occurring either before or after parturition. The phosphate content of calf blood at birth is higher than that of the dam, and compares favorably with the value shown by the dam several days before calving. The inorganic phosphorus content of the blood in calves increases until they are about six months old, after which a decrease sets in which continues until the normal range for mature cattle is attained.

876. Heat and ultraviolet irradiation as means of differentiating vitamins B and G in yeast. Cornelia Kennedy and L. S. Palmer. *Journal of Biological Chemistry* 83, No. 3:493-496. September, 1929.

This was a study of a method recently proposed for separating vitamin G from vitamin B by ultraviolet irradiation. It has been definitely shown as a result of this study that irradiation can not be relied upon to destroy the growth-promoting factors of yeast other than the antineuritic factor.

877. The breeding of improved varieties of spring wheat. H. K. Hayes. *Cereal Chemistry* 6, No. 6:483-493. 1929.

Plant diseases are one of the chief causes of the great seasonal variability in the yield of spring wheat. New and improved varieties must be produced if spring wheat continues to be a profitable crop. The most satisfactory general method of controlling disease is the production and introduction of resistant varieties. The problem is difficult because resistance to several diseases is essential and because of the difficulty of combining a considerable number of characters, including desirable milling and baking qualities, in a single variety. The progress already made is an indication, however, that the problem can be solved satisfactorily by this method.

878. Preliminary report on the relation of *Bact. abortus* Bang to fistulae, poll-evil, and other suppurations of horses. C. P. Fitch, A. L. Delez, and W. L. Boyd. *Journal of the American Medical Association* 29 n.s.:17-24. 1930.

Following the work of two French veterinarians, Rinjard and Hilger, who found *Bact. abortus* associated with fistulous withers and poll-evil in horses, an investigation of the relationship of *Bact. abortus* Bang to this condition in horses in this country was undertaken. It was found that *Bact. abortus* Bang was associated in more than 50 per cent of the cases of these relatively common conditions in horses. *Bact. abortus* Bang was also isolated in pure culture from the pus from certain cases of fistulous withers and poll-evil. This is the first time, in this country, that *Bact. abortus* Bang has been isolated from suppurations of horses.

881. Willet Martin Hays. Andrew Boss. *Journal of Heredity* 20, No. 11:497-509. November, 1929.

A biographical sketch of the life and activities of Willet Martin Hays as a pioneer in the field of plant breeding. A brief description, with illustrations, of the methods employed in securing mass production of selected plants and of measures for recording individual plant performances.

883. Studies in embryonic mortality in the fowl. IV. Comparative mortality rates in eggs laid at different periods of the day and their bearing on theories of the origin of monsters. F. B. Hutt. *Poultry Science* IX, No. 3:194-203. 1930.

Data gathered in the examination of 12,728 fertile eggs unhatched after 21 days' incubation, each egg being marked with the hour of laying, showed a mortality rate of 35.89 per cent in the fertile eggs laid after 12 m., compared with one of 32 per cent in those laid before 9 a.m. The difference is statistically significant and results at both University Farm and the Crookston station were consistent. The difference was greatest early in March, when it was nearly 10 per cent at one station. After April 15 the difference was not evident at either station.

Observed abnormalities (microphthalmia, anophthalmia, cerebral hernia, duplicity, etc.) were twice as frequent among the eggs laid after 2 p.m. as in those laid prior to 9 a.m. All of these findings corroborate the theory that teratological abnormalities result from the arrest of growth occurring when embryos are chilled at a critical period of ontogeny, and indicate, as was anticipated, that the proportion of embryos developed beyond the critical stage is greatest in the eggs laid before 9 a.m. and is least in those laid in the afternoon. They also confirm previous observations that the frequency of such abnormalities decreases as the spring laying season advances.

884. Use of dyes for the localization of transpiration over the leaf surface. R. B. Harvey. *Ecology* XI, No. 1:233-235. January, 1930.

Dye accumulation may be used as a means for the localization of differences in transpiration rate over leaf surfaces in normal leaves or to show differences at the margins and tips of leaves. The accumulation of dye is affected by the rate of air movement and by the intensity of illumination, rather sharply outlining the area affected. Places injured by cuts, or by puncture by insects, showed dye accumulation around them. Also, frozen areas showed greater accumulation of dye than elsewhere.

885. Effect of storage and of various bleaching agents on the carotin concentration of flour. C. G. Ferrari and C. H. Bailey. *Cereal Chemistry* 6, No. 5:457-482. September, 1929.

It was found that replacement of atmospheric air in flour with CO_2 did not appreciably reduce the rate of decrease in the carotin concentration of the flour on storage at room temperatures, as, for instance, at 0° C. it markedly reduced the rate of natural bleaching of the carotin. Increasing the dosage of chlorine used in bleaching flour tended to increase in like proportion the extent of removal of the carotin of the flour. About four times as much chlorine by weight was required to effect a given degree of bleaching as of nitrogen trichloride. Approximately 30 hours were required before the bleaching action of benzoyl peroxide was completed. Bleaching with ultra-violet radiation from mercury vapor lamps was relatively slow. With the largest lamp used, 4½ hours of exposure were required to effect a 25 per cent reduction in carotin concentration, and about 7 hours for a 50 per cent reduction.

886. Potato blackleg: The survival of the pathogene in the soil and some factors influencing infection. J. G. Leach. *Phytopathology* 20:215-228. 1930.

Experiments extending over a period of five years disproved the popular belief that the bacteria causing potato blackleg could not survive in the soil. Evidence is presented to show that infected seed tubers are not the sole source of infection but that infection may take place directly from bacteria in the soil when conditions are favorable. Excessive moisture in the soil resulting in the inhibition of wound-cork formation is an important factor influencing infection from the soil. The bacteria were shown to be resistant to very low temperatures and to extreme dessication when dried slowly in soil.

887. The feed requirements and the feed cost of the dairy sire. O. G. Schaefer and C. H. Eckles. *Journal of Dairy Science* XIII:165-173. 1930.

The average expense, other than feed and labor, for maintaining bulls on 118 farms is about $28.37 per year. The average yearly feed cost for maintaining 58 bulls, as found in cost accounting routes in Minnesota, is $69.71. The total cost of maintaining a herd sire is approximately $98, in addition to 37 hours of man labor. The feed intake necessary to maintain bulls in breeding condition, measured in total digestible nutrients, is approximately the same as the maintenance requirements given for cows by Morrison and Haecker.

890. Some recent advances in the chemistry of milk. L. S. Palmer. *Industrial and Engineering Chemistry* 22, No. 1:39-42. January, 1930.

This is a general review of the recent literature on the chemistry of milk, in which it is pointed out that there are still numerous problems which must be solved before many of the problems of the dairy industry and dairy manufacture can be cleared up.

891. Jan Ingen-Housz. R. B. Harvey and Helen M. Whittier Harvey. *Plant Physiology* 5:283-287. 1930.

A biography compiled from various original biographies and translated, with portraits.

894. The effect of fertilizers upon the forms of phosphorus and the amounts of phosphorus, nitrogen, and silica in hays. T. H. Mather. *Scientific Agriculture* 10, No. 1:35-63. September, 1929.

Various methods for the determination of inorganic phosphorus in the presence of organic phosphorus in plant tissues were compared, with a view to obtaining a rapid and accurate method for this type of analysis. A modification of the Fiske and Subbarow colorimetric method for phosphorus was developed,

which proved much more rapid than any of the older volumetric methods, and proved more accurate, owing to the prevention of hydrolysis of organic phosphorus compounds which may occur in the more time-consuming methods. This modified method proved accurate and rapid in the determination of total phosphorus in plant tissues, and, with a few alterations, proved very satisfactory as a method for the determination of total soil phosphorus. Many samples of forage crops were examined to determine the extent to which total phosphorus increased in the plant tissues under various applications of phosphate fertilizer, and to what extent this increase, if any, occurred in the inorganic or the organic fractions. Very large increases in total phosphorus in plants were obtained on the plots receiving heavy fertilizer applications as compared to the check plots receiving no fertilizer. The increases in phosphorus found in the various crops, expressed as percentages, were, respectively: A mixed hay (alsike clover and timothy) cut in October, 69; timothy from the same plots cut in July, 89; alsike, 175; alfalfa samples from upland sandy soils, 34; two sets of rape samples cut at the end of six weeks' growth, 130 and 94; sweet clover, 135; wheat straw, 150; barley straw, 100. An average of the various increases in the above crops gave 100 per cent increases, or a doubling of the phosphorus content, due to the application of fertilizer. A sample of rape allowed to mature gave a 300 per cent increase in total phosphorus. The value was not included in the above list as being above the average increase. Practically the entire increase in total phosphorus of hays was confined to the inorganic phosphorus fraction, fertilization increasing the organic fraction only in so far as it increased the pounds of hay per acre. Very heavy fertilizer applications were necessary to obtain these large increases of inorganic phosphorus in the plant. The fertilizer experiments show, on the other hand, that a maximum yield in pounds of hay per acre can be obtained with a 200-pound application of treble superphosphate, instead of the 1000- to 2000-pound applications necessary to give the extremely high phosphorus content obtained in these crops. It would seem, therefore, that phosphate fertilizer could be profitably applied only in so far as it increases the pounds of hay per acre, and that phosphate required in a ration in excess of the quantity supplied in such a hay could be added directly to the feed. Where it was deemed necessary to supplement a ration with organic phosphorus, this could be done by feeding cereal grains rather than by attempting to increase the organic phosphorus content of forage crops by means of large applications of phosphate fertilizer. These grains contain high percentages of phosphorus, for the most part in organic combination, and they do not show the extreme fluctuations in percentage of phosphorus which seem characteristic of forage plants. The content of silica in the ash of the various hays appears to decrease with the application of fertilizer. The variation, in the case of alfalfa, between the check plots and those receiving fertilizer was 100 per cent. The legumes from the check plots, in general, did not exceed 1.0 per cent of silicia, with decidedly less on the fertilized plots. Timothy contained 2.0 to 3.0 per cent of silica under all treatments, showing the largest percentages, however, on the check plots, while the native wild hays contained as high as 5.0 to 8.0 per cent.

895. The relative transpiration rate at infection spots on leaves. R. B. Harvey. *Phytopathology* XX, No. 4:359-362. April, 1930.

The accumulation of such nontoxic dyes as Light Green S.F. can be used in demonstrating the effect of certain local infections by fungi on transpiration from the leaf. Insect punctures were found to cause local accumulations of dyes and also of ash constituents in the immediately adjacent tissue.

896. Length of the period of exposure to low temperature as a factor in the hardening process in tree seedlings. R. B. Harvey, *American Journal of Forestry* 28:50-53. 1930.

Tree seedlings begin to harden when the temperature falls to 5° C. (41° F.) for one or two hours per day. Alternation of low and high temperature is more effective in producing hardiness than a continuous low temperature.

898. A probable explanation of recent epidemics of bunt in durum wheats. C. S. Holton. *Phytopathology* 20:353-357. 1930.

Experimental results and general observations, prior to 1925, indicated that the durum wheats, as a class, appeared to be far more resistant to bunt in the United States than the common wheats. Beginning about 1925, complaints were made that durum wheats were smutting quite generally. In subsequent years bunt seems to have caused greater damage in durums than in common wheats. The suggestion was made that a new physiologic form of bunt had arisen which was especially virulent on durum wheats.

The virulence of five collections of *Tilletia tritici* was compared on eight varieties of common and durum wheats and emmer. The collections from Washington, California, and Manitoba were quite virulent on some of the varieties of common wheats but failed to attack severely the durum varieties and emmer. The collection from Devils Lake, North Dakota, was especially virulent on Mindum and Pentad (durums), while the emmer was quite susceptible to the collection from Litchfield, Minnesota. It seems quite probable that outbreaks of bunt in durum wheats in recent years are explained by the presence of a physiologic form of bunt hitherto unknown in durum-growing regions.

899. The march of acidity in stored flours. C. C. Fifield and C. H. Bailey. *Cereal Chemistry* 6, No. 6:530-540. November, 1929.

Spring wheat second clear flour that contained about 0.1± per cent of acidity (Greek method) when freshly milled increased in acidity at a rapid rate under good storage conditions. After 40 days or less, at temperatures varying from 25° to 35° C., the acidity exceeded the limit of 0.15 per cent imposed by the Greek government. The rate of increase in acidity tended to rise with the temperature between these limits, and was greater during the early period of storage than after the first three months. Durum wheat first clear flour had a lower initial acidity than the spring wheat second clear, ranging from 0.05 to 0.06 per cent. It increased in acidity at a slower rate than the latter, reaching the limit, 0.15 per cent, in less than 150 days when stored at 25° C. and in proportionately shorter time at higher temperatures. Patent flour stored for more than five months still contained appreciably less than 0.15 per cent of acidity. Baking tests of the patent, first clear, and second clear flours after five to seven months of storage failed to reveal any evidence of unsoundness in the flour. This was true even after the clear flours contained more than the Greek limit of 0.15 per cent of acidity. The ratio of percentage of acidity, Greek method, to percentage of acidity, A.O.A.C. method, was not constant through the range studied, but tended to become narrower as the percentage of acidity increased.

900. The cooking process. I. Role of water in the cooking of wood. S. I. Aronovsky and R. A. Gortner. *Industrial and Engineering Chemistry* 22, No. 3:264-274. March, 1930.

The cooking of wood, as practiced in the industry for the production of cellulose, involves the use of cooking liquors containing various chemicals in various concentrations. The exact effect of the individual constituents upon the cooking process is largely unknown. This paper reports the first of a projected series of studies designed to ascertain the role of each constituent of the cooking liquor. Since water comprises the main bulk of the liquor, cooking with water only was selected for the first study. It is shown that cooking with water at different temperatures for varying lengths of time has a profound effect upon the various constituents of the wood. Pentoses and pentosans are rapidly destroyed, resulting in the production of appreciable quantities of furfural; lignin, altho apparently the most stable constituent, undergoes partial depolymerization; and the celluloses are broken down to water-soluble constituents and to gaseous products. Approximately 37 per cent of the total celluloses and 46 per cent of the alpha-cellulose were destroyed in the 12-hour (186° C.) cooks. At the longer times and higher temperatures the rate of destruction of the alpha-cellulose was faster than was that of the total celluloses, indicating a conversion of alpha-cellulose to hydrocelluloses. Water can, therefore, be looked upon as a very active reagent in the cooking process.

901. Plant characters as indices in relation to the ability of corn strains to withstand lodging. H. K. Wilson. *Journal of the American Society of Agronomy* 22, No. 5:453-458. 1930.

Certain self-fertilized lines of Minnesota No. 13, Rustler, and Northwestern Dent corn varieties of observed lodging behavior were studied in an effort to learn certain morphological differences that might be used as indices of ability to withstand lodging.

Preliminary investigations in the greenhouse and field indicate that the distance between the lower internodes of the corn plant and accompanying development of brace roots may be useful in predicting the probable resistance of selfed lines to lodging under field conditions. It is suggested that growing plants in the greenhouse with insufficient light, as under winter conditions, may produce lodging in a manner similar to field performance.

902. Quantitative changes in the microflora of butter during storage. H. Macy. *Journal of Dairy Science* 13:266-272. 1930.

