

**Section of Land Reclamation**

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<sup>26</sup>J. H. NEAL, Ph.D., Assistant Agricultural Engineer  
 J. K. PARK, B.S., Assistant in Agricultural Engineering  
 P. W. MANSON, B.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  
<sup>27</sup>O. W. HOWE, B.S., Assistant Agricultural 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  
<sup>28</sup>R. J. CHRISTGAU, M.S., Assistant Animal Husbandman  
 A. M. PILKEY, Assistant in Poultry Husbandry  
<sup>29</sup>E. R. CLARK, M.S., Assistant Agronomist and Pure Seed Specialist  
 A. M. FOKER, Assistant Agricultural Engineer  
<sup>30</sup>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  
<sup>31</sup>A. W. EDSON, B.S., Assistant Poultry Husbandman  
 J. A. ANDERSON, B.S.Agr., Assistant Horticulturist

**North Central Experiment Station**

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  
<sup>32</sup>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

<sup>26</sup> Resigned October 15, 1939.

<sup>27</sup> Resigned June 30, 1940.

<sup>28</sup> Sabbatical leave October 1, 1938 to September 30, 1939.

<sup>29</sup> Resigned May 31, 1940.

<sup>30</sup> Appointed July 1, 1939.

<sup>31</sup> Sabbatical furlough April 1 to June 30, 1940.

<sup>32</sup> Appointed July 1, 1939.

## FORTY-SEVENTH ANNUAL REPORT

# Agricultural Experiment Station

## University of Minnesota

JULY 1, 1939 TO JUNE 30, 1940



UNIVERSITY FARM, ST. PAUL

LETTERS OF TRANSMITTAL

UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.

July 1, 1940

*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, 1940.

Respectfully transmitted,  
GUY STANTON FORD,  
*President of the Board of Regents*

UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.

July 1, 1940

*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, 1940.

Respectfully transmitted,  
GUY STANTON FORD,  
*President of the University of Minnesota*

UNIVERSITY FARM, ST. PAUL, MINN.

July 1, 1940

*Guy Stanton Ford,  
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, 1940.

Respectfully transmitted,  
W. C. COFFEY, *Director*

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## FORTY-SEVENTH ANNUAL REPORT

### MINNESOTA AGRICULTURAL EXPERIMENT STATION

JULY 1, 1939 TO JUNE 30, 1940

W. C. Coffey, Director

#### FOREWORD

In most of its aspects, agricultural research is a very practical undertaking. It is a service the purpose of which is to be of help to farmers and country people generally. It is most in demand when there are obstacles in achieving desired ends or when new or abnormal conditions arise to cause trouble and disappointment. As our agriculture becomes older and our society grows more complex, obstacles and abnormal conditions arise in greater frequency. Therefore, it is to be expected that each decade will bring demands for more research in all important lines of agricultural activity. If satisfactory solutions are to be found for the problems on which these demands are based, the research attack must be varied, continuous, and fairly intense. A plant disease may be checked, controlled, or even eradicated by the application of sprays, or it may be more satisfactorily and economically controlled by breeding varieties of plants resistant to it. To be of most service, research should attempt to find as many methods of control as possible. To do this requires a cooperative, carefully planned attack from as many angles as available resources will permit. No matter what the problem may be, the method of the research approach should be comprehensive and thoroughgoing.

An experiment station can be kept very busy on problems which are constantly arising in connection with growing, processing, and distributing plant and animal crops or in connection with changing social and economic conditions. Doubtless a large part of its energy must be expended on them, for, as already stated, agricultural research is a service and as a rule the service the farmer wants most relates to the problems closest at hand and most in evidence.

It is also the duty of an experiment station to be of assistance in emergency situations of national significance. Our country is undertaking a complete program of national defense. For this our agricultural plant is well prepared with respect to food and textile supplies. It can easily grow more food and textiles than available markets can absorb, and the government has considerable stocks of food and textile supplies in storage. However, attention is being drawn to the need of better human nutrition and health throughout the nation as factors of importance in a defense program. In this matter the experiment station has a duty which it should gladly welcome, for it has implications of human welfare which should continue indefinitely after the defense program is completed.

**CHANGES IN STAFF****Appointments**

W. G. Andberg, D.V.M., as assistant veterinarian, Division of Veterinary Medicine, effective July 26, 1939.

L. L. Kempe, M.S., as associate chemist, Division of Soils, effective March 1, 1940.

J. C. Shaw, Ph.D., as associate physiologist, Division of Dairy Husbandry, effective July 1, 1939.

O. R. Shelley, B.S., as junior economist, Division of Agricultural Economics, effective April 1, 1940.

G. E. Toben, M.S., as assistant in agricultural economics, Division of Agricultural Economics, effective December 16, 1939.

R. E. Nylund, B.S., as assistant in horticulture, Northwest Experiment Station, effective July 1, 1939.

A. L. Richardson, M.S., as assistant in horticulture, North Central Experiment Station, effective July 1, 1939.

T. S. Weir, B.S.A., as assistant in horticulture, Division of Horticulture, effective July 1, 1939.

A. G. Karlson, M.S., as assistant in veterinary medicine, Division of Veterinary Medicine, effective July 1, 1939.

**Promotions**

W. L. Boyd, D.V.S., veterinarian to veterinarian and chief of the Division of Veterinary Medicine, effective March 1, 1940.

W. E. Petersen, Ph.D., associate dairy husbandman to dairy husbandman, Division of Dairy Husbandry, effective July 1, 1939.

Thorvald Schantz-Hansen, Ph.D., associate forester to associate forester and director of the Forestry and Biological Station at Lake Itasca, effective February 1, 1940.

A. J. Schwantes, B. Agr. Eng., associate agricultural engineer to agricultural engineer and acting chief of the Division of Agricultural Engineering, effective July 1, 1939.

T. M. Currence, Ph.D., assistant horticulturist to associate horticulturist, Division of Horticulture, effective July 1, 1939.

Ethel L. Phelps, M.S., assistant home economist to associate home economist, Division of Home Economics, effective July 1, 1939.

C. M. Christensen, Ph.D., assistant in plant pathology to assistant plant pathologist, Division of Plant Pathology and Botany, effective July 1, 1939.

Louise T. Dossall, Ph.D., assistant in plant pathology to assistant plant pathologist, Division of Plant Pathology and Botany, effective July 1, 1939.

Helen Hart, Ph.D., assistant in plant pathology to assistant plant pathologist, Division of Plant Pathology and Botany, effective July 1, 1939.

A. E. Hutchins, Ph.D., assistant in horticulture to assistant horticulturist, Division of Horticulture, effective July 1, 1939.

E. H. Rinke, M.S., research assistant to assistant in agronomy, Division of Agronomy and Plant Genetics, effective January 1, 1940.

B. E. Anderson, Ph.D., teaching assistant to associate chemist, Division of Agricultural Biochemistry, effective April 1, 1940.

C. L. Hankinson, Ph.D., teaching assistant to assistant in agricultural biochemistry, Division of Agricultural Biochemistry, effective September 16, 1939.

W. M. Roberts, M.S., teaching assistant to assistant in agricultural biochemistry, Division of Agricultural Biochemistry, effective April 1, 1940.

