FORTY-EIGHTH ANNUAL REPORT

Agricultural Experiment Station
University of Minnesota

JULY 1, 1940 TO JUNE 30, 1941

UNIVERSITY FARM, ST. PAUL

LETTERS OF TRANSMITTAL

UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.
July 1, 1941

To His Excellency, Harold E. Stassen,
Governor of Minnesota.

SIR: I have the honor to transmit to you herewith the report of the Agricultural Experiment Station of the University of Minnesota for the fiscal year ending June 30, 1941.

Respectfully transmitted,
WALTER C. COFFEY,
Acting President of the Board of Regents

UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.
July 1, 1941

To the Honorable Board of Regents,
University of Minnesota.

GENTLEMEN: I have the honor to transmit herewith the report of the Director of the Agricultural Experiment Station of the University of Minnesota for the fiscal year ending June 30, 1941.

Respectfully transmitted,
WALTER C. COFFEY,
Acting President of the University of Minnesota

UNIVERSITY FARM, ST. PAUL, MINN.
July 1, 1941

Walter C. Coffey,
Acting President of the University of Minnesota.

SIR: I have the honor to submit herewith the report of the Agricultural Experiment Station for the fiscal year ending June 30, 1941.

Respectfully transmitted,
C. H. BAILEY, *Acting Director*

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FORTY-EIGHTH ANNUAL REPORT

MINNESOTA AGRICULTURAL EXPERIMENT STATION

JULY 1, 1940 TO JUNE 30, 1941

C. H. Bailey, Acting Director

FOREWORD

Agricultural experiment stations are continually changing certain of their programs and fields of investigations to fit the varying needs of the agricultural community which they serve. These changes result in part from natural causes, such as the appearance or increased ravages of plant and animal diseases or pests; in part from changing economic situations, reflected in altered land uses, and shifting commodity price levels. Each modification in the interests and needs of the farmers of the area is reflected in the program of study of the experiment stations and in the demands for facts and service which are made of them.

Not all of the experiment station activities change from year to year under these fluctuating pressures, however. Thus, certain programs in the breeding of plants and animals require extended periods of continuous work to bring them to fruition. Other research activities, as in the field of nutrition for example, must be sustained for a considerable time to yield reliable results. In fact, it is from these and other long-time programs that investigators derive those basic principles and discern those natural and economic laws which ultimately can be applied to the solution of immediate and changing needs.

A proper and healthy balance between these two types of technical and scientific investigations distinguishes the effective experiment station. Trained and far-sighted leaders of such work recognize these responsibilities of the stations and endeavor to mold and guide the programs of investigation in such a manner as to maintain this balance in current activities. Likewise, many members of the community recognize the same needs and bring intelligent support to the recommendations of the project leaders. As in other industries, so also in agriculture, a reasonable support of both types of researches leads to a stability and development of the industry that cannot be effected by any other means.

CHANGES IN STAFF

Appointments

F. H. Kaufert, Ph.D., as associate forester, Division of Forestry, effective July 1, 1940.

E. G. Sharvelle, Ph.D., as assistant plant pathologist, Division of Plant Pathology and Botany, effective October 1, 1939.

C. K. Otis, B.S., as assistant agricultural engineer, Division of Agricultural Engineering, effective October 21, 1940.

D. C. Quimby, M.S., as assistant in economic zoology, Division of Entomology and Economic Zoology, effective September 1, 1940.

Robert Jenness, M.S., as assistant in agricultural biochemistry, Division of Agricultural Biochemistry, effective September 16, 1940.

A. F. Sellers, V.M.D., as assistant in veterinary medicine, Division of Veterinary Medicine, effective October 1, 1940.

L. W. Krefting, M.S., as assistant in entomology, Division of Entomology and Economic Zoology, effective February 1, 1941.

A. C. Maack, B.S., as assistant in dairy husbandry, Division of Dairy Husbandry, effective February 1, 1941.

A. R. Schmid, M.S., as assistant in plant genetics, Division of Agronomy and Plant Genetics, effective May 16, 1941.

A. B. Erickson, M.S., as junior entomologist, Division of Entomology and Economic Zoology, effective August 16, 1939.

C. H. White, B.S., as junior forester, Division of Forestry, effective January 2, 1941.

Promotions

E. C. Stakman, Ph.D., plant pathologist to plant pathologist and botanist and chief, Division of Plant Pathology and Botany, effective July 1, 1940.

A. J. Schwantes, M.S., associate agricultural engineer to agricultural engineer and chief, Division of Agricultural Engineering, effective July 1, 1940.

G. A. Pond, Ph.D., associate agricultural economist to agricultural economist, Division of Agricultural Economics, effective July 1, 1940.

S. A. Engene, Ph.D., assistant in agricultural economics to assistant agricultural economist, Division of Agricultural Economics, effective July 1, 1940.

Leaves of Absence

E. C. Stakman, Ph.D., plant pathologist and chief, Division of Plant Pathology and Botany, without salary, to visit South America to investigate the rubber industry, August 16, 1940 to January 15, 1941.

R. L. Donovan, B.S., superintendent, North Central Experiment Station, with salary, November 16, 1940 to May 15, 1941, due to illness.

R. B. Harvey, Ph.D., plant physiologist, Division of Plant Pathology and Botany, sabbatical furlough March 16, 1941 to March 15, 1942.

H. H. Shepard, Ph.D., assistant entomologist, Division of Entomology and Economic Zoology, with salary, to continue research on insects infesting cereal and stored products at ports of entry and shipment, January 1 to March 31, 1941.

A. W. Edson, B.S., assistant poultry husbandman, West Central Experiment Station, with salary, August 1 to September 30, 1940, because of illness.

Gustav Swanson, Ph.D., assistant in economic zoology, Division of Entomology and Economic Zoology, without salary, for research with the United States Department of the Interior, Fish and Wildlife Service, February 16, 1941 to February 15, 1942.

J. C. Olson, Jr., B.S., assistant in dairy husbandry, Division of Dairy Husbandry, without salary, for military service January 16 to December 15, 1941.

L. L. Kempe, M.S., associate chemist, Division of Soils, without salary, for military service June 1, 1941 to May 31, 1942.

Resignations

R. L. Donovan, B.S., Superintendent of the North Central Experiment Station, because of illness, effective June 30, 1941.

D. M. Hatfield, Ph.D., assistant in entomology, Division of Entomology and Economic Zoology, to accept a position with the Chicago Academy of Science, effective August 31, 1940.

L. W. Neubauer, M.S., assistant in agricultural engineering, Division of Agricultural Engineering, to accept an appointment as assistant agricultural engineer, Department of Agricultural Engineering, University of California, Davis, effective September 15, 1940.

D. W. Johnson, Ph.D., assistant in animal husbandry, Division of Animal and Poultry Husbandry, to engage in farming at Perry, Iowa, effective March 31, 1941.

H. K. Schultz, Ph.D., assistant in agronomy and plant genetics, Division of Agronomy and Plant Genetics, to accept an appointment as assistant agronomist in the University of Idaho Agricultural Experiment Station at Moscow, effective May 15, 1941.

G. S. Taylor, B.A., analyst, Division of Agricultural Biochemistry, because of illness, effective August 31, 1940.

Margaret V. Davis, M.S., junior scientist, Division of Home Economics, to accept a position as instructor of home economics at Connecticut State College for Women, effective September 15, 1940.

Retirement

Louis Sando, assistant in floriculture, Division of Horticulture, effective June 30, 1941.

PUBLICATIONS

The following list includes reports, bulletins, and papers published during the year in the several regularly organized Experiment Station series.

Because they relate largely to results of researches and are of interest to readers of Experiment Station publications, a list is included also of publications of the Agricultural Extension Division.

General Bulletin Series

351. Minnesota cooperative oil associations. E. Fred Koller and O. B. Jesness, Division of Agricultural Economics. 58 pages, 10,000.

From 1921 to 1939 the number of cooperative oil associations in Minnesota increased from one to 189. These organizations handled 83 million gallons of light oils during 1939, which was about 10.6 per cent of the total volume handled by all companies in the state. This study of the organization structure, financial condition, operating methods, and operating efficiency of cooperative oil associations is based on data obtained from 92 associations selected from all parts of the state and operating under a wide range of conditions. The sales of these cooperatives averaged $69,627 in 1939. The net income on this volume of business averaged $4,449 per association, or 6.39 per cent of net sales. The net income of individual associations varied from a high of 13.89 per cent of sales to a net loss of 4.14 per cent. Comparison of the 20 highest return associations with the 20 lowest return associations showed that those with the highest returns had (1) larger annual sales, (2) higher gross margins, and (3) lower operating expenses per dollar of sales than either the lowest return or average associations. These organizations have enabled their members to effect worthwhile savings in purchasing petroleum and other farm supplies. While significant progress has been made, this study shows numerous ways in which the business methods and operating policies of these organizations may be improved.

352. Livestock auctions in Minnesota. A. A. Dowell and G. Engelman, Division of Agricultural Economics. 40 pages, 6,000.

Rapid expansion in the number of auction markets for the sale of commercial livestock has taken place in Minnesota since 1932. The number of active auctions increased from two in 1932 to a peak of 52 in July, 1940, and then declined slightly to 45 at the end of 1940. Most of these markets are in the southern half of the state, with the greatest concentration in the southwestern area.

The volume of livestock handled per auction market during 1938 varied from 1,251 head of all species combined to 20,956 with an average for the 22 markets studied of 7,247. Cattle and calves constituted 51 per cent of all animals sold, hogs 34 per cent, sheep and lambs 12 per cent, and horses and mules 3 per cent. The seasonal distribution of receipts varied considerably among the different species and classes of livestock.

The bulletin includes a discussion of the organization and operation of auction markets in Minnesota. One section is devoted to a discussion of public regulation of auctions, and the concluding section is devoted to an appraisal of livestock auctions together with suggestions for improvement.

353. Farm tenancy in Minnesota. George A. Pond, Division of Agricultural Economics. 56 pages, 10,000.

Thirty-four per cent of the farms in Minnesota in 1935 were operated by tenants, 50 per cent by full owners, and 16 per cent by part owners. Forty-seven per cent of all farm land in the state was tenant operated. The percentage of tenant operators has increased steadily since first reported by the Federal Census in 1880. The largest proportion of tenant-operated farms is found in western Minnesota and the smallest in the northeastern part.

Twenty-two per cent of the rented land in Minnesota in 1936 was owned by corporations (mostly lending agencies), 46 per cent by farmers, widows of farmers, and local estates, 11 per cent by local nonfarmers, and 21 per cent by nonresident individuals and estates.

The average age of tenants is 41 years and the average length of their experience as tenants is 11 years. Nearly one third are related to their landlords.

The distribution of leases by type are crop-share cash, 44 per cent; cash, 30 per cent; livestock share, 14 per cent; and crop share, 12 per cent. Cash rentals varied from $4.60 per acre in the southwest to $0.92 in the northeast. The distribution of the share of the crop given as rent is one fourth, 4 per cent; one third, 41 per cent; two fifths, 13 per cent; and one half, 42 per cent.

Seventy per cent of the leases are written. Two thirds are effective in the spring and one third in the fall. March 1 and October 1 are the common dates on which leases are effective.

Eighty-two per cent of all leases are for one year. The average occupancy of present tenants is 4.6 years and 40 per cent have been on the same farm more than five years. More than 50 per cent of the tenants who move do so at their own volition.

Tenant operators have slightly less land in soil-building crops, a less desirable selection of crops, and less livestock, but they have larger farms, higher dairy production, and greater efficiency in the use of feed and labor as compared with owner operators. Their earnings are somewhat higher than those of owner operators.

The principal tenancy problems are quality of farming, equity of leases, and security of tenure.

354. Minhybrid corn varieties for Minnesota. H. K. Hayes, R. P. Murphy, E. H. Rinke, and Carl Borgeson, Division of Agronomy and Plant Genetics. 40 pages, 10,000.

A description was given of the breeding, characters, and performance of 14 double crosses of yellow endosperm (seed) color recently released by the Minnesota Agricultural Experiment Station. These new hybrids excel in yielding ability, in resistance to smut, and in ability to withstand lodging.

The adaptation of these new hybrids to one of the five maturity zones was determined by extensive yield trials comparing each of the new hybrids with one or more of the standard Minhybrids—401, 402, 301, and 403—and with open-pollinated varieties that were known to be adapted to particular sections of Minnesota.

Minhybrid 800, adapted to the Northern Zone, requires, on the average, 82 to 88 days from emergence of the seedlings until the corn on the ear is approximately at 40 per cent moisture content. Minhybrids 700, 701, and 702 are adapted to the North Central Zone, requiring 89 to 95 days for maturity. Minhybrids 600, 601, 602, 603, and 604 are adapted to the Central Zone designated as requiring

96 to 102 days for maturity. Minhybrids 500, 501, and 502 were described that are adapted to the South Central Zone requiring 103 to 109 days for maturity. Two new hybrids were described, Minhybrids 404 and 405, that are adapted to the Southern Zone requiring 110 to 116 days for maturity.

355. Date and rate of lawn seeding. L. E. Longley, Division of Horticulture. 8 pages, 5,000.

This bulletin records tests as to the best time of the year for seeding lawn grass and the best amounts of grass seed to use. The tests indicate that by using a Kentucky Bluegrass mixture containing also white clover, red top, and perennial rye grass, it is possible to obtain a good lawn at almost any time of the season provided sufficient moisture is present. But the best time was indicated to be August 15 to September 15. Very early in the season (May) did not seem quite as good, largely due to competition of annual weeds. The time of seeding affected the ultimate lawn in regard to the amount of clover present; that is, early and midseason seedings gave considerable clover during the second and third seasons' growth of the lawn but late seedings tended to give little clover in those seasons.

As to the rate of seeding, the data indicate that on good lawn soils three to four pounds per 1,000 square feet of a good Bluegrass mixture was the optimum amount. On poorer sandy soils a somewhat heavier seeding improved the stand. Also, on good lawn soil, if a turf was not needed until the second or third year, a much lighter seeding would suffice, to as low as 1½-2½ pounds per 1,000 square feet. So light a seeding gave a poor or only fair lawn the first or second seasons, becoming good by the third year.

356. Gourds—their culture, uses, identification, and relation to other Cucurbitaceae. A. E. Hutchins and L. Sando, Division of Horticulture. 36 pages, 7,500.

A discussion of a number of genera and species of the cultivated Cucurbitaceae with special attention given to those genera and species commonly designated as gourds. Information is given as to their adaptability to Minnesota conditions, culture, preparation for use, and uses. Considerable information is given in the form of descriptive material and photographs to enable the grower and gourd enthusiast to identify the various genera and species. Intercrossing between genera and species is discussed and a summarized table presenting the present knowledge of the chromosome numbers of various Cucurbitaceae is given.

Technical Bulletin Series

145. Some morphological and functional relationships of the bovine hypophysis. Lester O. Gilmore, W. E. Petersen, and A. T. Rasmussen, Division of Dairy Husbandry and Department of Anatomy. 56 pages, 2,000.

Hypophyses secured from animals considered normal and with known histories were studied for developmental changes in weight with age and producing ability, gross dimensions, ratio of anterior lobe to total weight, and certain histological features which included the epithelial cell types and innervation of the anterior lobe. The glands were removed at death or shortly after and were trimmed to a uniform degree before fixation in formalin. Histological sections were made from

glands dehydrated in dioxan and stained with Ehrlich's acid-hemotoxylin to bring out the nuclei after which azo-carmine was followed by Mallory's II for differential staining of cytoplasmic granules. The weight increase of the glands from the females showed a rapid increase from about .5 grams at birth until two years, after which there is a decreasing rate of increase. The glands obtained from 2½-year-old animals weighed four times as much as those obtained at birth. At 4½ years the indicated increase was over five times the birth weight. With males there is a tendency for the gland to grow at a more constant rate throughout rather than to level off at maturity. To some extent this difference corresponds to the difference in body growth between the sexes. A difference in hypophysis weight due to inheritance is indicated. The weights of glands from six freemartins were all below the nonfreemartins. To some extent at least this is accompanied by smaller body size.

No consistent difference between the relative hypophysis weight $\left(\frac{\text{hypophysis weight in mgms.}}{\text{body weight in kgms.}}\right)$ and producing ability was found. The general proportions of the hypophysis described that of an oval or oblong shaped body. The anterior lobe of the bovine gland is larger than the rest of the gland, the ratio for 20 glands averaging 77 per cent.

Histologically, a cone of Wulzen was found in several glands. Its presence apparently is not limited to breed, sex, or any particular post-natal age. The proportion of acidophiles, basophiles, and chromophobes was found to be 44.3, 7.0, and 48.7 for 12 females and 43.1, 5.8, and 51.1 for 22 males. Observations were made on two types of acidophiles with a possible relationship to sexual activity indicated.

Although nerve fibers were found in great numbers in the posterior lobe and were rather abundant in the intermediate lobe, none were found in the anterior lobe, even where it bordered the intermediate lobe.

146. Factors affecting the decreasing rate of flow of liquids through wood. Bror Ernest Anderson, Ross Aiken Gortner, and Henry Schmitz, Division of Agricultural Biochemistry and Division of Forestry. 70 pages, 2,000.

The electrokinetic potentials and rate of flow of various liquids through sections of northern white cedar (*Thuja occidentalis* L.) sapwood and heartwood, eastern hemlock (*Tsuga canadensis* L.) sapwood, jack pine (*Pinus banksiana* Lambert) sapwood, loblolly pine (*Pinus taeda* L.) sapwood, Norway pine (*Pinus resinosa* Solander) sapwood, tamarack (*Larix laricina* Kock) sapwood, white oak (*Quercus alba* L.) sapwood, and paper birch (*Betula papyrifera* Marshall) sapwood and heartwood, and other artificial systems (cloth pads, filter paper pads, microporous rubber, etc.) were studied.

The following conclusions were drawn:

The observed change in zeta potential with decreasing rate of flow (constant pressure) is in the opposite direction to that required for an electrokinetic explanation of the decreased flow. The decrease in potential appears to be a result rather than a cause of decreasing flow and, at least in the case of softwoods, to arise from a decreasing effective pore size. Our studies definitely indicate that the falling off of flow either through wood or through cellulose diaphragms is not primarily caused by electrokinetic effects.

When distilled water is followed by 0.1 N KCl solution, rate of flow may be increased by many times. Proportionately greater increases are obtained with the

diaphragms having the smaller capillary sizes. This fact has suggested the possibility that the percentage increase in rate with salt solutions could be used to estimate pore size.

The apparent zeta potential found for the pit membranes by the streaming method does not agree with that assumed by Stamm. His electroosmotic method of estimating pore size was based on hazardous assumptions, but the fair agreement in the results by different methods indicates that either the assumptions were not far from correct or else they involved compensating errors.

Variable increases in rate of flow upon first reversal of the direction have been frequently observed. Electrical conductivity measurements during flow have shown that, in all probability, the same cell lumens were used before and after the direction of flow was reversed. Pit aspiration does not appear to be a factor in volume changes upon direction of flow reversal.

The disproportionate increase in rate of flow through woods and diaphragms composed of cellulosic fibers or granular particles has been explained by the application of Bernoulli's theorem to the determination of the relative static pressures on different sides of the individual units composing the diaphragms. From these theoretical considerations it was shown that the larger capillaries would increase at the expense of the smaller ones, resulting in increased specific permeability at higher pressures.

Both by theory and experiment it has been shown that the specific permeability in a direction perpendicular to the main path of flow through a diaphragm tends to be decreased by an increase in pressure which simultaneously increases the specific permeability in the primary direction.

The decrease in rate of flow through cellulose diaphragms is brought about by a pivoting of the fibers on their longitudinal axis in such a manner that they offer a greater resistance to flow. The torques produced by motion of the liquid around fibers suspended across the path of flow are in equilibrium only when the orientation of the fibers is that which presents the greatest resistance to flow. The decrease in rate of flow through woods probably is largely due to a similar action in the structural units of the membrane.

When pressure is first applied to a wood section or cellulose diaphragm, two forces are active on its structural units: (a) the resultant of the unequal static pressures on the fibrous elements, which tends to increase rate of flow; and (b) the resultant of the torques on these units, which tends to decrease the rate of flow. During the first few minutes either of these may be dominant, so rate of flow may either increase or decrease. The forces of (a) reach equilibrium rapidly; with further penetration only the forces of (b) are active, so rate of flow always decreases.

When the logarithm of the rate of flow is plotted against the logarithm of the time of penetration, a rather straight line results after the forces of (a) have come to equilibrium. As long as our experiments were run (up to 30 hours in some cases), there was no evidence that an equilibrium of other than zero rate of flow was being approached in most softwoods or in cellulose diaphragms of not too loose structure.

The hypotheses developed in this section have been used successfully for the prediction of phenomena in flow through other materials.

147. Protein surveys of American hard spring and soft winter wheats. C. H. Bailey, Division of Agricultural Biochemistry. 46 pages, 2,500.

Distribution curves were drawn which show the percentage of 14 hard spring wheat crops from 1925 to 1938 which fell into each of the protein categories when the latter had a range of 0.5 per cent. In general the level of protein content mounted in progressing with time from the more humid period prior to 1929 into the drouth period that followed, and which reached its climax in 1936. Protein content was not perfectly correlated with rainfall by crop seasons, however, since soil moisture and other conditions were influenced by the precipitation in the preceding season or seasons.

Coefficients of variation of the shipments from individual shipping points in Minnesota averaged 1.14 for an average of 161 shipping points per season, and for four seasons. Thus if the average protein content of shipments from a single shipping point was 15.0 per cent, the chances were even that an individual shipment would have a protein content within ± 0.17 per cent of that average.

Protein premiums for hard spring wheat appeared to be an exponential function of the percentage of the crop which contained more than 13 per cent protein. This relation was expressed by the equation: $\log (y-c) = x$, in which $y =$ percentage of crop containing more than 13 per cent protein, $c =$ a constant which proved to be 4, and $x =$ protein premium in cents per bushel per 1 per cent protein.

Red winter and white winter wheats grown in Illinois, Indiana, Ohio, and Michigan during the crop seasons 1931-32 to 1937-38 contained a lower average percentage of crude protein than the hard spring wheats harvested during the same seasons. Also the variability among the soft winter wheats as computed in terms of the standard deviation was about half that of the hard spring wheats.

Report Series

Forty-seventh annual report of the Minnesota Agricultural Experiment Station, July 1, 1939 to June 30, 1940. 104 pages, 2,200.

Agricultural Extension Service

Bulletin Series

215. Sheep equipment. W. E. Morris and H. G. Zavoral, Division of Agricultural Extension. 16 pages, 20,000.

216. Community discussion meetings. D. C. Dvoracek, Division of Agricultural Extension. 12 pages, 15,000.

217. County cooperative councils. D. C. Dvoracek, Division of Agricultural Extension. 16 pages, 15,000.

218. Feeding the dairy herd. J. B. Fitch, H. R. Searles, E. A. Hanson, and Ramer Leighton, Division of Dairy Husbandry and Division of Agricultural Extension. 90 pages, 35,000.

219. War and the farmer. O. B. Jesness, Division of Agricultural Economics. 16 pages, 25,000.

220. Marketing costs of Minnesota foods. W. B. Garver, Division of Agricultural Economics. 16 pages, 15,000.

221. Electric motors for the farm. Norton Ives and Andrew Hustrulid, Division of Agricultural Extension and Division of Agricultural Engineering. 20 pages, 25,000.

222. Marketing Minnesota eggs and poultry. W. H. Dankers, Division of Agricultural Extension. 24 pages, 10,000.

223. What makes farm prices. Warren C. Waite, Division of Agricultural Economics. 12 pages, 10,000.

224. Fruit varieties for Minnesota. E. M. Hunt, Division of Agricultural Extension. 16 pages, 15,000.

225. Supplemental irrigation. H. B. Roe and J. K. Park, Division of Agricultural Engineering. 24 pages, 10,000.

226. Home vegetable storage. A. E. Hutchins and E. M. Hunt, Division of Horticulture and Division of Agricultural Extension. 16 pages, 30,000.

227. Straw sheds. S. B. Cleland, Division of Agricultural Extension. 8 pages, 15,000.

Pamphlet Series

68. Straw-loft poultry house plan. Cora Cooke, Division of Agricultural Extension. 8 pages, 5,000.

69. Market for forest products grown on Minnesota farms. Parker Anderson, Division of Agricultural Extension. 12 pages, 10,000.

70. A survey of cooperative creameries in west central Minnesota, 1939. W. H. Dankers and E. Baughman, Division of Agricultural Extension. (Mimeographed.) 30 pages, 2,000.

71. A survey of the egg and poultry marketing enterprise of cooperative creameries in west central Minnesota. E. Baughman and W. H. Dankers, Division of Agricultural Extension. (Mimeographed.) 12 pages, 1,500.

72. Dairy and poultry outlook—Minnesota, 1941. W. H. Dankers, Division of Agricultural Extension. 8 pages, 10,000.

73. Making community surveys. Lowry Nelson and Olaf Wakefield, Division of Rural Sociology. (Mimeographed.) 26 pages, 500.

74. Establishing conservation farming under the AAA. Division of Agricultural Extension. 20 pages, 15,000.

75. Commercial and experiment station corn yield trials, 1940. Ralph F. Crim, Division of Agricultural Extension. 32 pages, 25,000.

76. Minnesota livestock outlook for 1941. D. C. Dvoracek, Division of Agricultural Extension. 8 pages, 7,500.

77. Marketing livestock in Faribault County, Minnesota. C. G. Gaylord and E. T. Baughman, Division of Agricultural Extension (Mimeographed.) 10 pages, 2,000.

78. Older youth in rural Minnesota. Ruby Christenson, Division of Agricultural Extension. (Mimeographed.) 21 pages, 500.

79. Preparation of fruits and vegetables for the frozen food locker. J. D. Winter, Division of Horticulture. 8 pages, 15,000.

80. Storing the 1941 wheat crop. Norton Ives, Division of Agricultural Extension. 8 pages, 10,000. (Reprinted 5,000.)

81. Potato vine lifter. A. H. Thompson, Division of Agricultural Engineering. (Mimeographed.) 6 pages, 1,000.

Folder Series

90. Care and feeding of brood sows. H. G. Zavoral, Division of Agricultural Extension. 6 pages, 20,000.

91. Pruning young windbreak trees. Parker O. Anderson and C. M. Kaufman, Division of Agricultural Extension. 6 pages, 20,000.

92. Mastitis or garget in cattle. W. L. Boyd, W. A. Billings, and W. G. Andberg, Division of Veterinary Medicine and Division of Agricultural Extension. 8 pages, 15,000.