In connection with studies of the keeping quality of butter, mold, yeast, and bacterial counts of 483 samples of commercial salted butter and 123 samples of unsalted butter, before and after storage, were obtained. These data show that there is a general tendency for the counts to decrease during the storage of salted butter but an equally significant tendency for them to increase in unsalted butter. The rate of increase of counts in the latter butter is much greater, proportionately, than the rate of decrease in salted butter. The salt content of butter has a decided effect upon quantitative changes in the microflora of butter during storage, but this is not in proportion to the amount of salt present. Certain types of micro-organisms are affected by salt concentration more than others. It is clear that certain molds, yeasts, and bacteria can grow in butter, especially in that which is unsalted, and consequently may be expected to take an important part in the deterioration of butter.

903. Solonetz and Solonchak soils of the Red River Valley. C. C. Nikiforoff. *Reports of American Soil Survey Association.* Bulletin 11:141-150. March, 1930.

The origin and characteristics of the Solonetz and Solonchak soils in general are described and the soil types included in these groups that have so far been been mapped in the Minnesota portion of the Red River Valley are described in detail.

904. The genetics of the fowl. I. The inheritance of frizzled plumage. F. B. Hutt. *Journal of Genetics* 22, No. 1:109-127. April, 1930.

The paper reports a two-year investigation to determine the mode of inheritance of frizzling in the domestic fowl and to substantiate or disprove the current theory that homozygosity for frizzling is lethal. In frizzled fowls the contour feathers, instead of conforming to the shape of the body, have their shafts so recurved that the outer surface of each feather becomes concave and the plumage appears to have been rubbed the wrong way.

Incubation records failed to show any evidence of a zygotic lethal factor being operative during embryonic development and suitable crosses showed that no gametic lethal factors are involved. In F_2 and in back-crosses frizzling behaved as a dominant character, but two types of it, one more extreme than the other, were found. Birds of the extreme type were proved to be homozygous for frizzling, while all those of the ordinary type were found to be heterozygous. Both genotypes are quite viable. Reciprocal crosses showed that no sex-linked factors were involved. It is concluded that frizzling is a dominant character dependent for its expression upon a single autosomal pair of genes. The reputed inability of frizzled fowls to breed true arises from a preference by the fancier for the phenotype of the homozygous fowl, resulting in the exclusion from the breeding pen of all those that are homozygous for frizzling. The case is parallel with that of the Blue Andalusian, since in both breeds the show-room standard calls for a hybrid which can not breed true.

905. Effect of superphosphates upon the germination of corn. C. O. Rost. *Journal of the American Society of Agronomy* 22:498-507. June, 1930.

The effect of different amounts of 16 per cent and 46 per cent superphosphate upon the germination of corn is reported. The fertilizers were applied with a fertilizer attachment to the planter, as well as by hand. When used at rates ordinarily employed in farm practice, the fertilizers were not harmful, but when used at 10 to 20 times these amounts germination was seriously retarded. Very large amounts of 46 per cent superphosphate were more toxic than equivalent amounts of 16 per cent superphosphate. Greenhouse trials gave results similar to those secured in the field.

907. The use of dyes in coloring flowers and ornamentals. R. B. Harvey. *Proceedings of the American Society for Horticultural Science* 26:143-144. 1929.

The function of floral parts, glumes, etc., as structures for securing transpiration can be nicely demonstrated by the dye accumulation method.

Of several hundred dyes tested, those which give most rapid penetration and least toxicity are as follows: Light Green S.F., bluish green; Brilliant Blue, deep clear blue; Ponceau 3 R, deep purplish red; Tartrazine, brilliant lemon yellow; Amaranth, purplish red; Acid Fuchsin, purplish red; Orange G, light yellow.

This list covers a range of spectral colors so that almost any color can be obtained by mixing two dyes in different proportions. Thus, Tartrazine and Light Green S.F. in equal concentrations give a very attractive green for St. Patrick's Day decorations.

908. Effect of ethylene on the growth of celery. R. B. Harvey. *Proceedings of the American Society for Horticultural Science* 26:141-142. 1929.

The blanching reactions of celery varieties can be determined in seedling stages. Ethylene checks the growth of celery and causes changes in the shape of the bunch.

910. Cambial activity in the red raspberry cane in the second season. W. G. Brierley. *Proceedings of the American Society for Horticultural Science* 26:278-280. 1929.

Cambial activity, as evidenced by the formation of new xylem, probably occurs in nearly all growing raspberry canes in the second season, but activity is feeble and the new xylem very limited in extent. As in other woody stems, cambial activity is associated with the development of buds, begins at the point of bud insertion, and progresses downward. The stimulus from the growing bud seems to bring about the production of a fairly extensive amount of new xylem just beneath the point of insertion, but this new xylem rapidly diminishes in area a short distance below. In about nine out of ten old canes, no new xylem is produced at the base of the cane, and there is evidence that no new phloem is formed in this region. This performance is believed to account in part for the death of the old cane, or is evidence of very feeble meristematic activity in the second season.

911. Pruning studies with Beta grapes. W. H. Alderman and W. G. Brierley. *Proceedings of the American Society for Horticultural Science* 26:272-273. 1929.

Cultivated varieties of *Vitis vulpina* have not heretofore been studied as regard to their pruning requirements. In ordinary pruning practice, using the single trunk four-cane Kniffen system, the amount of bearing wood retained ranges from 13 to 14 feet. This amount was increased 57 per cent and 105 per cent per vine by using six and eight lateral canes per vine. These increases in bearing wood produced increases in yield of 37 per cent and 49 per cent, respectively. This increase was due to increased numbers of clusters. The size of the cluster diminished slightly, but not seriously, as the amount of crop increased. The data suggest that more bearing wood should be retained in the small-fruited varieties of *Vitis vulpina* than is desirable in the larger-fruited table grapes of the type of Concord.

912. The relation of hardiness and maturity in the apple. B. H. Wilson. *Proceedings of the American Society for Horticultural Science* 26:199-202. 1929.

Dropping of leaves is assumed to indicate a state of maturity in the apple tree. In the fall of 1927, weather conditions were favorable for late growth and correlations between late maturity (as indicated by persistent foliage) and subsequent winter-injury were 0.52 ± 0.051 on level ground and 0.59 ± 0.056 on a slope. In the following year, conditions were favorable for early maturity of all varieties of apple and under such conditions correlations between winter-injury and leaf-fall were only 0.19 ± 0.067 on the level and 0.15 ± 0.083 on the slope. Hence, data for leaf-fall, as indicative of probable hardiness, are of value only in seasons favorable to late growth in the fall.

913. Relative productivity of certain types of potato seedling population. F. A. Krantz and R. M. Bailey. *Proceedings of the 16th Annual Meeting of the Potato Association of America*, pp. 56-63. December, 1929.

A study was made of time of maturity and productivity of Triumph and Cobbler seedlings in relation to their parents. These families were further studied in comparison with other selfed and cross-bred populations in relation to their productivity.

915. The commercial use of double-crossed corn in Minnesota. H. K. Hayes. *Journal of the American Society of Agronomy* 22:606-613. 1930.

Experimental results indicate that single crosses of Golden Bantam selfed lines have commercial possibilities, as the selfed lines appear to yield sufficently well that the use of F_1 seed appears feasible as a commercial practice.

Yields in bushels per acre and other data of three double-crosses, E x I, E x K, and E x L, and of standard varieties are given. The double-crosses have yielded more than 10 per cent more shelled corn per acre than normal varieties and they mature about five days earlier. A plan for the distribution of these double-crosses is given.

916. Relation of maturity in the apple to relative winter injury. B. H. Wilson. *Scientific Agriculture* X, No. 9:598-606. May, 1930.

Data are presented to show relationship between early maturity of apple trees, as indicated by time of leaf-fall, and susceptibility of these varieties to winter injury. A significant correlation between early leaf-fall and winter-hardiness was found in the fall and winter of 1927-28, when weather conditions favoring late growth were followed abruptly by severe freezing temperatures. The following season, with conditions favorable for early maturity of all varieties and with severe freezing weather delayed a month over the preceding year, there was no correlation between early-leaf-fall and hardiness.

Rapidity, or extent, of twig elongation during the summer bore no relation to subsequent winter-injury.

Leaf-fall records are of value as a measure of probable hardiness only in seasons that tend to produce an abnormally late growth and the difference in time of maturity between varieties becomes exaggerated.

917. Duration of elimination of *Bact. abortus* Bang in the vaginal and uterine discharges of infected cattle. C. P. Fitch, W. L. Boyd, and A. L. Delez. *Journal of the American Veterinary Medical Association* 76, 29 n.s., No. 5:680-685. May, 1930.

Two hundred and eighty-four specimens of discharge from vagina and uterus of cattle were examined for the presence of *Bact. abortus* Bang. Twenty-four series of examinations were from animals known to be infected with the Bang organism. Two series were from animals suspected of being infected, and 9 were from animals which failed to react to the agglutination test for the presence of Bang's disease. The longest period following abortion, or parturition, that *Bact. abortus* was found in the discharges and secretions of the vagina and uterus was 25 days; the shortest, 5 days; and the average, 12 days. The results of this work show that *Bact. abortus* is eliminated rather rapidly following the act of parturition.

918. Research relating to co-operative marketing. O. B. Jesness. *Journal of Farm Economics* XII, No. 2:233-245. April, 1930.

The problems in the field and the methods of attack on them may be classified as follows: (1) Statistical surveys, (2) historical studies, (3) organization plans and operating problems, (4) membership, (5) price and sales policies, (6) measuring economic results, (7) legal aspects. Earlier studies were largely in the nature of statistical surveys. These are helpful as a starting point for more detailed studies of specific problems. Much attention has been paid to organization forms and operating problems. There is need for further work on membership problems and on sales and price policies. Legal aspects have been the subject of considerable research, but some problems still remain.

As in other fields of agricultural research, a large share of the activity must continue to fall to the lot of public institutions and agencies. Co-operatives themselves, however, can and should do more in conducting research work of their own on their problems. Close working relations among the research students in this field are highly desirable.

919. *Thlaspi arvense* (French weed) in relation to dairy products. C. H. Eckles, W. B. Combs, and Paul Derby. *Journal of Dairy Science* XIII:308-313. 1930.

Serious defects in the quality of butter were traced to the presence of the seed of this plant in rations fed dairy cows. Experiments show an injection of 90 to 150 grains of the seed, or 500 grains of the green plant, results in a taint in the milk. The effect of intervals between feeding and milking was determined. Methods in use for eliminating other taints are ineffective. A method is given for detecting the presence of the seed in feed mixtures.

920. Quantity and nutrient contents of pine leaf litter. F. J. Alway and Raphael Zon. *Journal of Forestry* 28:715-727. May, 1930.

Earlier investigations on the subject, all European, are reviewed and determinations reported on the amount and composition of the annual fall of leaf litter on 5 plots in unthinned stands of Jack and Norway pine forests on sandy land of low productivity. The average fall in 12 months amounted to 1,738 pounds of moisture-free material and carried 11.2 pounds of nitrogen, 17.2 pounds of CaO, 2.6 pounds of K_2O, 2.2 pounds of P_2O_5, and 3.4 pounds of SO_3.

923. A statistical study of collaborative protein determinations. Alan E. Treloar. *Cereal Chemistry* 6, No. 5:429-453. September, 1929.

This study of collaborative protein testing in different laboratories of high repute, in which great care has been exercised to secure strict adherence to a standard method officially recommended by the American Association of Cereal Chemists, has been made primarily to obtain a better insight into the causes of variation in this determination, to subject to critical quantitative measurement the extent of the variation, and also to determine any association between comparable series of determinations made in the same laboratory.

Reasonable concordance appears in the amount of variation found within the laboratories collaborating in this study, with the submitted samples of flour. The amount of this variation changes with the flour sample, and does not appear to be associated with the quantities of protein present. It may be conditioned by the nature of the nuclei of the amino acids involved in the structure of the complex protein molecules. Variation among the group of laboratories is approximately twice as great as that found within them individually, being due to the systematic personal or laboratory equation of analysis. Definite standards of variation to be expected in protein analyses within and among laboratories characterized by the precision of those collaborating have been submitted. Analysts reporting the average of even three determinations in a protein test can be only reasonably sure that a repetition within their own laboratory would check within 0.2 per cent, while for a single determination a replicate may fall more than 0.3 per cent away. Checking against another laboratory of high repute using the same method, discrepancies of 0.35 per cent for the average of three determinations, or as high as 0.6 per cent for a single analysis, may be expected to arise. That analysts systematically deviate in a definite direction so that highly significant, and frequently very important, differences arise between them in reporting the average value of replicate determinations has again become apparent. Furthermore, this study has indicated that analysts may show progressive variations in technic in making a series of determinations, these variations becoming apparent in the results of the analyses. Thus, significant correlations appear between comparable series of determinations made in the same laboratory, and also between consecutive determinations of the same series.

926. Water imbibition of frosted wheat. C. H. Bailey and E. G. Bayfield. *Cereal Chemistry* 7, No. 2:108-116. March, 1930.

Water-imbibing capacity of entire wheat kernels was found to be related to their previous history. Those grains which were frozen when their moisture content was greater than 40 per cent would imbibe more water than the normal or mature kernels. There was a high correlation between the amino nitrogen content of such wheat and the percentage of imbibed water. A survey of the data further indicates that the level of water content, on wetting the wheat, tended to return to that of the grain at the time it was frozen, when the latter was in excess of 40 per cent. Thus, the water-imbibing capacity of wheat appears to afford an approximate measure of damage effected by premature freezing.

932. Inheritance of immunity from flax rust. A. W. Henry. *Phytopathology* 20:707-721. 1930.

Results are presented of studies on the inheritance of immunity from flax rust caused by *Melampsora lini* var. *liniperda* (Pers.) Lev. made during the years 1923 to 1926. A brief report is given also of progress during this period in breeding improved rust-immune varieties of seed and fiber flax.

Three varieties immune from flax-rust, Argentine selection, Ottawa 770 B, and Bombay, were used as parents in these studies. All three varieties have remained immune in all tests. These immune varieties were crossed with susceptible varieties of fiber and seed flax. The principal susceptible parents used were Saginaw and Winona.

Immunity from rust proved completely dominant in all crosses. In the cross Argentine selection x Saginaw, evidence was obtained that indicates that immunity from rust depends on two duplicate factors for the expression. However, in the crosses in which Ottawa 770 B and Bombay were used as immune parents, the results of inoculation indicate but a single factor difference between immunity and suceptibility.

Numerous selections were made of F_3 and F_4 families of the various crosses. In these selections, immunity to rust was combined with various characters not possessed by the immune parents. Altho the writer did not have the opportunity to test the relative wilt-resistance of the selections, he indicates that selections combining immunity from rust and wilt-resistance should be obtained.

934. Is it desirable for agronomy to train its own research workers? W. C. Coffey. *Journal of the American Society of Agronomy* 22, No. 4:349-351. April, 1930.

Our chief concern about the research worker in agronomy should not be whether or not agronomy should train him, but rather how should he be trained. Every department of agronomy should know what are the fundamentals necessary to the training of its workers, and in case it does, agronomy might have much to say in directing their training, but not necessarily sole voice. If the worker is adequately trained, he will need to know something about a number of lines of science, but he must be able to work in the terms of some one science which he will chiefly employ in his research. While his training should be intensive in one certain direction, it nevertheless should be basic and fairly broad. Therefore, it is not likely that many departments of agronomy will be organized on a basis that will permit of the entire training of its workers. This task is so comprehensive that it is likely to demand the services not only of agronomy but also a goodly number of the natural science departments of a college or university and, in addition, some of the departments within the social science group.