**Leaves of Absence**

A. W. Edson, B.S., poultryman, West Central Experiment Station, sabbatical furlough, April 1 to June 30, 1940.

**Resignations**

I. J. Johnson, Ph.D., associate agronomist, to accept a position as professor of farm crops, Department of Agronomy, Iowa State College, Ames, Iowa, effective December 31, 1939.

J. C. Shaw, Ph.D., associate physiologist, to accept a position as assistant professor in the dairy department at Connecticut State College, Storrs, Connecticut, effective December 31, 1939.

A. J. Bailey, Ph.D., assistant forester, to accept a position at the University of Washington, effective September 30, 1939.

E. R. Clark, M.S., assistant agronomist and pure seed specialist at the Northwest Experiment Station, to accept a position as assistant seed technologist, United States Department of Agriculture, with headquarters at the Federal-State Seed Laboratory, Lafayette, Indiana, effective May 31, 1940.

O. W. Howe, B.S., assistant agricultural engineer, effective June 30, 1940.

J. H. Neal, Ph.D., assistant agricultural engineer, to accept a position as head of the Department of Agricultural Engineering at Alabama Polytechnic Institute, Auburn, Alabama, effective October 15, 1939.

C. F. Rogers, M.S., assistant agricultural biochemist, effective June 15, 1939.

C. L. Hankinson, Ph.D., assistant in agricultural biochemistry, to accept a position with the Carnation Milk Company at Milwaukee, Wisconsin, effective March 31, 1940.

Catherine Barrett Mulvehill, B.S., assistant in animal genetics, effective June 30, 1940.

W. P. Ranney, Ph.D., assistant in agricultural economics, to accept a position as associate professor in the department of agricultural economics and rural sociology at the Tennessee Agricultural Experiment Station, Knoxville, Tennessee, effective September 30, 1939.

H. G. Sandhoff, M.S., assistant in poultry husbandry, effective June 30, 1940.

O. E. Stamberg, Ph.D., American Dry Milk Research Fellow, effective June 30, 1940.

#### Deaths

C. P. Fitch, D.Sc., animal pathologist and bacteriologist and chief of the Division of Veterinary Medicine, January 11, 1940.

#### 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.

#### Report Series

Forty-sixth annual report of the Minnesota Agricultural Experiment Station, July 1, 1938 to June 30, 1939. 100 pages, 2,000.

Miscellaneous Report No. 1. A study of the values sought and the practices followed by consumers in the purchase of "silk" street dresses and silk yard goods. Ethel L. Phelps, Florence E. Petzel, Allene S. Loring, and Eleanor A. Nielson, Division of Home Economics. 15 pages, 1,500.

A consideration of recommendations which might help to obtain greater returns for the clothing dollar prompts such preliminary questions as, "What do people buy?" "What factors or reasons influence their choices?" and "What practices do they rely upon to get what they want?"

This study presents answers to the last two of these questions with respect to "silk" street dresses and silk yard goods. Two hundred ninety-four women, classified according to age, occupation, and income, were interviewed, and their reactions to factors influencing their purchases recorded. In addition 303 sales of silk yard goods were observed, and the information accumulated was assembled on the bases of customers' estimated age, amounts purchased, fabrics selected, prices, and intended use. Values consciously sought by both groups indicated the influence of such factors as color, price, quality, fashion, and art.

It was assumed that frequency of mention most nearly measured the importance of each factor. Color, price, and quality constituted 75 per cent of the frequency of mention of all factors enumerated in the purchase of yard goods. Color was outstanding also in the choice of "silk" dresses, 80 per cent of the respondents claiming they planned general color schemes and bought accordingly. Quality ranked second, texture third.

Some relationships were noted between qualifications consciously desired in yard goods and intended use and price; also between color and price and amount bought. In buying dresses, the relative importance of color, quality, and texture appeared to be generally unaffected by age or income.

Eighty per cent of the respondents preferred ready-to-wear dresses, feeling they save time, displayed immediately the desired effect, and were smarter and more economical. Only about 50 per cent indicated any preference for dressmaker-made or homemade dresses. Also only one-half reported using any method to determine quality, while nearly all acknowledged the influence of advertising, quality guarantees, and persuasive sales methods upon their ultimate purchases.

Based on these findings, several items are recommended for consideration as part of a program to achieve greater returns for clothing expenditures.

#### General Bulletin Series

345. Minnesota cold storage locker plants. A. A. Dowell, S. T. Warrington, R. J. Eggert, L. J. Fenske, Division of Agricultural Economics, Division of Agricultural Extension, and West Central Experiment Station. 39 pages, 15,000.

The first cold storage locker plant in Minnesota was opened in 1935. By March 1, 1939, 179 plants were in operation. Of these, 57 were cooperatively owned, and 122 were owned by individuals or ordinary corporations. A few plants are equipped with locker rooms only. Some are equipped with chill, cutting, sharp freeze, and locker rooms but do not provide the services of a butcher. The largest number of plants are equipped to render all of these services and employ full-time butchers. Most of the latter group are operated in connection with some other enterprise, although several are housed in separate buildings and operated as independent units.

The investment in locker plants varied from \$19.88 to \$38.23 per locker depending upon type, size, and kind of insulation and equipment. The average plant handled 586 pounds of all kinds of meat combined per patron year. Of this amount the patrons supplied 540 pounds, and the plants sold 46 pounds. The plants cut 94 per cent and ground 15 per cent of the meat handled.

The most important source of income for the plants was from locker rentals. Additional income was obtained from slaughtering and processing meats, commission on meat sold, and miscellaneous items.

Farm and town patrons consumed about the same amount of beef per person. However, farm patrons consumed more pork and poultry and hence more total meat per person than town patrons.

346. Trends in the Minnesota dairy industry. E. Fred Koller and O. B. Jesness, Division of Agricultural Economics. 40 pages, 10,000.

The principal outlet for Minnesota's rapidly increasing milk supply is in creamery butter, the output of which rose from 83,000 pounds in 1879 to 302 million pounds in 1938, with the greatest expansion occurring between 1920 and 1933. The number of creameries in the state has not changed greatly since 1912, hence output per plant has risen steadily with favorable effects on efficiency of operations. The proportion of butter made by cooperative creameries has expanded while that

of centralizers has declined sharply. The leading markets for Minnesota butter are New York, Philadelphia, Chicago, and Boston, respectively. However, a smaller proportion is sold in these markets than formerly as butter now moves more directly to consuming centers. Other significant changes in butter marketing include greater concentration of handling by large national distributors and increased shipments by motor trucks and over the Great Lakes. The state's output of cheese, evaporated milk, and dried milk products has expanded rapidly in recent years. The fluid milk markets have likewise shown steady growth. It is emphasized that future growth of the industry in this area depends upon further improvements in the efficiency of the farm dairy industry, the manufacture of dairy products, and the marketing of these products.

347. Agricultural production and types of farming in Minnesota. S. A. Engene and G. A. Pond, Division of Agricultural Economics. 71 pages, 10,000. (Statistical Supplement, 25 pages, 2,000.)

With increasing interest in agricultural adjustment and conservation, it is important that the citizens of the state, and particularly the farmers, be thoroughly familiar with its agriculture. A graphic and descriptive analysis of the agriculture of Minnesota is presented in this bulletin. The analysis deals with the causal factors leading to the present types of farming, as well as with the distribution of the various enterprises. The acreages and proportions of the various crops, the numbers of livestock, and other data relating to the organization of the farms are presented for each county, as well as for the state as a whole.