93. Gladiolus diseases and their control. Louise Dosdall, Division of Plant Pathology and Botany. 8 pages, 10,000.

94. Bridge grafting. W. H. Alderman and T. S. Weir, Division of Horticulture. 4 pages, 7,500.

95. How to control bacterial ring rot. C. J. Eide and R. C. Rose, Division of Plant Pathology and Botany and Division of Agricultural Extension. 8 pages, 15,000.

96. Wood boring insects attacking timber. A. G. Ruggles, Division of Entomology and Economic Zoology. 4 pages, 10,000.

97. The scab of wheat and barley. J. J. Christensen and R. C. Rose, Division of Plant Pathology and Botany and Division of Agricultural Extension. 6 pages, 10,000.

98. The food we eat. Ina B. Rowe, Division of Agricultural Extension. 6 pages, 25,000.

99. Tomatoes—Minnesota's health food. Division of Agricultural Extension. 6 pages, 100,000.

100. Home canning fruits and vegetables. Inez Hobart, Division of Agricultural Extension. 8 pages, 50,000.

Boys' and Girls' Club Series

24. 4-H farm and home safety. 4-H Club Staff, Division of Agricultural Extension. 16 pages, 25,000.

25. 4-H family meal project. Juanita F. Silcox, Division of Agricultural Extension. 12 pages, 7,000.

News Letters
(With average circulation)

The News Letter, Weekly, 1,465.
Minnesota Farm Business Notes, Monthly, 2,558.
Engineering News Letter, Monthly, 950.
Turkey News Letter, Monthly, 5,515.
Poultry Letter, Monthly, 399.
Rural Program Helps, Monthly, 1,375.
Dairy Herd Improvement News Letter, Monthly, 2,744.
4-H Club News Letter, Monthly, 3,156.
Minnesota Extension News, Monthly, 300.
Sheep News, Bi-monthly, 3,478.
Current Information Letter, 250.

Scientific Journal Series Papers

Agronomy and Plant Genetics

1709. The breeding of improved selfed lines of corn. H. K. Hayes and I. J. Johnson. *Journal of the American Society of Agronomy* 31: 710-24. 1939.

Inbred lines were bred by the pedigree method from crosses between inbreds where as a rule one parent at least of each cross was outstanding in ability to withstand lodging and in smut resistance. Selection during the segregating generations was made in selfed lines for plant vigor, smut resistance, and ability to withstand lodging. Evidence was given to show the extent to which the inbreds were improved in various characters and, in general, the methods used appeared to lead to distinct improvement in many characters. The inbreds produced by the pedigree method were studied in inbred-variety crosses to determine their combining ability. The evidence as given indicated that lines of good combining ability are obtained more frequently from crosses between inbreds that themselves are good combiners than from crosses between inbreds that are low in combining ability. Combining ability, therefore, is an inherited character. Twelve characters of the inbreds, many of them related to growth vigor, were studied in relation to the yield of inbred-variety crosses. Using the multiple correlation coefficient it was shown that there was a significant association between the vigor of inbred lines and their combining ability in inbred-variety crosses. Using inbreds that combined well in inbred-variety crosses and making appropriate single crosses, it was evident that single crosses between unrelated inbreds gave a significantly higher number of high yielding single crosses than when the crosses were made between inbreds that were closer in genetic relationship as measured by their origin.

1714. Genetic and cytologic studies of a brachytic mutation in barley. S. P. Swenson. *Journal of Agricultural Research* 60:687-714. 1940.

A mutant dwarf character in barley, designated as brachytic, was studied with respect to its genetic and cytologic behavior. The mutant strain, which was later named Brachytic, had been discovered by Dr. L. J. Stadler of the Missouri Agricultural Experiment Station as a mutation in a plot of Himalaya barley. Dr. L. R. Powers of the Minnesota Agricultural Experiment Station found the brachytic habit of growth to be inherited as a simple Mendelian recessive and assigned the symbol *br* to the gene. Tests in the seven linkage groups revealed that the gene pair, *Br br,* was inherited independently of the first six linkage groups and was linked in Group VII with the gene pair, *Fc fc,* which differentiates normal and chlorina seedlings. The crossover value from F_3 repulsion data was 9.27±.90 per cent. Chromosome appearance, behavior, and number were as regular in Brachytic as in the normal strains, Himalaya and B4, indicating that Brachytic is the result of a gene mutation rather than a change in chromosome structure. Comparative measurements of grass morphological structures in Brachytic and Himalaya disclosed the following: (1) Brachytic grew about two thirds as tall; (2) its leaf sheaths were about two thirds as long; (3) its awns were about one half as long; (4) it produced about the same number of seeds per plant; and (5) its seeds were only 85 per cent as heavy. Comparisons of cell size and number in culms and leaves of field plants and in coleoptiles, primary leaves, and primary roots from seeds germinated on blotters, furnished evidence that statistically significant differences in cell size between Brachytic and Himalaya did not exist. The reduced size of Brachytic is therefore attributed to fewer rather than smaller cells. Primary roots were larger in diameter in Brachytic than in Himalaya, but the difference was associated with number rather than size of cells. A large number of cells per microscopic field in the region differentiating the zones of cell division and cell elongation, and a higher frequency of mitosis per unit area in root tip sections of Himalaya furnished some concrete evidence for the conclusion that the rate of cell division must be lower in Brachytic. Genes for differentiation and maturity appeared to act independently of the gene for rate of growth as indicated by data on the dates of leafing, tillering, heading, and maturity in Brachytic, Himalaya, and progenies of crosses involving Brachytic.

1808. The value in hybrid combinations of inbred lines of corn selected from single crosses by the pedigree method of breeding. I. J. Johnson and H. K. Hayes. *Journal of the American Society of Agronomy* 32:479-85. 1940.

In a study of single crosses between selfed lines, which in themselves were obtained by inbreeding several single crosses, comparisons were made to determine the relation between top-cross performance and extent of relationship in origin to their yield performance. Single crosses between low combining inbreds, as measured by the top-cross test, were somewhat lower in yield than single crosses between high combining inbreds. Single crosses of high x low combiners were as good in crosses as high x high combiners when both groups involved self lines of diverse genetic origin. In a comparison of 121 single crosses of which 83 were between inbred lines of unrelated origin and 38 between parents of related origin, 41 per cent of those in the first group were significantly higher and 11 per cent of those in the second group were significantly higher in yield than recommended double crosses of comparable maturity. These results indicate the desirability of selecting inbreds for use in double crosses by inbreeding several single crosses, thus providing an opportunity to combine parents of diverse origin.

1843. A summary of linkage studies in barley. D. W. Robertson, G. A. Wiebe, and F. R. Immer. *Journal of the American Society of Agronomy* 33:47-64. 1941.

The linkage information in barley was reviewed, giving the known linkages as well as information on independent inheritance of the factors studied. Standard methods of assigning symbols to the various factors were proposed and the previous symbols used were changed wherever there seemed to be a chance for confusion with other characters. Seven linkage groups appear to be well established. A list of polysomics and polyploids in barley is given.

1850. The Minnesota method of seed increase and seed registration for hybrid corn. Carl Borgeson and H. K. Hayes. *Journal of the American Society of Agronomy* 33:70-74. 1941.

The Minnesota Agricultural Experiment Station in cooperation with the Minnesota Crop Improvement Association produces the seedstocks of inbred lines and single crosses of hybrids developed by the Experiment Station. The work

is financed through the sale of pure seed of all kinds including hybrid seedstocks. Policies of increase and distribution are decided upon by a Corn Committee of the Experiment Station. Beginning in 1930 the first increases of inbred lines were obtained principally under open pollination in isolated plots and by a limited amount of self pollination. Inasmuch as the degree of purity necessary in the lines was not obtained by this system the method now in use was adopted. All inbred seed used in the program at the present time is obtained by hand pollination. The bulk of the seed used which is for the single cross plots is selfed seed. Enough selfed ears are also selected which will truly represent the range in type of an inbred line. The following year the progeny of these selfed ears are crossed by hand. Each cross is examined and all crosses of satisfactory type are bulked. This bulk hand crossed seed is used in the selfing plot the following year. By this method an ample supply of pure inbred seed has been obtained. Single crossed seed is produced mainly through contracts with farmers. Contracts in the past have called for payment by the acre or by the pound. Due to the fact that yields of seed were unpredictable the contract used this year was adopted. This contract allows the single cross producer to retain a part of the seed produced for his share in the contract. Two classes of hybrid seed are recognized by the Minnesota Crop Improvement Association, Registered and Certified. Commercial hybrids resulting from seedstocks from the Experiment Stations of Wisconsin and Minnesota are entitled to either the registered No. 1 or No. 2 grade depending upon germination, purity, grading, and moisture. The term certified seed applies to hybrids of seed companies who control the seedstocks used. Eligibility for certification depends upon the yield and other characters of the variety. The inspections made on this class are the same as for registered seed.

1860. Breeding for resistance to crown rust, stem rust, smut, and desirable agronomic characters in crosses between Bond, *Avena byzantina*, and cultivated varieties of *Avena sativa*. H. K. Hayes. *Journal of the American Society of Agronomy* 33:164-73. 1941.

The Bond variety of oats has been used extensively at Minnesota as a parent in crosses with *sativa* varieties. It excels in resistance to crown rust and smut, in plumpness of grain, and in ability to withstand lodging. Data presented on inheritance of characters that differentiate *sativa* and *byzantina* oats, and on reaction to crown rust, stem rust, and the smuts, show that it is relatively easy to combine resistance to the three diseases with the desirable characters of the two parents. Many of the Bond crosses tested in replicated rod-row trials are equal or superior to Bond in weight per bushel. Some appear outstanding in yielding ability and in ability to withstand lodging. Bond and the Bond crosses averaged as high in stooling as the *sativa* varieties. These results indicate that the Bond variety is desirable as a parent in crosses with varieties of *Avena sativa*. If further data substantiate the results already obtained, the Bond variety may be classed as having good combining ability.

1861. Relation between yielding ability and homozygosis in barley crosses. F. R. Immer. *Journal of the American Society of Agronomy* 33:200-06. 1941.

As an average of six crosses in barley, tested in replicated yield trials, the F_1 exceeded the average of the parents by 8.3 per cent in number of heads per plant,

11.1 per cent in number of seeds per head, 4.9 per cent in weight per seed, and 27.3 per cent in yield per plant. The average yield of the six crosses in F_2 and F_3 in replicated trials exceeded the average of the parents by 24 per cent and 13 per cent, respectively. It was suggested that the yield performance of different crosses may be determined from replicated yield trials in F_2 or F_3 and such tests used to discard the poorest crosses, plant selections being made in the high-yielding crosses only.

Horticulture

1874. The effect of time of mulching on the cold resistance of strawberry plants. W. G. Brierley and R. H. Landon. *Proceedings of the American Society for Horticultural Science* 38:424-26. 1940.

Plants of the Beaver strawberry were potted in September, 1939 and so handled that they were considered comparable to plants in the field. These were divided into lots of 100 pots each and one lot was mulched each week from October 7 to November 11. By mid-November several etiolated new leaves were found on all the plants mulched October 7. Those mulched on October 14 showed less leaf development but all were etiolated. The lot mulched on October 21 showed only slight development of new leaves but these all were etiolated. No growth was observed in the lots mulched on October 28 and later.

When samples of the several lots were exposed late in November to freezing at controlled temperatures in the laboratory, and then placed where their growth response could be observed, it was found that all plants mulched on October 7 were killed by exposure for 24 hours at −3° C., a temperature comparable to a moderate frost in the field. The lots mulched on successively later dates showed a progressive increase in their ability to withstand freezing temperatures. The greatest resistance to cold as indicated by growth, following the controlled freezing treatments, was found in the lot mulched on November 4 that had been exposed longer to light or medium frosts. Nine out of ten plants from this lot grew normally after exposure for 24 hours at −9° C. The somewhat greater injury found in the plants mulched on November 11 and subjected to the same freezing treatments was attributed to exposure in the open to two severe frosts (−8° C.) that occurred on the nights just prior to mulching.

When subsequent growth response is considered in relation to the experimental procedures it appears that cold resistance in strawberry plants is developed by light frosts in the field. Although early mulching is generally recommended as a means to avoid injury from cold, the data obtained in this study indicate that if strawberry plants are covered too early they are not likely to harden. It is evident that plants need to be exposed to a series of light to moderate frosts in order to harden before the mulch is applied. The increased injury to the lot mulched on November 11 is in agreement with the results of earlier studies of the cold resistance of strawberry plants and adds further support to the recommendation that strawberry plants should be mulched before the occurrence of severe frosts.

1881. The relation of yield of staminate and pistillate asparagus plants to the rate of growth of progenies in the young stage. A. L. Richardson and T. M. Currence. *Proceedings of the American Society for Horticultural Science* 38:613-17. 1940.

In order to determine whether or not parental vigor is transmitted to asparagus progenies, 3♀ and 6♂ asparagus plants and the progenies of their 18 possible com-

binations were tested for vigor, the former on the basis of weight, yield, number of spears per plant, and average weight of individual spears, the latter on the basis of time elapsing from seeding to emergence and plant weights at two and one-half months after seeding. The ♀ parents did not differ significantly in the factors considered. With one exception, ♂ parents did not differ significantly in weight, yield, spear size, or number of spears produced. In regard to days to emergence, variation due to the interaction between ♂ and ♀ plants was highly significant; that due to ♂ plants was significant. Weights of two and one-half month old progenies showed the variation due to the interaction of ♂ and ♀ parents to be significant; that due to ♀ parents was significant. These results suggest that ♀ and ♂ parents may be of equal importance in transmitting vigorous growth to their offspring but that certain plants may prove to be good parents only in combination with certain others and that favorable combinations can best be determined by testing of progenies. Of the phenotypic factors considered, none of the parental factors was significantly correlated with those of the progenies.

Plant Pathology and Botany

1764. Physiologic specialization and genetics of the smut fungi. J. J. Christensen and H. A. Rodenhiser. *Botanical Review* 6:389-425. 1940.

The importance of the number, prevalence, distribution, and virulence of physiologic races of smut fungi are discussed in relation to development of resistant varieties of crop plants. The loss of resistance of a variety is attributed not to a change in the host but to introduction and production of a new race or races of smut by hybridization and mutation or to changes in pathogenicity induced by the "screening" effect from a collection of chlamydospores involving numerous biotypes. The importance of studying the genetics of the pathogen is emphasized in relation to breeding disease resistant varieties. The lack of stability in many smuts is attributed to mutation and frequency of hybridization among biotypes of some species and also to interspecific and intergeneric crosses.

Inheritance studies on the following characters are presented: size, color, and wall markings of chlamydospores; nature of chlamydospore germination with respect to degree of branching and production of sporidia, disintegration of promycelia (lysis), size of sporidia and promycelia, tendency for sporidia to bud in culture, and production of sporidia that are lethal; color, topography, margin, consistency, and rate of growth of colonies in culture, and tendency of lines to sector on nutrient media; sexual compatibility and pathogenicity; and general morphology and consistency of smut sori, color of peridium of sori, and degree to which the infected host plant may be stunted. The nature and frequency of genetic variations are discussed. References are made to 132 papers.

1783. Comparative studies of sugar-beet and potato isolates of *Rhizoctonia solani*. E. L. LeClerg. *Phytopathology* 31:274-78. 1941.

Comparative studies of morphology, physiology, and pathogenicity were made with representative isolates of *Rhizoctonia solani* of each of the following groups: sugar beet, mature-plant, sclerotial, and sprout from potatoes.

Four mature-plant and six sclerotial isolates did not differ materially in hyphal diameters. All the ten sugar-beet isolates, except one, are definitely smaller than any of the potato isolates.

The sugar-beet isolates grew faster on potato-dextrose and high-nitrogen media than any of the other three potato groups. Of the potato groups, the sprout isolates grew faster, followed by mature-plant and sclerotial groups, respectively.

From a study of the optimum temperature for radial growth on potato-dextrose agar of twenty isolates from each of the four groups, it was found that the mature-plant and sclerotial isolates from potatoes all had an optimum at 25° C. or below, whereas 30° C. was optimum for 19 of the 20 sugar-beet isolates. Likewise, those potato-sprout isolates which do not cause dryrot canker of sugar beets have an optimum at 25° C. The sprout isolates capable of causing dryrot canker of sugar beets grew best at 30° C.

Sugar-beet isolates, as a group, were more virulent on seedlings of sugar beets, beans, peas, and cabbage than any of the three potato groups. The potato-sprout group was more virulent than either the mature-plant and sclerotial groups on sugar beets, beans, and peas. The mature-plant and sclerotial groups were equally virulent on all hosts and the former tended to be more virulent on peas. All three potato groups were equally virulent on cabbage.

1784. Pathogenicity studies with isolates of *Rhizoctonia solani* obtained from potato and sugar beet. E. L. LeClerg. *Phytopathology* 31:49-61. 1941.

In tests with 89 isolates obtained from lesions on the underground stems of older potato plants or from sclerotia on potato tubers, none was found to be pathogenic to sugar beet roots. Although these isolates were secured from a wide geographical range, and the results are in line with earlier observations, it is possible that by further sampling, isolates pathogenic to sugar beets may be found. This point of view finds substantiation in the results of inoculating potatoes, with sugar-beet isolates, which, in general, were more aggressive to potatoes than the potato isolates used for comparison. Furthermore, isolates were obtained from potato stolons affected by *R. solani* which in a high per cent rotted sugar-beet roots. From potato plants, grown in a field which had a previous history of sugar-beet cropping and severe root rot, two isolates were obtained from potato stems which were strongly virulent to sugar-beet roots. Field surveys of sugar-beet and potato fields made in three seasons showed that sugar beets grown following a potato crop were, in general, relatively free from Rhizoctonia root rot, in strong contrast to the situation when sugar beets followed sugar beets. Observational evidence, relative to deleterious effects when potatoes follow a sugar-beet crop in which root rot was a factor, is presented as bearing on the desirability of a potato-sugar beet sequence rather than the reverse order of cropping.

1786. Delayed reduction of the diploid nucleus in promycelia of *Ustilago zeae*. St. John P. Chilton. *Phytopathology* 30(7):622-23. July, 1940.

Monosporidial cultures were made from the promycelia of chlamydospores of *Ustilago zeae* which germinated abnormally. Inoculation of these cultures singly and in various combinations into young Maize plants showed that both haploid and diploid sporidia (based on whether segregation for sex or compatibility factors had occurred or not) were produced by the same chlamydospore in three cases. The reduction of the diploid nucleus may evidently be delayed past the first division in *Ustilago zeae*.

1787. Variation in the tolerance of certain physiologic races of *Actinomyces scabies* to hydrogen ion-concentration. Lawrence A. Schaal. *Phytopathology* 30:699-700. 1940.

Actinomyces scabies was isolated from potato tubers growing in soils with a *p*H of 5.4 and 6.8 respectively. Both isolates were grown on potato dextrose agar adjusted to *p*H 5.0 to 8.5. Both appeared identical on this medium at *p*H 7.0. The isolate from the more acid soil grew on this medium adjusted to *p*H 5.0, while that one from the less acid soil did not grow at *p*H 5.0, and appreciable growth was noted only on the medium with *p*H values of 6.0 and above. Both isolates were pathogenic on Katahdin and Green Mountain tubers grown in the greenhouse in a soil with a *p*H of 6.8. The isolate from the more acid soil produced only a shallow pustule, whereas the other produced a deep pustule, indicating that these isolates are physiologic races of *Actinomyces scabies* and can be differentiated on the basis of *p*H tolerance in culture and by differences in pathogenicity.

1788. Unseasonable germination of teliospores of *Puccinia graminis tritici*. Ralph U. Cotter. *Phytopathology* 30:689-91. 1940.

Teliospores of *Puccinia graminis tritici* from durum wheat collected at St. Paul, Minnesota in the late summer of 1939 germinated in November of that year although according to observations during the previous 10 years germination would not have been expected before the following March or April. Not all collections of *P. graminis tritici* germinated in November, nor did teliospores of other stem rust varieties germinate early. The reason for the germination of the teliospores without the usual rest period is unknown, but it is suggested that their formation on durum wheat late in the year may have been responsible.

1792. Observations on *Polyporus circinatus*. C. M. Christensen. *Phytopathology* 30:957-63. 1940.

In Itasca Park, in northwestern Minnesota, *Polyporus circinatus* was found commonly on *Picea glauca* (Moench) Voss, occasionally on *Picea mariana* (Miller) Br., St. and Pog., *Pinus banksiana* Lambert and *Abies balsamea* (Linn.) Miller, and once on *Pinus resinosa* Aiton. Observations over a period of years indicate that the fungus enters the roots of comparatively young trees and progresses slowly toward the root crown and up the trunk. Eventually decay involves so much of the diameter of the main roots and lower trunk that the trees stagnate and later fall or are blown over. The fungus may penetrate out through the cambium of dying trees. Infection loci occur in the forest, but the reason for this is not known. One hundred and fifty spores from three fruit bodies averaged 4.9μ in length. One hundred and sixty setae from seven fruit bodies averaged 44μ in length, ranging from 23μ to 79μ. Cultures on 2 per cent malt agar form a dense, firm, appressed mat, yellowish brown or dark brown in color. The mycelium is without clamp connections, but both aerial and submerged hyphae bear numerous chlamydospore-like enlargements.

1798. Problems in the determination of physiologic races of *Ustilago avenae* and *U. levis*. I. W. Tervet. *Phytopathology* 30:900-13. 1940.

Under field conditions at St. Paul, Minnesota, three races of *Ustilago levis* and three of *U. avenae* were distinguished on the basis of their pathogenicity on

five oat varieties, Anthony, Gopher, Rusota, Iogold, and Black Mesdag. By using for inoculum chlamydospores from a resistant variety such as Black Mesdag or D. C. II-22-220, it was possible, with some collections, to increase the amount of smut produced on these varieties. However, attempts to build up races of *U. avenae*, which attack slightly Bond and Fulgrain, were unsuccessful. Part of the variation in pathogenicity of collections of the oat smuts in successive years is due to changes in the genetic nature of the collections, resulting from the screening action of the varieties on which the chlamydospores for inoculation were grown.

1800. An unusual telial collection of *Puccinia graminis*. Ralph U. Cotter. *Phytopathology* 30:693-95. 1940.

Teliospores of *Puccinia graminis* on *Agrostis* stems produced aecia on *Berberis vulgaris*, whose aeciospores infected wheat in one trial, rye in another, but not *Agrostis*. When this rust collection was crossed with one from wheat, a race of *Puccinia graminis tritici* resulted; when crossed with one of the secalis variety, both the tritici and secalis varieties were obtained; and when crossed with a second collection of rust on Agrostis both tritici and secalis varieties resulted. Race 161 of the tritici variety, a new race, appeared when the Agrostis collection was crossed with a race of the secalis variety.

1806. Variation in *Helminthosporium sativum* induced by a toxic substance produced by *Bacillus mesentericus*. J. J. Christensen and F. R. Davies. *Phytopathology* 30:1017-33. 1940.

Isolates of *Bacillus mesentericus*, when grown on artificial culture, produced a substance that suppressed growth, increased conidial production, inhibited or retarded germination, caused abnormal hyphal growth, and induced mutation in certain races of *Helminthosporium sativum*. The bacterial substance was thermostable although prolonged heating tended to weaken its potency, it was diffusible, passed through a Berkefeld filter, was adsorbed on infusorial earth, and withstood freezing and desiccation. The toxic substance tolerated acid but was inactivated by alkali and by certain bacteria and fungi.

Sterilized cultures of *B. mesentericus* when added to solid nutrient media suppressed growth of many fungi but did not increase the frequency of sectoring in any fungus, except *H. sativum* and possibly one species of Pencillium. Even races of *H. sativum* responded quite differently to toxic substance. The frequency of sectoring also was associated with the concentration of toxic substance with certain types of medium and with relatively high temperatures. *B. mesentericus* did not induce sectoring when grown in close association with *H. sativum*.

A race of *H. sativum* while growing on potato dextrose agar containing toxic substance produced by *B. mesentericus* gave rise to numerous variants that differed in cultural characters, in general physiology, in pathogenicity, and, to some extent, in morphology. By means of mutation, *H. sativum* may adapt itself to a new environment.

1809. Wood decay in apple trees in Minnesota. Carl J. Eide and C. M. Christensen. *Phytopathology* 30:936-44. 1940.

Wood decay of limited extent was found in 48 of 50 15-year-old apple trees. In 68 trees 22 years old, 12 were badly decayed, 22 moderately so, and in 22 slight decay was found. Most trees 30 or more years old were badly decayed.

Ten species of wood-decaying fungi were found associated with decay in apple trees. These were: *Fomes applanatus* (Pers.) Wallr., *Trametes malicola* Berk. and Curt., *Polyporus versicolor* (L.) Fries, *Thelephora* spp., *Polyporus resinosus* (Schrad.) Fries, *Schizophyllum commune* Fries, *Pholiota adiposa* Fries, *Trametes hispida* Bagl., *Polyporus adustus* (Willd.) Fries, and *Lenzites betulina* (L.) Fries. Other species were isolated but are not identified.

Decay entered chiefly through branch stubs; other avenues of entrance being crotch cracks, sunscald injuries, and frost cracks. The spread of rot within the trees was facilitated by sunscald, cold injury (blackheart), frost cracks, and other injuries. Decay, along with winter injury, is apparently one of the chief causes of early decline of apple trees in marginal regions of production.

1831. Variation in the germination of chlamydospores of *Ustilago zeae*. M. F. Kernkamp and M. A. Petty. *Phytopathology* 31:333-40. 1941.

Germination of chlamydospores from 14 crosses and collections of *Ustilago zeae* was studied on agar drops on cover slips on van Tieghem cells, the environment being held constant. Twenty-five germination types were observed; of these, the production of the supposedly normal four-cell promycelium, with a sporidium on each cell, was neither the most characteristic nor prevalent. The number of cells in individual promycelia ranged from one to eight. There also were variations in the number of chlamydospores from which sporidia grew directly and in the number of chlamydospores having promycelia on two sides. The germination type varies with the cross or collection, and the differences between crosses and collections were much greater than within crosses and collections. One type usually predominated in each cross or collection. As the environment in which the spores were germinated was held constant, differences are probably due to genetic differences between the crosses and collections.

1832. A heritable lysis in germinating chlamydospores of *Sphacelotheca sorghi* (Link) Clinton. Thomas Laskaris. *Phytopathology* 31: 254-63. 1941.