935. Some comparisons between commercially and experimentally milled flours. T. A. Pascoe, R. A. Gortner, and R. C. Sherwood. *Cereal Chemistry* 7, No. 3:195-221. May, 1930.

A comparative study of the properties of a series of "commercial" and "experimental" flours milled from the same wheats has been made. There was also included in this study a comparative study of the properties of the flours from the seventeen mill streams of the Minnesota State Experimental Flour Mill. The data presented seem to warrant the following conclusions: The saccharogenic activity of flour milled with the experimental mill does not truly represent the potential activity of commercially milled flour from the same wheat. The flours milled in a commercial mill have from one to four times the saccharogenic activity of flours milled from the same sample of wheat in a small experimental mill. The degree of granulation of flours is an important factor in the consideration of the saccharogenic properties, as is shown by the fact that grinding a sample of flour milled in the commercial mill in a ball mill for 20 hours increased the saccharogenic activity approximately 35 per cent. The basic procedure of the American Association of Cereal Chemists experimental baking test, without extended fermentation periods, does not permit detection of flours low in saccharogenic activity (when saccharogenic activity is measured on a flour-water suspension by the Rumsey method) from loaf volume values, as evidenced by the fact that the "commercial" flours and the "experimental" flours, while differing materially in saccharogenic activity, did not differ appreciably in loaf volume. In the peptizing action of potassium halide salts on flour proteins, a definite lyotropic effect can be demonstrated. This series is KF > KCl > KBr. The coefficients of variability were calculated for these halide salts, and the KBr series, altho showing the highest peptization, showed the lowest variability. The series of "experimental" and "commercial" (patent and straight-grade) flours gave a coefficient of correlation of $r = +0.797 \pm 0.041$ between protein content and loaf volume. A similar correlation on the mill-stream series of flours, all milled from one sample of wheat, was $r = -0.018 \pm 0.163$. The serious objection recently raised against the present definition of a "globulin" is entirely justified. The coefficients of correlation between loaf volume and the fraction peptized from the mill-stream flours by the sales were -0.187 ± 0.158 for the KBr series, -0.235 ± 0.072 for the KCl series, -0.317 ± 0.417 for the KF series, and $=0.241 \pm 0.154$ for the $MgSO_4$ series. The correlation coefficients between total protein content and the percentage of protein peptized from the mill-stream flours by the various salts varied from $+0.839$ to $+0.877$ and the correlation between a variable and the deviation of a dependent variable from its probable value were found to be $+0.369$ for KBr, $+0.555$ for KCl, $+0.606$ for KF, and $+0.548$ for $MgSO_4$ solutions (0.5 N). The last data indicate that while the fraction of the protein peptized by a salt varies with the percentage of protein present, nevertheless there is less influnce of the original protein content in the KBr series than in the case of the other salts.

937. The effect of acid potassium tartrate as an ingredient in angel cake. Alice M. Child and Emily Grewe. *Cereal Chemistry* 7, No. 3:245-250.

This article gives the results of a study of color and grain of angel cake and the effect of H-ion concentration upon them. The results showed that angel cake made with acid potassium tartrate as a part of the ingredients is a fine-grained white product, while without it the cake is yellow and coarse-grained. Effect of acid potassium tartrate on color in terms of hue is very slight, whereas there is a marked change in terms of brilliance and chroma. Sodium potassium tartrate gives the same effects as potassium tartrate, therefore the tartrate radical may not be a factor in the effects produced. Citric, malic, and tartaric acids used in place of acid potassium tartrate have the same effects on color and grain of cake.

Egg whites that vary in H-ion concentration produce cakes that differ in color, the higher the H-ion concentration the lighter the color of the cake.

It is concluded that the change in color and grain of angel cake resulting from the use of acid potassium tartrate is due largely to acidity.

940. Strength and resistance to sulfate waters of concrete cured in water vapor at temperatures between 100° and 350° F. D. G. Miller. *Proceedings of the American Society for Testing Materials* 30, Part II, pp. 636-653. 1930.

Solely from the standpoint of strength, nothing is gained by curing concrete in water vapor at a temperature much above 155° F., and little is gained, even at this temperature, by prolonging the curing period beyond 48 hours.

Solely from the standpoint of resistance to sulfate water, nothing is gained by increasing the temperature of the water vapor in which concrete is cured until 212° F. is reached. Between 212° and 260° F., increased resistance follows increase of curing temperature. Data are incomplete for curing temperatures above 260° F. For a temperature of 212° F., concreate increases in resistance with increase of curing period up to 6 days. No data are available for longer curing periods and for other temperatures.

942. The transmission of pullorum disease among sexually mature fowls. H. C. H. Kernkamp. *Journal of the American Veterinary Medical Association* LXXVII, n.s. 30:280-294. 1930.

This article reports the results of extensive experiments to determine whether bacillary white diarrhea can be transmitted between sexually mature fowls. The results indicate that the disease does spread, or is transmitted, or disseminated among infected and non-infected adult fowls that are kept together in the same enclosures. It was highly important, in conducting these experiments, that the pre-contact history of the birds used in such experiments be definitely determined. Two experiments were carried out. The results obtained show that approximately 24 per cent of the non-reacting and presumably non-infected birds became infected and developed the disease subsequent to association with infected fowls. This figure represents only those birds from which *Salmonella pullorum* was isolated. On the other hand, if all birds showing positive agglutination be included, the percentage would be 46.3.

947. The association of *Bacterium abortus* Bang with hygroma of the knee of cattle. W. L. Boyd, A. L. Delez, and C. P. Fitch. *The Cornell Veterinarian* XX:263-269. 1930.

Affections of the joints are quite common in human cases of undulant fever. For some time it has been suspected that *Bact. abortus* Bang was concerned with the production of joint lesions in cattle. Blood of cattle having enlargement of the joints has many times shown agglutinins for the Bang germ. This gives the results of studies of hygroma of the carpal joint and reports the isolation of *Bact. abortus* Bang from the contents of two carpal hygromata in different animals. The organism was secured by direct culture and by inoculation into guinea pigs.

The data so far accumulated indicate that the Bang germ is an associated etiological factor in the production of carpal hygromata of the cow. This is the first time the Bang germ has been reported from these lessions.

Miscellaneous Journal Series

212. An earliness test of some melon varieties. T. M. Currence. *Minnesota Horticulturist* 58:79-80. 1930.

The varieties Golden Champlain and Knight were the earliest of the 26 varieties of muskmelons tested. The Osage variety is the type preferred for commercial use in Minnesota, but it is too late to produce best returns. Cole's Early is the earliest watermelon variety, but it is poor in quality.

216. Biochemistry and the problems of organic evolution. R. A. Gortner. *The Scientific Monthly* 30, No. 5:416-426. May, 1930.

A general discussion of the contributions that biochemistry can make to the broad general problems of organic evolution. "A marvelous harmony pervades throughout the biochemical processes which characterize vital phenomena. There is more order than chaos in the biochemical inter-relationships throughout the plant and animal kingdoms, and biochemistry, as an independent science, has much to offer toward the solution of the problems of organic development."

SUMMARY OF PUBLICATIONS

Series	Number issued	Number of pages	Number in edition	Total number of pages in edition
General Bulletin	9	364	57,500	2,414,000
Technical Bulletin	5	304	11,000	624,000
Special Bulletin	12	164	140,000	2,520,000
Circular	5	20	50,000	230,000
Pamphlet	3	20	17,500	124,000
Folder	3	20	37,000	308,000
Boys' and Girls' Clubs	3	26	20,000	180 000
Annual Report	1	60	2,200	132,000
Miscellaneous	71	125	6,850	216,000
Total	112	1,103	342,050	6,718,000
Journal Series Papers	80	265	.....	.....
Total Publications	192	1,368	.....	.....

PROJECTS

The scope of the investigational work in progress at the Experiment Station is indicated by the organized projects. These are listed below.

Of the 218 projects at the Central station, 186 were actively prosecuted during the year and 32 were allowed to lie dormant; 41 new projects were initiated, and 20 were completed. The projects are distributed, by divisions, as follows: Agricultural Biochemistry, 16; Agricultural Engineering, 21; Agronomy and Plant Genetics, 23; Animal Husbandry, 8; Dairy Husbandry, 12; Entomology and Economic

Zoology, 25; Farm Management and Agricultural Economics, 21; Forestry, 20; Home Economics, 8; Horticulture, 17; Plant Pathology and Botany, 22; Poultry, 6; Soils, 10; Veterinary Medicine, 7; General, 2.

At the branch stations, 70 projects were actively prosecuted, as follows: At the North Central Station, 15; at the Northeast Station, 7; at the Northwest Station, 25; at the Southeast Station, 13; and at the West Central Station, 10.

Agricultural Biochemistry

101. Analytical Service (C. H. Bailey, G. S. Taylor, M. C. Markley, J. W. Nelson)

Subproject.—Nitrogen determinations for the Division of Agronomy and Plant Genetics

Subproject.—Tests of wheat for milling and baking quality

Subproject.—Tests of rye for milling and baking quality

Subproject.—Feed analyses for the Division of Animal Husbandry

Subproject.—Miscellaneous analyses

102. Cereal and flour investigations (Co-operative with the Divisions of Agricultural Engineering and Agronomy and Plant Genetics) (C. H. Bailey, C. C. Fifield, M. C. Markley)

Subproject.—Moisture content of grain with especial reference to combine harvesting

103. Investigations of proposed official methods of analysis (Collaborative with the Association of Official Agricultural Chemistry) (C. H. Bailey)

104. The strength of wheat flour (Co-operative with the State Testing Mill and Fleischman Yeast Company) (Adams project) (Reorganized)

Subproject.—Enzymes of flour and their relation to flour strength and baking practice (C. H. Bailey, L. P. Karacsonyi)

Subproject.—Work input as a measure of plasticity of dough (C. H. Bailey, Oscar Skovholt)

Subproject.—Chemical and physical properties of the flour proteins (C. H. Bailey, E. G. Bayfield)

Subproject.—Studies in the inheritance of flour strength (C. H. Bailey, M. C. Markley)

105. Biochemistry of milling and baking (Co-operative with the American Dry Milk Institute, Pillsbury Flour Mill Company, Institute of American Meat Packers, and the Strietman Company) (Purnell project)

Subproject.—Rancidity in baked products (C. H. Bailey, Anna L. Sommer, Lawrence Zeleny)

Subproject.—Effect of dry skimmilk on dough properties (C. H. Bailey, Oscar Skovholt)

Subproject.—Change in acidity of stored flour (C. H. Bailey, C. C. Fifield, M. C. Markley)

Subproject.—Flour color and carotinoid pigments (C. H. Bailey, C. L. Brooke)

201. The biochemistry of carotinoid pigments in animals (L. S. Palmer) (Dormant)

202. Chemical and biological studies in animal nutrition (Co-operative with Geo. A. Hormel & Co.)

Subproject.—The fundamental food requirements for animals

(1) The relation between the nutritive character of the diet and its utilization for gain in weight (L. S. Palmer, Cornelia Kennedy, H. P. Morris)

(2) The growth-promoting factors in yeast (Cornelia Kennedy, L. S. Palmer)

(3) The influence of fat in the diet on the growth of rats (Cornelia Kennedy)

(4) Coprophagia as a factor in rat nutrition (Cornelia Kennedy, L. S. Palmer)

Subproject.—A study of the nutritional requirements of certain insects (L. S. Palmer, J. W. Nelson)

Subproject.—Effect of commercial freezing process on the nutritive value of meat (L. S. Palmer, Hilda F. Wiese) (New)

Subproject.—The nutritive properties of rye for growth (L. S. Palmer, Cornelia Kennedy) (New)

Subproject.—Vitamin synthesis by algae (Cornelia Kennedy, Millard Gunderson) (New)

203. The chemistry of milk as a colloid system (Co-operative with the Division of Dairy Husbandry) (Adams project)

Subproject.—The colloid chemistry of rennin action (L. S. Palmer)

Subproject.—The effects of heat on the inorganic constituents of milk (L. S. Palmer)

Subproject.—The colloid chemistry of churning (L. S. Palmer, Hilda F. Wiese)

204. Mineral requirements of cattle (Joint project with Dairy Husbandry No. 105) (Purnell project) (L. S. Palmer, H. P. Morris, C. H. Eckles, T. W. Gullickson, J. W. Nelson)

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 phosphorus-deficient ration (Included as part of subproject entitled "The cause of mineral deficiency in rations of cattle in western Minnesota")

Subproject.—The mineral requirements for growth of cattle

205. The relation of the mineral content of the ration to reproduction in cattle (Joint project with Dairy Husbandry No. 106 and Veterinary Medicine No. 104) (Purnell project)

301. Chemical studies on forest products (Co-operative with the Cloquet Wood Products Company)

Subproject.—The effect of wood-rotting fungi on the chemical composition of wood (Co-operative with the Division of Forestry) (S. I. Aronovsky, H. Schmitz)

Subproject.—The cooking of wood

(1) The rôle of water in the cooking process (S. I. Aronovsky, R. A. Gortner)

(2) Cooking with sodium carbonate solutions (R. A. Gortner, S. I. Aronovsky)

302. Comparative studies of the biochemistry of normal and abnormal plants (Revised) (Adams project) (C. F. Rogers)

Subproject.—The biochemistry of fungi

Subproject.—The chemistry of insecticides, fungicides, and other "pesticides"

Subproject.—Biochemical factors involved in winter and drouth hardiness in plants (Dormant)

Subproject.—Effects of various chemical compounds or groups of compounds on the compositions and reactions of host and parasite (Dormant)

401. The chemical and physico-chemical properties of plant tissue fluids (R. A. Gortner, I. D. Jones)

Subproject.—The determination of "bound water"

402. Chemical studies of pollen (Dormant)

403. Protein investigations

Subproject.—The proteins of wheat flour: The effect of inorganic salt solutions on gliadin (R. A. Gortner, W. B. Sinclair) (Completed)

Subproject.—Physico-chemical studies of derived proteins (R. A. Gortner, W. M. Sandstrom) (Completed)

Subproject.—The alkali binding of casein and paracasein (R. A. Gortner, A. D. Robinson) (Dormant)

Subproject.—Sulfur in proteins. The effect of alkalies upon cystine (R. A. Gortner, W. B. Sinclair) (Completed)

Subproject.—The peptization of vegetable proteins by solutions of the potassium halides (R. A. Gortner, E. V. Staker) (Completed)

Subproject.—The effect of formaldehyde on amine formation from amino acids (R. A. Gortner, Lawrence Zeleny)

404. The fundamental properties of colloid systems with particular reference to biochemical problems (Formerly a subproject under Project No. 104) (Adams project) (New)

Subproject.—The Zeta potential at cellulose-organic interfaces (formerly part of Project No. 301) (R. A. Gortner, W. M. Martin)

Subproject.—The temperature coefficient of the Zeta-potential (R. A. Gortner, H. B. Bull)

Subproject.—The Zeta potential and ion antagonism (R. A. Gortner, H. B. Bull)

Subproject.—The significance of surface conductance in colloid systems (R. A. Gortner, H. B. Bull)

Agricultural Engineering

101. Determination of the relative efficiency of different depths and spacings of tile drains in four typical Minnesota soils (J. H. Neal, H. B. Roe, B. C. Colby)

102. Drainage and water control investigations on peat lands (Co-operative with the Divisions of Agronomy and Plant Genetics and Horticulture) (H. B. Roe, J. H. Neal, A. A. Anderson, B. C. Colby)