The state is divided into nine type-of-farming areas, in each of which the type of farming differs from that in the others. The location and outstanding characteristics of each of these areas are as follows:

- Area 1—Southeast dairy and livestock—low-lime soils, rolling to hilly, with erosion a serious problem in some counties; hogs and beef cattle of some importance in the southern counties.
- Area 2—South-central dairy and livestock—the most intensive dairy section in the state; crop yields highest of any area; hogs an important source of income.
- Area 3—Southwest livestock and cash grain—large proportion of land in corn; beef cattle and hogs more important than in any other area; corn, oats, and barley sold.
- Area 4—West-central livestock and cash grain—very similar to Area 3, but with less corn and more small grain, particularly wheat.
- Area 5—East central dairy and potatoes—large area of sandy soils; few livestock other than dairy cattle.
- Area 6—Northwestern dairy and livestock—an area of mixed or general farming.
- Area 7—Red River Valley small grain, potatoes, and livestock—level land, large farms; dairying principal livestock enterprise.
- Area 8—Northern cut-over dairy, potatoes, and clover seed—only a small proportion of the land is in farms; small farms, low incomes; large proportion of part-time and subsistence farms.
- Area 9—Twin City suburban truck, dairy, and fruit—producing perishable commodities for the markets of Minneapolis and St. Paul.

348. Brucellosis or Bang's disease of farm animals. C. P. Fitch and W. L. Boyd, Division of Veterinary Medicine. 32 pages, 7,500.

Brucellosis is a contagious disease that causes about 85 per cent of the abortions occurring in cattle. The disease is widespread, and approximately 12 per cent of the cattle in Minnesota are infected. In the gravid uterus the micro-organism causes necrosis of the cotyledons resulting in death of the fetus or premature birth. Common sequelae are retention of the fetal membranes, lowered milk production, and infertility. Many animals may abort once and thereafter remain clinically normal. They continue to harbor the causative agent and are dangerous sources of the infection. Susceptible animals become infected by contact with an aborted fetus and its membranes or milk. It cannot be emphasized too often that infected cows may give birth normally and still eliminate the micro-organism with the calf and its membranes and in the milk.

The agglutination reaction is a safe and reliable test for diagnosis. The disease is best controlled by eliminating all animals that react. The purchase of cows should be limited to herds free of the disease, and all recently purchased animals should be quarantined for at least sixty days and then retested.

All cows should be isolated at the time of parturition and not returned to the herd for twenty days. Vaccination of calves with a viable nonvirulent vaccine increases the resistance to infection, but at present there is no evidence that the disease may be eradicated by this method. There is no medicinal treatment known to be of any value.

Brucellosis may cause abortions in swine and sheep. Horses may also be infected, but abortions do not occur. Infected horses frequently have chronic suppurative lesions, such as poll evil and fistula of the withers. There is some evidence that infected horses may be a source of the disease for cows.

349. Sugar beet culture in Minnesota. J. O. Culbertson, Division of Agronomy. 24 pages, 5,000.

Studies were made of the most important agronomic phases of sugar-beet culture in Minnesota in relation to soils, rotations, date of planting, stand, thinning, fertilizers, and varieties. Minnesota soils best suited for sugar beets are: Fargo clay loam, Fargo silt loam, Bearden silt loam, and Bearden loam in the Red River Valley; Clarion loam, Clarion silt loam, Webster silt loam, and Webster silty clay loam in the south-central area. Rotations found suitable for sugar beets include: small grain with sweet clover, summer fallow, potatoes, and sugar beets for the Red River Valley; fodder or canning corn, sugar beets, and small grain in south-central Minnesota. Planting as soon as the seedbed can be prepared in the spring has produced highest average yields per acre of both roots and sucrose. When a single plant was missing from an 18x18 inch spacing, the surrounding plants recovered only 53 per cent of the yield of check plants grown under full competition. Maintenance of a full stand of plants was shown to be of great importance in the production of a high yield per acre. Highest yields were obtained from thinning in the two-leaf stage. Increased yields were obtained from plots in which large beets were left by the thinners as compared to the yield of plots in which small or unselected plants were left. Cultivation should be sufficiently frequent to effectively destroy weed growth. The use of phosphatic fertilizers has proved profitable in most parts of Minnesota where sugar beets are grown. Tonnage

type beets produced the highest yields per acre of both roots and sucrose. Cercospora leaf-spot resistant varieties are being developed which are suited to Minnesota. Sugar-beet by-products are of value to livestock feeders.

350. Planning the physical layout of farms. O. W. Howe and A. J. Schwantes, Division of Agricultural Engineering. 20 pages, 4,000.

In this bulletin the importance of planning the farm layout systematically on a long time basis is stressed. Logical planning procedure is presented and illustrated. The factors that influence field layout are discussed and illustrated by examples from actual Minnesota farms.

The planning procedure consists of trying out various field arrangements, each one of which is adapted to a desirable cropping system, on skeleton maps of the farm and then, after the plan that appears to make the best use of the farm resources has been selected, the changes that will be necessary for its accomplishment must be considered. The maps to be used may be line drawings prepared from a photographic enlargement of an aerial map. A cropping or land-use schedule is worked out for each year of the transition period between the old plan and the full accomplishment of the proposed plan. A schedule of required improvements is prepared showing which improvements should be made each year in order that the cropping and livestock schedules may be directed most efficiently toward the new plan.

In planning the farm layout the possibilities for improving the farmstead arrangement with relation to fields and pastures should be considered. The number of fields should be as small as the desired rotation and the topography of the farm will permit. It is desirable that fields be arranged so one end is near the farmstead to minimize traveling distance to and from them. This is not always practicable as other conditions may control the shape and arrangement of the fields. The slope of the land may determine the direction the fields lie in order to control erosion, or varying soil types may determine the locations of field divisions. Ordinarily, power and machinery may be used most economically on fields that are relatively long and narrow. Square fields are most economically fenced. The squaring up of fields by removing stones, stumps, or wet places is always desirable where the cost is not too great.

Other points to consider are the arrangement of lanes and roads for minimum travel and necessity of opening gates, the accessibility of water to pasture, the availability of individual fields for supplemental pasture, and the avoidance of weed-infested field corners.

#### Technical Bulletin Series

140. The Syrphidae of Minnesota. Horace S. Telford, Division of Entomology and Economic Zoology. 76 pages, 2,000.

A study of the biology, economic importance, taxonomy, and distribution of the syrphid fauna of Minnesota. A general classification of the immature stages is presented. The economic importance of the family is considered under the following heads: predators of insects, plant pollinators, plant feeders, scavengers, parasites, and laboratory animals. A brief discussion on the natural enemies of the Syrphidae is given. Keys to the subfamilies, genera, and species are presented with distributional notes. A review of the biology of each genus is given.

Four new species are described and illustrated: *Microdon robusta*, *Cheilosia angelica*, *C. cottrelli*, and *C. minnesotensis*. The larva and puparium of *Microdon robusta* new species and *Lejops bilinearis* (Williston) are described. The abdomen of *Baccha fascipennis* Loew, the wing of *Eristalis* sp., and the larva of *Microdon robusta* new species are illustrated. 237 references are listed in the bibliography.