A study was made of an abnormality occurring in germinating chlamydospores produced by certain monosporidial combinations of *Sphacelotheca sorghi*. The abnormality was characterized by the disintegration or lysis of the promycelia prior to or after the formation of sporidia, and by the production of promycelia and sporidia that were decidedly atypical in morphology and size. Measurements revealed that the chlamydospores, promycelia, and sporidia of such crosses were significantly larger than those of normal crosses and in some cases they easily exceeded the limits of the species. Some association was apparent between the amount of deviation from the normal and the degree of lysis. By making appropriate crosses it was shown that the tendency toward lysis is characteristic of certain combinations of monosporidial lines only, which is regarded as evidence that the tendency toward lysis is due to genetic factors. It was also shown that the tendency toward lysis is not necessarily associated with solopathogenicity in *Sphacelotheca sorghi*. Of 322 monosporidial lines which were tested for solopathogenicity, only one produced chlamydospores, and then in only one test out of three.

1840. Physiologic races of *Puccinia graminis* in the United States in 1939. E. C. Stakman and W. Q. Loegering. *United States Department of Agriculture, Bureau of Entomology and Plant Quarantine* multigraphed paper. 14 pp. January 1941.

In the survey of physiologic races of *Puccinia graminis tritici* in the United States in 1939, 1,063 uredial isolates were made, representing 14 races, and 95 aecial isolates, representing 17 races. In uredial and aecial isolates together, races 56, 38, and 17 predominated, constituting almost 88 per cent of the total. Two changes in prevalence are noteworthy, a decrease in race 56 and an increase in race 17. In uredial collections, race 56 was most prevalent for the sixth consecutive year, constituting 55.5 per cent of the isolates, compared with the high of 66 per cent in 1938. Race 38 was second in prevalence for the fourth consecutive year, constituting 24 per cent of the isolates. Race 17, which has been gradually increasing during recent years, was third in prevalence and constituted 10 per cent of the isolates. Other races isolated from uredial collections were 19, 11, 36, 147, 34, 49, 59, 21, 15, 24, and 14. Race 56 was isolated from 100 per cent of the rust collections made on common wheat (mostly Ceres) and barley in North Dakota, while races 38 and 19 were most commonly isolated from the durum wheats.

Races 2 and 5 of *Puccinia graminis avenae* constituted 96.8 per cent of 221 isolates of this rust on oats. Other races isolated were 7, 8, 10, 12.

1884. The relative susceptibility of different lots of oat varieties to smuts. I. W. Tervet. *Phytopathology* 31:672-73. 1941.

Eleven seed lots of Anthony oats that varied in that they were grown at four locations in Minnesota and in different years, were inoculated with a purified collection of *Ustilago levis* and planted at St. Paul, Minnesota in 1940. The number of infected heads produced ranged from 14 to 72 per cent. Greenhouse tests showed a close correlation between rapidity of germination and relative resistance to smut attack, the most susceptible seed lot requiring 40 hours more to produce primary leaves than the most resistant seed lot. Similar results were obtained when a purified collection of *U. avenae* was used. Seed lots of Rusota, Iogold, and Gopher also showed differences in susceptibility to smut.

1855. Cocklebur Dermatitis. S. Ericson and R. B. Harvey. *Canning Age* 22:(6)297. 1941.

A discussion of an irritation believed to be cocklebur dermatitis that occurred among pickers of a prominent corn canning plant in Minnesota.

Agricultural Biochemistry

1739. The density of dry milk solids. Olof E. Stamberg and C. H. Bailey. *Food Research* 5(3):575-80. 1940.

Particles of dried skim milk made by the spray process vary in apparent density due to occluded air cells, but practically no air cells were observed in particles made by the roller process. The density index of such dried milks was determined by measuring the ratio between the particles remaining in suspension and those settling out of a naphtha-carbon tetrachloride mixture of density 1.250. Commercially manufactured spray powders were found to vary widely in density index.

1777. Physical and chemical properties of the fat globule adsorption "Membrane." II. Nature and origin of surface active materials involved in curd tension reduction and prevention of rennet clot of cow's milk by "membranes" from natural and synthetic creams. L. S. Palmer and N. P. Tarassuk. *Journal of Dairy Science* 23:861-71. 1940.

Experiments are described showing a reduction in curd tension when artificial fat globule "membrane" sols derived from spray dried whey were added directly to natural or "remade" skim milk. Since some of these sols exhibited evidence of protein denaturation on shaking, the experiments suggest that this may interfere, under some conditions, with normal clotting of milk by rennet.

Experiments are described showing that the normal rennet clot may be completely prevented by emulsifying a small amount of diglycol laurate into raw milk at room temperature, aging the emulsion in the cold and adding rennet at 35° C. This phenomenon also occurs in "remade" buttermilks from "creams" whose butter fat globule "membrane" is diglycol laurate. A decrease in surface tension and *p*H accompanies the destruction of clotting ability. The explanation of this phenomenon is the liberation of lauric acid from the diglycol ester by natural milk enzyme. It does not occur if the milk is first pasteurized.

1802. Browning of autoclaved milk. J. P. Kass and L. S. Palmer. *Industrial and Engineering Chemistry* 32:1360. 1940.

An explanation for the tan color of autoclaved and evaporated milk was sought in a study of the effect of inorganic and organic buffers on lactose at autoclave temperatures. The discoloration is accompanied by the development of acidity, pronounced fall of optical activity, comparatively slight loss of copper-reducing ability, and an appreciable but constant conversion of lactose to ketoses, or substances not oxidized by sodium hypoiodite. Although the *p*H at which any buffer produces an equivalent color or loss of optical activity depends upon its nature, connected with its concentration, dissociation, and buffer capacity, the trend of the caramelization reaction is the same for all buffers, and the coloration developed is a logarithmic function of the optically inactivated lactose. This loss of optical activity and resulting discoloration is a complex function of the buffer concentration and duration of heating and is directly proportional to the initial concentration of lactose. The coloration can be inhibited with formaldehyde which, however, does not prevent the optical inactivation of lactose. Lactocaramel can be decolorized by bromination.

Three per cent sodium caseinate sols affect lactose like other buffers, and casein adsorbs caramel according to the Freundlich isotherm. The extent of adsorption is determined by the *p*H of the sol and is complete at *p*H 11. The brownish protein precipitated from autoclaved milk is also decolorized by bromination.

The increase in coloration due to increased initial *p*H's is independent of the quantity of free amino nitrogen, and the characteristic color of autoclaved milk is ascribed to the caramelization of the lactose by, and the adsorption of the lactocaramel on, the caseinates of heated milk, with no stiochiometric bifunctional reaction between the aldose and amino groups forming definite lactose-protein compounds involved.

1813. Organic selenium compounds. Their decomposition in alkaline solutions, and other properties related to the behavior of selenium compounds in cereals. Edgar P. Painter, Kurt W. Franke, and Ross Aiken Gortner. *Journal of Organic Chemistry* 5:579-89. 1940.

Organic diselenides, selenium ethers, and seleninic acids of acetic, β-propionic, n-propyl, and benzyl radicals, were synthesized and their decomposition studied by hydrolyzing in alkaline solutions. Diselenides, like disulfides, decompose in alkaline solutions. Inorganic selenide and selenite formed. Selenium ethers, like sulfur ethers, were stable but the selenide of propionic acid decomposed in alkaline plumbite to give nearly all the selenium as lead selenide. The selenium from seleninic acids of organic acids appeared to be quantitatively cleaved while the seleninic acids of hydrocarbons were partially cleaved. Selenite and lead selenide were formed. It is probable that the mechanism of the decomposition of these compounds is the same as that of the corresponding sulfur compounds.

The relationship of the selenium compounds in plants, and synthesized compounds, in regard to their stability in different solutions and upon storage was discussed.

1816. Relations between wheat malt dosage, flour diastatic activity and gassing power. F. C. Hildebrand and W. F. Geddes. *Cereal Chemistry* 17:626-35. 1940.

In a study of the diastatic activity and gassing power of flour blends made by adding varying levels of malted wheat flours (which differed widely in amylase activity) to a common base flour, gas production was found to vary directly as the logarithm of the malt-flour dosage whereas the relationship between dosage and diastatic activity was best expressed by a quadratic equation. Estimation of malt flour activity is most conveniently and simply made by plotting ml. CO_2 produced by blends against the logarithm of dosage and the quantity of malt flour required to produce the selected level of gas production read from the straight line thus obtained. The relation between diastatic activity and gassing power was curvilinear although the substrate was essentially the same throughout.

1817. The effect of wheat type, protein content and malting conditions on the properties of malted wheat flour. W. F. Geddes, F. C. Hildebrand, and J. A. Anderson. *Cereal Chemistry* 18:42-60. 1941.

Representative samples of high-grade hard red spring and amber durum wheats, each at two protein levels differing by approximately 2 per cent, were experimentally malted using eight different treatments representing combinations of steeping to 44 per cent and 40 per cent moisture, germinating for five and three days, and kilning for 12 hours at 100° F. Growth and yield of malt were not affected by wheat type or protein content. Increasing the steeping level and germination time resulted in greater growth and lower yield; raising the kilning temperature decreased yield slightly. Increase in germination time and steeping level and the use of hard red spring wheat rather than durum raised amylase activity of flours milled from the malted wheats; increasing the germination time had the greatest influence. Autolytic protease activity of the malted wheat flour was increased with longer germination, higher steeping level, higher protein content, and with the use of durum wheat. Amylase and protease activity were significantly and positively correlated, the relation between these activities being markedly influenced by wheat type, protein content, steeping level, and germination time. Baking tests on blends of a common base flour with amounts of the various malt flours giving constant gassing power revealed no significant difference on dough or bread characteristics indicating that protease activity is of little or no significance in evaluating malts for diastating purposes.

1822. A pyrex all-glass microelectrophoresis cell. David R. Briggs. *Industrial and Engineering Chemistry* 12:703. 1940.

The manufacture and manner of use of a pyrex all-glass microelectrophoresis cell and the electrical circuits are described. This equipment was designed to use in measurements of the electrophoretic velocity of solid particles suspended in highly non-conductive organic liquids, but the same apparatus may be used just as readily for aqueous systems. Certain advantages of construction and arrangement of the cell make it relatively easy to use.

1839. Sulfur in proteins. VI. Qualitative studies in the alkaline decomposition of cystine. H. V. Lindstrom and W. M. Sandstrom. *Journal of Biological Chemistry* 138:445-49. 1941.

Uvitic, uvitonic, and thiolactic acids were identified for the first time as alkaline decomposition products of cystine, and it was shown that they arose from the action of the alkali on the primary decomposition products: pyruvic acid, ammonia, and hydrogen sulfide.

Alanine was demonstrated as a decomposition product by quantitative analyses on a powder isolated from a barium hydroxide decomposition. Since alanine was found to stabilize cystine somewhat in sodium and potassium hydroxide solutions but not in barium hydroxide solutions, a theory was put forth that alanine stabilized cystine in alkaline solutions, the alanine arising from the decomposition of cystine and inhibiting the action of the cystine-labilizing factor, pyruvic acid. The result is that alanine is resynthesized and pyruvic acid (as well as any acetaldehyde derived from it) is removed by being condensed rapidly in sodium or potassium hydroxide but only slowly in barium hydroxide.

1845. The effect of rations deficient in phosphorus and protein on ovulation, estrous, and reproduction of dairy heifers. L. S. Palmer, T. W. Gullickson, W. L. Boyd, C. P. Fitch, and J. W. Nelson. *Journal of Dairy Science* 24:199-210. 1941.

We concluded from this study that a combined deficiency of phosphorus and protein in the bovine, analogous to similar deficiencies in animals reared largely on prairie hay in the phosphorus deficient regions, delays sexual maturity, represses normal evidences of estrum so that periods of estrum appear to be missed, but does not interfere with normal regularity of ovulation or the ease of conception. The reduction in breeding efficiency noted in a previous experiment when phosphorus alone was deficient, was not observed in this study. The ease with which these undersized, miserable appearing specimens of the bovine species conceived when bred long after the normal age of first breeding and the normal vigor of the calves produced were definitely contrary to all expectations. However, the marked dystocia (mainly maternal) which occurred in four of the eight animals employed for the breeding study must be regarded as probably due in large measure to the dietary deficiencies imposed.

1849. Studies in electrokinetics. XXIV. The electroviscous effect. I. In systems of sodium gum arabic. David R. Briggs. *Journal of Physical Chemistry* 45:866-76. 1941.

The Smoluchowski equation for the electroviscous effect has been put into a form which makes possible its testing against experimental data obtained from

measurements of the electrokinetic potentials (ζ), specific conductivities (λ), and relative viscosities (η_s/η_o) on colloid-containing solutions.

When the equation is written as

$$\frac{1}{\eta_{sp}} = -\frac{3\epsilon^2}{8\pi^2 r^2} \cdot \frac{\zeta^2}{\lambda\,(\eta_s - \eta_o)} + \frac{1}{K\emptyset}$$

and the values of $1/\eta_{sp}$ and $\zeta^2/\lambda\,(\eta_s - \eta_o)$ are chosen as coordinates in plotting the data, the values of $K\emptyset$ and r can be obtained from the intercepts and slopes, respectively, of the straight line obtained, provided the Smoluchowski equation is valid.

Plotted in this manner, the data from sodium gum arabic, without and with the addition of small amounts of sodium chloride, do fall on a straight line, and the values of $K\emptyset$ obtained are proportional to the colloid concentration. This much is in verification of the validity of the equation. The slopes of the lines, at varying colloid concentration, change in such a manner that the calculated value of r appears to decrease directly as the concentration of colloid increases. To this extent the equation is apparently not verified.

1854. The reducing properties of l-Sorbose. F. K. Broome and W. M. Sandstrom. *Journal of the American Chemical Society* 63: 1028-30. 1941.

The reducing power of l-sorbose was determined by the method of Hildebrand and McClellan on a lot which had been carefully purified until its properties agreed with the best data recorded in the literature. The direct titration of the formed ferrocyanide with standard ceric sulfate is satisfactory in the concentration range of from 0.01 to 0.70 per cent. For comparison, a similar run was made with fructose, the only other common ketohexose. Fructose has approximately 10 per cent greater reducing power. However, these values are sufficiently similar to bear out the hypothesis of Sobotka and Reiner that the configurations about the third and fourth carbon atoms are important in determining the reducing properties; these two ketohexoses have similar configurations on these carbon atoms and their reducing properties are of the same order of magnitude.

1856. The origin of the humin formed by the acid hydrolysis of proteins. IX. Hydrolysis in the presence of djenkolic and of thiazolidine-4-carboxylic acids. H. A. Lillevik and W. M. Sandstrom. *Journal of the American Chemical Society* 63:1028. 1941.

The two compounds, djenkolic and thiazolidine-4-carboxylic acids, are hydrolytically cleaved to formaldehyde and cysteine (or cystine) after hydrolysis for 24 hours with 20 per cent hydrochloric acid. This has been supported by evidence of polarographic analysis, Sullivan's colorimetric analysis and condensation of the derived formaldehyde with tryptophan. This finding with respect to djenkolic acid is contrary to that reported by other workers.

Djenkolic acid, a naturally occurring compound, or thiazolidine-4-carboxylic acid added to gelatin and tryptophan and hydrolyzed for 24 hours has provided a possible factor of an "aldehyde of unknown origin" to bring about humin formation.

It has been found that a lesser amount of formaldehyde, as obtainable from these precursor compounds, is needed to bring about the maximum insoluble humin than when formaldehyde is added as trioxymethylene.

1869. The reaction of ethyl glycinate hydrochloride with primary, secondary, and tertiary Grignard reagents. Fred L. Greenwood and Ross Aiken Gortner. *Journal of Organic Chemistry* 6:401-09. 1941.

Ethyl glycinate hydrochloride reacted with n-propylmagnesium chloride to give a 75 per cent yield of 2-amino-1,1-di-n-propylethanol-1. The ester hydrochloride was also treated with isopropylmagnesium chloride and aminomethyl isopropyl ketone and 2-amino-1,1-diisopropylethanol-1 were isolated from the reaction mixture. The ester hydrochloride failed to react with t-butyl-magnesium chloride.

Converting the amino group to the amino hydrochloride failed to protect the amino group from the Grignard reagent as previously reported. All of the Grignard reagents reacted with the ester hydrochloride to yield the hydrocarbon corresponding to the Grignard reagent, and all three hydrogen atoms can be replaced if the reaction is allowed to proceed for a sufficient time.

1877. Effect of free fat acids of milk fat on curd tension of milk. Relation to milk esterase, temperature, use of $CaCl_2$, kind of fat acid, milk lipase and churning. L. S. Palmer and C. L. Hankinson. *Journal of Dairy Science* 24:429-43. 1941.

In this study it was found that raw skim milk and whey hydrolyze diglycol laurate and diglycol oleate and other esters at 10° C.; that ultrafiltration removes and heat inactivates the enzyme(s) involved; and that lauric and oleic acids when liberated from their esters or when dispersed directly in milk will, under proper conditions, seriously impair or even prevent the clotting by rennet, especially if the milk containing the free acids has been aged at low temperature. Capric acid was the only other common fat acid of milk found to have this effect. It was shown that the milk clotting must be done at 35° C. to show these effects. They were not evident if the lauric and capric acid-containing milks were first heated to 40° C. for one-half hour or more and were less evident if the milks were held at 35° C. for several hours. Similar heat treatment did not completely overcome the effects of oleic acid. It was found the addition of suitable amounts of $CaCl_2$ in the clotting tests also completely overcomes the effects of lauric and capric acids. Lipolysis of milk fat by natural lipases of milk was shown to impair to some extent the normal clotting by rennet but such effects were not found to be induced in the churning of cream. Lipolysis, therefore, does not seem to account for the normal low curd tension of sweet cream buttermilk.

1879. Electrokinetics XXV. The electroviscous effect. II. In systems of calcium and sodium caseinates. C. L. Hankinson and D. R. Briggs. *Journal of Physical Chemistry* 45:944-53. 1941.

Experimental data are presented for measurements of electrokinetic potentials (ζ), specific conductivities (λ), and relative viscosities (η_s/η_0) on systems of both calcium caseinate and sodium caseinate, without and with the addition of small amounts of the chloride of the cation common to the colloid.

These data, when calculated and plotted as variables in the linear form of the electroviscous equation, fall on a straight line. The values of Kϕ calculated from the intercept are proportional to colloid concentration. This is in agreement with the results already obtained on sodium gum arabic systems.

The electroviscosity accounts for 59 per cent of the specific viscosity in a 1 per cent calcium caseinate system and for only 38 per cent in a 1 per cent sodium caseinate system. The data on sodium gum arabic showed that electroviscosity accounted for 79 per cent of the specific viscosity of a 1 per cent sodium gum arabic system.

Assuming spherical particles with the value of K = 2.5, and the density of dry casein to be 1.25, calculations show that 1 g. of casein combines with 2.4 g. of water when dispersed at *p*H 6.6 in calcium hydroxide and with 7.2 g. of water when dispersed in sodium hydroxide at the same *p*H. Sodium gum arabic was shown to combine with 12 g. of water per gram of dry colloid at *p*H 7.0. This is in a ratio of 1:3:5 for the above three systems.

The numerical values of the slopes of the straight lines obtained from the electroviscosity data increase linearly with increasing colloid concentration, indicating that the calculated value of the radius of the micelle decreases with increasing colloid concentration. This is again in agreement with the data for sodium gum arabic, but to this extent the electroviscous equation is not verified.

1887. Objectives in breeding for improved quality in hard wheat. W. F. Geddes. *Journal of the American Society of Agronomy* 33:490-503. 1941.

The industrial quality of hard wheats depends upon their milling quality and the value of the flour for bread-making purposes. For good milling quality, the kernels should be plump, uniformly large in size to permit ready separation of foreign material, absorb water readily and uniformly in the tempering process, and produce a high yield of flour of low yellow pigment and ash content with a maximum and clean separation from the bran and germ. Good baking quality involves the production of satisfactory bread over a considerable range of baking conditions and includes the facility with which the dough can be handled in the bakery and the bread yield obtainable. A new wheat variety should yield a flour which is "well balanced" in regard to the various attributes of quality. Where the present types of wheat are satisfactory in quality the plant breeder should endeavor to produce new varieties with the desired agronomic characteristics which are as similar as possible in grading, milling, and baking characteristics to the superior present varieties. Scientific and technological advances may change the quality requirements or introduce new factors and close contact with the milling and baking industry is essential.

1906. The chemistry and toxicity of selenium compounds, with special reference to the selenium problem. Edgar Page Painter. *Chemical Reviews* 28:179-213. 1941.

A critical survey of the literature through 1940 on organic selenium compounds and their toxicity with especial reference to the nature of the form in which selenium occurs in seleniferous plants and grains.

The subject matter is discussed under four sections: the selenium problem in agriculture, methods of analysis, organic compounds of selenium, and the properties of selenium in plants and their relation to known compounds of selenium and sulfur. 186 references.

Soils

1755. The relative productivity of some humid subsoils. C. O. Rost. *Soil Science Society of America Proceedings* 4:281-87. 1939.

Results of pot tests on successive layers from 14 soil profiles are reported. The yield of oats, based on the yield from the unfertilized surface soil, fell very rapidly from the surface downward, paralleling the decreasing nitrogen supply. A nitrogen fertilizer usually remedied the unproductivity, this being as effective as NP or NPK.

Relative yields of red clover on the unfertilized soil declined in the second 6-inch layer, the second foot and, in all but one case, the third foot. The one third-foot and all but one of the fifth-foot samples gave yields above those of the surface soil. The unproductivity was fully remedied for all but two layers of one profile by the addition of phosphate or phosphate and potash combined.

Inoculated sweet clover behaved in a similar manner, the relative yields for the unfertilized pots falling steadily until the B or upper C horizon was reached. Below this they rose. In most cases an application of phosphate or of phosphate and potash removed any unproductivity.

On six fields with soil removed to depths varying from 5 to 25 feet inoculated alfalfa grew satisfactorily without fertilizer treatment although on only one field was the fertilizer entirely without effect. On the remaining five there was a slight effect.

1827. The effect of a compact subsoil horizon on root penetration. D. I. Crossley. *Journal of Forestry* 38:794-96. 1940.

During the fall of 1938 an investigation was undertaken in Mille Lacs County to ascertain the behavior of forest tree roots when confronted with difficultly penetrable soil horizons. Bur oak, which has a persistent tap root, was selected as meeting the requirements of this investigation. It was concluded that permanently compacted subsoils confine the rooting medium mainly to the overlying soil horizons with the degree of confinement depending upon the degree of compaction. The irregular growth habit exhibited by the roots of bur oak (*Quercus macrocarpa,* Michx.), growing on soils that have no compact subsoil horizon is more likely to be attributable to hereditary characteristics than to any external factor.

1862. A study of factors affecting the stability of soil aggregates. C. O. Rost and Chas. A. Rowles. *Soil Science Society of America Proceedings* 5:421-33. 1940.

The dispersion and erosion ratios were determined on soils differing markedly in erodibility. It was found that these ratios qualitatively separated the soil into two groups, those less susceptible to erosion and those which were more susceptible. The erosion ratio served as a better index for classifying the soils. Cultivation of the forest soils made them more susceptible to erosion than they were in their natural condition by increasing the amount of silt and clay which would disperse in water. Cultivation has produced little change in dispersion in prairie soils.

Under Minnesota conditions the results indicate that cultivated soils with dispersion and erosion ratios of less than 19 may be expected to be resistant to erosion and that those with dispersion ratios greater than 19 and erosion ratios greater than 30 will be susceptible to erosion. In the case of uncultivated soils the separation is not as clear but it would appear that if an uncultivated soil was found to have an erosion ratio of more than 20 it would be susceptible to erosion when cultivated.

Cultivation was found to have led to a marked reduction in aggregation in the forest soils and comparatively little change in aggregation in the prairie soils. It was found also that the cultivated soils had lost clay and organic matter in the same order.

As has been reported by other workers, clay, organic matter, and total base exchange capacity were found to be positively correlated with aggregation. In addition a positive correlation was found betwen alkali soluble humus and aggregation, but no relation was found between aggregation and the carbon-nitrogen ratio. There was no correlation found between exchangeable magnesium and aggregation but a slight negative correlation was found between exchangeable calcium and aggregation and between the degree of saturation and aggregation.

From these results it is concluded that clay and organic matter are the limiting aggregation factors in the soils studied. Of all the other factors studied the one most closely related to aggregation is the base exchange capacity.

To study the effect of humus on soil aggregation the ammonium salt was added and then precipitated with calcium. It was found effective in improving aggregation. It was found that the aggregation in cultivated soils was restored simply by adding humus. When increasingly large additions of humus were made, it was found that the first small addition of humus was the most effective in producing aggregation and that further additions were less effective. In most of the soils humus rapidly lost its effect after the soil contained 2 to 2.5 per cent of humus.

1864. A nutrient element slighted in agricultural research. Frederick J. Alway. *Journal of the American Society of Agronomy* 32 (12): 913-21. 1940.

The history of the use of sulfur fertilizers is divisible into three periods: (1) from 1768 to about 1845, gypsum was widely used and its beneficial effects given much consideration in texts on agricultural chemistry; in (2) covering about 60 years, agricultural scientists ignored the needs of any S additions to the soil and discouraged the use of gypsum; in (3) (present), various localities have been identified as potentially S-deficient; the heavy loss of S in drainage in many parts of the country is recognized and the S brought down in precipitation considered the chief replenishment except on irrigated lands. Knowledge of the S brought down in the rain and snow in the open country is important. Many of the reported data are suspect because of the manner of collecting the water for analysis. Where uncoated metal collectors are employed the SO_2 in the air attacks the surface and the resulting sulfate is included in the water analyzed. When water is allowed to stand exposed where there is much SO_2 in the air, it may accumulate enough H_2SO_4 within a month to double the amount of S found. Where there is little SO_2 in the air, as in northern Minnesota, the error introduced by the use of uncoated metal collectors is small; and that due to prolonged exposure of the rain water to the air appears negligible. Parallel measurement of the SO_2 in the air, using the "lead peroxide" method, is recommended wherever a study is being made in the S of the precipitation.

Home Economics

1830. Anthropometric data on college women of the middle states. Eva G. Donelson, Margaret A. Ohlson, Bernice Kunerth, Mary Brown Patton, and Gladys M. Kinsman. *American Journal of Physical Anthropology* 27(3):319-32. 1940.

Anthropometric measurements of 1,013 college women from Iowa, Kansas, Minnesota, Ohio, and Oklahoma are reported. The measurements taken were height, weight, chest breadth (lateral), chest depth (antero-posterior), girth of the arms and left leg, and pressure of the right and left hands.

There were 437 Old Americans observed, that is, persons whose ancestry on both sides had been American for at least three generations. Seventy-eight per cent of the Oklahoma students were Old Americans, 62 per cent of the Ohio group, 45 per cent of those from Kansas, 27 per cent of the Minnesota group, and 21 per cent of the Iowa Students. The means for the Old Americans were slightly smaller for all measurements than the means for those not classed as Old Americans, with the exception of the chest breadth and depth which were no different; the girth measurements were significantly smaller.