103. Farm building ventilation (H. B. White, C. L. Berggren, L. W. Newbauer) (Dormant)

104. Farm sewage disposal (Dormant)

105. Heating and ventilating of homes (Dormant)

106. Hydro-electric plants (Dormant)

107. Investigations 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 the United States Department of Agriculture Bureau of Public Roads and the Minnesota State Department of Drainage and Waters) (H. B. Roe, P. W. Manson, D. G. Miller)

108. Investigations in the cost of clearing land (Included as part of Project No. 112)

110. Investigations in land clearing methods and equipment (Included as part of Project No. 112)

111. Investigations of farm buildings (H. B. White, C. L. Berggren)

112. Investigations in land clearing (Co-operative with the United States Department of Agriculture Bureau of Public Roads) (M. J. Thompson, L. H. Schoenleber, N. A. Kessler, Alvin Stinson)

Subproject.—Seasonal brush cutting

Subproject.—Preparation of a stump-land pasture

Subproject.—Use of poison in killing trees, stumps, and brush that has been cut

Subproject.—Relation or influence of burning brush and stump piles (incident to land clearing) to later crop production and to seemingly sterile areas on given fields

Subproject.—Effectiveness of dynamite vs. tractor in pulling stumps

Subproject.—Broadcast burning as an aid to land clearing

Subproject.—Influence of frost in lifting stone

Subproject.—Land-clearing machinery

Subproject.—Relation of land valuations to clearing costs on soil types A, B, C, and D

Subproject.—Clearing costs of soil types A, B, C, and D

Subproject.—Economics of stump removal for pasture crops

Subproject.—Agricultural uses of explosives

114. The utilization of electricity in agriculture (Co-operative with the Divisions of Home Economics and Farm Management and Agricultural Economics, and with the National Committee on the Relation of Electricity to Agriculture) (Julius Romnes)

115. Wind-power electric lighting plants (Dormant)

116. Investigation of the drainage requirements of swamp forest growth, of the proper type of drainage system, and of the methods and costs of its installation and operation (Joint project with Forestry Project No. 101; co-operative with the Division of Soils and the United States Department of Agriculture Forest Service) (Dormant) (Closed)

119. Combine harvesting of grain and seed crops (Joint project with Farm Management and Agricultural Economics Project No. 105; co-operative with Divisions of Agricultural Biochemistry and Agronomy and Plant Genetics, and with the United States Department of Agriculture Bureaus of Public Roads and Agricultural Economics) (A. J. Schwantes, J. G. Dent, W. R. Anderberg, B. R. Colby)

120. A study of the farm tractor in Minnesota (Joint project with Farm Management and Agricultural Economics Project No. 106) (A. J. Schwantes, J. B. Torrance, W. R. Anderberg)

Subproject.—Survey of farms operated by experienced tractors users

Subproject.—A continued study of the mechanical and economical phases of the performance of tractors in the hands of experienced tractor users

Subproject.—A study of the performance of tractors and their effect on farms where no tractor has been previously used

122. A study of the influence of differing depths of drainage on the temperature of peat soil and the adjacent layers of the atmosphere, and of methods of summer frost prevention (Co-operative with the Division of Horticulture and the United States Department of Agriculture Bureau of Public Roads) (H. B. Roe, J. H. Neal, G. F. Krogh, A. A. Anderson, S. A. Wallin, B. C. Colby, B. R. Colby)

123. Investigation of hydraulic rams (A. G. Tyler) (New)

124. A study of some problems dealing with the use of flexible connectors for transmission power on the farm (J. G. Dent, A. J. Schwantes, H. Soderberg, B. R. Colby) (New)

Subproject.—A study of the comparative strength and suitability of five forms of rawhide belt lacings

Subject.—A study of the comparative wearing qualities and resistance to weather and "dry rot" of three- and four-strand rope, both manila and sisal

125. Gully control and prevention in the loess and glacial soils of southeastern Minnesota (Co-operative with the United States Department of Agriculture Bureau of Public Roads) (H. B. Roe, D. G. Miller, G. F. Krogh, A. A. Anderson, C. F. Bang) (New)

126. Sheet erosion control by terracing and field and crop management in the terminal moraines and outwash plains of southern Minnesota (Co-operative with the United States Department of Agriculture Bureau of Public Roads) (H. B. Roe, D. G. Miller, A. A. Anderson, G. W. Franzmeier) (New)

Agronomy and Plant Genetics

101. Varietal improvement in rye (Co-operative with the Divisions of Plant Pathology and Botany and Soils, and with the branch stations) (H. E. Brewbaker) (New)

102. Varietal improvement in barley (Co-operative with the Divisions of Plant Pathology and Botany and Soils, and with the branch stations) (F. J. Stevenson) (New)

Subproject.—Breeding studies

Subproject.—Rod-row trials

Subproject.—Fortieth-acre plot trials

103. Varietal improvement in spring wheat (Co-operative with the Divisions of Plant Pathology and Botany and Soils, the branch stations, and the United States Department of Agriculture Bureau of Plant Industry) (H. K. Hayes, H. K. Wilson, E. R. Ausemus, S. M. Raleigh, C. L. Alexander, D. U. Harvey) (New)

104. Varietal improvement in winter wheat (Co-operative with the Divisions of Plant Pathology and Botany and Soils, the branch stations, and the United States Department of Agriculture Bureau of Plant Industry) (H. K. Hayes, H. K. Wilson, E. R. Ausemus, S. M. Raleigh, C. L. Alexander, D. U. Harvey) (New)

105. Varietal improvement in oats (Co-operative with the Division of Plant Pathology and Botany and the Branch Stations) (H. K. Hayes, H. K. Wilson, S. M. Raleigh, C. L. Alexander, D. U. Harvey) (New)

106. Varietal improvement in alfalfa and source of seed investigations (Co-operative with the Divisions of Plant Pathology and Botany and Soils, and with the branch stations) (A. C. Arny, D. U. Harvey) (New)

Subproject.—Row tests
Subproject.—Tests in replicated fortieth-acre plots of new strains and varieties for yield and quality of hay and for cold resistance
Subproject.—Tests in replicated fortieth-acre plots, planting from commercial lots of alfalfa seed drawn by a representative of the Minnesota Experiment Station from sealed bags certified as to variety and origin and as to origin only

107. Varietal improvement in flax (Co-operative with the Divisions of Plant Pathology and Botany and Soils, the branch stations, and the Flax Development Committee) (A. C. Arny, I. J. Johnson, D. U. Harvey, W. E. Haines, G. H. Robinson) (New)

Subproject.—Rod-row trials
Subproject.—Fortieth-acre plot trials

108. Cytology in relation to genetics (F. J. Stevenson) (New)

109. Forage and pasture crop investigations (Co-operative with the Divisions of Dairy Husbandry and Soils and the branch stations) (A. C. Arny, I. J. Johnson, W. E. Haines, D. U. Harvey) (New)

110. Studies in the classification of farm crops (Co-operative with the United States Department of Agriculture Bureau of Plant Industry and with the Flax Development Committee) (A. C. Arny, H. K. Wilson, A. C. Dillman, D. U. Harvey)

111. Methods of eradicating perennial weeds (Co-operative with the Division of Plant Pathology and Botany, the Northwest, Southeast, and West Central branch stations) (A. C. Arny, R. O. Bridgford, A. H. Larson, W. E. Haines, D. U. Harvey)

Subproject.—Eradicating the perennial weeds quack grass, Canada thistle, Austrian field cress, leafy spurge, sow thistle, and such other weeds as it may appear desirable to work on with chemicals
Subproject.—Effect of frequent cutting on the vigor of perennial weeds
Subproject.—Amounts of reserve food in the underground parts of perennial weeds at different stages of development

112. Varietal improvement in sweet clover (Co-operative with the Divisions of Plant Pathology and Botany and Soils, and with the branch stations) (H. E. Bewbaker) (New)

Subproject.—Improvement phases
Subproject.—Variety tests
Subproject.—Methods of handling sweet clover in relation to the effect on the succeeding crop

113. Physiological studies of crop varieties (H. K. Wilson)

Subproject.—Lodging of corn

114. Varietal improvement in field peas, soybeans, and field beans (Co-operative with the Division of Soils and the branch stations) (A. C. Arny, I. J. Johnson, D. U. Harvey) (New)

Subproject.—Classification
Subproject.—Preliminary trials
Subproject.—Fortieth-acre plot trials

115. Reed canary grass investigations (Co-operative with the Division of Soils, the branch stations, and county agents) (C. A. Arny, I. J. Johnson, D. U. Harvey) (New)

Subproject.—Adaptation of seed
Subproject.—Cultural methods
Subproject.—Analysis
Subproject.—Flowering and seeding habits
Subproject.—Improvement through isolation of superior strains
Subproject.—Comparison of the feeding value of reed canary grass hay with other grass and legume hays

116. Controlled pollination as a means of corn improvement (Co-operative with the Division of PlantPathology and Botany, the branch stations, and the Minnesota Valley Canning Company) (Purnell project) (H. K. Hayes, H. E. Brewbaker, F. R. Immer, I. J. Johnson, H. L. Thomas, C. W. Doxtator, R. E. Hodgson)

117. The effect of self-fertilization in naturally cross-pollinated plants) (Co-operative with the Division of Plant Pathology and Botany) (Purnell project) (I. J. Johnson, H. E. Brewbaker) (New)

118. Genetics of maize and barley (Co-operative with the Minnesota Valley Canning Company) (Adams and Purnell projects) (H. K. Hayes, F. J. Stevenson, H. E. Brewbaker, F. R. Immer, C. L. Alexander, H. L. Thomas, L. Humphrey) (New)

Subproject.—Genetic studies with maize
Subproject.—The mode of inheritance and linkage relationships of certain characters in barley

119. Varietal improvement in sugar beets (Co-operative with the Division of Plant Pathology and Botany, the Southeast branch station, and the American Sugar Beet Company) (Purnell project) (F. R. Immer, R. E. Hodgson) (New)

120. Alsike clover seed production (Co-operative with the Divisions of Entomology and Economic Zoology and Soils, the Northeast and North Central branch stations, R. J. Bibelhausen, R. McCamus) (H. K. Wilson) (New)

Subproject.—Survey
Subproject.—Rate and method of seeding
Subproject.—Source of seed
Subproject.—Selection

121. Crop rotation investigations (A. C. Arny, I. J. Johnson, D. U. Harvey)

Subproject.—Field C and Field T rotations
Subproject.—Effect of crops on those which follow (Dormant)

122. Co-operative seed production and distribution (Co-operative with the Minnesota Crop Improvement Association and farmers) (A. D. Haedecke)

124. The development of disease-resistant varieties of farm crops (Reorganized—joint project with Plant Pathology and Botany Project No. 104; co-operative with the United States Department of Agriculture Bureau of Plant Industry)

Subproject.—Spring wheat (H. K. Hayes, H. K. Wilson, E. R. Ausemus, K. S. Quisenberry)
Subproject.—Winter wheat (H. K. Hayes, H. K. Wilson, E. R. Ausemus, K. S. Quisenberry)
Subproject.—Oats (H. K. Hayes, H. K. Wilson, C. W. Doxtator)
Subproject.—Barley (F. J. Stevenson)
Subproject.—Rye (H. E. Brewbaker)
Subproject.—Flax (A. C. Arny, I. J. Johnson)
Subproject.—Corn (H. K. Hayes, H. E. Brewbaker, F. R. Immer, I. J. Johnson, H. L. Thomas, C. W. Doxtator)
Subproject.—Timothy (F. R. Immer, I. J. Johnson)
Subproject.—Red Clover (F. R. Immer, I. J. Johnson)
Subproject.—Sweet clover (H. E. Brewbaker)
Subproject.—Sugar beets (F. R. Immer)
Subproject.—Alfalfa (A. C. Arny)
Subproject.—Sunflowers (H. E. Brewbaker)

Animal Husbandry

106. Fattening yearling steers (Included as part of Project No. 107)

107. Fattening beef calves (W. H. Peters, George Wight) (New)

301. Studies in wool and other animal fibers (Co-operative with the United States Department of Agriculture Bureau of Animal Industry) (Dormant) (Closed)

Subproject.—Studies in the growth of wool

302. Emasculating and docking of approximately four- and five-month-old ram lambs (Co-operative with the Division of Veterinary Medicine) (P. A. Anderson, W. L. Boyd) (New)

303. The relationship of the plane of nutrition to thrift in lambs infested with internal parasites (W. H. Peters, J. M. Brown) (New) (Closed)

401. Swine feeding investigations (E. F. Ferrin, Don Johnson)

Subproject.—The feeding value of rye
Subproject.—A comparison of protein supplements in rations for pigs following weaning (Dormant)
Subproject.—A study of the cost of production and quality of the product from lard type and from bacon type hogs (Closed)
Subproject.—The feeding value of oats (Dormant)
Subproject.—The comparative values of corn and oats for growing pigs (Dormant)
Subproject.—A comparison of protein supplements
Subproject.—A study of the nutritive requirements of growing swine by means of a comparison of the leading feeding standards (Closed)
Subproject.—Corn compared with barley and mixtures of barley and oats (Dormant)
Subproject.—A comparison of slop feeding with dry feeding for growing pigs (New)
Subproject.—The feeding values of Manchuria and Trebi barleys (New)

402. Swine-breeding investigations (Co-operative with the Northeast and West Central branch stations) (L. M. Winters, P. S. Jordan, O. M. Kiser)

Subproject.—Cross-breeding swine

403. Record of performance work with swine (E. F. Ferrin, P. A. Anderson, Don Johnson) (New)

Dairy Husbandry

102. Feeding trials with crops new to Minnesota farmers (C. H. Eckles, N. N. Allen)

Subproject.—Sweet clover
Subproject.—The utilization of sugar beet tops

103. Food requirements of cattle (T. W. Gullickson)

Subproject.—The energy requirements for growth
Subproject.—The deficiencies of milk as an exclusive diet for growing calves

104. The immediate influence of various feeds upon the quality and quantity of milk

Subproject.—The effect of feed upon fat percentage (W. E. Petersen)

Subproject.—The synthesis of lactose (Co-operative with the Divisions of Agricultural Biochemistry and Veterinary Medicine) (W. E. Petersen, W. L. Boyd)

105. Mineral requirements of cattle (Joint project with Agricultural Biochemistry Project No. 204) (Purnell project) (C. H. Eckles, T. W. Gullickson, L. S. Palmer, H. P. Morris, J. W. Nelson))

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.—The mineral requirements for the growth of cattle

Subproject.—Analysis of blood and bones from animals receiving phosphorus-deficient ration

106. The relation of the mineral content of the ration to reproduction in cattle (Joint project with Agricultural Biochemistry Project No. 205 and Veterinary Medicine Project No. 104) (Purnell project) (C. H. Eckles, T. W. Gullickson, C. P. Fitch, W. L. Boyd, L. S. Palmer, Cornelia Kennedy, J. W. Nelson)

Subproject.—The effect of a ration low in calcium on abortion and other reproductive disturbances

202. Factors influencing the composition and market qualities of butter (Co-operative with the State Creamery) (Purnell project) (H. Macy, W. B. Combs, E. O. Herreid, Henry Morrison, S. T. Coulter)

Subproject.—Moldiness in butter

Subproject.—Cheesy flavors in butter

Subproject.—The cause and prevention of crumbly butter

Subproject.—Distribution of salt in butter (Discontinued)