141. High temperature tolerance of forest trees. Ralph W. Lorenz, Division of Forestry. 25 pages, 2,000.

At times temperatures become so high in the Lake States and other parts of the country that they cause heavy losses to young tree seedlings in the nursery and on southerly exposed planting sites. It is desirable to know the time-temperature relationships existing in the upper biokinetic zone for the various tree species. The purpose of this study was to determine the time and temperature necessary to kill the cells of the cortical parenchyma of white pine (*Pinus strobus* L.), red pine (*Pinus resinosa* Ait.), white spruce (*Picea glauca* [Moench] Voss.), American elm (*Ulmus americana* L.), and hardy catalpa (*Catalpa speciosa* Ward.), and to devise some means of interpreting this injury. As an approach to this subject, a temperature range from one which showed no injury to one in which complete killing resulted in 1, 3, 5, 10, 20, and 30 minutes was determined for the above named tree species. The degree of injury resulting from high temperature exposures in the water bath was determined by the per cent of cells in the section which would stain with neutral red. Approximately 90 specific time-temperature relationships were established for each tree species. The data shows that no staining is evident in the cortex cells after they have been exposed for 30 minutes at temperatures of 57°-59°C. Temperatures 66°-69°C. resulted in complete killing with one minute exposure.  $Q_{10}$  determinations were made on the rate of killing of the cortical parenchyma cells for each tree studied. The Arrhenius formula was also applied to data for the determination of the "temperature characteristic" on "critical thermal increment."

142. The spruce budworm in Minnesota. S. A. Graham and L. W. Orr, Division of Entomology and Economic Zoology. 27 pages, 2,000.

The spruce budworm, *Cacoecia fumiferana*, is a native insect which for years may be so scarce in our northern coniferous forests that it attracts no attention. However, at long intervals, representing the period required for a generation of balsam fir to reach a dominant position, the population may increase tremendously and a disastrous outbreak may result. The last series of outbreaks in Minnesota began in 1912 and persisted in varying intensity through 1923. It is estimated 85 and 90 per cent of the merchantable balsam fir was destroyed over most of the area. Injury to spruce was less severe.

Although the budworm has been quiescent for more than a decade in the balsam fir and spruce forests, the stage is now being set for another outbreak. Many balsam fir stands which were unsuitable in 1912 to 1918 are now becoming suitable.

Outbreaks invariably arise in areas where the forest is predominantly balsam fir that averages 4 inches or more in diameter. After three successive years of defoliation the trees begin to die rapidly. Chemical control may be justifiable in the case of infestations on valuable trees, but the high cost would practically exclude its use in forests where commercial timber production is the objective.

In the latter instance, the most promising methods of control are silvicultural, the ideal objective being to produce and maintain a forest in which balsam fir occupies a subsidiary position. If the development of extensive stretches in which balsam fir over 4 inches in diameter is predominant can be avoided, it is believed that danger of a general budworm outbreak will be very slight. A relatively evenly developed forest may be converted into an unevenly developed one in which the balsam fir will reach maturity and may be logged at different times. Partial control may be attained through logging which utilizes the balsam fir to the smallest merchantable size.

143. Biochemical studies of some varieties of apples, plums, and grapes grown in Minnesota. Eleanor Olds Barnes, Division of Agricultural Biochemistry. 35 pages, 2,000.

The juices of 33 varieties of Minnesota apples from the crop seasons of 1935 and 1936 were analysed for total sugars, titratable acidity, pH, buffer index, specific gravity, and crude pectin. Total sugars showed a range from 4.68 to 9.76 per cent, which is essentially the same range that Brierley found for a series of Minnesota apples analysed a number of years ago. Evidently only a few of the Minnesota apple varieties have sufficient sugars to yield satisfactory cider vinegars. Titratable acidity, expressed as malic acid, ranged from 0.026 per cent to 1.45 per cent and crude pectin from 0.68 per cent to 5.60 per cent.

The buffer curves could be adequately duplicated by an artificial mixture of malic acid and sodium malate, or malic acid-apple juice ash.

The juices of 25 samples (11 varieties) of Minnesota plums from the 1936 crop and 15 samples (11 varieties) of Minnesota grapes from the 1936 and 1938 crops were similarly analysed. In the plums total sugars ranged from 5.13 per cent to 10.43 per cent and in the grapes from 9.75 per cent to 17.29 per cent. Grape No. 81 with 17.29 per cent contained a much larger part of sugar than any other grape tested. It gives promise of developing a wine grape adapted to Minnesota's climatic conditions.

Acidity in the plums ranged from 1.09 per cent to 2.22 per cent and in the grapes from 0.83 per cent to 2.29 per cent calculated as malic acid. Tannins ranged from 0.008 per cent to 0.335 per cent in the plums and from 0.005 per cent to 0.046 per cent in the grapes, and total astringency from 0.104 per cent to 0.530 per cent in the plums and 0.083 per cent to 0.132 per cent in the grapes, indicating a rather wide range in the chemical composition of these hybrid fruits developed at the University Fruit Breeding Farm. Here again the buffer indices could be fairly satisfactorily accounted for by artificial mixtures of fruit acids and fruit acid-salts or juice ash.

It is suggested that studies such as these, conducted through a series of crop seasons, may assist the horticulturist and fruit breeder in selecting specific varieties of fruits as being particularly adapted for specific industrial or domestic uses. Furthermore, similar studies, over a series of crop seasons, should indicate to what extent climatic factors, on the one hand, or genetic factors, on the other, are responsible for the marked differences of serum between the various varieties.

144. A laboratory study of the drainage requirements of sweet clover. P. W. Manson, Division of Agricultural Engineering. 28 pages, 2,000.

The problem of drainage design as influenced by soil type has largely been solved, but still before us is the scientific determination of the rate at which drain-

age of saturated soils must take place and the depth to which the water table must be lowered for the various types of crops, for optimum results in quantity and quality of yield.

Four blocks of undisturbed field soil (Swan silty clay loam), measuring approximately 33 inches to the side, were brought to the laboratory where a water control system was set up in each box for regulating the ground water.

The crop, biennial white sweet clover, was grown under artificial light furnished by a 1000 watt bulb placed over each soil cube. The studies show that biennial white sweet clover can be satisfactorily grown in the laboratory under artificial light if the heat developed by the lamps be intercepted by a water filter placed between the lamps and the plants.

The growth of sweet clover is definitely stimulated by good drainage, but it may be grown successfully on soils that are known to be too poorly drained for satisfactory results with many farm crops. Sweet clover is so water tolerant that no great difference in growth and yield could be detected as between drainage depths of 18 and 27 inches. It may take several weeks of continuous flooding, depending on crop age, to break the plant tissue. Sweet clover flooded for one day after cutting and then drained at the rates of one quarter, one half, and one inch per day shows marked increases in rate of growth and yields with the increase in rate of drainage.

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## Scientific Journal Series Papers

## Agronomy and Plant Genetics

1756. A genetic study of mature plant resistance in spring wheat to black stem rust, *Puccinia graminis tritici*, and reaction to black chaff, *Bacterium translucens*, var. *Undulosum*. C. L. Pan. *Journal of the American Society of Agronomy* 32:107-15. 1940.