The measurements, ranked according to degree of variability expressed by the coefficient of variation, follow in increasing order of magnitude: height, chest breadth, chest depth, leg girth, arm girths, weight, and pressure.

The measurements for height, weight, girth of right arm, and leg circumference show a small consistent increase with ages 17, 18, and 19 years.

The women measured for this study excel in height and weight previously measured college women from the respective states. The chest diameter measurements were of a magnitude similar to earlier measurements on college women.

Animal and Poultry Husbandry

1729. A moose-dairy cow cross? W. W. Green and R. Fenstermacher. *Journal of Heredity* 30:458-60. 1931.

A reputed natural cross between a moose and a dairy cow is reported. Skeletal abnormalities were confined to the vertebral column. Testicular development, meat, and skeleton were mainly bovine in type. Autopsy findings plus the presence of horns on an individual whose dam has produced 12 polled calves indicated a mutation rather than species cross as responsible for the specimen. A purebred Shorthorn female exhibiting similar characteristics is also reported.

1731. Records of performance for meat animals. L. M. Winters. *The Empire Journal of Experimental Agriculture* VIII(32). October, 1940.

A record of performance to be useful must be usable; otherwise it will have served no purpose. To be effective it must identify the factors of performance which have the greatest bearing on profit. In beef animals these factors are economy of gains and suitability for market purposes, and they are of about equal importance in their effects on profit. Economy of gain can be obtained through individual feeding but that is expensive. Fortunately rate and economy of gains are closely correlated; rate of gain may therefore be used as an indicator of economy of gain.

The ewe's performance is calculated in terms of pounds of product, wool and lamb, per unit of feed cost. Feed costs are calculated in terms of maintenance requirements, and it is recognized that maintenance requirements increase in direct proportion to increased body weight. Standard ages are used for weaning and weighing out of the project.

In swine the factors of chief concern are (1) size of litter raised, (2) feed per unit of gain, and (3) carcass value. Since environmental factors cause many early death losses, a record should be kept of the pigs farrowed alive and pigs weaned. It is recommended that rate of gain be taken as a measure of feed lot efficiency. Since an animal cannot be slaughtered and yet retained for breeding, it is suggested that live animal form be used as an indicator of carcass value.

It is proposed that in the selection of breeding stock all the factors affecting the animal's value be taken into consideration individually rather than collectively because a serious defect in any one is enough to make the animal useless in a breeding herd.

1857. Seasonal trends of sperm cell types in sheep. W. W. Green. Thirty-third Annual Proceedings of *The American Society of Animal Production* pp. 207-10. 1940.

Cytological study was made of the semen of twelve purebred Shropshire ram lambs for a period of one year. Aceto-carmine stain and dark field illumination were used, and the spermatozoa were classified into approximately 30 categories.

From January to June (1939) few cytological changes were noted except for a slight but gradual lowering of seminal quality. During June, however, the proportions of all cell types changed rapidly, and later various categories of spermatozoa exhibited different seasonal trends. The relative number of normal cells decreased sharply until mid-July and then abruptly started to increase steadily until mid-November. The per cent of normal cells then remained rather constant until the end of January (1940). Sperm with abnormal tails were reduced in numbers during July, increased during August, and then declined toward a lower level until October. The per cent of tailless sperm heads rose rapidly at the end of June and then fell steadily until November. Except for an increase from June to August, the proportion of cells with head abnormalities remained constant throughout the trial.

The number of vesiculated cells was very low during the summer but increased to larger percentages by mid-October.

The density of sperm (billions per ml.) decreased rapidly from May to August and did not approach spring values until late November.

1858. New portable equipment for measuring respiration of sperm cells. R. E. Comstock. Thirty-third Annual Proceedings of *The American Society of Animal Production* pp. 216-20. 1940.

Both glycolytic and respiratory activity have been advanced as criteria of sperm quality. They are, in fact, closely correlated. The equipment used in the past to make these determinations, because of bulk and fragility, is not adapted to field use.

Development of a new and simpler type of apparatus for measuring respiration has made possible a more compact, less fragile unit which is suitable for use in both field and laboratory. Details of design and construction are given, together with precautions to be observed in construction and operation.

Determinations on the same sperm samples have been made with this apparatus and with Warburg manometers. While the error is slightly larger than with the Warburg manometers, it still is not so large as to impair the usefulness of the equipment. The results of these simultaneous determinations are presented in full.

Dairy Husbandry

1814. The fat metabolism of the mammary gland. J. C. Shaw and W. E. Petersen. *Journal of Dairy Science* 23:1045-56. 1940.

Using simultaneously drawn arterial and mammary vein blood samples, it was found that an average of 9.0 mg. per cent of neutral fat and/or cholesterol fractions were taken up by the mammary gland. This amount is enough to account for all the milk fat. Immediately after milking, very little calcium or blood fat is taken up by the mammary gland while blood glucose is used in normal amounts. The amount of calcium and fat taken up by the gland increases for the first four hours after milking when the maximum is reached.

Intravenous injection of oxytocin also prevents use of blood fat and calcium. On the basis of these observations it is suggested that some distention of the alveoli and secretory cells is essential for the passage of fat into the mammary gland.

1825. Avenized versus standard parchment for wrapping print butter. W. B. Combs, S. T. Coulter, and Dana W. Whitman. *Journal of Dairy Science* 24:117-25. 1941.

Samples of print butter from a large number of churnings were wrapped in standard parchment wrappers and wrappers that had been treated with oat flour (Avenex). The butters were stored for varying periods. The surface deterioration was measured organoleptically and by means of the fat aldehyde test. The results indicate that parchment paper treated with oat flour had a very slight effect in retarding the deterioration of the surface of butter. The treated parchment proved of most value when used on butter made from neutralized cream and of a "90" score.

1836. A technique for perfusing excised bovine mammary glands. W. E. Petersen, J. C. Shaw, and M. B. Visscher. *Journal of Dairy Science* 24:139-46. 1941.

Details are given for the construction of a suitable apparatus for perfusing the bovine mammary glands. For satisfactory perfusion experiments the gland should be hooked up within one-half hour after slaughter. The excised gland must be handled carefully or vasoconstriction may result. One g. chlorazol fast pink or 5 g. sodium citrate per liter of blood were found to be satisfactory anti-coagulants. Heparin is the best anti-coagulant.

1841. Some factors involved in efficient milking. Kenneth Miller and W. E. Petersen. *Journal of Dairy Science* 24:225-33. 1941.

Data are presented to show the effect upon milk and fat production of lengthening the interval between milking and stripping; stimulating the cow to let down the milk sometime before the milking begins and increasing the length of time involved in the milking process. Delaying the time when cows are stripped following the milking machine has little or no effect upon milk and butterfat production. Stimulating the cow to "let down" milk 20 minutes before milking decreased both milk production and fat percentage and had a tendency to "dry off" cows. Lengthening the time required for milking had the same effect as stimulating the "let down" before the milking begins. The observed effects are tentatively explained as being due to a dissipation of the oxytocic principle before the milk is emptied out of the alveoli and ductules of the gland.

Entomology and Economic Zoology

1723. The influence of temperature, moisture and food upon the development and survival of the saw-toothed grain beetle. Edward L. Thomas and Harold H. Shepard. *Journal of Agricultural Research* 60:605-15. 1940.

A study was made of the development of all stages of the saw-toothed grain beetle, an extremely common pest of cereals and cereal products in Minnesota, under varying conditions of temperature, moisture, and food. Under rather favorable conditions of moisture and food the total life cycle of the insect from egg to adult is 69 days at 68° F. and decreases as the temperature is higher until at 95° F. the cycle is completed in only 18 days. Moisture and nutritive variations change the rate of development much less than temperature differences. The susceptibility of this species to the high and low extremes of temperature differs little from that of the confused flour beetle for which rather complete data are available.

1734. Two new species of Trematodes (*Apharyngostrigea bilobata*: Strigeidae and *Cathaemasia nycticoracis*: Echinostomidae) from herons, with a note on the occurrence of *Clinostomum campanulatum* (Rud.). O. W. Olsen. *Zoologica* 25:323-28. 1940.

A new species of strigied fluke, *Apharyngostrigea bilobata* from black-crowned night herons (*Nycticorax nycticorax hoactli* Gruelin) and great blue herons (*Ardea herodias herodias* Linn.), and an echinostome fluke, *Cathaemasia nycticoracis* from the black-crowned night herons are described. These birds originated from rookeries in Ramsey, Steele, and Rice counties. Keys are provided for the species of both genera.

From the 49 black-crowned night herons and 11 great blue herons examined only four infections of *Clinostomum campanulatum* were found, these being in the black-crowned night herons. The double-crested cormorant (*Phalacrocorax auritus auritus*) is reported as a new host for *Clinostomum campanulatum*. It occurred in 6 of 18 birds.

1779. *Sarcocystis* in Wilson's snipe, American pintail, and blue-winged teal, and a list of avian hosts of the genus *Sarcocystis*. Arnold B. Erickson. *Auk* 57:513-19. 1940.

The protozoan genus *Sarcocystis*, which is parasitic in the muscles of vertebrates, has been reported from 8 orders, 13 families, 18 genera, and 19 species of birds. As new host records we may add Wilson's snipe *(Capella delicata)*, the American pintail *(Dafila acuta tzitzihoa)*, and the blue-winged teal *(Querquedula discors)*, all three of which were infested with *Sarcocystis rileyi*. The three host species were collected in Minnesota in 1939.

The frequency of occurrence of *Sarcocystis* in birds is not known, but of 279 ducks of 18 species examined in the Division of Economic Zoology, University of Minnesota, eight or 2.86 per cent were infected with *Sarcocystis rileyi*. The autopsy

records of the Minnesota Wildlife Disease investigation indicate that of 43 ducks of eight species examined, three or 6.97 per cent were infected with *Sarcocystis rileyi*.

In order to make the published information on avian hosts of *Sarcocystis* more available a host catalogue was prepared. Authorities for host and locality records have in each case been listed.

1789. Food habits of the sharp-tailed grouse by analysis of droppings. Gustav Swanson. *Journal of Wildlife Management* 4:432-36. 1940.

The analysis of droppings as a method of determining food habits of gallinaceous birds deserves wider application although it has a tendency to exaggerate the importance of the harder items. Review of the chief literature on food habits of the carnivorous mammals determined by this method reveals a lack of uniformity in presentation of data. It is suggested that frequency of occurrence, volumetric data, and number of prey individuals should all be presented wherever possible to facilitate comparison with other studies. All published studies of the autumn and winter foods of the sharp-tailed grouse reveal that they are relatively few in number.

1791. Methods of increasing deer browse. Laurits W. Krefting. *Journal of Wildlife Management* 5:95-102. 1940.

One of the purposes of this study was to determine the production of sprout growth of several species of deer browse by methods which induce sprouting. Briefly the findings were as follows:

1. Although the amount of browse produced by the "snow line" and "ground line" methods varied considerably both methods showed increased production over untreated samples.

2. Red-osier dogwood produced the largest amount of browse on a weight basis while honeysuckle produced the least.

3. On a length basis, trembling aspen was first (28 inches), red-osier dogwood second (19.2 inches), and mountain maple third (18.1 inches).

4. Neither trembling aspen nor paper birch are recommended for cutting: first, because the deer do not utilize their sprout growth to any great extent in winter; second, because the rate of growth is too rapid; and third, because the excessive cost of treatment makes it impractical.

5. Mountain maple was the most important species treated: first, because it was abundant in both deer yards and in the deer range in northern Minnesota; second, because both methods of treatment showed that the amount of browse could be increased very much; and third, because most of the browse produced still remained available five years after treatment.

6. The "ground line" method appeared to be the best method from the viewpoint that a larger number of species could be included and that the sprout growth might remain within reach for a longer time. However, additional years of growth on the experimental plots will be necessary to prove this point.

7. For paper birch and trembling aspen no correlation was found between the amount of sprout growth produced and the diameter of the stump cut which varied from 1-3 inches.

The second purpose of this study was to point out the practicability of the methods employed to increase the deer browse. Briefly the data showed the following:

1. The amount of labor required to treat an acre varied from 3.28 to 10 man-days on a 6-hour-day basis. This variation was due to the method of treatment used, the kind of species treated, and the density of stocking.

2. Trembling aspen and paper birch required the most labor because of the greater density of stocking and because of the need of using axes.

3. Shrub types required less labor because brush cutters could be used to a better advantage than axes.

4. About half as much labor was required when the "snow line" method of increasing deer browse was applied.

5. Costs ranged from $4.92 an acre in shrub types cut at the "snow line" to $15 an acre in tree types cut at the same level.

6. Although the cost of cutting mountain maple at the "ground line" was $9 per acre, it is recommended that future work be centered on this species and on this method of increasing deer browse in the locality studied.

1793. The identification of the females of the Myrmosid Myrmosula (Hymenoptera: Tiphiidae). Clarence E. Mickel. *Pan-Pacific Entomologist* 16(3):132-34. 1940.

The species in this subgenus were recently monographed by Krombein. This paper describes a new species and presents a new key to the females, using characters which were overlooked in the recent revision.

1794. Two new species of Lomachaeta, with a key to the described species (Hymenoptera: Mutillidae). Clarence E. Mickel. *Pan-Pacific Entomologist* 16(3):127-31. 1940.

This genus of Mutillidae was proposed in 1936 by Mickel, with four species included. Two new species are described and the first key separating the species in both the male and the female sexes is offered.

1795. Rat mite dermatitis in Minnesota. William A. Riley. *Minnesota Medicine* 23(4):423. 1940.

The tropical rat mite, *Liponyssus bacoti* is for the first time reported for as far north as Minnesota, where four widely separated localities are cited. The mite is the cause of a severe dermatitis and has been reported as a vector of endemic typhus in Texas.

1811. *Euparyphium melis* (Trematoda: Echinostomidae) from the snowshoe hare. Arnold B. Erickson. *Journal of Parasitology* 26:334. 1940.

In over 600 examinations of snowshoe hares, *Lepus americanus phaeonotus*, we have found but one fluke—a single specimen of the echinostome, *Euparyphium melis*, in the stomach of one hare. This animal was collected by the Minnesota Wildlife Disease Investigation at Lake Alexander in Morrison County, Minnesota, on July 9, 1936. This appears to be the first record of *E. melis* from the snowshoe hare.

1812. The snowshoe hare a new host of *Dermatoxys veligera* and *Nematodirus leporis*. Arnold B. Erickson. *Journal of Parasitology* 26:433. 1940.

A snowshoe hare, *L. a. phaeonotus,* collected on January 23, 1933, south of Lake Mille Lacs, was found by Dr. F. G. Wallace to harbor 10 specimens of *Dermatoxys veligera.* Another hare, collected on June 9, 1934, by the Minnesota Wildlife Disease Investigation at Lake Alexander, was found by the writer to be infested with 42 *Dermatoxys veligera* and 33 specimens of *Nematodirus leporis.*

1820. A technique for removing lead from the gizzard of living waterfowl. Warren H. Nord. *Journal of Wildlife Management* 5: 175-79. 1941.

A stomach pump for removing the gizzard contents of living ducks was devised for use in treating birds suffering from lead poisoning. The apparatus has been used on mallards but with modifications in size should be applicable to other species of waterfowl. In tests on over 20 ducks, the pump was successful in removing all lead shot and food contents in nearly every case. Poisoned birds have an improved chance for recovery if fed soft foods after the shot is removed from their gizzards. The technique for using the device is described in detail and an illustration of the apparatus is included.

1872. Vitamin content of bee foods. III. Vitamin A and riboflavin content of bee bread. M. H. Haydak and L. S. Palmer. *Journal of Economic Entomology* 34(1):37-38. 1941.

A biological assay has been described in which laboratory rats were fed various levels of bee bread in order to evaluate the vitamin A activity and riboflavin content of this food of honey bees. It has been found that the vitamin A activity of bee bread is equal to that of 6 I.U. and 8.4 I.U. for gram of fresh and dry matter, respectively. The riboflavin content was equal to 20 γ per one g. of fresh and 28 γ per g. of dry matter of bee bread.

Veterinary Medicine

1735. Detection of contamination of raw market milk with *Brucella abortus.* C. P. Fitch and Lucille M. Bishop. *Cornell Veterinarian* 29 (4):410-15. 1939.

Raw milk was tested as sold to the consumers of one city. The milk used was just as sold in bottles and was probably mixed milk from the whole dairy.

The study was made to determine whether milk with agglutinins in dilutions lower than 1:25 was significant of infection in a herd.

By guinea-pig inoculation *Brucella abortus* was demonstrated in 12 of the 37 milk samples which were examined. Eight of the samples had agglutinins in at least the 1:5 dilution. One sample which was tested came from a herd producing certified milk.

The herd status at or near the time the milk examination was made was compared with the results found on the agglutination titer of the milk.

Milk samples containing agglutinins in 1:5 dilution or higher came from herds whose average infection was 14 per cent; while samples in which no agglutinins could be demonstrated came from herds in which the average herd infection was 3 per cent.

1736. The blood picture in hog cholera. H. C. H. Kernkamp. *Journal of the American Veterinary Medicine Association* 95(752): 525-29. 1939.

Enumeration studies of the total numbers and types of cellular elements per unit volume of blood collected from healthy and cholera-sick swine are the basis of this report. Certain definite measurable changes occur in the course of this disease which can be useful as an aid to the diagnosis. The principal change noted is a decrease in numbers of leukocytes. The decrease is of sufficient magnitude to be characteristic of a severe leukopenia. Leukocyte counts of 8,000 cells per cmm. or less are justifiable evidence of less than the normal and therefore strongly suggestive of hog cholera. The occurrence of a leukopenia in three or more sick pigs of a drove is a most valuable diagnostic criterion. No significant change in numbers of erythrocytes or in the amounts of hemoglobin per unit volume of blood was observed in this disease. The study was conducted on naturally infected and artificially induced cases of hog cholera.

1805. The reticulo-endothelial system and immunity in hog cholera. H. C. H. Kernkamp. *Journal of Immunology* 39(1):85-88. 1940.

On the premise that the reticulo-endothelial system of swine functions as a mechanism responsible for immunity of hog cholera, attempts have been made to render it nonfunctional. The "blockade" method of interference was used. Trypan blue, in amounts varying from 10 to 40 mgm./lb. (dry dye basis), was introduced into the peritoneal cavity. It was readily taken up and distributed throughout the body. In some cases the dye was introduced just prior to the immunization (serum-virus) treatment and in others simultaneously with it. The results indicated that the mechanism which functions in immunity in hog cholera was not disturbed by "blocking" the reticulo-endothelial system with trypan blue.

1833. Brucellosis in horses. A study of five cases without clinical symptoms. A. G. Karlson and W. L. Boyd. *Journal of the American Veterinary Medicine Association* 97(765):576-80. 1940.

Five clinically healthy horses with positive reactions to the agglutination test for brucellosis have been studied by bacteriological examination of blood, urine, and feces. These studies were extended over periods ranging from 4 months in the case of one horse up to 12 months in the case of another. Complete necropsies were made on each animal and various tissues were examined by culture and guinea-pig inoculation for the presence of *Brucella abortus.*

Br. abortus was isolated once from a guinea pig inoculated with fecal material from one of the horses. On two other occasions guinea pigs inoculated with feces from this animal showed the presence of specific agglutinins, but the microorganism could not be recovered from them. Seventy-three fecal specimens from this horse were examined. The microorganism was recovered from a guinea pig inoculated with feces from another horse once out of 32 trials. The third horse developed an abscess of the withers from which *Br. abortus* was isolated. It was recovered from a lesion in the sternum of a fourth horse and from lesions in three ribs of a fifth. *Br. abortus* could not be demonstrated in the blood stream or urine of any of the animals.

1834. The effect of variation in technic on the rapid or plate agglutination test for Bang's disease. M. H. Roepke and W. D. Murdock. *Cornell Veterinarian* 30(4):449-64. 1940.

Studies were conducted on some of the more common variations in technic now used by various operators with the plate test for Bang's disease. The following variations in the technic introduced sufficient variation in the titers obtained with bovine serums to warrant a more rigid standardization of the technic to reduce to a minimum discrepancies in the results obtained by different operators on the same serums:

1. The mixing of serum and antigen should be sufficient to give a homogenous mixture free of all visible clear areas of serum.

2. The area over which the serum-antigen mixture is spread on the plate should be standardized. Also the area of the serum-antigen mixture for each dilution of the test should be such that the depth of the fluid is approximately the same for each of the various dilutions.

3. Slight variations in the short time interval between rotating the test plate and reading the test eight to ten minutes after mixing the serum and antigen may introduce frequently an increase in the reading obtained of a half of a dilution or nearly 50 per cent in the titer. This variation may be reduced considerably by speeding up the agglutination more nearly to completion with an extra tilting and rotation of the test plate at the five-minute period in the test.

1835. Brucellosis in a dog. A. G. Karlson and L. B. Clausen. *Cornell Veterinarian* 30(4):546-47. 1940.

The dog, a nine-year-old castrated male German shepherd, came from a farm where 9 of the 14 cows had Bang's disease. The owner had undulant fever. The dog had been fed a quart of raw milk from the infected cattle for several years. His serum showed a complete reaction at 1:50 and incomplete at 1:100. He was isolated for three months from contact with any diseased animals. During this time he remained clinically healthy but his agglutinin titer did not change. Twenty-seven blood specimens were cultured and used for guinea-pig inoculation with negative results. He was then fed daily a quart of milk known to contain *Brucella abortus*. This was continued for two months during which time there was no change in the agglutinin titer or clinical appearance. Fourteen blood specimens were examined during this period. *Br. abortus* was isolated from a guinea pig inoculated with 2 cc. of blood one month after the feeding of the contaminated milk was started. The dog was destroyed but no significant lesions were demonstrable at necropsy. Bacteriological study of tissues gave negative results. Histopathologic studies showed only a chronic lymphadenitis of the mesenteric lymph nodes.

1842. A convenient field test for albuminuria. M. H. Roepke. *Journal of the American Veterinary Medicine Association* 97(765): 602-03. 1940.

A 20 per cent solution of sulfosalicylic acid added to urine in a test tube, in the ratio of 1 cc. of the reagent to 4 or 5 cc. of urine, serves as a simple and quick method for the determination of albuminuria.

A table is included to show methods of preparing urine samples containing varying amounts of serum protein in order to familiarize the veterinarian with the various degrees of turbidity for the various reactions from a negative test up to a four plus reaction.

1846. The cultural and biochemical properties of *Erysipelothrix Rhusiopathiae*. A. G. Karlson and I. A. Merchant. *American Journal of Veterinary Research* 2(2):5-10. 1941.

Sixty strains were studied. In general they were short, slender, curved rods when isolated from mice and formed small discrete colonies. On prolonged incubation they formed long filamentous threads which grew in larger and more irregular colonies. Both forms were Gram-positive. In gelatin stabs the growth radiated from the center to form a test-tube brush appearance. A small degree of hemolysis was seen about deep colonies. Litmus milk showed no change, indol was not formed, and nitrates were not reduced. Hydrogen sulfide was formed. No gas was formed on the fermentable media used. Acid was produced readily from dextrose, lactose, galactose, and levulose with delayed reactions on mannose and cellibiose media. No acid reactions were seen on arabinose, xylose, rhamnose, maltose, melibiose, sucrose, trehalose, raffinose, melezitose, dextrin, starch, inulin, amygdalin, salicin, glycerol, erythritol, adonitol, mannitol, sorbitol, dulcitol, or inositol.

1851. Wound healing in sheep. W. G. Andberg. *Journal of the American Veterinary Medicine Association* 98(766):36-37. 1941.

This is a case report of dog-inflicted injuries in sheep and their treatment. The presence of living larvae in October indicated that viviparous flies were still active, which may have caused one to err in diagnosis as to the time the wounds were inflicted. Sheep in good condition appear resistant to wound infection.

1863. Endocarditis in swine due to *Erysipelothrix Rhusiopathiae* and to streptococci. H. C. H. Kernkamp. *Journal of the American Veterinary Medicine Association* 98(767):132-33. 1941.

Within the past decade swine erysipelas has become quite prevalent in certain sections of this country. Among the chronic cases of this disease, a vegetative endocarditis appears to be a common and characteristic lesion. In fact, many veterinarians and others are of the opinion that a vegetative endocarditis in swine is pathognomonic of swine erysipelas. To this we disagree vigorously. During the past 10 years we have examined and studied 19 cases of vegetative endocarditis. From the standpoint of the gross and microscopic morphology, all resembled the lesion described as characteristic of swine erysipelas and due to *Erysipelothrix rhusiopathiae*. However, the bacteriological examination showed that *E. rhusiopathiae* was responsible for 11 of the cases and 8 were due to streptococci. The distribution of the lesion in the hearts was about equal for both groups, the location being the mitral, tricuspid, aortic, and pulmonary valves, the atrial and ventricular endocardium. We advised to be cautious about reaching a conclusive etiologic diagnosis from the gross appearance of a vegetative endocardial lesion in swine.

1870. Syndrome of temporary alveolar pulmonary emphysema (heaves) in the horse following intravenous injection of histamine. W. G. Andberg, W. L. Boyd, and C. F. Code. *Journal of the American Veterinary Medicine Association* 98(769):285-87. 1941.

This report deals with the clinical symptoms following the intravenous injection of histamine and those occurring during certain foreign-protein reactions in horses. Histamine injection into the blood stream of horses induced respiratory symptoms indistinguishable from those associated with acute anaphylactic shock and, with the exception of coughing, characteristic of acute alveolar emphysema (heaves).

1890. Cystitis in a stallion due to an amorphous calculus with involvement of the genital tract. A. G. Karlson, W. L. Boyd, and D. B. Palmer. *Journal of the American Veterinary Medicine Association* 98 (768) :232-33. 1941.

A ten-year-old stallion developed dysuria with frequent straining and elimination of small amounts of urine. The left testicle was enlarged about four times. He was afebrile and evinced no pain on palpation of the affected testicle. Rectal examination revealed a distended bladder with thick, firm walls. The left vas deferens was about three times normal size. Straw-colored fluid aspirated from the scrotum contained no pus cells and was found to be sterile. He became progressively worse and was destroyed about three weeks after onset of the symptoms. Necropsy showed the presence of large amounts of clay-like sediment adhering to the bladder walls. The seminal vesicles contained urine and fibrinous exudate. The urethra was distended and contained fibrinous purulent exudate. The orifice of each vas deferens was closed. Histopathologic studies showed small foci of necrosis and suppuration in the kidneys and ureters. The walls of the seminal vesicles and bladder were thick and covered with a dense fibrinous layer. The left testicle showed no inflammatory changes, but there were large areas of tubular atrophy.