Subproject.—Manufacture of unsalted butter

203. Ice cream studies (W. B. Combs) (Dormant)

205. The loss of fat in churning sweet cream and methods for control (Co-operative with the State Creamery) (W. B. Combs, E. O. Herreid, S. T. Coulter, W. E. Petersen, A. T. Miller)

Subproject.—Methods of fat determination in buttermilk (Closed)

Subproject.—Factors influencing the loss of fat in sweet cream churnings

207. The feed requirements and the cost of keeping dairy herd sires (C. H. Eckles) (Closed)

208. French weed as a possible source of injury to the market qualities of dairy products (C. H. Eckles) (Closed)

209. The value of proven sires in building up a dairy herd (W. E. Petersen)

210. The utilization of skimmilk on dairy farms (C. H. Eckles) (Dormant)

Entomology and Economic Zoology

102. Biologic and taxonomic studies on the *Mutillidae* (Hymenoptera) (C. E. Mickel)

103. The bronze birch-borer, *Agrilus anxius* (Co-operative with the United States Department of Agriculture Bureau of Entomology and Forest Service; University of Michigan; Minnesota State Department of Conservation) (S. A. Graham)

105. The economic status of fur-bearing animals in Minnesota (M. S. Johnson)

Subproject.—Status of fur-farming in Minnesota

Subproject.—Common injurious mammals of Minnesota (Closed)

107. The endoparasites of man and domesticated animals (Co-operative with the Division of Veterinary Medicine, the United States Department of Agriculture Bureau of Animal Husbandry, Swift and Company, and fox farmers) (W. A. Riley, W. B. Owen, L. D. Christenson, 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) (Dormant)

110. Greenhouse insects (A. G. Ruggles, H. L. Parten, F. Munger)

111. Insect collection (Co-operative with the Division of Forestry) (C. E. Mickel)

Subproject.—Insect collection—University Farm

Subproject.—Insect collection—Itasca Park

112. Insect defoliators of forest trees (Co-operative with the United States Department of Agriculture Bureau of Entomology and Forest Service; University of Michigan; and the Minnesota State Department of Conservation) (S. A. Graham, L. W. Orr)

Subproject.—The Jack pine sawfly, *Neodiprion banksianae*

Subproject.—The spruce budworm of jack pine

Subproject.—The spruce budworm of 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

116. Insecticides (A. G. Ruggles, H. L. Parten)

Subproject.—Orchard spraying (Dormant)
Subproject.—Potato spraying
Subproject.—Scale insect control
Subproject.—Root maggot control

119. The parasites and symbionts of insects (Revised) (W. A. Riley)

120. The productivity of Minnesota lakes in fish and fish food (M. S. Johnson)

121. Soil insects (A. G. Ruggles, F. Munger)

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 (R. N. Chapman)

Subproject.—A study of temperature of grain in storage when left undisturbed and when run during cold weather; effect of chilled grain upon mortality of grain weevils

Subproject.—Experiments on low temperature and moisture as factors in the ecology of grain weevils (Closed)

Subproject.—Continuation of moisture determination of insects by electric method

125. A study of the *tabanide,* or horseflies, of Minnesota (W. A. Riley) (Dormant)

127. Field crop insects (A. G. Ruggles) (Dormant)

128. Effect of temperature and humidity on the wintering of bees (M. C. Tanquary) (Dormant)

129. A study of the rôle of temperature and moisture in the physiology of insects (R. N. Chapman) (Dormant) (Closed)

130. Studies of the Jack pine lecanium scale, *Lecanium numismaticum,* on Scotch and Jack pine in Minnesota (Joint project with Forestry Project No. 121; co-operative with the Minnesota State Forest Service and the St. Paul City Water Department) (L. W. Orr)

131. The toxicity of insecticides (A. L. Strand)

Subproject.—The measurement of toxicity
Subproject.—The examination of new materials
Subproject.—The relation to insect physiology
Subproject.—The relation to the physiology of the plant

132. The application of chlorpicrin, the chlorpicrin-carbontetrachloride mixture (Chapman patent), or other modification of chlorpicrin to industrial fumigation (A. L. Strand)

Subproject.—The mechanics of application of chlorpicrin

Subproject.—The physico-chemical processes governing the effectiveness of fumigations

133. Methods of bee management (Co-operative with the branch stations) (M. C. Tanquary)

134. Bees as a factor in pollination (Co-operative with the branch stations and county agents) (M. C. Tanquary)

135. The equilibrium of insect populations on the basis of biotic potential and environmental resistance (Adams project) (R. N. Chapman, John Stanley, Lillian Baird) (New)

Farm Management and Agricultural Economics

101. Agricultural credit (Purnell project) (Dormant)

102. A study of the organization of farms in the Red River Valley (Co-operative with the United States Department of Agriculture Bureau of Agricultural Economics) (Purnell project) (Andrew Boss, G. A. Pond, G. A. Sallee, L. H. Watkins, V. S. Perry, W. H. Dankers)

103. Farmers' incomes in Minnesota (D. D. Kittredge, R. W. Cox)

104. An accounting study of farm organization for beef production (Co-operative with the Division of Animal Husbandry and the United States Department of Agriculture Bureau of Agricultural Economics) (Andrew Boss, G. A. Pond, G. A. Sallee, W. P. Ranney, V. S. Perry, L. H. Watkins, W. H. Dankers, R. H. Loreaux)

105. Combine harvesting of grain and seed crops (Joint project with Agricultural Engineering Project No. 119; co-operative with the Divisions of Agricultural Biochemistry and Agronomy and Plant Genetics, and with the United States Department of Agriculture Bureaus of Agricultural Economics and Public Roads) (G. A. Pond, L. B. Bassett) (Closed)

106. A study of the farm tractor in Minnesota (Joint project with Agricultural Engineering Project No. 120) (G. A. Pond)

Subproject.—Survey of farms operated by experienced tractor owners (Closed)

Subproject.—A continued study of the mechanical and economic phases of the performance of tractors in the hands of experienced operators (Dormant)

Subproject.—A study of the performance of tractors and their effect on farms where no tractor has been previously used (Dormant)

107. Market price quotations (D. D. Kittredge)

108. Marketing farm products (Co-operative with the Division of Forestry and the United States Department of Agriculture Bureau of Agricultural Economics) (Purnell project) (O. B. Jesness, E. C. Johnson, L. L. Ullyot, G. B. Clarke, E. A. Johnson, C. L. Wallmark)

Subproject.—Problems of the Minnesota Co-operative Creameries Association (Dormant)

Subproject.—Organization and management problems of local creameries in Minnesota

Subproject.—Organization for selling livestock in the central markets

Subproject.—Local concentration of livestock in Minnesota

Subproject.—Federation of local grain elevators (Dormant)

Subproject.—Margins of locally grown fruits and vegetables (Dormant) (Closed)

Subproject.—Problems of the Lake Region Egg and Poultry Association (Dormant)

Subproject.—Co-operative marketing of honey (Dormant) (Closed)

Subproject.—Organization and management problems of farmers' elevators

Subproject.—Marketing small fruits (Dormant) (Closed)

109. Market organization investigations (O. B. Jesness, L. L. Ullyot, C. L. Wallmark, D. C. Dvoracek)

110. Cost accounting investigations on Minnesota farms (Co-operative with the United States Department of Agriculture Bureau of Agricultural Economics) (G. A. Pond)

111. An accounting study of the factors affecting the income on dairy farms (Co-operative with the Division of Agricultural Extension and the United States Department of Agriculture Bureau of Agricultural Economics) (Purnell project) (Andrew Boss, G. A. Pond, W. P. Ranney, R. C. Bevan, V. S. Perry, L. H. Watkins, W. H. Dankers)

112. Comparison of fence posts (L. B. Bassett)

113. Prices of farm products (Co-operative with the United States Department of Agriculture Bureau of Agricultural Economics) (Purnell project) (O. B. Jesness, R. W. Cox, D. D. Kittredge, P. L. Slagsvold)

114. Taxation in relation to agriculture (Purnell project) (G. B. Clarke, O. B. Jesness)

115. A study of the physical organization of farms (Dormant)

Subproject.—The farm layout

Subproject.—The farmstead arrangement

116. Types of farming and production areas in Minnesota (Co-operative with the United States Department of Agriculture Bureau of Agricultural Economics) (L. F. Garey, F. F. Elliott)

117. Economic study of potato production in relation to farm organization (L. F. Garey)

118. A study of the farm lease situation in Minnesota (Co-operative with the Division of Agricultural Extension) (G. A. Pond) (New)

119. A study of certain human factors in farm management (Co-operative with the University of Minnesota Departments of Sociology and Psychology, and with the United States Department of Agriculture Bureau of Agricultural Economics) (O. B. Jesness, Andrew Boss, G. A. Pond) (New)

120. Market outlets for woodland products in northeastern Minnesota (Joint project with Forestry Project No. 124) (Purnell project) (O. B. Jesness) (New)

123. Minnesota land economic survey (Co-operative with the Divisions of Forestry and Soils and with the Minnesota State Conservation Commission) (O. B. Jesness) (New)

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 Project No. 116; co-operative with the Division of Soils and with the United States Department of Agriculture Forest Service) (Dormant)

102. Management of the Cloquet forest (T. S. Hansen, J. A. Stillwell)

104. Possibilities of cutover lands in Minnesota (T. S. Hansen)

106. Studies of forest planting (T. S. Hansen)

107. Thinning of Jack and Norway pine (Dormant)

109. Windbreak planting investigations (E. G. Cheyney) (Closed)

110. Studies in yield and volume (Co-operative with the North Central Branch Station and the St. Paul City Water Department) (J. H. Allison)

111. Working plan for the Cloquet forest area (Co-operative with the United States Department of Agriculture Forest Service) (J. H. Allison, T. S. Hansen)

114. A study of the economic management of the farm woodlot (Purnell project) (J. H. Allison, H. Schmitz)

115. Relation between specific gravity and pulp yield of partially decayed aspen wood (Dormant)

117. A study of hazel and alder brush in its relation to reproduction (E. G. Cheyney)

118. Yields of second-growth red and white pine in Minnesota (R. M. Brown)

120. The value of "Treater Dust" as a wood preservative, particularly for fence posts and poles (Dormant)

121. Studies of the Jack pine lecanium scale, *Lecanium numismaticum,* on Scotch and Jack pine in Minnesota (Joint project with Entomology and Economic Zoology Project No. 130) (J. H. Allison) (Closed)

122. Aspen in the Lake States: Availability, properties, and utilization (Co-operative with the United States Department of Agriculture Forest Service) (H. Schmitz, R. P. A. Johnson, J. Kittredge, Jr.) (New)

123. The determination of composition and amount of gases in tree trunks (W. W. Chase) (New)

124. Market outlets for woodland products in northeastern Minnesota (Joint project with Farm Management and Agricultural Economics Project No. 120) (Purnell project) (T. S. Hansen, O. B. Jesness) (New)

125. The biologic significance of mycorhizas of the forest trees of Minnesota (Co-operative with the Division of Plant Pathology and Botany) (Dormant) (New)

126. A survey of soil erosion in southeastern Minnesota (H. Schmitz) (New)

127. The determination of the rate of moisture absorption by wood (L. W. Rees) (New)

Home Economics

101. A quantitative and qualitative study of farm homes in Minnesota, with emphasis upon the influence of the farm upon the management of the home and the life of the family (L. A. Studley)

102. Relation of the diet to blood formation and regeneration (Purnell project) (J. 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 formation and regeneration

103. Quality tests for studying pork cuts (Purnell project) (A. M. Child)

Subproject.—Quality test for roasting pork loin
Subproject.—Quality test for ham cooked in water
Subproject.—Quality test for bacon cooked in oven and in pan
Subproject.—Preparation of a set of standard charts for judging sliced bacon

104. Factors affecting the selection, care, and wearing qualities of textile materials (Purnell project) (E. L. Phelps)

Subproject.—A study of fiber quality and physical properties in relation to the cost of staple wool materials

105. A study of bound and free water in meat (Purnell project) A. M. Child, Myrna Hovlid)

106. The utilization of electricity in agriculture (Joint project with Agricultural Engineering Project No. 114 (A. M. Child) (Dormant) (Discontinued)

107. A study of quantity methods of preparing canned vegetables, fruits, and fish (A. M. Child, Frances Dunning, Grace Erskine) (New) (Discontinued)

108. A study of quantity methods for meat cookery (Co-operative with the Institute of American Meat Packers) (A. M. Child, A. J. Bacon) (New)

Subproject.—A study of method of cooking and relative economy of cooking fresh pork cuts
Subproject.—A study of the relative economy of cured hams—large, medium, and small unskinned, and large skinned
Subproject.—A study of the relative economy of roasts prepared with and without skewers

Horticulture

101. A study of ornamental varieties and their uses (L. E. Longley)

102. Turf construction and maintenance (L. E. Longley)

201. Hardiness studies in fruit breeding (Adams project) (A. N. Wilcox, W. H. Alderman, R. B. Harvey, Ernest Angelo, F. E. Haralson, B. H. Wilson)

202. Sterility studies in fruit breeding (A. N. Wilcox, W. H. Alderman, Fred Haralson, Eldred Hunt, Ernest Angelo)

203. A study of inheritance of characters in fruit (A. N. Wilcox, W. H. Alderman, B. H. Wilson, Ernest Angelo, F. E. Haralson)

Subproject.—Apple breeding
Subproject.—Plum breeding
Subproject.—Peach breeding
Subproject.—Pear breeding
Subproject.—Cherry breeding
Subproject.—Raspberry breeding
Subproject.—Blackberry breeding (Dormant)
Subproject.—Gooseberry breeding
Subproject.—Grape breeding
Subproject.—Strawberry breeding
Subproject.—Variety testing

301. Blueberry culture (W. G. Brierley, W. H. Alderman, A. N. Wilcox, Ernest Angelo)

303. Cost of producing fruits (Co-operative with the Division of Farm Management and Agricultural Economics) (Dormant)

304. Fruit variety studies (Co-operative with the Division of Home Economics, the North Central, Northeast, and Northwest branch stations, and trial stations) (W. G. Brierley, W. H. Alderman, Ernest Angelo)

305. Nut culture in Minnesota (W. G. Brierley)

306. A study of the nature of the injury arising from fall planting of apple trees in Minnesota (W. G. Brierley)

307. Pruning studies

Subproject.—The effect of height of pruning upon the performance of the Latham red raspberry (W. G. Brierley)
Subproject.—The effect of tree vigor on the rate of healing of wounds in the apple (W. G. Brierley)
Subproject.—Pruning studies with the Beta grape (W. G. Brierley, W. H. Alderman)

402. Vegetable breeding and selection (Revised) (Co-operative with the Division of Plant Pathology and Botany and the Northeast branch station) (F. A. Krantz, T. M. Currence, A. E. Hutchins, W. H. Alderman)

Subproject.—Pea breeding
Subproject.—Tomato breeding
Subproject.—Inheritance studies on tomatoes
Subproject.—Bean improvement
Subproject.—Inheritance studies on beans
Subproject.—Radish breeding
Subproject.—Cabbage breeding

Subproject.—Carrot breeding
Subproject.—Melon breeding
Subproject.—Studies on vegetable varieties

403. Effect of differential water table on the development of vegetable crop plants on peat lands (Co-operative with the Division of Agricultural Engineering) (T. M. Currence, F. A. Krantz, W. H. Alderman)