Crosses were made of Marquis x H44, III-31-7, and Pentad x Marquis, III-34-1, with Minnesota Double Cross, II-21-80, Hope, and H44 to study the inheritance of reaction to stem rust and black chaff. Resistance to stem rust appeared to be dominant to semi-resistance. The data indicated that Marquis x H44, III-31-7, carries a single dominant gene which is allelomorphous to that carried by Hope and H44 and that Minnesota Double Cross, II-21-80, carries two complementary factors for semi-resistance similar to those carried by Pentad x Marquis, III-34-1. Susceptibility to black chaff appeared to be dominant to resistance. Resistance to stem rust was associated with susceptibility to black chaff, but the association was not complete; however, no single plant was found that was susceptible to both diseases.

1776. Maternal inheritance of chlorophyll in  $F_1$  crosses between selfed lines of corn. E. S. Miller and I. J. Johnson. *Proceedings of Experimental Biology and Medicine* 44:26-28. 1940.

Reciprocal crosses between high and low chlorophyll inbred lines of corn prove that male and female parents each contribute equally to the genotype of the  $F_1$  cross in respect to chlorophyll concentration.

1782. Leaf pigment concentration and its relation to yield in Fairway crested wheat grass and Parkland brome grass. I. J. Johnson and E. S. Miller. *Journal of the American Society of Agronomy* 32:302-307. 1940.

In a study of 55 clonal lines of Fairway crested wheat grass and 76 clonal lines of Parkland brome grass, highly significant differences were obtained in percentage of total carotenoid pigments, beta carotene, and total chlorophyll. The strains studied varied significantly in yield on a green weight basis. No significant relationship was found between the concentration of chlorophyll or carotenoid pigments and yielding ability. Significant correlations were obtained between the concentration of total chlorophyll and either local carotenoids or beta carotene.

#### Forestry

1450. Variation in rainfall over short distances. T. Schantz-Hansen and R. M. Brown. *Journal of Forestry* 37:804-06. 1939.

Four 8-inch standard Weather Bureau rain gauges were set up for the summer of 1935. Two were located in the center of a 14-acre cleared field, 100 yards apart. A third station was located in the center of a 4-acre field, 100 yards from the regular United States Bureau Cooperative Station. Measurements were taken after each storm. Variations for the season amounted to 1.9 per cent for the stations in the 14-acre field and 6 per cent for the other two stations.

1535. The chemistry of lignin I. The existence of a chemical bond between lignin and cellulose. A. J. Bailey. *Paper Trade Journal* 109:29-34. 1940.

Commercial cellulose production from wood employs hydrolyzing liquors, yet the necessity of hydrolysis in dissolving lignin has never been proved or disproved. Digestion of aspen and jack pine wood in butanol-water mixtures, buffered to prevent hydrolysis, removed all of the lignin from aspen and 80 per cent of the lignin from jack pine. The remaining jack pine lignin was easily removed in the same solvent made 2 per cent in NaOH. The lignin fractions appeared to be similar or identical, the difference being that one was in chemical combination with cellulose, the other not combined. Yields under various conditions of digestion were determined, and changes in wood caused by digestion were followed by determining the analytical constants of the residues from digestion. All tests indicated that lignin may exist partly in true chemical combination with cellulose and partly free, or entirely uncombined to cellulose, the determining factor being the species of wood.

1536. The chemistry of lignin II. The butanolysis of wood. A. J. Bailey. *Paper Trade Journal* 110:29-32. 1940.

Further studies in the use of butanol in pulping wood showed that 2 per cent of alkali added to the butanol-water mixtures accelerated the delignification from 5 to 16 times. Using this type of liquor, almost white pulps containing only one-third of one per cent of lignin were obtained in yields of 43 to 50 per cent, by cooking aspen for 15 minutes and jack pine for 1 hour. Time-yield alkali-lignin

content curves are shown for the entire practicable range for the pressure used. It is shown that the alkali functions chiefly as a catalyst in the lignin-butanol condensation rather than as a reactant. A theory of the mechanism of butanol pulping is offered and supporting experimental evidence pointed out. Butanol was easily recovered from the final liquor, 95 per cent being recovered by separating the immiscible layer and several per cent more by distilling only 10 per cent of the total liquor.

1654. Some effects of the 1936 drought on the forest at the Cloquet Forest Experiment Station. T. Schantz-Hansen and P. N. Joranson. *Journal of Forestry* 37:635-39. 1939.

The investigation was undertaken to observe and describe the various effects of the extremely severe drought of 1936 upon coniferous stands in and near the Cloquet Forest. The differences between the average surface areas of the needles of the native jack, Norway, and northern white pines produced in 1936 and those produced during the more normal growing season of 1935 were, without exception, found to be highly significant.

The length, and probably also the surface area, of balsam fir and black spruce needles were not reduced as a result of the drought.

In a stand of Norway and northern white pine ranging from 30 to 40 feet in height and located on a thin soil underlain by rock, approximately half of all the trees and nearly all of the Norway pines were killed.

It is reasonable to suppose that such a significant reduction in leaf area would be reflected in a decrease in the rate of growth for the 1937 season as well as the 1936 season. Apparently the size and development of the needles of the three species of native pines are dependent upon the growing conditions of the year in which they are produced.

1694. Diameter variation in cellulose fibrils. A. J. Bailey. *Industrial and Engineering Chemistry* 32:57-63. 1940.

Various plant fibers were disintegrated by mechanical means alone and by beating after different chemical treatments. Measurements of fibril diameters were made and analyzed statistically. The analysis showed that cellulose fibrils exist as uniform and true morphological units. Diameters of these fibrils are in the range of 0.928 to 0.956 and are apparently independent of botanical origin, chemical treatment, or physical processing. The fact that cellulose fibrils fluctuate around a common average diameter, the amount of fluctuation being essentially the same for various species and treatments, has far-reaching industrial significance. Two physical materials were found in all fibers—a compact, dense, unit fibril and a substance forming a hydrogel upon comminution in water. The unit fibril was incapable of gelatinization in water by ordinary methods. The disintegration of fibers into a gel and an inert fraction indicates that freeness and similar tests have only limited and empirical significance. The observed course of fiber disintegration explains many of the complex physical and chemical changes accompanying commercial beating. Unit fibrils from various sources are illustrated by photomicrographs.

1706. Ten-year observations on the thinning of fifteen-year-old red pine. T. Schantz-Hansen. *Journal of Forestry* 37:963-66. 1939.

Four thinning plots and a check plot were established in a fifteen-year-old stand of red pine in 1927. The first remeasurement, made in 1932, showed some advantage in diameter growth for the 7 by 7 spacing. This advantage held good in the second five-year period. Differences in height growth are apparently caused by slight variations in site. All the thinned plots showed considerably better growth than the check plots and suffered less from storm damage.

1740. Removal of adhered rubber stoppers. A. J. Bailey. *Industrial and Engineering Chemistry, Analytical Edition* 12:52. 1940.

A method is described for quickly and easily removing rubber stoppers adhering to bottles, tubing, and other glass or metal parts. Only a file is required and the removal is less likely to cause breakage than other methods.