Agricultural Engineering

1754. Some soil changes resulting from drainage. H. B. Roe. *Soil Science Society of America, Proceedings* 4:403-09. 1940.

Studies in California, Colorado, New Mexico, and Oregon show reduction of alkali in the first 4 to 6 feet of soil of 0.15 to 1.28 per cent on a dry weight of soil basis, in one to two years, through flooding (5 feet of water or more per season) and drainage 5 to 8 feet deep. Fine resulting fruit and forage crops are also cited. One Utah report covering 13 years shows total alkali reduction of only 0.05 per cent, believed due to faulty drainage design because not supported by other studies in the same region. Studies of open ditch drainage effects on Minnesota swamp forests show reduction of harmful acidity and stimulation of desirable bacterial action and of timber growth as much as 1,000 per cent during the life of the trees. Good permeability was shown to be developed, through 13 to 20 years of tile drainage, in originally tight silt and clay loam and marl soils in Minnesota and North Dakota. Total subsidence of cultivated peat in Minnesota (0.5 to 1.1 feet through nine years) is shown closely proportional to depth of drainage on a 2½ acre experimental tract containing five parallel plots 2 rods wide by 15½ rods long, on which the water level was controlled at successive depths of 1 to 5 feet.

1821. Tests of 106 commercial cements for sulfate resistance. D. G. Miller and P. W. Manson. *Proceedings of the American Society for Testing Materials* 40:988-1006. 1941.

Results of five-year sulfate resistance tests of 5,724 concrete cylinders, 2x4 inches, made of 106 commercial cements from 74 mills are recorded in this report. Some of the cylinders were continuously stored in the laboratory in 1 per cent solutions of magnesium sulfate (MgS_4), some in 1 per cent solutions of sodium sulfate (Na_2SO_4), and some in the water of Medicine Lake, South Dakota. During the five-year period, the water of this lake averaged 12 per cent total salts, of which two thirds were magnesium sulfate and one fourth sodium sulfate. Resistance of the specimens stored in the laboratory solutions was determined by length changes while resistance of the Medicine Lake cylinders was determined by strength ratios calculated from compression tests at one and five years of the Medicine Lake cylinders stored in tap water in the laboratory.

The many tests and chemical analyses indicate close correlation between sulfate resistance of the cements and the percentage of the calculated compound tricalcium-alumniate.

1824. Sawdust concrete test results. L. W. Neubauer. *Journal of the American Society of Agricultural Engineers* 21(9) :363-65. 1940.

Sawdust is known to be of organic nature and therefore should be considered undesirable in concrete. Local interest led to a study and tests of sawdusts in various sawdust concrete mixtures.

At the Minnesota Agricultural Experiment Station a sawdust concrete floor was placed in a hog barn. Some of the mixtures used set very slowly. This led to the testing of 698 cylinders made up of 11 species of wood. A number of variables such as kind of wood, size of particles, proportions, water-cement ratio, age, and method of curing were observed and recorded. With some sawdusts little strength was secured. If enough cement was used to give strength the insulation value was lost. None of the sawdusts gave much strength. The soluble vegetable matter in a given sawdust is an index to the strength of the concrete made from that sawdust.

Because of the above mentioned variables it is difficult to give safe rules for making sawdust concrete. It is advisable to make a trial batch at least two days before mixing sawdust concrete in quantity.

Miscellaneous Journal Series Papers

Horticulture

436. The Golden Gopher muskmelon. T. M. Currence, C. J. Eide, and J. G. Leach. *Minnesota Horticulturist* 68:171. 1940.

The Golden Gopher is a melon which has been developed during the past eight years of work on the Fusarium wilt of muskmelons. It combines wilt resistance, earliness, and high eating quality with several other desirable characteristics.

The variety originated from controlled pollinations and selections of progeny of a plant found growing on wilt infected soil. A complete description of the fruit is given in the text.

The Golden Gopher compares favorably with the average and the best of 12 wilt resistant strains grown under the same conditions in 1938.

445. Rating of Minnesota apples by hotels and restaurants. J. D. Winter. *Minnesota Horticulturist* 69:65. 1941.

A summary is given of the results of tests of 23 varieties of Minnesota grown apples for baking, pie, and sauce. These tests were made at hotels, restaurants, and other commercial establishments in Minneapolis and St. Paul during the period, 1935-40. Factors that were found to influence the quality of the product included not only the variety used but also the grade, maturity, and season of use of individual varieties and methods used in cooking.

Plant Pathology and Botany

435. Use of ultraviolet light for detecting ring rot of potatoes. R. B. Harvey. *Chicago Packer.* October 5, 1940.

Seed potato cutting machines using the G.E. BH4 lamp are described for use by inspectors, and also a practical hopper type cutter for four knives.

439. Farmstead weeds. A. H. Larson, Lambert Erickson, and R. B. Harvey. *Seed Trade Buyers Guide* 24:65-82. 1941.

Descriptions and drawings of use in the identification of weeds that are commonly found around the buildings and in the plantings of the farmstead.

443. A new spray for the control of apple scab in Minnesota. E. G. Sharvelle. *The Fruit Grower* 8:9-11. 1941.

Experiments designed to demonstrate the utility of sodium salt of di-nitro-ortho-cresylate (Elgetol) as an eradicant spray for the control of apple scab were conducted during the season of 1940-41. This material is applied at the strength of 1 per cent to the ground at the rate of 400 to 500 gallons per acre while the trees are strictly dormant. Results obtained with this material clearly demonstrated that it was worthy of use in Minnesota as an eradicant spray for apple scab control, reducing, during the past season, the percentage of scabby fruit 20 to 40 per cent. It was recommended that this material be included in the apple scab control program.

447. Turf injuries in Minnesota. Ian W. Tervet. *The Greenkeeper's Reporter.* May-June. p. 40. 1941.

Snow mold of bent and other turf grasses was severe in the spring of 1941. Some of this injury was due to a fungus—*Typhula itoana*—that had not been recognized in Minnesota as associated with this disease. An unusual development of fruiting bodies of this fungus occurred on one bent grass area in November, 1940 and severe snow mold occurred in April, 1941 on the grass which had previously borne sporophores. A second type of injury resulting in the death of extensive areas of bent and blue grass occurred in the two weeks following the disappearance of the snow. This injury apparently resulted from exposure of the waterlogged turf to sunlight and strong wind resulting in a scorching of the leaf blades and finally death to the plant.

Soils

409. The modern conception of soil and its relation to plant growth. C. O. Rost. *The Greenkeeper's Reporter* 7(4):5, 6, 43. 1939.

The paper presents a general discussion of the modern concepts of soil formation in relation to climatic factors and the effect of these upon plant growth. Under natural conditions vegetation tends to conserve nutrients in that it prevents their loss by leaching. With the removal of crops there is a gradual depletion of plant nutrients. Considerable progress has been made in testing soils for nutrient deficiencies but such tests still fall short of perfection. The proper interpretation of such tests, however, requires a knowledge of the fundamentals involved and a background of experience which permits the consideration of the factors concerned.

Dairy Husbandry

419. Effect of salt on the microflora and acidity of cream. D. I. Thompson and H. Macy. *National Butter and Cheese Journal* 31(2): 12-14. 1940.

The results indicate that, with increasing salt concentrations in the cream ranging from 5.0 to 10.0 per cent, the growth of bacteria and especially yeasts was quite effectively checked if the cream was maintained at reasonably low temperatures, and as a consequence the acidity of the cream did not increase materially during the 10-day period of storage. As judged by the aroma, the quality of the cream samples containing 7.5 and 10.0 per cent salt and stored at temperatures as high as 70 degrees F. could not be criticized except for a slight staleness at the end of the 10-day storage period. The cream with 5 per cent salt and stored at 70 degrees F., in at least one instance, was criticized as being "yeasty." But in the unsalted samples very definite odors such as "cheesy," "yeasty," or "alcoholic" were present.

Entomology and Economic Zoology

448. Minnesota forest insect survey for 1940. A. C. Hodson. *Department of Conservation, Division of Forestry.* 13 mimeographed pages. 1941.

Seasonal weather conditions are reviewed with particular emphasis on the relation of weather to insect abundance. The reports of State Forest Rangers are summarized and the results of rearing of specimens collected by them are included. Some important forest insect problems such as the prevalence of bark beetles in wind-thrown and ice-damaged timber and the spruce budworm are discussed in some detail.

Rural Sociology

432. Recent changes in farm trade centers of Minnesota. Lowry Nelson and E. T. Jacobson. *Rural Sociology* 6(2):99-106. 1941.

The impact of the depression on Minnesota rural trade centers, as measured by the change in number of business units from 1929 to 1933, showed a rather marked decline of 7.5 per cent for small centers and of 2.6 per cent for medium sized places, while the larger centers actually gained by the slight margin of 1.1 per cent. Moreover, the small places while losing more heavily during the depression years failed to gain as rapidly from 1933 to 1937 as did the medium and larger places. A large part of the "recovery" gains in business units was in filling stations and eating and drinking establishments. Distance from a major trade center seems to influence the growth or decline of smaller places.

SUMMARY OF PUBLICATIONS

Kind of publication	Number issued	Number of pages	Number of copies in edition
Reports	1	104	2,200
General Series Bulletins	6	238	48,500
Technical Series Bulletins	3	172	6,500
Extension Service			
Bulletins	13	286	240,000
Pamphlets	14	209	105,000
Folders	11	70	282,500
News Letters			
Dairy Herd Improvement Letter	12	79	32,925
Engineering News Letter	12	12	11,400
Minnesota Farm Business Notes	12	48	30,700
News Letter	52	104	76,180
Poultry News Letter	12	27	4,790
Turkey News Letter	8	16	44,125
Rural Program Helps	9	68	12,378
4-H Club News Letter	10	118	31,568
Minnesota Extension News	12	29	3,550
Sheep News	5	5	17,390
Current Information Letter	10	26	2,500
	202	1,611	952,206

Papers	Scientific Journal Series	Miscellaneous Journal Series
Agronomy and Plant Genetics	7	.....
Horticulture	2	2
Plant Pathology and Botany	16	4
Agricultural Biochemistry	17	.....
Soils	4	1
Home Economics	1	.....
Animal and Poultry Husbandry	4	.....
Dairy Husbandry	4	1
Entomology and Economic Zoology	12	1
Veterinary Medicine	12	.....
Rural Sociology	.....	1
Agricultural Engineering	3	.....
	82	10
Total publications	294	

PROJECTS

Agronomy and Plant Genetics

6. Growth habits and feeding qualities of plants suitable for pasture. (Cooperative with the Southeast, West Central, Northwest, North Central, and Northeast experiment stations) (H. K. Hayes, R. P. Murphy, C. L. Alexander, D. U. Harvey, Catherine Harrington, H. K. Schultz, R. E. Hodgson, R. O. Bridgford, R. S. Dunham, O. W. Swenson, M. J. Thompson) (Bankhead-Jones)

7. Pasture-management studies. (Cooperative with the Division of Soils and the Southeast, West Central, and Northwest experiment stations, Minnesota Agricultural Experiment Station; and with the Soil Conservation Service, United States Department of Agriculture) (A. C. Arny, R. F. Crim, R. S. Dunham, R. E. Hodgson, R. O. Bridgford) (Bankhead-Jones)

Subproject: Renovating permanent bluegrass pastures.
Subproject: Comparison of delayed with continuous grazing of treated and untreated permanent pastures.
Subproject: Comparison of the values of different mixtures of grasses and legumes.
Subproject: Comparison of sweet clover and Sudan grass as supplementary pasture crops.
Subproject: Comparison of methods of freeing permanent pastures from weeds and brush. (Inactive)

8. Characteristics, growth habits, and control methods of weedy plants. (Cooperative with the Division of Plant Pathology and Botany, the Northwest, West Central, and Southeast experiment stations, Minnesota Agricultural Experiment Station; with the State Department of Agriculture; and with the Bureau of Plant Industry, United States Department of Agriculture) (H. K. Wilson, R. B. Harvey, L. M. Stahler, A. H. Larson, W. J. N. Brown, R. F. Crim, Arne Carlson, Nick Eidem, Russell Nelson, George Roadfelt) (Bankhead-Jones)

Subproject: Cultural methods as a means of control, with special reference to field bindweed.
Subproject: The morphology and physiology of perennial weeds.
Subproject: Chemical eradicants in the control of weeds.
Subproject: The development of new chemicals for weed control.
Subproject: Weed dissemination.

101. Varietal improvement in rye. (Cooperative with the Southeast, West Central, North Central, and Northeast experiment stations) (H. K. Hayes, C. L. Alexander, D. U. Harvey, Catherine Harrington, R. E. Hodgson, R. O. Bridgford, O. W. Swenson, M. J. Thompson, H. H. Kramer)

Subproject: Continuous selfing and selection.
Subproject: Inheritance of degree of seed setting, kernel color, and possible other characters. (Inactive)
Subproject: Yield in fortieth-acre plots.

102. Varietal improvement in barley. (Cooperative with the Division of Plant Pathology and Botany and the Southeast, West Central, Northwest, North Central, and Northeast experiment stations) (F. R. Immer, R. E. Hodgson, R. O. Bridgford, R. S. Dunham, O. W. Swenson, M. J. Thompson, C. L. Alexander, D. U. Harvey, Catherine Harrington) (Purnell, Bankhead-Jones)

Subproject: Breeding studies.
Subproject: Rod-row trials.
Subproject: Fortieth-acre plot trials.

103. Varietal improvement in spring wheat. (Cooperative with the Division of Plant Pathology and Botany, Division of Soils, the Division of Agricultural Biochemistry, and the Southeast, West Central, Northwest, North Central, and Northeast experiment stations, Minnesota Agricultural Experiment Station; with the North Dakota, South Dakota, and Montana agricultural experiment stations; and with the Bureau of Plant Industry, United States Department of Agriculture) (H. K. Hayes, E. R. Ausemus, R. E. Hodgson, R. O. Bridgford, R. S. Dunham, O. W. Swenson, M. J. Thompson, C. L. Alexander, D. U. Harvey, Catherine Harrington)

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

104. Varietal improvement in winter wheat. (Cooperative with the Division of Plant Pathology and Botany, the Division of Soils, and the Southeast and North Central experiment stations, Minnesota Agricultural Experiment Station; the South Dakota and Montana experiment stations; and with the Bureau of Plant Industry, United States Department of Agriculture) (E. R. Ausemus, H. K. Hayes, C. L. Alexander, D. U. Harvey, Catherine Harrington, R. E. Hodgson, O. W. Swenson)

Subproject: Breeding studies.
Subproject: Rod-row trials.
Subproject: Fortieth-acre plot trials.

105. Varietal improvement in oats. (Cooperative with the Division of Plant Pathology and Botany, and the Southeast, West Central, Northwest, North Central, and Northeast experiment stations) (H. K. Hayes, H. K. Wilson, C. L. Alexander, D. U. Harvey, Catherine Harrington, R. E. Hodgson, R. O. Bridgford, R. S. Dunham, O. W. Swenson, M. J. Thompson)

Subproject: Breeding studies.
Subproject: Rod-row trials.
Subproject: Fortieth-acre plot trials.

106. Varietal improvement in alfalfa and source-of-seed investigations. (Cooperative with the Division of Plant Pathology and Botany, and the West Central, Northwest, and North Central experiment stations, and with the Bureau of Plant Industry, United States Department of Agriculture) (A. C. Arny, D. U. Harvey, R. O. Bridgford, R. S. Dunham, O. W. Swenson)

Subproject: Rod-row trials.
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 of plantings from commercial lots of alfalfa seed.

107. Varietal improvement in flax. (Cooperative with the Division of Plant Pathology and Botany, Division of Soils, and the Southeast, West Central, Northwest, North Central, and Northeast experiment stations, Minnesota Agricultural Experiment Station; and with the Bureau of Plant Industry, United States Department of Agriculture) (A. C. Arny, D. U. Harvey, C. L. Alexander, A. H. Moseman, Catherine Harrington, R. E. Hodgson, R. O. Bridgford, R. S. Dunham, O. W. Swenson, M. J. Thompson)

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

108. Cytology in relation to genetics. (C. R. Burnham, L. C. Saboe) (Adams)

109. Forage and pasture crop investigations. (Cooperative with the divisions of Dairy Husbandry and Soils and the West Central, Northwest, North Central, and Northeast experiment stations) (A. C. Arny, D. U. Harvey, R. O. Bridgford, R. S. Dunham, O. W. Swenson, M. J. Thompson) (Completed)

110. Studies in the classification of farm crops. (Cooperative with the Bureau of Plant Industry, United States Department of Agriculture) (A. C. Arny, A. C. Dillman)

112. Varietal improvement and studies on the fertilizing value of sweet clover. (Cooperative with the Division of Plant Pathology and Botany, the Division of Soils, and the Southeast, West Central, Northwest, North Central, and Northeast experiment stations) (H. K. Hayes, D. U. Harvey, E. H. Rinke, R. P. Murphy, R. E. Hodgson, R. O. Bridgford, R. S. Dunham, O. W. Swenson, M. J. Thompson)

Subproject: Improvement phases.
Subproject: Variety tests.

Subproject: Methods of handling sweet clover in relation to the effect on the succeeding crop.

114. Varietal improvement in field peas, soybeans, and field beans. (Cooperative with the Division of Soils and the Southeast, West Central, Northwest, North Central, and Northeast experiment stations) (A. C. Arny, W. W. Brookins, D. U. Harvey, R. E. Hodgson, R. O. Bridgford, R. S. Dunham, O. W. Swenson, M. J. Thompson)

Subproject: Classification. (Inactive)
Subproject: Preliminary trials.
Subproject: Fortieth-acre plot trials.

116. Controlled pollination as a means of corn improvement. (Cooperative with the Division of Plant Pathology and Botany and the Southeast, West Central, Northwest, and North Central experiment stations) (H. K. Hayes, R. P. Murphy, Catherine Harrington, E. H. Rinke, H. H. Kramer, E. L. Pinnell, D. U. Harvey, R. E. Hodgson, R. O. Bridgford, R. S. Dunham, O. W. Swenson) (Purnell)

118. Genetics of maize and barley. (H. K. Hayes, F. R. Immer, L. C. Saboe) (Adams)

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

119. Varietal improvement in sugar beets. (Cooperative with the Southeast, North Central, and Northwest experiment stations, Minnesota Agricultural Experiment Station; and with the Bureau of Plant Industry, United States Department of Agriculture) (R. E. Hodgson, D. U. Harvey, J. O. Culbertson, Catherine Harrington, O. W. Swenson, R. E. Nylund)

Subproject: Variety testing.
Subproject: Crop sequence.
Subproject: Genetic studies.

121. Crop rotation investigations. (Cooperative with the divisions of Soils and Agricultural Extension, and the Northeast, Northwest, and West Central experiment stations) (A. C. Arny, D. U. Harvey, W. W. Brookins, R. O. Bridgford, R. S. Dunham, M. J. Thompson)

Subproject: Field C rotations.
Subproject: Field T rotations.

122. Cooperative seed production and distribution. (Cooperative with the Minnesota Crop Improvement Association, and farmers) (Carl Borgeson, H. K. Hayes, D. U. Harvey)

124. The development of disease-resistant varieties of farm crops. (Joint project with Plant Pathology and Botany Project No. 104; cooperative with the Bureau of Plant Industry, United States Department of Agriculture) (H. K. Hayes, E. R. Ausemus, A. C. Arny, R. P. Murphy, F. R. Immer)

Subprojects: Spring wheat, winter wheat, oats, barley, rye, flax, corn, sweet clover, sugar beets (dormant), and alfalfa.

125. Demonstration trials with new crop varieties. (Cooperative with the Division of Agricultural Extension) (R. F. Crim, W. W. Brookins, H. K. Hayes)

Subproject: Small grain and forage crops.
Subproject: Hybrid corn.

126. Mode of inheritance of the drying qualities of linseed oil and related characters. (Cooperative with the Division of Plant Pathology and Botany, Minnesota Agricultural Experiment Station; and with the Bureau of Plant Industry, United States Department of Agriculture) (A. C. Arny, C. L. Alexander, Catherine Harrington) (Completed)

127. Emergency fodder, hay, and pasture crops. (Cooperative with the West Central Experiment Station) (A. C. Arny, D. U. Harvey, R. O. Bridgford)

128. Studies on quality of barley varieties and strains. (Cooperative with the Division of Agricultural Biochemistry and the Southeast Experiment Station, Minnesota Agricultural Experiment Station; and with the Malting Barley Laboratory at Madison, Wisconsin) (F. R. Immer, R. E. Hodgson)

131. Adaptation and performance of experiment station and commercial seed company corn hybrids. (Cooperative with the Division of Agricultural Extension, Minnesota Crop Improvement Association, and commercial seed companies) (R. F. Crim, H. K. Hayes, C. H. Griffith)

Forestry

106. Studies of forest planting. (T. Schantz-Hansen)

107. Thinning of jack and Norway pine. (T. Schantz-Hansen)

110. Studies in yield and volume.

Subproject: Lake Vadnais plots. (J. H. Allison)
Subproject: Studies in yield and volume. (Cooperative with the Division of Horticulture) (R. M. Brown, T. M. Currence, S. Gevorkiantz, R. Larson)

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

127. The determination of the rate of moisture movement through wood. (L. W. Rees)

128. A study of the efficacy of wood preservatives. (Cooperative with the American Creosoting Company) (Henry Schmitz, F. H. Kaufert)

129. Silvicultural aspects of the farm woodlot management in the hardwood region of Minnesota. (Inactive) (Discontinued)

134. Statistical correlations of Cloquet weather data and the diameter growth of trees at the Cloquet Forest Experiment Station. (R. M. Brown, T. Schantz-Hansen) (Inactive)

137. A study of the factors affecting the durability of wood. (Henry Schmitz, F. H. Kaufert)

139. A study of the structure of wood and wood products. (F. H. Kaufert) (Dormant)

141. Problems in wood utilization. (Cooperative with the American Creosoting Company, Louisville, Kentucky) (L. W. Rees)

Subproject: The effect of steaming on the strength of shortleaf pine and slash pine.

Subproject: The effect of urea and other chemicals on the static bending and crushing strength of wood.

142. Determining the value of seed contained in the serotinous cones of jack pine (*Pinus banksiana* Lamb.) as a source of seed for natural and artificial regeneration. (Cooperative with the Forest Service, United States Department of Agriculture) (T. Schantz-Hansen)

143. The effect of defoliation on the growth of certain tree species indigenous to northern Minnesota. (Cooperative with the Division of Entomology and Economic Zoology) (Henry Schmitz, A. C. Hodson) (Bankhead-Jones)

144. A study of the effect of the source of seed upon the growth, development, and habits of jack pine (*Pinus banksiana* Lamb.) and other native tree species. (T. Schantz-Hansen) (Bankhead-Jones)

145. Biochemical and technological studies of wood, wood constituents, and products derived from wood, with special reference to the forest resources of Minnesota. (Joint project with Agricultural Biochemistry Project No. 405) (Henry Schmitz, R. A. Gortner) (Bankhead-Jones)

146. A study of the factors influencing the rate of flow of liquids in wood. (Cooperative with the Division of Agricultural Biochemistry and with the American Creosoting Company) (R. A. Gortner, Henry Schmitz, Bror Anderson)

147. Minnesota Farm Forestry Project. Wood requirements of Minnesota farms and possibilities of meeting them through better utilization of farm-forest products and increased productivity of the farm woods; methods of establishment, care, growth, development, and effect of shelterbelts on Minnesota farms. (Cooperative with the divisions of Agricultural Economics and Agricultural Engineering, Minnesota Agricultural Experiment Station; and with the Forest Service, United States Department of Agriculture) (Charles H. White, T. Schantz-Hansen, Henry Schmitz, Russell Swain)

148. Ten-year revision of the management plan for the Cloquet forest. (T. Schantz-Hansen, J. H. Allison, R. M. Brown)

Horticulture

9. Utilization of disease-resistant germ plasm in the improvement of the potato. (Cooperative with the Division of Plant Pathology and Botany and with the State Seed Potato Certification office and with the Bureau of Plant Industry, United States Department of Agriculture) (F. A. Krantz, Z. M. Fineman) (Bankhead-Jones)

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

102. Turf construction and maintenance. (Cooperative with the Division of Plant Pathology and Botany and the Division of Soils) (L. E. Longley)

Subproject: Weed eradication.

104. Breeding and selecting greenhouse and garden flowers. (L. E. Longley, L. Sando)

105. Effect of different media on the rooting of cuttings and layers of herbaceous and hardwood plants. (L. E. Longley, L. Sando)

107. A study of quality, outlets, handling methods, prices, and volume of sale of certain Minnesota fruits and vegetables. (J. D. Winter, W. H. Alderman, F. A. Krantz) (Purnell)

Subproject: A study of the packs and grades of apples and other fruits sold by Minnesota growers and an analysis of the factors which cause culls and low-grade fruits.

Subproject: A study of new uses and market outlets for Minnesota fruits.

Subproject: A study of Minnesota-grown fruits and vegetables to determine their adaptability for freezing preservation in locker storage plants.

Subproject: A study of temperatures in refrigerated locker storages to determine what temperatures are satisfactory for the storage of fruits and vegetables for varying periods using different methods of preparation and packing.

108. Processing of fruits and vegetables. (Cooperative with the divisions of Dairy Husbandry and Home Economics) (J. D. Winter, W. H. Alderman, W. G. Brierley, F. A. Krantz, R. B. Harvey, R. H. Landon, Isabel T. Noble, W. B. Combs, S. T. Coulter) (Bankhead-Jones)

Subproject: Effect of carbon dioxide or other gases on the quality, rate of ripening, and development of decay of fruits and vegetables.

Subproject: Effect of freezing on the flavor, texture, color, and quality of fresh fruits and vegetables.

Subproject: Changes in flavor, texture, color, and quality of fruits and vegetables resulting from processing or utilization.

Subproject: Use of Minnesota fruits in ice cream.

201. Hardiness in relation to fruit breeding. (W. H. Alderman, R. H. Landon, A. N. Wilcox, T. S. Weir) (Adams)

202. Sterility in fruit breeding. (W. H. Alderman, T. S. Weir, A. N. Wilcox, R. Schutz, Philip Geiger) (Adams)

203. A study of inheritance of characters in fruits. (A. N. Wilcox, W. H. Alderman, T. S. Weir, R. Schutz, F. E. Haralson) (Adams)

Subprojects: Apple breeding, pear breeding, grape breeding, strawberry breeding, stone-fruit breeding, rubus breeding, and groselle breeding.