406. Nutrition studies in vegetable crop plants (Combined with Project No. 413) (T. M. Currence, F. A. Krantz)

408. Potato breeding (Co-operative with the North Central, Northeast, and Northwest branch stations, and with the United States Department of Agriculture Bureau of Plant Industry) (F. A. Krantz, R. M. Bailey, A. G. Tolaas)

Subproject.—Development of improved varieties through inbreeding and subsequent cross-breeding
Subproject.—Inheritance in the potato
Subproject.—Tests of varieties and seedlings

411. Summer frost prevention on peat and muck lands (Co-operative with the Division of Agricultural Engineering) (T. M. Currence, F. A. Krantz)

413. Hastening maturity and development of vegetable crops (F. A. Krantz, T. M. Currence, A. E. Hutchins) (New)

Subproject.—Effect of mulch paper on maturity and development of vegetable crops
Subproject.—Effects of checking vegetative growth on the ripening of tomatoes

Plant Pathology and Botany

101. Cereal and forage crop diseases (Co-operative with the Division of Agronomy and Plant Genetics) (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) (Closed)
Subproject.—Black chaff of wheat
Subproject.—Miscellaneous diseases of flax
Subproject.—Miscellaneous diseases of sunflowers
Subproject.—Smuts of sorghums

103. Dendropathological work (Co-operative with the Division of Forestry) (E. C. Stakman, A. F. Verall, Clyde Christensen, Frank Kaufert)

Subproject.—The rotting of posts and poles (Dormant)
Subproject.—The relation of environment to damping-off
Subproject.—White pine blister rust
Subproject.—Miscellaneous diseases of shade and forest trees, (a) cedar blight, (b) elm disease, (c) needle blight of conifers
Subproject.—Biology of wood rotting fungi (Dormant)
Subproject.—Mycorhiza of trees

104. Development of disease-resistant varieties of farm crops (Joint project with Agronomy and Plant Genetics Project No. 124; co-operative with the United States Department of Agriculture Bureau of Plant Industry) (Purnell project) (E. C. Stakman, J. J. Christensen, H. A. Rodenhiser, I. L. Forbes, C. S. Holton, R. H. Bamberg, Carl Eide, M. N. Levine, E. R. Ausemus, K. S. Quisenberry)

Subproject.—Spring wheat
Subproject.—Winter wheat
Subproject.—Oats
Subproject.—Barley
Subproject.—Rye (Dormant)
Subproject.—Flax
Subproject.—Corn
Subproject.—Timothy
Subproject.—Red clover (Dormant)
Subproject.—Sweet clover (Dormant)
Subproject.—Sugar beets
Subproject.—Alfalfa (Dormant)
Subproject.—Sunflowers (Dormant)

105. Diseases of ornamental plants (Louise Dosdall)

108. Fruit diseases (Co-operative with the Division of Entomology and Economic Zoology) (E. C. Stakman, C. V. Kightlinger, I. L. Forbes)

Subproject.—Experimental apple spraying (Dropped)
Subproject.—Experimental plum spraying (Dropped)
Subproject.—Diseases of small fruits and methods of control
Subproject.—Biology of *sclerotinia* sp. (Dropped)
Subproject.—Raspberry mosaic (Dropped)
Subproject.—Diseases of tree fruits and methods of control (New)

109. Minnesota mushrooms (Louise Dosdall)

110. Plant disease survey (Louise Dosdall)

111. Rusts of cereals (Co-operative with the United States Department of Agriculture Bureau of Plant Industry) (E. C. Stakman, J. G. Leach, Helen Hart, M. N. Levine, K. S. Quisenberry, L. W. Melander, R. U. Cotter)

Subproject.—Nature of resistance
Subproject.—Biologic specialization in cereal rusts

Subproject.—Epidemiology of cereal rust
Subproject.—Barberry eradication
Subproject.—Dusting for control of cereal rust (Dormant) (Discontinued)

112. The microflora of moldy silage and hay (Co-operative with the Divisions of Agricultural Biochemistry and Veterinary Medicine) (J. J. Willaman, C. P. Fitch, I. L. Forbes) (Dormant) (Closed)

113. Diseases of canning crops (Co-operative with the Minnesota Canners' Association) (E. C. Stakman, J. G. Leach, G. H. Starr)

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)

Subproject.—Pathological changes occurring in fruits and vegetables in storage (Dormant)
Subproject.—The effect of temperature and humidity on the development of storage rots (Dormant)
Subproject.—The length of holding in storage in relation to pathological changes in fruits (Dormant)

115. Physiologic specialization of smuts of cereals (Purnel project) (E. C. Stakman, J. J. Christensen, C. S. Holton, C. C. Allison, M. B. Moore)

116. Garden truck diseases (J. G. Leach)

Subproject.—Potato diseases
Subproject.—Miscellaneous truck crop diseases
Subproject.—The relation of dipterous insects to the spread and development of soft rot in vegetables

201. Effect of low temperature on plants (Co-operative with the Division of Agronomy and Plant Genetics) (R. B. Harvey, Harold Mitchell, L. O. Regeimbal)

Subproject.—Varietal differences in frost resistance of crop plants
Subproject.—Physiological factors concerned in frost injury
Subproject.—Dessication in the frozen condition as a cause of injury
Subproject.—Killing of seeds and seedlings of forest trees and horticultural plants by low temperature (Co-operative with the Division of Forestry and the United States Department of Agriculture Forest Service)

203. Investigations on respiratory enzymes (R. B. Harvey)

Subproject.—Oxydo reductase
Subproject.—State of oxidation in tissue

204. Light relations of forest reproduction (R. B. Harvey, L. O. Regeimbal, H. L. Mitchell)

Subproject.—Physical measurements of solar radiation and adsorption by green plants

Subproject.—Importance of factors which may alter the tolerance of a given species of plant

Subproject.—Studies on differences in tolerance of different species

Subproject.—Internal reactions of leaf cells of various types of forest trees to light of varying intensity and quality

205. Physiological changes occurring in the storage and ripening of fruits and vegetables under varying conditions (Co-operative with the Division of Horticulture) (R. B. Harvey, L. O. Regeimbal)

Subproject.—Physiological and chemical changes of fruits and vegetables in storage

Subproject.—Storage optimum temperature and humidity

Subproject.—Length of holding in storage in relation to stage of maturity of fruit

Subproject.—Storage in frozen conditions

Subproject.—Ripening in storage

206. Physiology of reproduction (A. H. Larson)

Subproject.—Determination of sexes in plants (New)

Subproject.—Temperature as a factor in self-fertility (Dormant)

Subproject.—Effects of fertilizer treatments upon self-fertility (Dormant)

Subproject.—Study of nutrition of the pollen tube (Dormant)

Subproject.—Moisture relations of pollen germination and growth (Dormant)

Subproject.—Role of growth-promoting and growth-inhibiting substances upon rate of pollen tube development (Dormant)

207. Physiology of seed germination (Co-operative with the Division of Agronomy and Plant Genetics) (A. H. Larson, R. B. Harvey)

Subproject.—Physiology of dormancy in seeds, including a study of means to shorten or eliminate the rest period (Dormant)

Subproject.—Effects of seed treatment upon germination, subsequent growth, and yield

Subproject.—Respiratory studies on seeds as related to condition at harvest, conditions of storage, and other factors (Dormant)

Subproject.—Light-sensitive seeds (Dorman)

208. Studies in plant metabolism and growth (R. B. Harvey, L. O. Regeimbal)

Subproject.—Effect of length of illumination period and light intensity upon growth and reproduction

Subproject.—Effect of increased CO_2 supply upon plant growth and reproduction

Subproject.—Salt nutrition

Subproject.—Effect of nightly illumination on control of seedling diseases

301. Seed studies (A. H. Larson)

Subproject.—Seed testing survey

Subproject.—Weed seed cases (Discontinued)

Subproject.—Germination of lettuce seed (Dormant)

302. Weeds (A. H. Larson)

Subproject.—Chemical eradication (New)

Poultry Husbandry

105. Investigations in the feeding of young chicks (Dormant)

106. Studies on embryonic mortality in the fowl (Purnell project) (F. B. Hutt)

Subproject.—Relationship of the hour of laying to the hatchability of the egg (Closed)

107. The physiology of reproduction in the fowl (Purnell project) (Dormant)

108. Studies on the genetic constitution of the fowl (Purnell project) (F. B. Hutt)

Subproject.—The genetics of frizzling in fowls

109. The practicability of storage brooder chicks (Dormant)

110. Investigations in the care and feeding of turkey poults kept in restricted quarters and restricted yards (A. C. Smith) (New)

Soils

102. Fertilizer experiments (F. J. Alway, G. H. Nesom, C. O. Rost, P. R. McMiller, Wm. Methley)

103. Hydrogen-ion concentration of soils (C. O. Rost)

104. Land classification (Co-operative with the United States Department of Agriculture Bureau of Public Roads) (F. J. Alway, P. R. McMiller, C. Nikiforoff)

105. Movement of water in soils (Adams project) (F. J. Alway, R. M. Pinckney, A. C. Libby)

106. Peat soils (F. J. Alway, G. H. Nesom, I. Nygard, A. C. Libby)

107. Sandy soils (F. J. Alway, G. H. Nesom, Wm. Methley)

108. Soils of the low-lime area (F. J. Alway, C. O. Rost, R. M. Pinckney)

109. Soil survey (Co-operative with the United States Department of Agriculture Bureau of Chemistry and Soils) (F. J. Alway, P. R. McMiller, C. Nikiforoff, G. H. Nesom)

110. Soils of the red drift (F. J. Alway, A. C. Libby)

111. Amount and placement of commercial fertilizers for cultivated crops (C. O. Rost)

Veterinary Medicine

101. The physiology and chemistry of the blood and urine of animals (E. A. Hewitt) (Discontinued)

102. Contagious abortion of mares and pyaemic arthritis of foals (Dormant) (Discontinued)

103. Diseases of poultry (R. Fenstermacher) (Closed)

104. The causes of Bang's disease (infectious abortion) and related diseases of the reproductive organs of cattle (Reorganized) (Co-operative with the Divisions of Agricultural Biochemistry and Dairy Husbandry) (Adams project) (C. P. Fitch, A. L. Delez, W. L. Boyd, C. R. Donham)

Subproject.—The relation of the mineral content of the ration to reproduction in cattle (Joint project with Agricultural Biochemistry Project No. 205 and Dairy Husbandry Project No. 106)

Subproject.—The serological tests and their relation to infectious abortion, or Bang's disease (Co-operative with the United States Department of Agriculture Bureau of Animal Industry)

Subproject.—Corpus luteum and its relation to breeding efficiency in cattle

Subproject.—Biological requirements of *Bact. abortus*

Subproject.—Relation of *Bact. abortus* Bang to arthritis in cattle

Subproject.—Comparative changes in the reproductive organs in cows following parturition or abortion

Subproject.—A study of animals that have been infected with *Bact. abortus* Bang and have ceased to react to the agglutination test for this disease (Dormant)

Subproject.—A study of *Bact. abortus* Bang and its relation to poll-evil and fistula of horses

Subproject.—Significance of *Bact. abortus* Bang in the udder of cows, with especial reference to its importance as a source of the spread of the disease (Dormant)

Subproject.—The bull as a factor in the spread of infectious abortion and sterility

105. Investigation of obscure diseases (Co-operative with the Divisions of Agricultural Biochemistry and Dairy Husbandry, and with the Minnesota State Livestock Sanitary Board) (R. Fenstermacher, A. L. Delez, W. L. Boyd, H. C. H. Kernkamp, C. R. Donham, W. L. Nilson C. P. Fitch)

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

109. Bacillary white diarrhea (Co-operative with the Division of Poultry Husbandry) (Purnell project) (C. P. Fitch, H. C. H. Kernkamp) (Closed)

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, (4) reliability and adaptability of the rapid agglutination test

Subproject.—Location of the germ in the body of the individual

Subproject.—Transmission of pullorum disease between infected and non-infected adult birds (New)

Subproject.—The time in which antibodies can be demonstrated in the blood after artificial infection (New)

Subproject.—Studies on some of the physico-chemical properties of the blood of infected and noninfected birds (New)

110. Study of the chemical and cellular composition of the blood of cattle affected with Bang abortion disease (W. L. Nilson, C. P. Fitch) (New)

General

101. Rural living in Minnesota (Dormant)

103. Farmers' retail trading towns and trading basins (Co-operative with the University of Minnesota School of Business, the Division of Farm Management and Agricultural Economics, and the Municipal Reference Bureau) (C. C. Zimmerman)

North Central Experiment Station

101. Study of soils (Co-operative with the Division of Soils) (O. I. Bergh)

Subproject.—Modified phosphate manure

Subproject.—Peat as a nitrogen fertilizer combined with potash and phosphate

Subproject.—Rate of stable manure application

Subproject.—Commercial fertilizer

Subproject.—Truck-crop fertilizer

102. Management of the dairy herd (O. I. Bergh)

Subproject.—Breeding for type and production

103. Potato investigations (O. I. Bergh)

Subproject.—Variety tests
Subproject.—Thickness of planting
Subproject.—Time of planting
Subproject.—Fertilizer for potatoes
Subproject.—Potato seedling trials

104. Experiments with small grains (Co-operative with the Division of Agronomy and Plant Genetics) (O. I. Bergh)

Subproject.—Variety tests of wheat, spring and winter oats, barley, rye, flax, and peas
Subproject.—Time of planting winter wheat and winter rye
Subproject.—Rate of planting winter wheat and winter rye

106. Alfalfa and sweet clover investigations (O. I. Bergh)

Subproject.—Variety tests
Subproject.—Nurse crop vs. no nurse crop for alfalfa
Subproject.—Rate of planting
Subproject.—Lime vs. no lime for alfalfa and sweet clover

107. Forage crop investigations (O. I. Bergh)

Subproject.—Corn
Subproject.—Sunflowers
Subproject.—Late planted annual forage crops
Subproject.—Reed canary grass

108. Garden crop investigations (O. I. Bergh)

Subproject.—Variety tests
Subproject.—Fertilizers
Subproject.—Onion maggot control

109. Variety tests of apples, crabs, plums, cherries, and plum cherries (O. I. Bergh)

110. Bush and vine fruits (O. I. Bergh)

Subproject.—Variety tests of raspberries, blackberries, dewberries, gooseberries, currants, highbush cranberries, blueberries, strawberries, and grapes

111. Forest experiments (O. I. Bergh)

Subproject.—Windbreaks
Subproject.—Reforestration
Subproject.—Arboretum

112. Peat for barn litter (O. I. Bergh)

113. Weather record (O. I. Bergh)

114. Experiments on muskeg soil (Co-operative with the Division of Soils) (O. I. Bergh)

Subproject.—Liming native muskeg

115. Poultry feeding and management (O. I. Bergh)

Subproject.—Poultry feeding experiments
Subproject.—Culling experiment
Subproject.—Trap-nesting
Subproject.—Artificial lights

116. Bees (Co-operative with the Division of Entomology and Economic Zoology) (O. I. Bergh)

Subproject.—Honey production records
Subproject.—Influence of bees upon yield of alsike clover seed

Northeast Experiment Station

101. Investigations of farm crop production (Co-operative with the Division of Agronomy and Plant Genetics) (M. J. Thompson)

Subproject.—Grain variety tests
Subproject.—Legume studies
Subproject.—Hay crops, non-legume studies
Subproject.—Rotations
Subproject.—Corn improvement
Subproject.—Sunflower improvement
Subproject.—Crop succession
Subproject.—Outlying field tests
Subproject.—Seeding practices
Subproject.—Miscellaneous