1799. Slash again in the Lake States. E. G. Cheyney. *Journal of Forestry* 37:640-41. 1939.

For many years the United States Forest Service and many states have been following a policy of compulsory burning of the slash left by logging operations. This policy originated in a belief that many of the destructive conflagrations in the past were developed in the slash on cutover lands, but this belief has never been supported by experimental data.

The writer points out some evidence that seems to indicate that the slash burning policy is rather unsatisfactory; that it is excessively expensive; that it does not fireproof the land or even greatly reduce the fire hazard; and that intensive patrol would be a far cheaper and more efficient method. He suggests that the problem be given some serious study rather than waste money in the future on conjecture.

1801. The literature of wood and wood technology. A. J. Bailey. *Paper Trade Journal* 109:97-104. 1939.

The increasing number of abstract periodicals bears mute testimony to the recognition of the necessity of keeping abreast of all current scientific developments through indexes. It yet remains to prepare a comprehensive bibliography under a single cover and with proper subject and author indexes to make all past information available. It is hoped that these notes will serve second best by pointing out the bibliographies, abstract journals, indexes, and other forms of literature, the devices for keeping informed of new publications as they appear, and the means of obtaining information by using the various services provided by the larger libraries.

1803. Intermediate cuttings in Danish forests. T. Schantz-Hansen. *Journal of Forestry* 38:367-69. 1940.

Two schools of thought on intermediate cuttings seem to prevail among Danish foresters; the "active" school, which is the common Danish system; and the

"delayed" school, which advocates a minimum of intermediate cuttings until the latter part of the rotation. Apparently, conclusive arguments are prescribed by each school of thought to support its contention.

#### Horticulture

1690. The Red Warba potato. F. A. Krantz and A. G. Tolaas. *American Potato Journal* 16(7):185-90. 1939.

Origin, chimerical nature, and technical description of the Red Warba.

1693. Inheritance in the cucumber. A. E. Hutchins. *Journal of Agricultural Research* 60(2):117-28. 1940.

In a study of the  $F_1$ ,  $F_2$ , and  $F_3$  progenies of a cucumber cross, determinate and indeterminate growth, black and white spines, coarse and fine spines, few and numerous spines, netting and non-netting of mature fruit, and height of plant appeared to be dependent on a single factor difference. Red, orange, yellow, and cream-colored mature fruits resulted from the interaction of two independently inherited factors. Spine color, mature fruit color, and netting appeared to be completely associated, as did spine size and number. Fruit size appeared to be associated with size and number of spines and with spine color, netting, and mature fruit color.

Determinate growth habit appeared to be associated with short plant, small number of mature fruit, small yield of mature fruit, small weight per mature fruit, small total number of fruits (mature + green), small total weight of fruit (mature + green), small weight per fruit (mature + green), greater number of days to first female flower, short laterals, few laterals, and small total length of laterals. Other associations were mature fruit color with number of female flowers and spine size and frequency with number of laterals.

Plant height, number of mature fruits, total weight of mature fruit, weight per mature fruit, total number of fruits (mature + green), total weight of fruit (mature + green), average weight per fruit (mature + green), number of female flowers, number of laterals, average length of laterals, and total length of laterals showed a positive and, in most cases, a significant association with each other when correlated in all possible combinations. In most cases, these characters also were significantly associated with days to production of first female flower but not with days to the first male flower. A high degree of association was found between time of production of the first female flower and maturity of the fruit.

1765. The effect of ice upon the survival of strawberry plants. W. G. Brierley, R. H. Landon, and R. E. Nylund. *Proceedings of the American Society for Horticultural Science* 37:557-63. 1939.

Studies carried on during the winters of 1937-38 and 1938-39 in a cold cellar and in the field have shown that dormant strawberry plants may be covered with ice for as long as 10 or 14 weeks with little or no injury resulting. When the plants are suitably protected from low temperatures, the ice alone has not injured the treated plants. As these results were contrary to the old idea of "ice smothering," further studies were carried on to determine the concentrations of  $CO_2$  and  $O_2$  beneath an ice seal. Dormant plants were tied to a screen wire cylinder and

coated with ice by spraying with ice water. The confined atmosphere showed a rise in the concentration of CO<sub>2</sub> to as high as 24 per cent and O<sub>2</sub> declined to 2 per cent. These plants were all killed, but with comparable plants sealed in glass jars and kept under similar conditions, there was only slight injury to the crowns and all the plants survived for two weeks concentrations of CO<sub>2</sub> as high as 20 per cent and with the O<sub>2</sub> reduced to as low as 0.1 per cent. These results indicate that the loss of plants under ice probably is due to causes other than "ice smothering."

Related studies have shown that dormant strawberry plants are not seriously injured by exposure for a week to concentrations of CO<sub>2</sub> varying from 2.7 to 7.3 per cent and similar results were obtained at concentrations up to 7.4 per cent for exposures varying from 2 to 10 days. It was found also that with various soil types saturated and frozen in blocks with CO<sub>2</sub> confined within a wire cylinder, the decline in the concentrations of CO<sub>2</sub> determined at weekly intervals closely paralleled the rate of decline calculated on the basis of the volume of the gas samples withdrawn for analysis. These results lead to the conclusion that there is not likely to be gaseous diffusion through soils that are frozen while saturated. The experiment mentioned above, in which concentrations of CO<sub>2</sub> as high as 20 per cent and of O<sub>2</sub> as low as 2 per cent were found beneath an ice seal, also shows that a uniform layer of ice is not permeable to these gasses. In the field, however, where ice is likely to be granular or cracked, or to contain straw or other plant debris, it seems likely that there would be opportunities for gaseous diffusion.

1767. Strawberry and raspberry varieties for freezing storage. J. D. Winter. *Proceedings of the American Society for Horticultural Science* 37:579-82. 1939.

Ratings of 19 varieties of strawberries and 10 varieties of red raspberries for freezing storage are given on the basis of their value for dessert use after 6 to 10 months storage at approximately -10° F. Named varieties found to be most satisfactory for the purpose were Beaver, Culver, Dorsett, Gem, and Wayzata strawberries and Chief, Latham, and Viking raspberries. To a large extent difference in qualities of the fresh berries as grown under local climatic conditions were reflected in the different ratings of the frozen berries. Fruit of the 1936, 1937, and 1938 crops was used in these experiments.

1768. Growth substances in rooting certain *Prunus* species. L. E. Longley. *Proceedings of the American Society for Horticultural Science* 37:1091-92. 1939.

Cuttings of several *Prunus* species were treated with Auxilin and Rootone to increase rooting. *P. tomentosa* gave little response, and *P. nana* none at all. *P. triloba* showed increase in rooting where Auxilin, a liquid form of growth substance, was used, but none where Rootone, a powder form, was used. *P. japonica* showed greatly increased rooting when treated with Rootone, and Auxilin relatively increased rooting, although there was evidence of considerable injury to the younger wood when Auxilin was used.

1769. Variation in blooming date of chrysanthemums in garden, frame and greenhouse. L. E. Longley. *Proceedings of the American Society for Horticultural Science* 37:1001-2. 1939.

Chrysanthemums of the early blooming garden type were grown under the following conditions: (1) In beds in an ordinary flower garden; (2) in a cold frame, with glass removed except as frost threatened in late fall; and (3) in pots in the greenhouse.