204. Fruit breeding and improvement. (Cooperative with the Bureau of Plant Industry, United States Department of Agriculture) (W. H. Alderman, F. E. Haralson, A. N. Wilcox, R. Schutz, W. G. Brierley, Walter Kroening, T. S. Weir, Roy Sauter)

205. Studies of hardiness in horticultural plants. (Cooperative with the Division of Plant Pathology and Botany) (W. G. Brierley, L. E. Longley, W. H. Alderman, R. H. Landon)

Subproject: An investigation of the fundamental differences between hardy and tender horticultural plants of the herbaceous type.

Subproject: A determination of the conditions under which horticultural plants of the herbaceous type are most likely to be injured by low temperatures.

Subproject: A study of the effects of excess water supply upon the survival of the strawberry and other herbaceous horticultural plants at the end of the dormant season.

Subproject: An investigation of the fundamental differences between hardy and tender horticultural plants of the woody type.

301. Blueberry culture. (Cooperative with the North Central Experiment Station) (W. G. Brierley, A. L. Richardson, T. S. Weir)

304. Fruit-variety studies. (Cooperative with the Division of Plant Pathology and Botany and the Southeast, West Central, Northwest, North Central, and Northeast experiment stations; and with private growers) (W. G. Brierley, W. H. Alderman, T. S. Weir)

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

307. Pruning studies. (W. G. Brierley, W. H. Alderman)

Subproject: Pruning requirements of the hybrid plums.

308. A study of management problems in red-raspberry culture in the Duluth area, with special reference to the effect of supplemental irrigation on yields and cost of production. (Cooperative with the Division of Agricultural Engineering and with the Northeast Experiment Station, Minnesota Agricultural Experiment Station; with the Minnesota Power and Light Company; with the St. Louis County Work Farm; and with raspberry growers in northeastern Minnesota) (W. G. Brierley, M. J. Thompson, O. C. Turnquist) (Bankhead-Jones)

Subproject: The effect of supplemental irrigation on plant growth and fruit production; the effect of different methods of applying water; and the effect of different sources of water on plant behavior.

Subproject: The effect of applications of commercial fertilizers on plant growth and fruit production and their relation to available soil moisture.

402. Breeding of vegetable crops. (T. M. Currence, A. E. Hutchins)

Subprojects: Tomatoes, beans, melons, cucumbers, peppers, eggplant, rhubarb, onions, asparagus, and variety and strain studies.

408. Potato breeding. (Cooperative with the Division of Plant Pathology and Botany, the Northeast, Northwest, and North Central experiment stations, Minnesota Agricultural Experiment Station; and with the Bureau of Plant Industry, United States Department of Agriculture) (F. A. Krantz, J. H. Wampole) (Adams)

Subproject: Development of improved varieties of potatoes through inbreeding and subsequent cross-breeding.

Subproject: Inheritance of certain characters in the potato.

Subproject: Tests of new varieties and seedlings.

414. Breeding of disease-resistant varieties of vegetable crops. (Joint project with Plant Pathology and Botany Project No. 118; cooperative with the Bureau of Plant Industry, United States Department of Agriculture) (F. A. Krantz, A. E. Hutchins, T. M. Currence) (Purnell)

Subproject: Breeding wilt-resistant muskmelon strains.

416. Genetics studies on vegetable crops. (Cooperative with the Division of Agronomy and Plant Genetics) (A. E. Hutchins, T. M. Currence)

Subprojects: Tomatoes, cucumbers, melons, beans, peppers, and onions.

417. Nutritional and physiological studies on potatoes. (Cooperative with the Division of Home Economics, the Division of Plant Pathology and Botany, and the Division of Soils) (R. B. Harvey, F. A. Krantz, Philip Hamm, Jacob Sevitt) (Bankhead-Jones)

Subproject: Factors causing discoloration.
Subproject: Effects of storage conditions.

Plant Pathology and Botany

101. Cereal and forage-crop diseases. (J. J. Christensen, M. B. Moore, N. E. Borlaug, A. E. Eagle, I. W. Tervet, E. A. Andrews, H. C. Young)

Subproject: Imperfects of cereals.
Subproject: Seed treatments.
Subproject: Scab of cereals. (Inactive)
Subproject: Miscellaneous diseases of flax.

103. Dendropathological work. (C. M. Christensen, T. H. King)

Subproject: Miscellaneous diseases of shade and forest trees.
Subproject: Biology of wood-rotting fungi.
Subproject: Experiments relating to the propagation, protection, and collection of plantation rubber. (Cooperative with the Firestone Tire and Rubber Company)

104. The development of disease-resistant varieties of farm crops. (Joint project with Agronomy and Plant Genetics Project No. 124) (E. C. Stakman, J. J. Christensen, M. B. Moore, M. N. Levine, A. E. Eagle, E. A. Andrews, A. R. Downie, E. W. Hanson, H. C. Young, N. E. Borlaug, I. W. Tervet)

Subprojects: Spring wheat (Cooperative with the Office of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture), winter wheat (Inactive), oats, barley, rye (Inactive), flax (Cooperative with the Office of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture), corn, grasses, red clover (Inactive), sweet clover (Inactive), sugar beets (Cooperative with the Office of Sugar Plant Investigations, Bureau of Plant Industry, United States Department of Agriculture), and alfalfa.

105. Diseases of ornamental plants. (Louise T. Dosdall, A. E. Eagle)

108. Fruit diseases. (E. G. Sharvelle, A. E. Eagle, T. R. Wright) (Purnell)

Subproject: Diseases of small fruits and methods of control.
Subproject: Diseases of tree fruits and methods of control.
Subproject: Nature and causes of strawberry degeneration in Minnesota.

109. Minnesota fungi. (Louise T. Dosdall, C. M. Christensen)

110. Plant-disease survey. (Louise T. Dosdall)

111. Rusts of cereals. (Cooperative with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, and the Division of Plant Disease Control, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture) (E. C. Stakman, A. E. Eagle, H. C. Young, M. Schuster, M. N. Levine, W. G. Loegering, R. U. Cotter, L. W. Melander) (Adams)

Subproject: Biologic specialization in cereal rusts.
Subproject: Epidemiology of cereal rusts.
Subproject: Barberry eradication.

115. Physiologic specialization of smuts of cereals. (E. C. Stakman, M. B. Moore, I. W. Tervet, M. F. Kernkamp, A. E. Eagle, W. Martin) (Purnell)

116. Garden-truck diseases. (Cooperative with the North Central and Northwest experiment stations) (C. J. Eide, A. E. Eagle, B. F. Shema, E. G. Sharvelle, H. C. Young, J. T. Presley)

Subproject: Potato diseases.
Subproject: Miscellaneous truck crop diseases.
Subproject: Etiology and control of purple-top wilt of potatoes.
Subproject: Etiology and control of hair-sprout of potatoes. (Inactive)
Subproject: Etiology and control of stem-end rot and wilt of potatoes.

117. The relation of insects to the dissemination and development of plant diseases. (J. J. Christensen, C. J. Eide) (Adams)

Subproject: The relation of insects to the development of bacterial wilt, ring rot, and soft rots of potatoes. (Inactive)
Subproject: The effect of aster leaf hoppers and similar insects on potatoes.
Subproject: The relation of insects to the development of potato scab. (Dormant)
Subproject: The relation of insects to the development of root rots of cereals.
Subproject: The relation of insects to the dissemination of ergot of cereals and grasses.

118. Development of disease-resistant varieties of vegetable crops. (Joint project with Horticulture Project No. 414; cooperative with the North Central Experiment Station, Minnesota Agricultural Experiment Station; and with the Office of Horticultural Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture) (C. J. Eide, A. E. Eagle, D. J. deZeeuw, J. R. Vaughn, J. W. Hendrix) (Purnell)

Subproject: Physiologic specialization of *Actinomyces scabies* and other potato pathogens in relation to disease-resistant varieties.
Subproject: Development of disease-resistant varieties of muskmelons, with special reference to fusarium wilt.

120. The nature and variability of plant-disease resistance. (Cooperative with the Division of Horticulture) (E. C. Stakman, J. J. Christensen, C. J. Eide, Helen Hart, J. R. Vaughn, T. R. Wright, D. Gottlieb, S. Silverberg, N. E. Borlaug, Dorothy J. Blaisdell, J. T. Presley) (Bankhead-Jones)

Subproject: Wheat and other small grains.
Subproject: Flax.
Subproject: Potatoes and other vegetables.
Subproject: Clover and other leguminous and forage plants.

121. Aerial dissemination of allergens and pathogens. (Cooperative with the University Health Service) (E. C. Stakman, D. A. Preston, R. V. Ellis)

201. Effect of low temperature on plants. (Cooperative with the Division of Agronomy and Plant Genetics and the Division of Horticulture) (R. H. Landon, R. B. Harvey)

Subproject: Varietal differences in frost resistance of crop plants.
Subproject: Physiological factors concerned in frost injury.
Subproject: Desiccation in the frozen condition as a cause of injury.
Subproject: Killing of seeds and seedlings of forest trees and horticultural plants by low temperatures.

203. Investigations on respiratory enzymes. (Cooperative with the Division of Horticulture) (R. H. Landon, R. B. Harvey)

Subproject: Oxido-reductase.
Subproject: State of oxidation in tissues. (Inactive)

204. Light relations of plants. (R. H. Landon, R. B. Harvey) (Inactive)

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. (Cooperative with the Division of Horticulture) (R. H. Landon, R. B. Harvey, R. C. Nelson)

Subproject: Physiological and chemical changes of fruits and vegetables in storage. (Inactive)
Subproject: Storage optimum temperature and humidity.
Subproject: Length of holding in storage in relation to stage of maturity of fruit. (Inactive)
Subproject: Ripening in storage. (Inactive)

206. Physiology of reproduction. (R. H. Landon, R. B. Harvey)

Subproject: Studies on plant hormones.

207. Physiology of seed germination. (R. B. Harvey, R. H. Landon)

Subproject: Physiology of dormancy in seeds including a study of means to shorten or eliminate the rest period.
Subproject: Effects of seed treatment upon germination, subsequent growth, and yield.

208. Studies in plant metabolism and growth. (R. B. Harvey, R. H. Landon, R. C. Nelson, Philip Hamm, D. H. Dodge)

Subproject: Effect of length of illumination period and light intensity upon growth and reproduction. (Inactive)
Subproject: Salt nutrition.
Subproject: Mineral nutrition.

301. Seed studies. (Cooperative with the State Seed Laboratory) (R. B. Harvey, A. H. Larson)

Subproject: Weed seed cases. (Inactive)
Subproject: Seed-testing survey. (Cooperative with State Seed Laboratory)
Subproject: Seeds in relation to game management.

302. Weeds. (R. B. Harvey, A. H. Larson)

Subproject: Weed identification and survey.

Agricultural Biochemistry

1. Problems concerning the calcium and phosphorus requirements of cattle in Minnesota. (Cooperative with the divisions of Dairy Husbandry and Veterinary Medicine) (L. S. Palmer, T. W. Gullickson, J. W. Nelson, W. L. Boyd, A. F. Sellers, J. L. Jensen, A. A. Spielman, S. P. Marshall) (Purnell)

Subproject: The calcium and phosphorus requirements for maintenance and for maintenance-plus-milk production in dairy cattle.
Subproject: The relationship of various levels and ratios of calcium and phosphorus requirements for maintenance, for maintenance plus growth, and for maintenance-plus-milk production of dairy cattle.
Subproject: The relationship of the skeletal reserves of calcium and phosphorus laid down during growth to the future productiveness of dairy cows. (Completed)
Subproject: The relative availability to cattle of the calcium and phosphorus in natural food and in the various proprietary sources of these elements offered for sale to dairy farmers and cattle breeders in Minnesota.
Subproject: The relation of the nutritive deficiencies of other major nutrients in the ration to the effects of phosphorus deficiency in cattle.
Subproject: An experimental study of the effect on oestrus cycle, ovulation, and reproduction of the nutritive deficiencies which may be associated with phosphorus deficiency.

14. Respiration and storage behavior of soybeans and soybean products. (W. F. Geddes, C. H. Bailey, P. E. Ramstad) (Bankhead-Jones)

16. A comprehensive study of the sulfur metabolism of plants and their natural supply of sulfur. (Cooperative with the Division of Soils and with the Frasch Foundation)

Subproject: The sulfur compounds of plants, their formation and intermediary products in the plant, and their role in plant metabolism. (R. A. Gortner, Harold Lindstrom, Ruth Yoshida, L. H. Johnson)

Subproject: Soil sulfur, atmospheric sources and contributions of sulfur, sulfur fertilizers, and plant response to sulfur fertilization. (F. J. Alway, L. L. Kempe, Irene Mattson)

101. Analytical service. (W. F. Geddes, H. A. Lillevik, D. E. Smith)

103. Investigations of proposed official methods of analysis.

Subproject: Determination of flour pigments. (W. F. Geddes)

Subproject: Revision of "Cereal Laboratory Methods." (W. F. Geddes)

Subproject: Ayer and Anderson method of proteolytic activity in malt products. (W. F. Geddes, H. A. Lillevik)

Subproject: Thiamin assay. (W. F. Geddes)

104. The strength of wheat flour. (Adams)

Subproject: Effect of flour and dough constituents on flour strength.

(a) Wheat protein survey. (C. H. Bailey)

Subproject: Role of enzymes in flour strength. (W. F. Geddes)

(a) Relation between diastatic activity and flour gassing power. (W. F. Geddes, P. P. Noznick)

(b) Protease activity and reducing matter content of wheat flour doughs in relation to baking behavior. (Ting Shen, W. F. Geddes)

(c) Yeast fermentation and potassium bromate as factors influencing the harmful effects of wheat germ on baking quality. (D. E. Smith, W. F. Geddes)

(d) Studies on wheat and flour tyrosinase. (C. H. Bailey, W. F. Geddes, L. F. Jents)

Subproject: Physical properties of flour and dough in their relation to flour strength. (W. F. Geddes, C. H. Bailey)

(a) Dough studies with the extensograph. (C. H. Bailey, W. F. Geddes, P. P. Merritt)

(b) Quantity of dough in relation to the use of the farinograph. (W. F. Geddes)

(c) Relations between physical properties of creaming mix, cake batter and cake quality. (W. F. Geddes, P. P. Noznick)

(d) Application of the baker compressimeter to cake studies. (W. F. Geddes, P. P. Noznick)

Subproject: Inheritance of flour strength and properties related thereto. (W. F. Geddes, P. P. Merritt)

105. The biochemistry of milling, baking, and macaroni manufacture. (Purnell)

Subproject: Milling.

(a) Experimental milling tests on plant breeders' varieties. (W. F. Geddes, P. P. Merritt)

(b) Effect of experimental mill room conditions on flour yield and flour properties. (W. F. Geddes)

(c) Relation between apparent specific gravity, test weight, protein content and flour yield of wheat varieties. (W. F. Geddes, P. P. Merritt)

Subproject: Baking and macaroni manufacture.

(a) Experimental baking tests. (W. F. Geddes, P. P. Merritt)

(b) Comparison of experimental baking methods. (W. F. Geddes, P. P. Merritt)

Subproject: Wheat and flour constituents in relation to baking properties.

(a) Changes in net weight and moisture content of wheat flour under different storage conditions. (W. F. Geddes, C. Anker, C. H. Bailey)

(b) Effect of leaf and stem rust on the agrotechnical and biochemical properties of wheat. (W. F. Geddes, P. P. Merritt, M. N. Levine)

(c) Starch gelatinization studies with the amylograph. (W. F. Geddes, C. Anker)

(d) Carotinoid pigment studies. (W. F. Geddes, H. A. Lillevik, D. E. Smith)

(e) Polarographic studies with carbohydrates. (W. F. Geddes, D. C. Hill)

Subproject: Dough ingredients other than wheat products.

(a) Comparative fermentation rates of bakers' yeasts with sucrose and maltose. (H. D. Goldman, W. F. Geddes)

(b) Dough fermentation with non-pathogenic colibacteris. (W. F. Geddes, Max Milner)

(c) Chemical composition of fats in relation to their value for cake-making. (W. F. Geddes, P. P. Noznick)

106. Oil seeds investigations. (Cooperative with the Bureau of Plant Industry, United States Department of Agriculture) (C. H. Bailey, W. F. Geddes, J. A. Schricker)

Subproject: Development of experimental techniques.

Subproject: Industrial quality of varieties.

Subproject: Inheritance of drying properties.

201. The biochemistry of carotinoid pigments in animals. (L. S. Palmer, L. D. Matterson) (Revived)

202. Chemical and biological studies in animal nutrition.

Subproject: Inheritance of efficiency of food utilization. (L. S. Palmer, Cornelia Kennedy, O. E. Mydland, Paul Weswig).

Subproject: Comparison of chemical composition of gain on uniform food consumption but different efficiency. (L. S. Palmer, Cornelia Kennedy, Richard Luecke)

Subproject: Calcium and phosphorus nutrition of growing colts. (Cooperative with the Division of Animal and Poultry Husbandry and the Divi-

sion of Veterinary Medicine) (L. S. Palmer, A. L. Harvey, J. W. Nelson, H. C. H. Kernkamp)

Subproject: Physiological and metabolic factors related to food utilization. (L. S. Palmer, Cornelia Kennedy, Paul Weswig)

Subproject: Curative effects of panthothenic acid and biotin (Vitamin H) in achromatricia in black rats. (L. S. Palmer, W. W. Kielley)

Subproject: Studies of the technique of bioassay of Vitamin E. (L. S. Palmer, W. W. Kielley)

Subproject: The Vitamin B_1, B_2 and C content of tissues and organs of normal and Vitamin E deficient rats. (L. S. Palmer, J. L. Jensen)

203. The chemistry of milk as a colloidal system. (Adams)

Subproject: The colloid chemistry of coagulation and clotting of milk by rennin. (L. S. Palmer, Robert Jenness)

Subproject: Churning as a phenomenon of inversion of emulsion in a complex colloidal system. (L. S. Palmer, Robert Jenness)

Subproject: Biochemical nature and colloidal properties of substances absorbed at fat globule surfaces and dispersed in milk plasma in relation to clotting or creaming or churning or various natural biochemical changes which milk undergoes. (L. S. Palmer, Robert Jenness)

210. Vitamin E in the nutrition and reproduction of cattle. (Joint project with Dairy Husbandry Project No. 215 and Veterinary Medicine Project No. 104) (L. S. Palmer, W. W. Kielley, A. F. Sellers, J. W. Nelson) (Bankhead-Jones)

302. Comparative studies of the biochemistry of normal and abnormal plants and plant diseases. (Inactive) (Discontinued)

Subproject: The biochemical aspects of cyanogenesis. (C. F. Rogers)

Subproject: Biochemistry of treated and untreated silages. (C. F. Rogers)

401. The chemical and physico-chemical properties of plant tissue fluids. (R. A. Gortner, E. O. Barnes)

403. Protein investigations.

Subproject: Alkaline decomposition of cystine.

(a) Rate of evolution of decomposition compounds. (W. M. Sandstrom, Melvin Karon)

(b) The intermediate Schliff base. (W. M. Sandstrom, Irving Ehrenthal)

Subproject: Studies on the occurrence of djenkolic acid in proteins. (W. M. Sandstrom, Melvin Karon)

Subproject: The preparation of o-Phthalaldehyde. (W M. Sandstrom, H. A. Lillevik)

Subproject: Studies on canavanine.

(a) The preparation and chemical behavior of canavanine. (W. M. Sandstrom, W. W. Benton)

(b) The enzymatic behavior of liver extract upon agrinine and canavanine. (W. M. Sandstrom, Elizabeth Cavert)

Subproject: Studies on the peptization of gliadin. (W. M. Sandstrom, Ching Fan Luh)

Subproject: The salt combining capacity of hemoglobin. (W. M. Sandstrom, Frank Mann)

Subproject: The catalytic hydrogenation of proteins. (W. M. Sandstrom, H. A. Lillevik)

Subproject: The alkaline hydrolysis of proteins. (R. A. Gortner, T. B. Niven)

Subproject: A study of the Fodor-Kok technique. (R. A. Gortner, Thomas Reid)

Subproject: A study of the Brazier-Schryver method of protein analysis. (R. A. Gortner, W. M. Sandstrom, H. E. Green)

Subproject: The homogeneity of zein. (R. A. Gortner, R. M. Theis McDonald)

404. The fundamental properties of colloid systems with particular reference to biological problems. (Adams)

Subproject: The electrokinetic properties of interfaces.

(a) Electrophoresis of solid particles suspended in organic liquids. (D. R. Briggs, Max Chilcote)

(b) A study on the effects of electrolytes on the electrokinetic potentials of solids against organic liquids. (R. A. Gortner, D. R. Briggs, W. H. Ward)

Subproject: The properties of matter in a state of orientation. (Inactive)

Subproject: Solvation in lyophilic systems, the factors determining its degree, and the extent of its influence upon other properties of such systems.

(a) Studies in the electroviscous effect. (D. R. Briggs)

(b) Hysteresis in "dry" starch granules. (R. A. Gortner, Henry Reitz, R. E. Carlson)

(c) Studies on the hydration of starches. (V. Kelley, R. A. Gortner, D. R. Briggs)

405. Biochemical and technological studies of wood, wood constituents, and products derived from wood, with special reference to the forest resources of Minnesota. (Joint project with Forestry Project No. 145) (Bankhead-Jones)

(1) The identity or nonidentity of cellulose from various wood sources. (R. A. Gortner, M. E. Ryberg)

(2) A lignin bibliography. (R. A. Gortner, R. Hossfeld)

(3) Cooking with sodium hydrosulfide. (R. A. Gortner, R. Hossfeld)

(4) The cooking of redwood with butyl alcohol-water and butyl alcohol-aqueous NaOH. (R. A. Gortner, R. Hossfeld, Bror Anderson)

500. Studies on fats and lipids.

(1) Studies on the film forming properties of the di-, tetra-, and hexahydroxy fatty acids obtained from oleic, linoleic, and linolenic acids. (D. R. Briggs, P. Biddison)

600. Studies on carbohydrate and on enzyme systems. (W. M. Sandstrom)

(1) The alkaline decomposition of l-sorbose. (W. M. Sandstrom, Sister M. Urban Stuart)

(2) The chemistry of chitin and glucosamine. (W. M. Sandstrom, Don Gold)

(a) The configuration of glucosamine. (W. M. Sandstrom, J. W. Hummel)

(b) The Lobry de Bruyn transformation upon glucosamine. (W. M. Sandstrom, Sister Carolyn M. Hermann)

(3) The activity of papain. (W. M. Sandstrom, E. M. Scott)

(4) The electrodialysis of pectic compounds and their uronic acid content. (R. A. Gortner, W. M. Sandstrom, Barbara McLaren)

(5) The properties of seed gums. (R. A. Gortner, W. M. Sandstrom, B. W. Lew)

Soils

101. Agricultural value of marl. (F. J. Alway, C. O. Rost, G. H. Nesom)

102. Fertilizer experiments. (Cooperative with the Division of Agronomy and Plant Genetics, the Division of Agricultural Extension, and the North Central, Northeast, and West Central experiment stations) (F. J. Alway, G. H. Nesom, Irene Mattson)

104. Land classification. (F. J. Alway, P. R. McMiller) (Inactive)

105. Movement of water in soils. (F. J. Alway) (Adams)

106. Peat soils. (F. J. Alway, G. H. Nesom) (Inactive)

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

108. Soils of the low-lime area. (F. J. Alway, C. O. Rost, G. H. Nesom)

109. Soil survey. (F. J. Alway, P. R. McMiller)

110. Soils of the red drift. (F. J. Alway) (Inactive)

112. Composition of forest floor. (Cooperative with the Division of Forestry) (F. J. Alway, E. G. Cheyney, Irene Mattson) (Adams)

113. Replaceable ions in soils. (C. O. Rost, A. G. Caldwell)

114. Soil-erosion factors. (C. O. Rost, M. A. Thorfinnson)

115. Nutrient deficiencies of potatoes in the Red River Valley. (Cooperative with the Northwest Experiment Station) (C. O. Rost, T. M. McCall) (Bankhead-Jones)

Home Economics

11. The nutritional status of college women as related to their dietary habits and indicated by (a) anthropometric measurements, (b) basal-metabolism determinations, and (c) blood studies. (Cooperative with the Iowa State College, Kansas State College, University of Ohio,

Oklahoma Agricultural Experiment Station, University of Nebraska) (Eva G. Donelson, Lucille M. Wall) (Purnell)

102. Relation of the diet to blood formation and regeneration. (Jane M. Leichsenring, Alice Biester, Loana Norris) (Purnell)

Subproject: The influence of vitamins on the rate of blood regeneration. (Inactive)

Subproject: The effect of liver on the number, size, volume, and hemoglobin content of the erythrocytes in hemorrhagic anemia.

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

Subproject: A study of fiber quality and physical properties in relation to cost of staple wool materials. (Ethel L. Phelps, Helen Ward, Lucille Aust)

Subproject: A study of silk and rayon crepes used for women's underwear with respect to (1) physical characteristics; (2) slippage and other differences due to the removal of finishing materials with two types of detergents; and (3) the effects of repeated washing with two types of detergents. (Ethel L. Phelps, Lucille Aust)

Subproject: The effect of wear on wool and part wool fabrics. (Cooperative with the Home Economics Department, South Dakota State College) (Ethel L. Phelps, Barbara Bailey, Lucille Aust) (New)

106. A study of the qualities of meat which affect its palatability, methods of cooking, and utilization. (Isabel T. Noble, Margaret V. Davis, Lillian Norvold, Lois Nyquist) (Bankhead-Jones)

Subproject: A study of juiciness, tenderness, and flavor of meat.

109. A study of the culinary quality of Minnesota potatoes. (Cooperative with the Northwest and North Central experiment stations) (Isabel T. Noble, Frances J. Major) (Bankhead-Jones)

110. Quality and utilization of Minnesota fruits. (Cooperative with the Division of Horticulture) (Isabel T. Noble, Margaret V. Davis, Lillian Norvold) (Bankhead-Jones)

Subproject: A study of Minnesota varieties of apples.

Subproject: A study of Minnesota varieties of plums.

112. A study of the properties and serviceability of cotton materials used for professional garments. (Ethel L. Phelps, Delphine Van Houten, Jane Brackett) (Bankhead-Jones)

Animal and Poultry Husbandry

4. A study of systems of breeding for the improvement of swine by intense inbreeding. (Cooperative with the Division of Veterinary Medicine and the Southeast, West Central, Northwest, and North Central experiment stations, University of Minnesota Experiment Station; and

with the Bureau of Animal Industry, United States Department of Agriculture) (L. M. Winters, E. F. Ferrin, R. E. Comstock, W. H. Peters, R. L. Donovan, R. E. Hodgson, O. M. Kiser, P. S. Jordan, W. W. Green, D. L. Dailey, N. D. Bayley, H. C. H. Kernkamp) (Bankhead-Jones)

Subproject: Within the Poland China breed.
Subproject: Within crossbred strains.