102. Experiments in general horticulture (Co-operative with the Division of Horticulture) (M. J. Thompson)

Subproject.—Co-operative orchard experiment (Old)
Subproject.—Co-operative orchard experiment (New)
Subproject.—Garden fertilization
Subproject.—Variety testing (small fruits)
Subproject.—Variety testing (vegetables)
Subproject.—Windbreak

103. Investigations in potato culture (Co-operative with the Division of Horticulture) (M. J. Thompson)

Subproject.—Variety tests
Subproject.—Spray studies
Subproject.—Rotations
Subproject.—Small uncut vs. large cut seed
Subproject.—Seed-end cut
Subproject.—Complete fertilizer
Subproject.—Potato breeding plots
Subproject.—Cultivation studies
Subproject.—Rate of manuring
Subproject.—Clover utilization
Subproject.—Continuous cropping
Subproject.—Mosaic determinations
Subproject.—Crop succession

104. Investigations in animal husbandry (Co-operative with the Division of Veterinary Medicine) (M. J. Thompson)

Subproject.—Heifers on roughage and pasture
Subproject.—Abortion control through the blood test and isolation method
Subproject.—Quack grass control with sheep

105. Studies in soil fertility (Co-operative with the Division of Soils) (M. J. Thompson)

Subproject.—Continuous cropping without clover or manure
Subproject.—Rate of manuring
Subproject.—Complete fertilizers on potatoes, grain, hay
Subproject.—Clover utilization
Subproject.—Garden fertilization
Subproject.—Pasture fertilization
Subproject.—Lime
Subproject.—Sunflower fertilization
Subproject.—Rutabaga fertilization
Subproject.—Fertilizer work (Co-operative with County Club)

107. Studies in stoning land (Co-operative with the Division of Agricultural Engineering) (M. J. Thompson)

Subproject.—Studies in frost and erosion in exposing stone
Subproject.—Studies in stone exposure in cultivated and cropped fields

108. Studies in bee management in northeastern Minnesota (Co-operative with the Division of Entomology and Economic Zoology) (M. J. Thompson)

Subproject.—Relation of daily honey production to temperature, precipitation, and season, or date
Subproject.—The influence of bees in clover fertilization

Northwest Experiment Station

101. Potato investigations (T. M. McCall)

Subproject.—Variety testing
Subproject.—Tuber and leaf diseases
Subproject.—Methods of planting
Subproject.—Fertilizer tests
Subproject.—Seed selection
Subproject.—Rotation tests

102. Tree, shrub, and flower investigations (T. M. McCall)

Subproject.—Growth and hardiness tests of ornamental and windbreak trees
Subproject.—Variety and hardiness tests of ornamental shrubs and vines
Subproject.—Variety and hardiness tests of perennial and other flowers

103. Root crop investigations (T. M. McCall)

Subproject.—Variety tests of mangels
Subproject.—Variety tests of stock carrots

Subproject.—Variety tests of rutabagas
Subproject.—Variety tests of turnips
Subproject.—Variety tests of sugar beets

104. Garden crop investigations (T. M. McCall)

107. The residual effect of phosphate fertilizer with and without manure on alfalfa (Co-operative with the Division of Soils) (R. S. Dunham, T. M. McCall)

109. Crop rotation and soil management studies (R. S. Dunham)

Subproject.—Continuous cropping of corn
Subproject.—Continuous cropping of wheat alone, and wheat with red clover
Subproject.—Comparison of sweet clover and cultivated crops for weed control in rotations

110. Varietal tests of corn and source-of-seed investigations (Co-operative with the Division of Agronomy and Plant Genetics) (R. S. Dunham)

113. Fruit investigations (T. M. McCall)

Subproject.—Variety and hardiness tests of tree fruits
Subproject.—Variety and hardiness tests of small fruits

133. Fattening beef calves for market (O. M. Kiser)

134. Hogging-off feeds (O. M. Kiser) (Closed)

140. Grain fattening two-year-old steers on (a) sweet clover pasture, (b) dry lot on sweet clover hay (O. M. Kiser)

141. Chick feeding methods (A. M. Pilkey)

142. Grain rations for egg production (A. M. Pilkey)

143. Studies on embryonic mortality in the fowl (Co-operative with the Division of Poultry Husbandry) (A. M. Pilkey)

144. Varietal improvement and studies on the fertilizing value of sweet clover (Co-operative with the Divisions of Agronomy and Plant Genetics and Soils) (R. S. Dunham)

145. Swine-breeding investigations (O. M. Kiser)

146. Varietal improvement in rye (Co-operative with the Division of Agronomy and Plant Genetics) (R. S. Dunham)

147. Varietal improvement in barley (Co-operative with the Division of Agronomy and Plant Genetics) (R. S. Dunham)

148. Varietal improvement in spring wheat (Co-operative with the Divisions of Agronomy and Plant Genetics and Plant Pathology and Botany) (R. S. Dunham)

149. Varietal improvement in winter wheat (Co-operative with the Division of Agronomy and Plant Genetics) (R. S. Dunham)

150. Varietal improvement in oats (Co-operative with the Divisions of Agronomy and Plant Genetics and Plant Pathology and Botany) (R. S. Dunham)

151. Varietal improvement in alfalfa and source-of-seed investigations (Co-operative with the Division of Agronomy and Plant Genetics) (R. S. Dunham)

152. Varietal improvement in flax (Co-operative with the Divisions of Agronomy and Plant Genetics and Plant Pathology and Botany) (R. S. Dunham)

153. Forage and pasture crop investigations (Co-operative with the Division of Agronomy and Plant Genetics) (R. S. Dunham)

154. Methods of eradicating perennial weeds (Co-operative with the Division of Agronomy and Plant Genetics) (R. S. Dunham)

Subproject.—Trials of sodium arsenate, sodium chlorate, potassium chlorate, sodium di-sulphate, sodium bi-chromate, borax, and Altacide

Subproject.—Cultivation trials

Subproject.—Rotation trials

Southeast Experiment Station

101. Inbreeding of swine as a basis for improvement (Co-operative with the Division of Animal Husbandry) (R. E. Hodgson)

102. Cultural methods when biennial sweet clover is used as a green manure crop (Co-operative with the Division of Agronomy and Plant Genetics) (R. E. Hodgson)

103. Increasing yields and decreasing costs of ensilage corn (Co-operative with the Division of Agronomy and Plant Genetics) (R. E. Hodgson)

104. Investigations in cereal breeding (Co-operative with the Division of Agronomy and Plant Genetics) (R. E. Hodgson)

105. Corn breeding investigations (Co-operative with the Division of Agronomy and Plant Genetics) (R. E. Hodgson)

107. Orchard and small fruit trials (Co-operative with the Division of Horticulture) (R. E. Hodgson)

108. Pure seed production and distribution (Co-operative with the Division of Agronomy and Plant Genetics) (R. E. Hodgson)

109. Growth studies of windbreaks and shade trees adapted to Minnesota conditions (Co-operative with the Division of Forestry) (R. E. Hodgson)

110. Maintaining a herd of grade Milking Shorthorns to observe the production of beef and butterfat under farm conditions (R. E. Hodgson)

111. Sugar-beet investigations (Co-operative with the Division of Agronomy and Plant Genetics) (R. E. Hodgson)

112. Flax investigations (Co-operative with the Division of Agronomy and Plant Genetics) (R. E. Hodgson)

113. Perennial weed eradication (Co-operative with the Division of Agronomy and Plant Genetics) (R. E. Hodgson)

114. Phalaris investigations (Co-operative with the Division of Agronomy and Plant Genetics) (R. E. Hodgson)

West Central Experiment Station

101. Bush and tree fruit investigations (J. A. Anderson)

103. Crop rotation experiments (Co-operative with the Divisions of Agronomy and Plant Genetics and Soils) (R. O. Bridgford)

Subproject.—The utilization of sweet clover in a four-year rotation of corn, wheat, barley, clover

Subproject.—An eight-year rotation without manure, including four years of cereal crops and four years of alfalfa (Closed)

Subproject.—The use of barnyard manure applied at rates varying from 0 to 32 tons per acre upon a four-year rotation of corn, wheat, barley, clover (Closed)

Subproject.—The use of crop residues applied at rates varying from 0 to 2 tons per acre upon a rotation of corn and wheat

Subproject.—A three-year rotation of oats, clover, and corn, applying 6 tons of manure per acre preceding corn

Subproject.—A five-year rotation of oats, clover hay, timothy and clover hay, corn, and wheat, applying 10 tons of manure preceding corn

104. Varietal improvement in spring wheat, oats, barley, and flax (Co-operative with the Division of Agronomy and Plant Genetics) (R. O. Bridgford)

106. Phosphate fertilizer investigations (Co-operative with the Division of Soils) (R. O. Bridgford)

107. Productivity in quantity of carefully selected seed of recommended varieties of farm crops (Co-operative with the Division of Agronomy and Plant Genetics) (R. O. Bridgford)

109. The testing of trees and ornamentals for western Minnesota conditions (J. A. Anderson)

110. Farm crops investigations (Co-operative with the Division of Agronomy and Plant Genetics) (R. O. Bridgford)

111. Sheep and lamb feeding investigations (Co-operative with the Division of Animal Husbandry) (P. S. Jordan)

112. Poultry feeding investigations (A. W. Edson)

113. Quack grass eradication with sodium chlorate (Co-operative with the Division of Agronomy and Plant Genetics) (A. C. Arny)

SUMMARY OF PROJECTS

Division	Number of projects				
	Total	Active	Dormant	New	Closed
Agricultural Biochemistry	16	14	2	1	0
Agricultural Engineering	21	15	6	4	3
Agronomy and Plant Genetics	23	23	0	16	0
Animal Husbandry	8	7	1	4	3
Dairy Husbandry	12	10	2	0	2
Entomology and Economic Zoology	25*	20	5	1	1
Farm Management and Agricultural Economics	21	19	2	4	1
Forestry	20	15	5	6	2
Home Economics	8	7	1	2	2
Horticulture	17	16	1	1	1
Plant Pathology and Botany	22	20	2	0	1
Poultry Husbandry	6	3	3	1	0
Soils	10	10	0	0	0
Veterinary Medicine	7	6	1	1	4
General	2	1	1	0	0
North Central Experiment Station	15	15	0	0	0
Northeast Experiment Station	7	7	0	0	0
Northwest Experiment Station	24	24	0	0	1
Southeast Experiment Station	13	13	0	0	0
West Central Experiment Station	10	10	0	0	0
Total	287	255	32	41	21

* One revived.

FINANCIAL STATEMENT

Revenue

Source of Revenue	University Farm	Branch Stations						Total Revenue
		Crookston	Morris	Grand Rapids	Duluth	Waseca	Zumbra Heights	Albert Lea	
Federal									
Hatch fund	$ 15,000.00	.....	.....	.....	.....	.....	.....	.....	$ 15,000.00
Adams fund	15,000.00	.....	.....	.....	.....	.....	.....	.....	15,000.00
Purnell fund	60,000.00	.....	.....	.....	.....	.....	.....	.....	60,000.00
State									
General University support	133,308.79	17,243.24	18,027.69	$11,769.40	$ 9,363.52	$ 8,483.59	$ 9,171.23	$2,713.62	210,081.08
Special state appropriations	40,350.00	.....	.....	.....	.....	.....	.....	.....	40,350.00
Endowments, fellowships, and other similar grants	53,516.00	.....	.....	.....	.....	.....	.....	.....	53,516.00
Sales and miscellaneous	35,232.30	24,569.92	22,624.74	7,191.55	6,417.16	4,067.31	2,737.94	.....	102,840.92
Total	$352,407.09	$41,813.16	$40,652.43	$18,960.95	$15,780.68	$12,550.90	$11,909.17	$2,713.62	$496,788.00

FINANCIAL STATEMENT

Expenditures

Classification	University Farm	Branch Stations: Crookston	Morris	Grand Rapids	Duluth	Waseca	Zumbra Heights	Albert Lea	Total Expend-itures
Salaries and labor	$244,583.74	$25,009.42	$22,842.69	$10,704.59	$ 8,887.13	$ 8,367.84	$ 8,653.34	$2,484.74	$331,533.49
Stationery and office supplies	1,776.54	351.64	252.56	163.80	38.71	14.77	27.11	......	2,625.13
Scientific supplies	10,117.10	1,039.32	203.64	235.58	52.02	49.07	138.36	59.92	11,894.91
Feeding stuffs	12,147.54	3,938.34	3,023.22	2,005.78	2,196.77	997.89	151.50	.84	24,461.88
Sundry supplies	5,363.18	2,080.39	3,842.03	1,984.69	994.25	913.13	827.97	45.17	16,050.81
Fertilizers	384.72	.67	......	32.37	......	83.18	41.25	......	542.19
Communication service	2,699.88	294.96	342.35	124.44	164.73	76.24	60.71	2.25	3,765.56
Travel expense	11,312.29	789.82	1,194.55	584.62	980.98	526.90	382.11	223.37	15,994.64
Transportation of things	584.71	547.77	591.51	232.69	66.42	80.50	66.08	20.00	2,189.68
Publications	7,733.39	457.54	339.60	194.25	112.37	7.88	6.75	......	8,851.78
Heat, light, water, power	11,920.05	1,682.11	2,425.08	958.20	654.62	544.75	558.63	......	18,643.44
Furniture, furnishings, fixtures	1,098.03	165.35	205.13	82.84	115.08	......	20.92	35.64	1,722.99
Library	1,813.37	264.68	351.31	106.81	......	13.80	......	......	2,549.97
Scientific equipment	2,155.00	......	16.71	19.35 cr.	......	......	......	177.07 cr.	1,975.29
Livestock	3,632.52	632.91	1,952.80	176.82	364.88	372.19	375.00	......	7,507.12
Tools, machinery, appliances	13,721.49	795.74	554.12	1,125.82	697.93	279.64	565.87	......	17,740.61
Buildings and lands	19,923.64	3,480.73	2,198.58	153.65	346.52	57.51	61.67	......	26,222.30
Contingent	1,439.90	281.87	316.55	113.35	108.27	165.61	71.90	18.76	2,516.21
Total	$352,407.09	$41,813.16	$40,652.43	$18,960.95	$15,780.68	$12,550.90	$11,909.17	$2,713.62	$496,788.00

EXPERIMENT STATION STAFF

The Board of Regents

The Hon. Fred B. Snyder, Minneapolis - - - - - - - - 1935
The President of the Board
Lotus D. Coffman, Minneapolis - - - - - - - - *Ex Officio*
The President of the University
The Hon. Theodore Christianson, St. Paul - - - - - *Ex Officio*
The Governor of the State
The Hon. J. M. McConnell, St. Paul - - - - - - *Ex Officio*
The Commissioner of Education
The Hon. W. J. Mayo, Rochester - - - - - - - - - 1935
The Hon. Bess M. Wilson, Minneapolis - - - - - - - 1933
The Hon. George H. Partridge, Minneapolis - - - - - - 1931
The Hon. Egil Boeckmann, St. Paul - - - - - - - - 1933
The Hon. John G. Williams, Duluth - - - - - - - - 1935
The Hon. Samuel Lewison, Canby - - - - - - - - - 1933
The Hon. Julius A. Coller, Shakopee - - - - - - - - 1931
The Hon. J. E. G. Sundberg, Kennedy - - - - - - - - 1931
The Hon. L. O. Teigen, Jackson - - - - - - - - - 1935
The Hon. W. H. Gemmell, Brainerd - - - - - - - - 1933
The Hon. A. J. Olson, Renville - - - - - - - - - 1931

The Agricultural Committee

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The Hon. J. M. McConnell
The Hon. W. H. Gemmell
The Hon. Bess M. Wilson
The Hon. Samuel Lewison
President L. D. Coffman

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
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
William Boss, Chief, Division of Agricultural Engineering
H. K. Hayes, D.Sc., Chief, Division of Agronomy and Plant Genetics

W. H. PETERS, M.Agr., Chief, Division of Animal Husbandry
C. H. ECKLES, M.S., D.Sc., Chief, Division of Dairy Husbandry
R. N. CHAPMAN, Ph.D., Chief, Division of Entomology and Economic Zoology
O. B. JESNESS, Ph.D., Chief, Division of Farm Management and Agricultural Economics
H. SCHMITZ, Ph.D., Chief, Division of Forestry
*WYLLE B. MCNEAL, M.A., Chief, Division of Home Economics
W. H. ALDERMAN, B.S.A., Chief, Division of Horticulture
E. M. FREEMAN, Ph.D., Chief, Division of Plant Pathology and Botany
A. C. SMITH, B.S., Chief, Division of Poultry Husbandry
F. J. ALWAY, Ph.D., Chief, Division of Soils
C. P. FITCH, M.S., D.V.M., Chief, Division of Veterinary Medicine

* On leave, July 1, 1929 to May 31, 1930.