Considerable variation was found in the dates, those in the garden blooming 5-61 days earlier than those in the frame, the average being 24.3 days; those in the garden bloomed 5-94 days earlier than those in the greenhouse, the average being 67.6 days; those in the frame mostly bloomed earlier than those in the greenhouse, the average being 31.5 days. However, in three cases the greenhouse bloom occurred first, and in two cases there was no difference.

1770. Use of carbon dioxide to retard the development of decay in strawberries and raspberries. J. D. Winter, R. H. Landon, and W. H. Alderman. *Proceedings of the American Society for Horticultural Science* 37:583-88. 1939.

Approximately 11,800 crates of red raspberries and strawberries were exposed to varying concentrations of CO<sub>2</sub> during the harvest seasons of 1936-39. It was found possible to extend the time these fruits could be held in good market condition by prompt cooling to 55° to 60° F. in an atmosphere containing an initial concentration of 30 per cent CO<sub>2</sub> at a relative humidity of 80 to 90 per cent. The concentration of CO<sub>2</sub> was reduced by leakage to about 20 per cent after 6 to 10 hours and to about 15 per cent after 16 to 20 hours. No advantage was found in using a constantly maintained concentration of the gas. Initial concentrations of 45 per cent or more CO<sub>2</sub>, and maintained concentrations of 25 per cent or more, produced loss of flavor in these fruits after varying periods of exposure.

1773. A comparison of tomato varieties for Vitamin C content. T. M. Currence. *Proceedings of the American Society for Horticultural Science* 37:901-904. 1939.

A number of tomato varieties were compared for ascorbic acid content. Although the means ranged from 0.157 milligrams per gram of fruit for an unnamed selection to 0.224 for the Bonny Best variety, the F value was below the 5 per cent point in three different tests, suggesting no definite differences between varieties. However, in a greenhouse test using 20 replicates varietal differences were demonstrated. The highest mean was 0.144 for selection 16-37, and Bison was the lowest variety with a mean of 0.098. A significant interaction between varieties and growing conditions was shown by comparing field results of five varieties with the same varieties grown as a greenhouse crop. The strain which was highest in the greenhouse with a mean of 0.144 was next to lowest of the five varieties when grown in the field with a mean of 0.181. The mean for the five varieties in the greenhouse was 0.116, being definitely lower than the outdoor mean for the same varieties which was 0.201. Weekly periods of harvest showed significant differences between weeks when weekly means were made up by combining all the data from the different varieties that were tested in the greenhouse. The highest mean of 0.138 was for the week of December 1-7, whereas the lowest of 0.090 was for the week of January 12-18. No relation between the weekly means and the percentage of sunshine could be noted.

## Plant Pathology and Botany

1653. A quantitative study of the production of ethylene by ripening McIntosh apples. R. C. Nelson. *Plant Physiology* 15:149-51. 1939.

Graphs of the production, consumption, and evolution of ethylene by apple varieties show that ethylene production by apples determines the time required to reach the climacteric stage of most rapid respiration, and hence the length of the storage life of apples. Those varieties that evolve ethylene rapidly after picking have short storage life; those that evolve it slowly have long storage life.

1672. Studies on dry-rot canker of sugar beets. E. L. LeClerg. *Phytopathology* 29:793-800. 1939.

In 1936 and 1938 dry-rot canker of sugar beets caused by *Rhizoctonia solani* was found in a number of fields in Minnesota. A comparative study was made with isolates obtained from dry-rot canker, those causing crown rot of sugar beets and those that attack potatoes. The outstanding feature of the dry-rot canker isolates is that the optimum temperature is unusually high. The organism causes greatest decay on sugar beet roots at 30-35°C. and is favored by relatively low soil moisture. The dry-rot canker and crown rot isolates, as groups, are about equally virulent in causing reduction in stand of corn seedlings and are more virulent than those of the potato group. Greater reduction in stands of peas, sugar beets, and cabbage is caused by crown-rot isolates, as a group, than by the dry-rot canker and potato groups. The crown-rot isolates, as a group, are more virulent on beans than was the dry-rot canker group. The isolates from dry-rot canker are sufficiently different from those causing crown rot as to justify their designation as a different species. It seems inadvisable to do this, however, until the perfect stage of the pathogen is found. (Cooperative investigations with the Division of Sugar Plants, Bureau of Plant Industry, United States Department of Agriculture.)

1673. Relative efficiency of quasi-factorial and randomized-block designs of experiments concerned with damping-off of sugar beets. E. L. LeClerg. *Phytopathology* 29:637-41. 1939.

The quasi-factorial design of plot arrangements was more efficient than a randomized-block test in some seasons for damping-off tests with sugar beets, with 36 treatments, in the field. With 25 or fewer treatments, the quasi-factorial design was less efficient in most comparisons, although it was more efficient in a few.

In greenhouse experiments, made on two types of plant beds, marked losses in efficiency resulted with quasi-factorial design as compared with a randomized-block arrangement. (Cooperative investigations with the Division of Sugar Plants, Bureau of Plant Industry, United States Department of Agriculture.)

1674. Methods of determination of physiologic races of *Rhizoctonia solani* on the basis of parasitism on several crop plants. E. L. LeClerg. *Phytopathology* 29:609-16. 1939.

A comparison was made of two methods for determining physiologic races of *Rhizoctonia solani* to a number of crop plants. Two methods of inoculation were

used: (1) the pathogen was mixed with the soil and the amount of damping-off of the seedling was determined and (2) underground stems of older plants with the pathogen.

The results for individual isolates from the damping-off data in successive tests were more variable than were those from direct inoculations. The latter method appears most promising, if a large number of plants are inoculated with each isolate to be tested and if environmental conditions can be accurately controlled. (Cooperative investigations with the Division of Sugar Plants, Bureau of Plant Industry, United States Department of Agriculture.)

1712. Toluene compounds to control plant disease. Helen Hart and J. Lewis Allison. *Phytopathology* 29:978-81. 1939.

Stem rust infection in Marquis, Ceres, and Mindum wheat varieties, caused by *Puccinia graminis tritici* race 56, was reduced by application of chemicals to the soil surface: para-toluenesulfonylamide, 1 g. to 1 sq. m.; and ortho-toluenesulfonylamide, 0.8 g. to 1 sq. m. The reduction was in percentage of plants infected and also in reaction type, and was somewhat more pronounced on sandy soils than on loam in these greenhouse experiments. Tips of the basal leaves were burned slightly, but the plants recovered. Applications of picric acid reduced rust infection only slightly and sodium borate resulted in so much leaf burning that the treatment was more severe than the rust infection. Although costs and practicability of treatment for field crops are still prohibitive, the authors recommend experiments with greenhouse crops, especially with ornamentals or other plants that have high individual values.

1726. The origin of parasitic races of phytopathogenic fungi through mutation. J. J. Christensen. *American Association for the Advancement of Science* 12:77-82. 1940.