105. Cattle feeding. (Cooperative with the Southeast Experiment Station) (W. H. Peters, R. E. Hodgson)

(2) Soybean products as a protein supplement for fattening cattle. (Completed)

203. Calcium and phosphorus nutrition of growing colts. (Cooperative with the divisions of Agricultural Biochemistry and Veterinary Medicine) (A. L. Harvey, L. S. Palmer, H. C. H. Kernkamp, J. W. Nelson) (Bankhead-Jones)

302. Sheep feeding. (Cooperative with the West Central Experiment Station) (W. H. Peters, P. S. Jordan)

Subproject: Marketing feeder vs. fat lambs. (Completed)

306. Breeding sheep for efficiency of production. (Cooperative with the North Central and Northwest experiment stations) (L. M. Winters, D. L. Dailey, R. J. Christgau, O. M. Kiser)

404. A study of the cause of the unpalatability of rye. (Cooperative with the Division of Agricultural Biochemistry) (D. W. Johnson, L. S. Palmer) (Inactive) (Completed)

411. The vitamin D requirement of the pig. (Cooperative with the Division of Agricultural Biochemistry) (D. W. Johnson, L. S. Palmer)

415. The comparative feeding value of dry rendered tankage and other protein supplements for swine. (D. W. Johnson, E. F. Ferrin)

416. Swine feeding. (E. F. Ferrin)

Subproject: A comparison of different mixtures of protein supplements for dry lot feeding of pigs. (Completed)
Subproject: The value of alfalfa hay when added to a ration of shelled corn and creamery buttermilk. (Discontinued)
Subproject: A comparison of pasture crops and creamery buttermilk as sources of protein for growing pigs. (Completed)

417. A study of a disease affecting nursing pigs from shortly after birth to about 15 days of age. (Cooperative with the divisions of Agricultural Biochemistry and Veterinary Medicine) (E. F. Ferrin, H. C. H. Kernkamp, L. S. Palmer, D. W. Johnson) (New)

418. A study of the weights and grades of hog carcasses as related to the purchase of live hogs. (Joint project with Agricultural Economics Project No. 133; cooperative with Swift & Company, South St. Paul) (E. F. Ferrin, P. A. Anderson) (Inactive)

419. The comparative feeding values for swine of hybrid and of open-pollinated corn. (Cooperative with the divisions of Agricultural Engineering and Agricultural Biochemistry) (E. F. Ferrin, D. W. Johnson) (New)

501. Genetic reactions in the fowl as influenced by various systems of breeding. (Cooperative with the West Central, Northwest, and North Central experiment stations) (H. J. Sloan, A. W. Edson, A. M. Pilkey, A. F. Dahlberg, T. H. Canfield, R. N. Shoffner) (Bankhead-Jones)

503. The use of distillers' feed as a supplement in poultry rations. (Cooperative with Hiram Walker & Sons, Inc.) (H. J. Sloan) (Completed)

Subproject: The use of distillers' feed in rations for growing chicks.
Subproject: The use of distillers' feed in rations for laying and breeding hens.

504. The effect of systems of feeding on laying performance and growth. (Cooperative with the Northwest and West Central experiment stations) (H. J. Sloan, O. J. Hemming, A. M. Pilkey) (New)

601. Studies of the physiology of reproduction in farm animals. (Cooperative with the Division of Veterinary Medicine and the North Central, Northwest, West Central, and Southeast experiment stations) (L. M. Winters, R. E. Comstock, W. W. Green, A. W. Nordskog, J. R. Rash, D. F. Jordan) (Adams, Purnell, Bankhead-Jones)

Subproject: The prenatal development of the bovine and the sheep.
Subproject: The physiology of the sperm cell.
Subproject: The cytology and chemical analysis of the sperm cell.
Subproject: Artificial insemination.
Subproject: Environmental factors affecting sperm production.
Subproject: Variations in male hormone production and its relation to fertility.

Dairy Husbandry

12. A genetic study of the bovine. (Cooperative with the Division of Animal and Poultry Husbandry) (W. E. Petersen, A. A. Spielman, T. M. Ludwick, J. B. Fitch) (Bankhead-Jones)

Subproject: Color inheritance.

15. Bovine mastitis. (Cooperative with the Division of Veterinary Medicine) (W. L. Boyd, J. B. Fitch, W. G. Andberg, W. E. Petersen, W. B. Combs, Harold Macy, A. G. Karlson)

Subproject: A field study to indicate the prevalence of mastitis in dairy herds in the state and to determine the influence of this disease on milk and other dairy products.
Subproject: Histopathology of mastitis.
Subproject: The physiological and chemical study of mastitis.

102. Feeding trials with crops new to Minnesota farmers. (Cooperative with the Northwest and West Central experiment stations) (N. N. Allen, W. E. Petersen, J. B. Fitch, P. S. Jordan, O. M. Kiser)

Subproject: Sweet-clover pasture, experiments. (Inactive)
Subproject: Acid preservation of silage. (Cooperative with the Division of Agricultural Biochemistry)
Subproject: Reed canary grass hay as feed for dairy cows. (Inactive)
Subproject: Pasture studies with dairy cows.

103. Food requirements for cattle. (T. W. Gullickson, J. B. Fitch, S. P. Marshall)

Subproject: The maintenance requirements of mature cows. (Inactive)
Subproject: Problems in calf raising.
Subproject: The protein requirements of cattle. (Inactive)
Subproject: Normal growth of dairy cattle.
Subproject: Problems in raising dairy heifers. (Inactive)

104. Factors influencing the quantity and quality of milk. (W. E. Petersen, N. N. Allen, J. B. Fitch)

Subproject: Blood-fat studies. (Inactive)
Subproject: The effect of food fat upon milk fat.
Subproject: Feed and barn odors and flavors in milk. (Inactive)

107. A comparison of fall and winter freshening at different levels of feeding (formerly "A comparison of two systems of dairy management in northern Minnesota"). (Cooperative with the North Central Experiment Station) (D. L. Dailey, R. L. Donovan, J. B. Fitch, N. N. Allen, T. W. Gullickson) (Completed)

108. Fundamental studies of the physiology of milk secretion (formerly "A study of the blood precursors of milk"). (Cooperative with the Division of Veterinary Medicine and the Department of Physiology) (W. E. Petersen, J. B. Fitch, W. L. Boyd, M. G. Visscher, L. T. Samuels, T. M. Ludwick, A. A. Spielman, B. S. Pomeroy) (Bankhead-Jones)

109. High fat content dairy rations and their influence on milk production. (Cooperative with the West Central Experiment Station) (N. N. Allen, P. S. Jordan, J. B. Fitch) (Bankhead-Jones) (Completed)

110. Pasture feeding trials with dairy cattle at the West Central Station. (J. B. Fitch, P. S. Jordan, R. O. Bridgford, T. W. Gullickson, N. N. Allen) (Bankhead-Jones) (New)

111. Alfalfa hay and ground corn for dairy cows. (Cooperative with the North Central Experiment Station) (D. L. Dailey, R. L. Donovan, J. B. Fitch, T. W. Gullickson) (New)

202. Factors influencing the market qualities of butter. (Cooperative with the Division of Agricultural Biochemistry) (H. Macy, W. B. Combs, S. T. Coulter, J. C. Olson, Jr., Harold Fournelle, O. J. Hawkins, A. C. Maack, D. S. Gibson, W. M. Roberts, Claude Harper, Edgar Selke) (Purnell)

Subproject: Microbiology of butter defects.
Subproject: Chemistry and physics of butter defects.

205. The loss of fat in churning sweet cream and methods of control. (W. B. Combs, S. T. Coulter)

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

209. The value of proven sires in building up a dairy herd. (N. N. Allen, W. E. Petersen, J. B. Fitch)

210. The utilization of skim milk on dairy farms. (W. E. Petersen) (Inactive) (Discontinued)

212. Investigations concerning the manufacture and utilization of cheese. (W. B. Combs, H. Macy, S. T. Coulter, R. W. Rivers, Karl Rausch, A. C. Maack)

Subproject: Manufacture and development of foreign and other types of cheese. (Purnell)
Subproject: Factors influencing the composition and market qualities of domestic cheeses, especially American cheddar.
Subproject: Problems in the utilization of cheese.

213. Factors influencing the composition and market qualities of frozen dairy products. (Cooperative with the Division of Horticulture and with the Northwest Ice Cream Manufacturers' Association) (W. B. Combs, H. Macy, S. T. Coulter, H. J. Fournelle, Hyman Love)

Subproject: Relation of ice cream ingredients to the market qualities of ice cream.
Subproject: The use of Minnesota fruits in ice cream. (Completed)
Subproject: Analysis of ice cream samples.

214. Factors influencing the composition and market qualities of milk and cream. (Cooperative with the Quality Control Committee, representing the distributors of pasteurized milk in the Twin Cities area; with the Twin City Milk Producers' Association; and with the

health departments of Minneapolis and St. Paul) (H. Macy, W. B. Combs, S. T. Coulter, J. A. Erekson, J. C. Olson, O. J. Hawkins, W. M. Roberts)

Subproject: Factors influencing the production of off-flavors in milk.
Subproject: Factors influencing the sanitary quality of the pasteurized milk supply of the Twin Cities.

215. Vitamin E in the nutrition and reproduction of cattle. (Joint project with Agricultural Biochemistry Project No. 210 and Veterinary Medicine Project No. 104) (T. W. Gullickson, J. B. Fitch) (Bankhead-Jones)

Entomology and Economic Zoology

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

103. The bronze birch-borer, *Agrilus anxius*. (A. C. Hodson)

107. The endoparasites of domesticated and game animals. (Cooperative with the Division of Veterinary Medicine) (W. A. Riley, A. B. Erickson)

111. Insect collection. (C. E. Mickel, Merle Wing, G. Kretschamer, H. Barnett)

Subproject: Insect collection, University Farm.

112. Insect defoliators of forest trees. (A. G. Ruggles, A. C. Hodson)

Subproject: The jack-pine sawfly.
Subproject: The larch sawfly.
Subproject: The spruce budworm on jack pine.
Subproject: The spruce budworm on spruce and balsam fir.

113. Insectary work. (A. G. Ruggles)

116. Insecticides. (A. G. Ruggles, A. C. Hodson)

Subproject: Orchard spraying.
Subproject: Scale insect control.

119. The parasites and symbionts of insects. (W. A. Riley, A. B. Erickson)

121. Soil insects. (A. A. Granovsky, H. C. Knutson, C. L. Hovey, A. G. Peterson) (Bankhead-Jones)

Subproject: White grubs.
Subproject: Other soil insects.

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

Subproject: Grasshoppers.

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

131. The toxicity of insecticides. (Cooperative with the Dow Chemical Co., Midland, Michigan) (H. H. Shepard, E. L. Thomas, Y. P. Sun)

Subproject: Stomach poisons.
Subproject: Contact insecticides.
Subproject: Fumigants.
Subproject: Miscellaneous, as repellants, etc. (Inactive)

133. Methods of bee management. (M. C. Tanquary, M. H. Haydak)

136. Bee diseases. (M. C. Tanquary, Joseph Reinhardt)

137. Ectoparasites of game and fur-bearing animals. (W. A. Riley, A. B. Erickson) (Adams)

139. The relation of insects to the spread, transmission, and development of plant diseases. (Joint project with Plant Pathology and Botany Project No. 117) (A. A. Granovsky)

Subproject: Miscellaneous dipterous insects and bacterial soft rots.
Subproject: The relation of insects to the decay of felled timber.
Subproject: The cucumber beetle in relation to cucumber wilt. (Inactive)
Subproject: The relation of insects to the storage rot of apples. (Inactive)
Subproject: The association of leaf hoppers with the alfalfa yellow-top disease.
Subproject: The relation of white grubs and other subterranean insects to the raspberry crown gall.
Subproject: The relation of insects to the transmission of virus disease.

141. The preferential ground covers for oviposition by the June beetles. (A. A. Granovsky) (Adams)

142. Use of pollen substitutes by bees. (M. C. Tanquary, M. H. Haydak) (Completed)

144. Mosquito pests of man and animals in Minnesota. (Cooperative with the State Department of Health) (W. A. Riley, Harold Peters, William Chalgren) (Revived)

145. The food value of honey. (Joint project with Agricultural Biochemistry Project No. 208) (M. H. Haydak) (Inactive)

146. Nutrition of the wax moth larvae. (M. H. Haydak, M. C. Tanquary)

147. Insect defoliators of deciduous forest and shade trees. (A. G. Ruggles, A. C. Hodson)

148. A study of the nutrition of the honeybee. (M. H. Haydak, M. C. Tanquary)

149. A study of the nutritive value of bee foods. (Cooperative with the Division of Agricultural Biochemistry) (M. H. Haydak)

150. Insects infesting stored food products. (H. H. Shepard, A. W. Buzicky, George Carter) (Adams)

Subproject: The biology and control of insects affecting cereals.
Subproject: The biology and control of insects affecting dried fruits, nuts, and other noncereal foods.
Subproject: The use of high or low temperature in the control of stored-product insects.

152. Minnesota game and fur-bearing animals. (Cooperative with the Division of Veterinary Medicine and with the State Department of Conservation) (Gustav Swanson)

Subproject: Ring-necked pheasant investigations.
Subproject: Ruffed grouse population study.
Subproject: Waterfowl studies.
Subproject: Winter-yarding of deer.

Veterinary Medicine

104. Brucellosis and related diseases of the reproductive organs of cattle. (Cooperative with the divisions of Agricultural Biochemistry and Dairy Husbandry and with the Bureau of Animal Industry, United States Department of Agriculture) (W. L. Boyd, M. H. Roepke, Margaret Kelly, A. G. Karlson, A. F. Sellers) (Adams)

Subproject: Serological tests.
Subproject: Elimination of *Brucella abortus*.
Subproject: Artificial infection.
Subproject: Etiology and significance of orchitis.
Subproject: Calves from positive dams.
Subproject: Hosts and disseminators of *Brucella abortus*.
Subproject: Causes of nonspecific abortions.
Subproject: *Corpus luteum* and its relation to the ovarian and oestrual cycle.
Subproject: Post-parturient changes in the genital tract.
Subproject: Food deficiencies and their relation to the oestrus cycle.
Subproject: Vitamin E in the nutrition and reproduction of cattle.

105. Investigation of obscure diseases. (Cooperative with the divisions of Agricultural Biochemistry and Dairy Husbandry, Minnesota Agricultural Experiment Station; and with the Minnesota State Livestock Sanitary Board) (R. Fenstermacher, W. L. Boyd, H. C. H. Kernkamp, B. S. Pomeroy, M. H. Roepke, A. G. Karlson, A. F. Sellers, W. G. Andberg)

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.

113. Hog cholera. (H. C. H. Kernkamp, M. H. Roepke) (Purnell)

Agricultural Economics

101. Agricultural credit. (G. L. Peterson, O. B. Jesness) (Purnell)

103. Farmers' incomes in Minnesota. (O. B. Jesness, W. C. Waite)

106. A study of new type farm tractors and new adaptations of tractors to farm use in Minnesota. (Joint project with Agricultural Engineering Project No. 120) (G. A. Pond, W. P. Ranney, T. R. Nodland)

Subproject: A study of accomplishments, performance, adaptation, and economy of new types of tractors and machines.
Subproject: A study of the effect of new type tractors and machinery on the size, organization, productive efficiency, and production practices on the farm.

108. Marketing of farm products. (Purnell)

Subproject: Marketing of creamery butter. (O. B. Jesness, E. F. Koller)
Subproject: Marketing of livestock. (O. B. Jesness, A. A. Dowell, G. Engelman)
Subproject: Study of the organization and operation of representative Minnesota oil associations. (O. B. Jesness, E. F. Koller)

111. An accounting study of factors affecting the income of dairy farms. (Cooperative with the Division of Agricultural Extension, University of Minnesota; and with the Division of Farm Management and Costs, Bureau of Agricultural Economics, United States Department of Agriculture) (G. A. Pond, S. A. Engene, G. E. Toben, A. W. Anderson, George Wilkens, Glen Myers, T. R. Nodland, Beatrice McDonald) (Purnell)

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

113. Prices of farm products. (O. B. Jesness, W. C. Waite, R. W. Cox, W. B. Garver, H. W. Halvorson) (Purnell)

118. A study of land tenure and farm leases in Minnesota with special emphasis on the effect of present leases and leasing systems on soil conservation and sound farm-management practices. (Cooperative with the Division of Farm Management and Costs, Bureau of Agricultural Economics, United States Department of Agriculture) (G. A. Pond) (Purnell)

120. Market outlets for woodland products in northeastern Minnesota. (Dormant) (Discontinued)

121. Factors influencing the demand for Minnesota agricultural products. (W. C. Waite, R. W. Cox, W. B. Garver, H. W. Halvorson) (Purnell)

122. Local prices of agricultural products in Minnesota. (W. C. Waite) (Purnell)

125. An analysis of factors influencing farm land values in Minnesota. (A. A. Dowell) (Purnell)

126. An accounting study of farm organization in west central Minnesota. (Cooperative with the West Central Experiment Station, Minnesota Agricultural Experiment Station; and with the Division of Farm Management and Costs, Bureau of Agricultural Economics, United States Department of Agriculture) (G. A. Pond, S. A. Engene, A. W. Anderson, George Wilkens) (Purnell)

128. Cash expenditures of Minnesota farmers for agriculture. (W. C. Waite, R. W. Cox)

129. A study of agricultural adjustment activities undertaken under the farm act and their economic consequences. (Inactive)

130. An accounting study of dairy farm organization in the low-lime area of southeastern Minnesota. (Cooperative with the Division of Farm Management and Costs, Bureau of Agricultural Economics, United States Department of Agriculture) (G. A. Pond, S. A. Engene, F. E. Wetherill, A. W. Anderson, George Wilkens, Bess M. Miller, Beatrice McDonald) (Purnell)

131. A study of methods of soil-erosion control and their effect on farm organization. (Cooperative with the Division of Agricultural Extension, University of Minnesota; and with the Soil Conservation Service, United States Department of Agriculture) (G. A. Pond, G. E. Toben, T. R. Nodland) (Purnell)

132. An accounting study of the earnings and financial progress of rehabilitation clients of the Resettlement Administration in Minnesota. (Cooperative with the Division of Agricultural Extension and

the Rural Sociology section of the Agricultural Experiment Station, University of Minnesota; with the Resettlement Administration, Region 2, Minnesota; and with the Division of Farm Management and Costs, Bureau of Agricultural Economics, United States Department of Agriculture) (G. A. Pond) (Purnell) (Inactive)

133. A study of the weights and grades of hog carcasses as related to the purchase of live hogs. (Cooperative with the Division of Animal and Poultry Husbandry and with Swift & Company) (A. A. Dowell) (Inactive)

134. Land use planning. (Cooperative with the Division of Agricultural Extension, University of Minnesota; and with the Bureau of Agricultural Economics, United States Department of Agriculture) (O. B. Jesness, O. R. Shelley) (Bankhead-Jones)

135. A study of farm organization and management problems in southwestern Minnesota. (Cooperative with the Division of Agricultural Extension, University of Minnesota, and with the Southwest Farm Management Association) (G. A. Pond, T. R. Nodland, G. E. Toben, Beatrice McDonald) (Purnell) (New)

136. An accounting study of the earnings and financial progress of T. V. A. phosphate test demonstration cooperators. (Cooperative with the Division of Agricultural Extension) (G. A. Pond, T. R. Nodland) (New)

137. An accounting study of dairy farm organization in south central Minnesota. (Cooperative with the Division of Farm Management and Costs, Bureau of Agricultural Economics, United States Department of Agriculture) (G. A. Pond, S. A. Engene, A. W. Anderson, George Wilkens, F. E. Wetherill, Bess M. Miller, Beatrice McDonald) (Purnell) (New)

Rural Sociology

112. Studies of the rural population in Minnesota. (Cooperative with the Work Projects Administration; and with the Division of Farm Population and Rural Life Activities, Bureau of Agricultural Economics, United States Department of Agriculture) (Lowry Nelson, D. J. Mitchell) (Purnell)

Subproject: Annual estimate of number and movement of farm population.

Subproject: Rural youth in Minnesota.

Subproject: Cultural regions within the Minnesota farm population.

113. Studies of Minnesota rural families. (Cooperative with the Work Projects Administration) (Lowry Nelson, F. H. Forsyth, R. M. Dinkel) (Purnell)

Subproject: A statistical analysis of trends in size, composition, tenure, nativity, and other characteristics of farm and nonfarm families.

Subproject: Trends in family organization, attitudes and behavior with special reference to status of the aged—dependent and independent—members.

Subproject: The effect upon farm and village family life of depression and drouth and of the various governmental relief agencies.

144. Rural community organization in Minnesota. (Lowry Nelson, E. C. McVoy) (Purnell)

Subproject: Distribution and characteristics of physicians and hospitals in Minnesota, by rural and urban areas.

Subproject: A study of the degree of want- and interest-satisfaction among rural people.

Subproject: Changes in rural church membership in Minnesota by separate denominations and by geographic areas.

Agricultural Engineering

103. Farm building ventilation. (H. B. White, C. K. Otis, C. H. Christopherson)

104. Farm sewage disposal. (A. G. Tyler)

107. Investigation of causes of failure of agricultural drain tile, the means of obviating such failures, and mapping areas where extra precautions are necessary. (Cooperative with the Division of Drainage and Waters, State Department of Conservation; and with the Soil Conservation Service, United States Department of Agriculture) (D. G. Miller, C. G. Snyder)

111. Investigation of farm buildings. (H. B. White, C. K. Otis, C. H. Christopherson)

112. Investigations in land clearing. (M. J. Thompson, A. J. Schwantes) (Inactive)

Subproject: Seasonal brush cutting. (Cooperative with the United States Department of Agriculture) (Discontinued)

Subproject: Preparation of stump land pasture. (Discontinued)

Subproject: Use of poison in killing brush and trees, both cut and standing. (Discontinued)

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

Subproject: Influence of frost in lifting stone.

Subproject: Land-clearing machinery. (Discontinued)

Subproject: Relation of land valuation to clearing costs and crop production on sandy loam, clay loam, and clay soils. (Discontinued)

Subproject: Economics of stump removal for pasture crops. (Discontinued)

Subproject: Relation of livestock to brush control. (Discontinued)

Subproject: Plowing of virgin lands to determine what influence it has on the following crop yields on sand, sandy loam, clay loam, and clay soils. (Discontinued)

Subproject: Agricultural use of explosives. (Discontinued)

114. The utilization of electricity in agriculture. (A. Hustrulid)

115. Wind-power electric-lighting plants. (A. Hustrulid)

119. Combine harvesting of grain and seed crops. (Cooperative with the Division of Agronomy and Plant Genetics) (A. J. Schwantes, J. B. Torrance, John Strait, John Shumway)

120. A study of new type farm tractors and new adaptations of tractors to farm use in Minnesota. (Joint project with Agricultural Economics Project No. 106) (A. J. Schwantes, J. B. Torrance, W. H. Walker) (Bankhead-Jones)

Subproject: A study of accomplishments, performance, adaptation, and economy of new types of tractors and machines.

Subproject: A study of the effect of new type tractors and machinery on the size, organization, productive efficiency, and production practices on the farm.

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. (H. B. Roe)

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

124. A study of some problems dealing with the use of flexible connectors for transmission of power on the farm. (J. G. Dent) (Completed)

Subproject: The wearing quality of leather and metallic belt fasteners.

Subproject: The weather-resisting qualities of different kinds of rope.

128. Investigations of draft and power requirements for field machinery. (A. J. Schwantes, A. H. Thompson)

Subproject: A study of draft and power requirements for field machinery.

130. Soil-erosion control by engineering methods and such in conjunction with field and cropping management. (Cooperative with the Division of Soils, Minnesota Agricultural Experiment Station; and with the Soil Conservation Service, United States Department of Agriculture) (H. B. Roe, E. K. Allred, N. B. Anderson, P. W. Manson, C. G. Snyder)

132. Supplemental irrigation investigations in Minnesota. (H. B. Roe, J. K. Park, C. G. Snyder)

133. Determination of the optimum soil-moisture conditions for growth and development of major crops and method of establishing and controlling those conditions by the adaptation of known subdrainage principles. (H. B. Roe, P. W. Manson)

134. Investigation of farm fences. (H. B. White, C. K. Otis, C. H. Christopherson)

135. Paint testing by exposure. (C. H. Christopherson, H. B. White, C. K. Otis)

136. A study of methods of moisture drainage from silos and factors influencing the quantity of moisture, the rate of flow, and its chemical compositions. (Cooperative with the Division of Agricultural Biochemistry) (C. G. Snyder, C. K. Otis) (Bankhead-Jones) (New)

North Central Station

101. Investigations in farm crop production. (R. L. Donovan, O. W. Swenson)

Subproject: Succotash trials.

102. Experiments in general horticulture. (O. W. Swenson, R. L. Donovan)

Subprojects: Ornamental planting, herbarium, potato seed plot, potato variety test, orchard planting, asparagus, wild-fruit culture, raspberry culture, and strawberry culture.

103. Investigations in animal and poultry husbandry. (D. L. Dailey, R. L. Donovan)

Subproject: Tuberculosis and Bang's disease testing.
Subproject: Building up a herd of purebred Guernseys.
Subproject: Establishing a turkey flock.

104. Investigations in forestry. (R. L. Donovan)

Subproject: Forest planting.
Subproject: Arboretum.

Projects in cooperation with Agricultural Engineering, No. 131; Agronomy and Plant Genetics, Nos. 6, 101, 102, 103, 104, 105, 106, 107, 109, 112, 114, 116, 119, 120; Animal and Poultry Husbandry, Nos. 4, 306, 501, 601; Dairy Husbandry, No. 107; Home Economics, No. 109; Horticulture, Nos. 301, 304, 408; Soils, No. 102.

Northeast Station

101. Investigations in farm crop production. (Cooperative with the Division of Agronomy and Plant Genetics) (M. J. Thompson, H. K. Hayes, H. K. Wilson, A. C. Arny, R. P. Murphy, H. K Schultz)

Subprojects: Grain variety tests, legume studies, hay crops not legume, crop rotations, corn improvement, sunflower improvement, outlying field tests, crop succession (inactive), and seeding and cultural practices. (Inactive)

102. Experiments in general horticulture. (Cooperative with the Division of Horticulture) (M. J. Thompson, F. A. Krantz, T. M. Currence, A. E. Hutchins)

Subproject: Cooperative orchard experiment. (Old)
Subproject: Cooperative orchard experiment. (New)
Subproject: Garden fertilizers.
Subproject: Variety testing—small fruits.
Subproject: Variety testing—vegetables.
Subproject: Seed improvement.
Subproject: Windbreak.
Subproject: Root crops.
Subproject: Raspberry-fertilizer test.