Division of Agricultural Biochemistry

R. A. GORTNER, Ph.D., Agricultural Biochemist

Section of Proteins and Colloids

R. A. GORTNER, Ph.D., Agricultural Biochemist
W. M. SANDSTROM, Ph.D., Assistant Biochemist
H. B. BULL, Ph.D., Assistant Biochemist
S. I. ARONOVSKY, Ph.D., Cloquet Wood Products Fellow
RACHEL RUDE, A.B., Assistant

Section of Cereal Technology and Analytical Service

C. H. BAILEY, Ph.D., Agricultural Biochemist
R. C. SHERWOOD, Ph.D., Assistant Biochemist
A. L. SOMMER, Ph.D., Institute of American Meat Packers Fellow
LAWRENCE ZELENY, Ph.D., Institute of American Meat Packers Fellow
G. S. TAYLOR, B.A., Analyst
M. C. MARKLEY, Ch.E., Research Assistant
C. L. BROOKE, Pillsbury Flour Mills Company Fellow
OSCAR SKOVHOLT, B.S., American Dry Milk Institute Fellow
L. P. KARACSONYI, Dr.Eng., Fleischman Fellow
J. W. READ, M.S., Strietmann Fellow

Section of Plant Chemistry

C. F. ROGERS, M.S., Assistant Biochemist
I. D. JONES, A.B., Assistant

Section of Nutrition and Dairy Chemistry

L. S. PALMER, Ph.D., Dairy Chemist
CORNELIA KENNEDY, Ph.D., Assistant Agricultural Biochemist
H. P. MORRIS, Ph.D., Research Assistant
H. F. WIESE, M.S., Hormel and Company Fellow
O. E. MYDLAND, Animal Caretaker

Division of Agricultural Engineering

WILLIAM BOSS, Agricultural Engineer

Section of Farm Machinery

*A. J. SCHWANTES, M.S. in A.E., Assistant Agricultural Engineer
J. B. TORRANCE, B.S. in Agr., Assistant Agricultural Engineer
JULIUS ROMNES, B.S., Assistant Agricultural Physicist
A. G. TYLER, B.S. in M.E., Assistant Agricultural Physicist
J. G. DENT, Assistant in Farm Mechanics

Section of Farm Structures

H. B. WHITE, M.S., Assistant Agricultural Engineer
C. L. BERGGREN, B.S. in Agr., Assistant in Farm Structures
L. W. NEUBAUER, B.S. in C.E., Assistant in Farm Structures

Section of Reclamation

H. B. ROE, B.S. in Engr., Agricultural Engineer
J. H. NEAL, M.S. in Soils, Assistant in Reclamation
P. W. MANSON, B.S. in C.E., Assistant in Drainage
G. F. KROGH, Assistant in Reclamation

Representative of the United States Department of Agriculture Bureau of Public Roads

D. G. MILLER, C.E., Drainage Engineer

Section of Land Clearing

M. J. THOMPSON, M.S., Associate in Land Clearing
L. H. SCHOENLEBER, M.S. in A.E., Assistant in Land Clearing

Representative of the United States Department of Agriculture Bureau of Public Roads

N. A. KESSLER, B.S. in For., Land Clearing Specialist

* On leave, March 7 to June 7, 1930.

Division of Agronomy and Plant Genetics

H. K. HAYES, D.Sc., Plant Geneticist
A. C. ARNY, M.S., Associate Agronomist
*H. E. BREWBAKER, Ph.D., Assistant Plant Geneticist
F. J. STEVENSON, Ph.D., Assistant Plant Geneticist
H. K. WILSON, Ph.D., Assistant Agronomist
R. F. CRIM, B.S., Extension Specialist in Agronomy
F. R. IMMER, Ph.D., Assistant in Plant Genetics
C. W. DOXTATOR, B.S., Assistant in Plant Genetics
L. R. POWERS, M.S., Assistant in Plant Genetics
C. L. ALEXANDER, Assistant in Plant Genetics
S. M. RALEIGH, B.S., Assistant in Agronomy
W. E. HAINES, B.S., Assistant in Agronomy
I. J. JOHNSON, M.S., Assistant in Agronomy
H. L. THOMAS, M.S., Minnesota Valley Canning Company Fellow
A. D. HAEDECKE, Assistant in Agronomy

Representative of the United States Department of Agriculture Bureau of Plant Industry

E. R. AUSEMUS, M.S., Associate Agronomist

* Resigned June 30, 1930.

Division of Animal Husbandry

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

Section of Horse Husbandry

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., Animal Husbandman
*M. A. MCCARTY, M.S., Assistant Animal Husbandman

Section of Sheep Husbandry

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

Section of Animal Breeding

L. M. WINTERS, M.S., Associate Animal Husbandman

* Resigned September 15, 1929.

Division of Dairy Husbandry

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

Section of Dairy Production

C. H. ECKLES, M.S., D.Sc., Dairy Husbandman
W. E. PETERSEN, Ph.D., Associate Dairy Husbandman
T. W. GULLICKSON, M.S., Assistant Dairy Husbandman
N. N. ALLEN, JR., B.S., Assistant Dairy Husbandman

Section of Dairy Products

W. B. COMBS, M.A., Dairy Husbandman
H. B. MORRISON, B.S., Assistant in Dairy Husbandry
E. O. HERREID, M.S., Assistant in Dairy Husbandry
A. T. MILLER, B.S., Assistant in Dairy Husbandry
E. F. HUBBARD, B.S., Assistant in Dairy Husbandry

Section of Dairy Bacteriology

HAROLD MACY, Ph.D., Associate Bacteriologist
G. H. STEELE, B.S., Assistant in Dairy Husbandry

Division of Entomology and Economic Zoology

*R. N. CHAPMAN, Ph.D., Entomologist
W. A. RILEY, Ph.D., Entomologist and Parasitologist
A. G. RUGGLES, M.A., Entomologist

M. C. TANQUARY, Ph.D., Apiculturist
†FILIPPO SILVESTRI, Ph.D., Entomologist
C. E. MICKEL, Ph.D., Assistant Entomologist
*M. S. JOHNSON, Ph.D., Assistant Zoologist
A. L. STRAND, Ph.D., Assistant Entomologist
‡J. D. WINTER, M.S., Assistant Entomologist
H. G. AHRENS, M.S., Assistant in Bee Culture
H. L. PARTEN, B.S., Extension Specialist in Entomology
E. W. JONES, B.A., Assistant in Entomology
L. D. CHRISTENSEN, B.S., Assistant in Entomology
J. STANLEY, M.S., Assistant in Entomology
H. C. DONOHOE, M.S., Assistant in Entomology
R. C. HALL, M.F., Assistant in Entomology
C. T. SCHMIDT, B.S., Assistant in Entomology
H. E. GRAY, M.S., Assistant in Entomology
ERDMAN BRAUN, B.S., Assistant in Entomology
*LILLIAN BAIRD, B.S., Assistant in Entomology
FRANCIS MUNGER, B.A., Assistant in Entomology

* Resigned June 30, 1930.
† Appointed April 1, 1930.
‡ Appointed September 1, 1929.

Division of Farm Management and Agricultural Economics

O. B. JESNESS, Ph.D., Agricultural Economist
ANDREW BOSS, D.Sc., Agricultural Economist
*W. C. WAITE, Ph.D., Agricultural Economist
G. A. POND, Ph.D., Associate Agricultural Economist
E. C. JOHNSON, Ph.D., Associate Agricultural Economist
L. B. BASSETT, Associate Agricultural Economist
L. F. GAREY, M.S., Assistant Agricultural Economist
D. D. KITTREDGE, M.A., Assistant Agricultural Economist
†A. G. BLACK, Ph.D., Assistant Agricultural Economist
R. W. COX, Ph.D., Assistant Agricultural Economist
‡G. A. SALLEE, M.S., Research Assistant
W. P. RANNEY, M.S., Research Assistant
G. B. CLARKE, B.A., Research Assistant
C. L. WALLMARK, B.S., Research Assistant
E. A. JOHNSON, B.S., Research Assistant

* On sabbatical leave, July 1, 1929 to June 30, 1930.
† Resigned July 21, 1929.
‡ On leave, September 19, 1929 to February 11, 1930.

Division of Forestry

HENRY SCHMITZ, Ph.D., Forester
E. G. CHEYNEY, A.B., Forester
J. H. ALLISON, M.F., Forester
T. S. HANSEN, M.F., Assistant Forester
R. M. BROWN, M.S., Assistant Forester
L. W. REES, Ph.D., Assistant Forester
W. W. CHASE, M.S., Assistant in Forestry
RAPHAEL ZON, F.E., Director, Forest Experiment Station, Cloquet

Division of Home Economics

*W. B. McNeal, M.A., Home Economist
Alice Biester, A.M., Associate Home Economist
A. M. Child, M.A., Associate Home Economist
J. M. Leichsenring, Ph.D., Associate Home Economist
E. L. Phelps, M.S., Assistant Home Economist
L. A. Studley, M.A., Assistant Home Economist
Hortense Honig, B.S., Assistant in Home Economics

* On sabbatical leave, July 1, 1929 to May 31, 1930.

Division of Horticulture

W. H. Alderman, B.S. in Agr., Horticulturist
R. B. Harvey, Ph.D., Associate Horticulturist

Section of Pomology

W. G. Brierley, Ph.D., Associate Horticulturist

Section of Fruit Breeding

A. N. Wilcox, Ph.D., Assistant Horticulturist
B. H. Wilson, M.S., Assistant in Horticulture
Ernest Angelo, M.S., Assistant in Horticulture
F. E. Haralson, Assistant Superintendent Fruit Breeding Farm

Section of Vegetable Gardening

F. A. Krantz, Ph.D., Assistant Horticulturist
T. M. Currence, Ph.D., Assistant Horticulturist
A. G. Tolaas, M.A., Assistant Horticulturist
A. E. Hutchins, B.S., Assistant in Horticulture

Section of Floriculture and Ornamental Horticulture

L. E. Longley, M.S., Assistant Horticulturist
L. Sando, Assistant in Floriculture

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., Associate Plant Pathologist
*J. J. Christensen, Ph.D., Assistant Plant Pathologist
H. A. Rodenhiser, Ph.D., Assistant Plant Pathologist
Louise Dosdall, Ph.D., Mycologist
Helen Hart, PhD., Assistant Plant Pathologist
I. L. Forbes, M.S., Assistant in Plant Pathology
A. F. Verrall, M.S., Assistant in Plant Pathology
C. S. Holton, M.S., Assistant in Plant Pathology
C. C. Allison, B.S., Assistant in Plant Pathology
M. B. Moore, B.S., Assistant in Plant Pathology
C. Christensen, B.S., Assistant in Plant Pathology

F. H. Kaufert, B.S., Assistant in Plant Pathology
G. H. Starr, M.S., Minnesota Canners' Association Fellow

Section of Plant Physiology and Agricultural Botany

R. B. Harvey, Ph.D., Associate Plant Physiologist
L. O. Regeimbal, M.S., Assistant in Plant Physiology
H. Mitchell, Assistant in Plant Physiology
A. H. Larson, B.S., Assistant Botanist

Representatives of the United States Department of Agriculture
Office of Cereal Crops and Diseases

M. N. Levine, Ph.D., Pathologist
R. U. Cotter, Ph.D., Associate Pathologist
E. R. Ausemus, M.S., Associate Agronomist
R. H. Bamberg, M.S., Agent

* On sabbatical leave, October 1, 1929 to June 30, 1930.

Division of Poultry Husbandry

A. C. Smith, B.S., Poultry Husbandman
F. B. Hutt, Ph.D., Associate Poultry Husbandman
E. A. Johnson, B.S., Assistant in Poultry Husbandry

Division of Soils

F. J. Alway, Ph.D., Soils Chemist
C. O. Rost, Ph.D., Associate Soils Chemist
P. R. McMiller, M.S., Assistant Soils Chemist
Constantin Nikiforoff, Ph.D., Assistant in Soil Chemistry
G. H. Nesom, B.S., Assistant in Soils
R. M. Pinckney, Assistant
William Methley, Assistant
A. C. Libby, B.S., Field Assistant

Division of Veterinary Medicine

C. P. Fitch, M.S., D.V.M., D.Sc., Animal Pathologist and Bacteriologist
W. L. Boyd, D.V.S., Veterinarian
H C. H. Kernkamp, M.S., D.V.M., Associate Veterinarian
E. A. Hewitt, B.S., D.V.M., Assistant Veterinarian
R. Fenstermacher, D.V.M., Assistant Pathologist
A. L. Delez, M.S., D.V.M., Assistant Pathologist
C. R. Donham, M.S., D.V.M., Assistant Pathologist
W. L. Nilson, D.V.M., Assistant Veterinarian

General

C. C. Zimmerman, Ph.D., Rural Sociologist; special investigator in rural sociology

North Central Experiment Station

*O. I. Bergh, B.S.Agr., Superintendent

* Resigned June 30, 1930.

Northeast Experiment Station

M. J. THOMPSON, M.S., Superintendent

Northwest Experiment Station

*A. A. DOWELL, M.S., Superintendent
†M. A. MCCALL, B.S.Agr., Assistant Horticulturist
O. M. KISER, B.S.Agr., Assistant Animal Husbandman
D. H. LAVOI, B.S.Agr., Assistant Animal Husbandman
R. S. DUNHAM, B.S.Agr., Assistant Agronomist
A. M. PILKEY, Assistant in Poultry Husbandry
E. R. CLARK, B.S.Agr., Pure Seed Specialist

* On leave, April 1 to June 30, 1930.
† On leave, September 1, 1928 to August 31, 1929.

Southeast Experiment Station

R. E. HODGSON, M.S., Superintendent

West Central Experiment Station

P. E. MILLER, M.Agr., Superintendent
P. S. JORDAN, B.S.Agr., Assistant Animal Husbandman
A. W. EDSON, B.S., Assistant Poultry Husbandman
*R. O. BRIDGFORD, B.S.Agr., Assistant Agronomist
J. A. ANDERSON, B.S.Agr., Assistant Horticulturist

* On leave September 1, 1929, to August 31, 1930.