103. Investigations in potato culture. (Cooperative with the Division of Horticulture) (M. J. Thompson, F. A. Krantz)

Subproject: Variety tests.
Subproject: Spray studies.
Subproject: Rotations.
Subproject: Complete fertilizer.
Subproject: Potato breed plots.
Subproject: Rate of manuring.
Subproject: Clover utilization.
Subproject: Continuous cropping. (Discontinued)
Subproject: Mosaic determinations. (Discontinued)
Subproject: Date of harvest. (Discontinued)
Subproject: Deep tillage. (Discontinued)
Subproject: Special fertilizer studies.

104. Investigations in animal husbandry. (Cooperative with the Division of Agronomy and Plant Genetics, the Division of Dairy Husbandry, the Division of Soils, and the Division of Veterinary Medicine) (M. J. Thompson, F. J. Alway, A. C. Arny)

105. Studies in soil fertility. (Cooperative with the Division of Soils) (M. J. Thompson, F. J. Alway, G. H. Nesom)

Subproject: Continuous cropping without clover or manure.
Subproject: Rate of manuring.
Subproject: Complete fertilizers on potatoes, hay, grain.
Subproject: Clover utilization.
Subproject: Garden fertilization.
Subproject: Pasture fertilization.
Subproject: Sunflower fertilization.
Subproject: Rutabaga fertilization.
Subproject: Fertilization of rotation plots.
Subproject: Fruit land fertilization.

Subproject: Cooperative potato work with county agents and Smith-Hughes instructors.
Subproject: Clover failure. (Inactive)
Subproject: Special potato fertilization.
Subproject: Nitrogen on grasses.
Subproject: Effect of early cutting and nitrate fertilization.

106. Investigations in farm engineering. (Cooperative with the Division of Agricultural Engineering) (M. J. Thompson, A. J. Schwantes)

Subproject: Studies in exposure of field stone through heaving or erosion.
Subproject: Studies in stoning land.
Subproject: Studies in stone utilization.
Subproject: Studies in deep tillage.

Projects in cooperation with Agricultural Engineering, No. 112; Agronomy and Plant Genetics, Nos. 6, 101, 102, 103, 105, 107, 109, 112, 114, 121; Horticulture, Nos. 304, 308, 408; Soils, No. 102.

Northwest Station

101. Tree, shrub, and flower investigations. (Cooperative with the Division of Horticulture) (R. E. Nylund)

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

102. Root-crop investigations. (Cooperative with the Division of Agronomy and Plant Genetics, Minnesota Agricultural Experiment Station; and with the Office of Sugar Plant Investigations, Bureau of Plant Industry, United States Department of Agriculture) (R. E. Nylund)

Subproject: Demonstration planting of mangel varieties.
Subproject: Variety and culture tests of sugar-beet varieties.

103. Crop-rotation and soil-management studies. (Cooperative with the divisions of Agricultural Engineering and Soils) (F. J. Alway, A. J. Schwantes, R. S. Dunham, R. E. Nylund)

Subproject: Continuous cropping of corn.
Subproject: Continuous cropping of wheat alone and wheat with red and alsike clover.
Subproject: Comparison of sweet clover and cultivated crops in rotation for weed control.
Subproject: Comparison of four methods of soil preparation in the fall with respect to the absorption of fall and winter moisture.

106. Potato investigations. (Cooperative with the divisions of Agricultural Engineering, Soils, and Horticulture) (R. E. Nylund)

Subproject: Variety testing.
Subproject: Tuber and leaf diseases.
Subproject: Methods of planting. (Discontinued)
Subproject: Fertilizer tests—soil improvement.
Subproject: Seed selection.
Subproject: Rotation tests.

107. Fruit investigations. (Cooperative with the Division of Horticulture) (R. E. Nylund)

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

108. Garden-crop investigations. (Cooperative with the Division of Horticulture) (R. E. Nylund)

Subproject: Variety and cultural tests of garden vegetables.

109. Crop-weather records and research. (Cooperative with the Bureau of Plant Industry, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station) (R. S. Dunham, T. M. McCall, E. A. Helgeson) (New)

111. Turkey production. (Cooperative with the Division of Animal and Poultry Husbandry) (H. J. Sloan, T. H. Canfield, A. M. Simonson, A. M. Pilkey) (New)

112. Summer confinement vs. open range for laying flocks. (A. M. Pilkey) (New) (Closed)

113. Effects of systems of feeding on laying performance and growth. (Cooperative with the Division of Animal and Poultry Husbandry) (H. J. Sloan, T. H. Canfield, A. M. Pilkey, Hilbert Thompson) (New)

Projects in cooperation with Agricultural Engineering, No. 131; Agronomy and Plant Genetics, Nos. 6, 7, 8, 102, 103, 104, 105, 106, 107, 109, 112, 114, 116, 119, 121; Animal and Poultry Husbandry, Nos. 4, 306, 501, 601; Dairy Husbandry, No. 102; Home Economics, No. 109; Horticulture, Nos. 304, 408; Soils, No. 115.

Southeast Station

103. Maintaining a herd of grade Milking Shorthorn cows to observe production of beef and butterfat under farm conditions. (R. E. Hodgson) (Discontinued)

104. A study of line breeding as a method of fixing desired characters in Milking Shorthorn cattle. (Cooperative with the Division of Animal and Poultry Husbandry and the Division of Veterinary Medicine, Minnesota Agricultural Experiment Station; and with the Bureau of Animal Industry, United States Department of Agriculture) (R. E. Hodgson)

106. Growth studies of common varieties of trees in southern Minnesota. (Cooperative with the Division of Forestry) (R. E. Hodgson)

Projects in cooperation with Agronomy and Plant Genetics, Nos. 6, 7, 8, 101, 102, 103, 104, 105, 106, 107, 112, 114, 116, 119, 122, 125, 128; Animal and Poultry Husbandry, Nos. 4, 105, 601; Horticulture, Nos. 304, 305.

West Central Station

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

102. The testing of trees and ornamentals for western Minnesota conditions. (Cooperative with the Division of Horticulture) (J. A. Anderson)

103. Fertilizer investigations. (Cooperative with the Division of Soils) (R. O. Bridgford, F. J. Alway)

Subproject: The use of acid phosphate and rock phosphate, alone and in combination with manures, and the use of lime with all of the above combinations on a four-year rotation of corn, wheat, oats, and sweet clover.

104. The cultivation of alfalfa in relation to hay production, seed production, disease resistance, and duration of life of the stand. (Cooperative with the Division of Agronomy and Plant Genetics, and the Division of Plant Pathology and Botany) (R. O. Bridgford, A. C. Arny)

105. Crop-rotation investigations. (Cooperative with the Division of Agronomy and Plant Genetics and the Division of Soils) (F. J. Alway, A. C. Arny, R. O. Bridgford)

Subproject: Utilization of sweet clover.

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

106. The effect of nitrogen, phosphate, and potash fertilizers on nonleguminous crops. (Cooperative with the Division of Soils) (F. J. Alway, R. O. Bridgford)

107. Sweet clover as a source of nitrogen. (Cooperative with the Division of Agronomy and Plant Genetics and Division of Soils) (R. O. Bridgford, F. J. Alway, A. C. Arny)

Projects in cooperation with Agricultural Economics, No. 126; Agronomy and Plant Genetics, Nos. 6, 7, 8, 101, 102, 103, 104, 105, 106, 107, 109, 112, 114, 116, 121, 127; Animal and Poultry Husbandry, Nos. 4, 302, 501, 601; Dairy Husbandry, Nos. 102, 109; Horticulture, No. 304; Soils, No. 102.

SUMMARY OF PROJECTS

Division	Total	Active	Dormant	Closed	New
Agronomy and Plant Genetics	26	24	2	2	0
Forestry	18	15	3	1	0
Horticulture	22	22	0	0	0
Plant Pathology and Botany	23	22	1	0	0
Agricultural Biochemistry	19	18	1	1	1*
Soils	13	10	3	0	0
Home Economics	7	7	0	0	0
Animal and Poultry Husbandry	16	14	2	2	3
Dairy Husbandry	18	17	1	3	2
Entomology and Economic Zoology	26	25	1	1	1*
Veterinary Medicine	3	3	0	0	0
Agricultural Economics	23	20	3	1	3
Rural Sociology	3	3	0	0	0
Agricultural Engineering	19	18	1	1	1
North Central Station	4	4	0	0	0
Northeast Station	6	6	0	0	0
Northwest Station	10	10	0	0	4
Southeast Station	3	3	0	1	0
West Central Station	7	7	0	0	0
Total	266	248	18	13	15

* Revived

FINANCIAL STATEMENT

Expenditures

Classification	University Farm	Branch Stations					
		Crookston	Morris	Grand Rapids	Duluth	Waseca	Total
Salaries and labor	$374,093.87	$24,445.51	$23,902.15	$10,915.29	$ 9,038.01	$12,040.14	$454,434.97
Stationery and office supplies	3,259.76	614.72	384.99	97.15	70.47	80.43	4,507.52
Scientific supplies	25,045.57	867.10	626.80	319.19	716.94	576.33	28,151.93
Feeding stuffs	11,849.70	1,294.02	1,649.72	2,002.98	1,415.13	732.72	18,944.27
Fertilizers	117.38	.....	.....	.....	.....	.....	117.38
Sundry supplies	3,817.32	1,675.31	1,799.91	879.11	646.56	1,544.86	10,363.07
Communication service	1,336.73	459.28	313.50	156.51	129.63	137.73	2,533.38
Travel expenses	10,455.93	171.07	227.26	277.62	294.81	41.50	11,468.19
Transportation of things	1,494.14	202.50	177.15	66.05	14.01	71.52	2,025.37
Printing	4,720.64	122.18	68.47	118.57	.....	.....	5,029.86
Heat, light, water, power	16,071.18	2,784.78	2,754.17	897.15	260.22	642.99	23,410.49
Contingent expenses	4,255.09	664.50	628.28	796.35	865.26	646.74	7,856.22
Furniture, furnishings, and fixtures	1,991.18	158.94	286.45	91.57	.....	.....	2,528.14
Library	28.03	16.95	3.09	1.67	.....	.....	49.74
Scientific equipment	10,632.24	321.84	411.48	298.88	124.74	284.22	12,073.40
Tools, machinery, and appliances	4,570.25	651.44	1,256.26	345.76	749.58	936.54	8,509.83
Livestock	3,178.17	539.66	1,352.45	.....	210.00	2,161.00	7,441.28
Buildings and land	11,251.88	4,012.51	937.92	444.69	1,049.97	514.41	18,211.38
Annuities	6,958.87	175.90	211.00	43.26	163.22	103.59	7,655.84
Total	$495,127.93	$39,178.21	$36,991.05	$17,751.80	$15,748.55	$20,514.72	$625,312.26

FINANCIAL STATEMENT

Income

Source of Revenue	University Farm	Branch Stations					
		Crookston	Morris	Grand Rapids	Duluth	Waseca	Total
Federal appropriations:							
Hatch fund	$ 15,000.00	.....	.....	.....	.....	.....	$ 15,000.00
Adams fund	15,000.00	.....	.....	.....	.....	.....	15,000.00
Purnell fund	60,000.00	.....	.....	.....	.....	.....	60,000.00
Bankhead-Jones fund	56,797.64	.....	.....	.....	.....	.....	56,797.64
State appropriations:							
General University support	257,836.87	$31,392.97	$27,507.08	$14,046.19	$10,430.00	$ 7,375.17	$348,588.28
Special appropriations	43,031.28	.....	.....	.....	.....	.....	43,031.28
Endowments, fellowships and other similar grants	27,370.85	.....	.....	.....	.....	.....	27,370.85
Fees, sales, and miscellaneous	20,091.29	7,785.24	9,483.97	3,705.61	5,318.55	13,139.55	59,524.21
Total	$495,127.93	$39,178.21	$36,991.05	$17,751.80	$15,748.55	$20,514.72	$625,312.26

EXPERIMENT STATION STAFF

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The Hon. Richard L. Griggs, Duluth	1945
The Hon. George W. Lawson, St. Paul	1945
The Hon. Albert J. Lobb, Rochester	1947
The Hon. E. E. Novak, New Prague	1943
The Hon. A. J. Olson, Renville	1943
The Hon. Albert Pfaender, New Ulm	1947
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H. K. Hayes, D.Sc., Chief, Division of Agronomy and Plant Genetics
W. H. Peters, M.Agr., Chief, Division of Animal and Poultry Husbandry
J. B. Fitch, M.S., Chief, Division of Dairy Husbandry
W. A. Riley, Ph.D., Chief, Division of Entomology and Economic Zoology
Henry 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
[2]E. C. Stakman, Ph.D., Chief, Division of Plant Pathology and Botany
F. J. Alway, Ph.D., Chief, Division of Soils
W. L. Boyd, D.V.S., Chief, Division of Veterinary Medicine

[1] Appointed July 1, 1940.
[2] Appointed July 1, 1940.

Division of Agronomy and Plant Genetics

H. K. Hayes, D.Sc., Agronomist and Plant Geneticist
F. R. Immer, Ph.D., Geneticist
H. K. Wilson, Ph.D., Agronomist
A. C. Arny, M.S., Associate Agronomist
C. R. Burnham, Ph.D., Associate Plant Geneticist
R. F. Crim, B.S., Assistant Agronomist and Extension Specialist in Agronomy
R. P. Murphy, B.S., Assistant in Plant Genetics
[3]H. K. Schultz, M.S., Assistant in Agronomy and Plant Genetics
C. R. Borgeson, M.S., Assistant in Agronomy
E. H. Rinke, M.S., Assistant in Plant Genetics
[4]A. R. Schmid, M.S., Assistant in Plant Genetics

Detailed by the United States Department of Agriculture for Cooperative Work
Division of Cereal Crops and Diseases

E. R. Ausemus, Ph.D., Associate Agronomist
J. O. Culbertson, Ph.D., Assistant Agronomist

Division of Forestry

Henry Schmitz, Ph.D., Forester
E. G. Cheyney, A.B., Forester
J. H. Allison, Ph.D., Forester
T. Schantz-Hansen, Ph.D., Associate Forester
[5]F. H. Kaufert, Ph.D., Associate Forester
R. M. Brown, M.S., Assistant Forester
L. W. Rees, Ph.D., Assistant Forester

Division of Horticulture

W. H. Alderman, B.S.A., Horticulturist
R. B. Harvey, Ph.D., Horticulturist

Section of Pomology

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

Section of Fruit Breeding

A. N. Wilcox, Ph.D., Assistant Horticulturist
J. D. Winter, M.S., Assistant in Horticulture
F. E. Haralson, Assistant Superintendent, State Fruit Breeding Farm
T. S. Weir, B.S., Assistant in Horticulture

Section of Vegetable Gardening

F. A. Krantz, Ph.D., Associate Horticulturist
T. M. Currence, Ph.D., Associate Horticulturist
A. G. Tolaas, M.A., Assistant Horticulturist
A. E. Hutchins, Ph.D., Assistant Horticulturist

[3] Resigned May 15, 1941.
[4] Appointed May 16, 1941.
[5] Appointed July 1, 1940.

Section of Floriculture and Ornamental Horticulture

L. E. LONGLEY, Ph.D., Assistant Horticulturist
[6]L. SANDO, Assistant in Floriculture

Division of Plant Pathology and Botany

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

Section of Plant Pathology

[7]E. C. STAKMAN, Ph.D., Plant Pathologist
J. J. CHRISTENSEN, Ph.D., Plant Pathologist
LOUISE DOSDALL, Ph.D., Assistant Plant Pathologist
C. J. EIDE, Ph.D., Assistant Plant Pathologist
[8]E. G. SHARVELLE, Ph.D., Assistant Plant Pathologist
HELEN HART, Ph.D., Assistant Plant Pathologist
C. M. CHRISTENSEN, Ph.D., Assistant Plant Pathologist
M. B. MOORE, M.S., Assistant in Plant Pathology
M. F. KERNKAMP, Ph.D., Assistant in Plant Pathology
I. W. TERVET, Ph.D., Assistant in Plant Pathology
T. H. KING, M.S., Junior Chemist, Firestone Plantations Company Fellowship

Section of Plant Physiology and Agricultural Botany

[9]R. B. HARVEY, Ph.D., Plant Physiologist and Agricultural Botanist
A. H. LARSON, B.S., Assistant Botanist
R. H. LANDON, Ph.D., Assistant in Plant Physiology

Detailed by the United States Department of Agriculture for Cooperative Work
Bureau of Plant Industry
Division of Cereal Crops and Diseases

M. N. LEVINE, Ph.D., Pathologist
E. W. HANSON, M.S., Agent

Division of Sugar Plant Investigations

ANDREW DOWNIE, M.S., Agent

Bureau of Entomology and Plant Quarantine
Division of Plant Disease Control

R. U. COTTER, Ph.D., Associate Pathologist
L. W. MELANDER, Ph.D., Associate Pathologist (State Leader of Barberry Eradication)
W. Q. LOEGERING, B.S., Agent

[6] Retired June 30, 1941.
[7] Cooperating with the Division of Plant Disease Control, Bureau of Entomology and Plant Quarantine; on leave August 16, 1940 to January 15, 1941.
[8] Appointed October 1, 1939.
[9] Sabbatical furlough March 16, 1941 to March 15, 1942.

Detailed by the State Department of Agriculture for Cooperative Work

A. G. TOLAAS, M.S., in Charge, Office of Seed Potato Certification
J. L. LARSON, Seed Analyst in Charge, Seed Germination
H. C. REGNIER, Deputy, Office of Seed Potato Certification

Division of Agricultural Biochemistry

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

Section of Proteins and Colloids

R. A. GORTNER, Ph.D., D.Sc., Agricultural Biochemist
W. M. SANDSTROM, Ph.D., Associate Agricultural Biochemist
D. R. BRIGGS, Ph.D., Associate Agricultural Biochemist

Section of Cereal Technology and Analytical Service

C. H. BAILEY, Ph.D., Agricultural Biochemist
W. F. GEDDES, Ph.D., Agricultural Biochemist
P. P. MERRITT, B.S., Assistant Agricultural Biochemist
[10]G. S. TAYLOR, B.A., Analyst

Section of Nutrition and Dairy Chemistry

L. S. PALMER, Ph.D., Dairy Chemist
CORNELIA KENNEDY, Ph.D., Associate Agricultural Biochemist
J. W. NELSON, Ph.D., Associate Chemist
[11]ROBERT JENNESS, M.S., Assistant in Agricultural Biochemistry

Detailed by the United States Department of Agriculture, Bureau of Plant Industry, Division of Cereal Crops and Diseases

J. A. SCHRICKER, B.S., Assistant Biochemist

Division of Soils

F. J. ALWAY, Ph.D., D.Sc., Soils Chemist
C. O. ROST, Ph.D., Soils Chemist
P. R. MCMILLER, M.S., Assistant Soils Chemist
G. H. NESOM, B.S., Assistant Soils Chemist
[12]L. L. KEMPE, M.S., Associate Chemist

Division of Home Economics

WYLLE B. MCNEAL, M.A., Home Economist
ALICE BIESTER, M.A., Associate Home Economist
ISABEL T. NOBLE, Ph.D., Associate Home Economist
JANE M. LEICHSENRING, Ph.D., Associate Home Economist
ETHEL L. PHELPS, M.S., Associate Home Economist

[10] Resigned August 31, 1940.
[11] Appointed September 16, 1940.
[12] On leave June 1, 1941 to May 31, 1942.

EVA G. DONELSON, Ph.D., Assistant Home Economist
[12]MARGARET V. DAVIS, M.S., Junior Chemist

Division of Animal and Poultry Husbandry

W. H. PETERS, M.Agr., Animal Husbandman
P. A. ANDERSON, B.S., Assistant Animal Husbandman
A. L. HARVEY, M.S., Assistant Animal Husbandman

Section of Animal Feeding

E. F. FERRIN, M.Agr., Animal Husbandman
[14]D. W. JOHNSON, Ph.D., Assistant in Animal Husbandry

Section of Animal Genetics

L. M. WINTERS, Ph.D., Animal Husbandman
R. E. COMSTOCK, Ph.D., Assistant in Animal Genetics
W. W. GREEN, Ph.D., Assistant in Animal Genetics

Section of Poultry Husbandry

H. J. SLOAN, Ph.D., Poultry Husbandman
T. H. CANFIELD, M.S., Assistant in Poultry Husbandry

Division of Dairy Husbandry

J. B. FITCH, M.S., Dairy Husbandman

Section of Dairy Production

J. B. FITCH, M.S., Dairy Husbandman
W. E. PETERSEN, Ph.D., Associate Dairy Husbandman
T. W. GULLICKSON, Ph.D., Assistant Dairy Husbandman
N. N. ALLEN, JR., Ph.D., Assistant Dairy Husbandman

Section of Dairy Products

W. B. COMBS, M.A., Dairy Husbandman
S. T. COULTER, Ph.D., Assistant Dairy Husbandman
[15]J. C. OLSON, JR., B.S., Assistant in Dairy Husbandry
[16]A. C. MAACK, B.S., Assistant in Dairy Husbandry

Section of Dairy Bacteriology

HAROLD MACY, Ph.D., Dairy Bacteriologist

[13] Resigned September 15, 1940.
[14] Resigned March 31, 1941.
[15] On leave January 16 to December 15, 1941.
[16] Appointed February 1, 1941.

Division of Entomology and Economic Zoology

W. A. RILEY, Ph.D., D.Sc., Entomologist and Parasitologist
M. C. TANQUARY, Ph.D., Apiculturist
A. G. RUGGLES, M.A., Entomologist
C. E. MICKEL, Ph.D., Associate Entomologist
A. A. GRANOVSKY, Ph.D., Associate Entomologist
H. H. SHEPARD, Ph.D., Assistant Entomologist
A. C. HODSON, Ph.D., Assistant Entomologist
M. H. HAYDAK, Ph.D., Assistant in Apiculture
[17]O. W. OLSEN, Ph.D., Assistant in Entomology
[18]D. M. HATFIELD, M.A., Assistant in Economic Zoology
[19]GUSTAV SWANSON, Ph.D., Assistant in Economic Zoology
[20]A. B. ERICKSON, Ph.D., Junior Entomologist
[21]D. C. QUIMBY, M.S., Assistant in Economic Zoology
[22]L. W. KREFTING, M.S., Assistant in Economic Zoology

Division of Veterinary Medicine

W. L. BOYD, D.V.S., Veterinarian
H. C. H. KERNKAMP, D.V.M., Associate Veterinarian
R. FENSTERMACHER, D.V.M., Assistant Pathologist
W. G. ANDBERG, D.V.M., Assistant Veterinarian
M. H. ROEPKE, Ph.D., Assistant Biological Chemist
B. S. POMEROY, D.V.M., Assistant in Animal Pathology
A. G. KARLSON, M.S., Assistant in Veterinary Medicine
[23]A. F. SELLERS, V.M.D., Assistant in Veterinary Medicine

Division of Agricultural Economics

O. B. JESNESS, Ph.D., Agricultural Economist
W. C. WAITE, Ph.D., Agricultural Economist
A. A. DOWELL, Ph.D., Agricultural Economist
G. A. POND, Ph.D., Agricultural Economist
L. B. BASSETT, Associate Agricultural Economist
R. W. COX, Ph.D., Assistant Agricultural Economist
E. F. KOLLER, Ph.D., Assistant Agricultural Economist
S. A. ENGENE, Ph.D., Assistant Agricultural Economist
G. E. TOBEN, M.S., Assistant in Agricultural Economics
G. L. PETERSON, M.A., Assistant in Agricultural Economics
TRUMAN NODLAND, B.S., Assistant in Agricultural Economics
F. E. WETHERILL, Field Agent
O. R. SHELLEY, B.S., Junior Economist

Rural Sociology

LOWRY NELSON, Ph.D., Rural Sociologist

[17] Resigned August 15, 1940.
[18] Resigned August 31, 1940.
[19] Sabbatical furlough February 16, 1941 to February 15, 1942.
[20] Appointed August 16, 1940.
[21] Appointed September 1, 1940.
[22] Appointed February 16, 1941.
[23] Appointed October 1, 1940.

Division of Agricultural Engineering

A. J. SCHWANTES, M.S., Agricultural Engineer

Section of Farm Power and Machinery

A. J. SCHWANTES, M.S., Agricultural Engineer
J. B. TORRANCE, B.S., Assistant Agricultural Engineer
ANDREW HUSTRULID, Ph.D., Assistant Agricultural Engineer
A. G. TYLER, B.S., Assistant Agricultural Engineer
J. G. DENT, Assistant in Agricultural Engineering

Section of Farm Structures

H. B. WHITE, M.S., Assistant Agricultural Engineer
[24]C. K. OTIS, B.S., Assistant Agricultural Engineer
C. H. CHRISTOPHERSON, M.A., Assistant in Agricultural Engineering
[25]L. W. NEUBAUER, M.S.C.E., Assistant in Agricultural Engineering

Section of Land Reclamation

H. B. ROE, C.E., Agricultural Engineer
J. K. PARK, M.S., Assistant in Agricultural Engineering
P. W. MANSON, M.S., Assistant in Agricultural Engineering

Section of Land Clearing

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

Detailed by the United States Department of Agriculture for Cooperative Work
Bureau of Agricultural Engineering

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

Northwest Experiment Station

T. M. MCCALL, M.S., Superintendent
R. S. DUNHAM, M.S., Assistant Agronomist
O. M. KISER, M.S., Assistant Animal Husbandman
R. J. CHRISTGAU, M.S., Assistant Animal Husbandman
A. M. PILKEY, Assistant in Poultry Husbandry
A. M. FOKER, Assistant Agricultural Engineer
R. E. NYLUND, B.S., Assistant in Horticulture

West Central Experiment Station

T. H. FENSKE, M.S., Superintendent
R. O. BRIDGFORD, M.S., Assistant Agronomist
P. S. JORDAN, B.S.Agr., Assistant Animal Husbandman
[26]A. W. EDSON, B.S., Assistant Poultry Husbandman
J. A. ANDERSON, B.S.Agr., Assistant Horticulturist

[24] Appointed October 21, 1940.
[25] Resigned September 15, 1940.
[26] On leave August 1 to September 30, 1940.

North Central Experiment Station

[27]R. L. DONOVAN, B.S.Agr., Superintendent
O. W. SWENSON, Assistant in Agronomy
A. F. DAHLBERG, B.S., Assistant in Poultry Husbandry
D. L. DAILEY, B.S., Assistant in Animal Husbandry
A. L. RICHARDSON, M.S., Assistant in Horticulture

Northeast Experiment Station

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

Southeast Experiment Station

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

[27] On leave November 16, 1940 to May 15, 1941, resigned June 30, 1941.