In studying genetics of microorganisms it is important to distinguish clearly between phenotypic modification and true genetic changes. Environmental factors may cause great fluctuation in character, which disappears when the stimulus is removed. Mutation has been reported in all classes of fungi and is extremely common in many pathogenic fungi. For instance, a haploid line of smut may give rise to an enormous number of mutants. There are marked differences in mutability, not only among different groups of fungi but also among species belonging to the same genus. Moreover, biotypes within a species may differ greatly in their tendency to mutate. The frequency of mutation can be altered profoundly by such environmental factors as temperature, light, nutrients, hydrogen-ion concentration, and addition of chemicals and toxic material to the substrate. Mutants may arise either on artificial culture or on living hosts. They may differ from their parents in cultural character, in physiologic character, in tendency to mutate, in morphology, and in pathogenicity. Although most mutants are less virulent than their parents, occasionally one is more pathogenic. Apparently new races of fungi may arise by mutation. In heterothallic species the mutant may hybridize with other biotypes and thus produce other sorts.

1727. The need for research on the genetics of pathogenic organisms. E. C. Stakman. *The American Association for the Advancement of Science* 12:83-90. 1940.

This is a general summary paper pointing out the need for research on the genetics of pathogenic organisms. Specific examples are given to show the need for distinguishing between phenotypic variability and genetic variation. It is pointed out that what appears to be genetic variation sometimes is probably due to the natural selection of biotypes out of a mixed population. The importance of knowing the genetics of pathogenic organisms in connection with vaccine and serum therapy, the development and maintenance of resistant varieties and plants, quarantine procedures, and an understanding of epidemiology is discussed.

1751. Studies on the biology of *Valsa sordida* and *Cytospora chrysosperma*. C. M. Christensen. *Phytopathology* 30:459-75. 1940.

A study was made of *Cytospora chrysosperma*, supposedly restricted to poplars, and *Valsa sordida*, which is a common bark inhabitant of several kinds of trees. Comparative studies of these two species show that isolates from each differed somewhat among themselves, but there were no consistent differences between the two groups. It is concluded, therefore, that there is no valid reason for considering them as being distinct from each other, especially since collections of *Cytospora* from hosts other than *Populus* could not be distinguished from collections of *C. chrysosperma* obtained from species of *Populus*. The fungus is a common inhabitant of the bark of apparently healthy *Populus* trees, especially *P. tremuloides* and *P. alba*, and probably also of willow and mountain ash, but the degree of its parasitism has not been determined. It is suggested that the control of *Cytospora* canker on ornamental poplars may be attained by the development of varieties more suited to environmental conditions than those that are now commonly grown.

1752. Observations on two ambrosia beetles and their associated fungi. J. G. Leach, A. C. Hodson, St. John P. Chilton, and C. M. Christensen. *Phytopathology* 30:227-36. 1940.

The habits of two ambrosia beetles, *Trypodendron retusum* Lec. and *T. betulae* Sw., the former inhabiting dying trees of *Populus tremuloides* and the latter inhabiting dying trees of *Betula papyrifera*, and the ambrosia fungi associated with them were studied. The two fungi were grown in pure culture, where they sporulated, and they are considered to be closely related strains of one species in the genus *Monilia* as described by Persoon, although not identical with *Monilia candida* Hartig. Observations indicated that the beetles studied derived most, if not all, of their nourishment from the fungi they cultivated. So long as the beetles were present in galleries a relatively pure culture of the fungus was maintained on the walls of the tunnel, but as soon as the beetles left the ambrosia fungi were overgrown with molds. The water content of the wood of healthy trees averaged 65.7 per cent; of infested parts of dying trees, 70 to 80 per cent; and of the upper noninfested portion of dying trees, 60 to 70 per cent.

Spores of the ambrosia fungi ingested by larvae did not survive metamorphosis within the pupae. The authors believed that the fungus overwintered on spores in the intestinal tract of adult beetles.

1771. Observations on stem rust epidemiology in Mexico. E. C. Stakman, W. L. Popham, and R. C. Cassell. *American Journal of Botany* 27:90-99. 1940.

The uredial stage of wheat stem rust, *Puccinia graminis tritici* Eriks. and Henn., can persist throughout the year in southern Mexico because there is an overlap of crop seasons. Most of the wheat is grown during the winter, but a small amount is grown during the summer also. Early-sown fields of summer wheat may become infected from late-maturing fields of winter wheat in spring or early summer and early-sown fields of winter wheat may become infected from late-maturing fields of summer wheat. During the past decade there appears to have been relatively little seasonal interchange of rust between southern Mexico on one hand and northeastern Mexico and United States on the other, because races 49 and 56 of *P. graminis tritici* have not been found in southern Mexico despite their abundance in United States and northeastern Mexico. There is no implication, however, that there never is interchange of inoculum.

On the other hand, interchange of rust between northeastern Mexico and United States, at least in some seasons, is indicated by studies of air movements, results of spore trapping, chronological development of rust, and tendency toward similar variations in prevalence of certain physiologic races. There are indications also that the uredial stage may sometimes persist throughout the year in certain high mountain valleys of northern Mexico. The occasional occurrence of unusual races of *P. graminis tritici* in Mexico suggests that sometimes the aecial stage may possibly develop there on native species of *Berberis* or *Mahonia*. (Cooperative investigations with the Division of Cereal Crop and Diseases, Bureau of Plant Industry, United States Department of Agriculture and the Division of Plant Disease Control, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.)

#### Agricultural Biochemistry

1681. Comparison of a chemical and a biochemical method of determining the biological value of proteins and an evaluation of the endogenous nitrogen. F. C. Olson and L. S. Palmer. *Journal of Agricultural Research* 60(5):331-42. 1940.

Nitrogen-balance studies were made with young rats, 10 food proteins being used. The values obtained (rounded) were: Whole egg 94, casein 63, whole wheat 47, wheat gluten 42, whole corn 52, corn-gluten meal 42, liver meal 56, meat and bone tankage 38, solvent-extracted soybean meal 61, and heated solvent-extracted soybean meal 68. The same foods were used for the determination of the protein quality index by the Almquist chemical method. The digestibility of the proteins was calculated from data obtained by the nitrogen-retention method. An attempt was made to compare these values with the digestibility determined by means of enzymes. The digestibility in vitro showed a poor comparison with the digestibility in vivo. The protein quality index showed no comparison with the biological value by the nitrogen-retention method when used on isolated proteins. For natural foods the comparison is fair if the enzymic digestibility most similar to that in vivo is used for the calculation of the protein quality index. Heated soybean meal was found to have a higher biological value than raw, but no difference was found in the digestibility of the raw and heated meals.

Correction of the endogenous urinary nitrogen according to body surface was found to give less variation than correction according to body weight. When the body surface correction was made, no difference was shown in endogenous urinary nitrogen between the first and second nitrogen-free periods. The regression lines were plotted for the endogenous urinary nitrogen when calculated according to body weight and body surface area. The formula for the regression line for the body weight graph is  $N = 135.6W^{-0.499}$ , and for the body surface graph,  $N = 5.61A^{0.009}$ .

1685. Study of physical and chemical properties of the adsorption "membrane" around the fat globules in cream. I. The effect of the adsorption "membrane" of synthetic cream on curd tension of cow's milk. N. P. Tarassuk and L. S. Palmer. *Journal of Dairy Science* 22(7): 543-58. 1939.

Synthetic creams were made by emulsifying butter fat in aqueous sols of dried whey, skim milk powder, calcium caseinate, gelatin, and tissue fibrinogen (a lecithoprotein). "Remade" whole milks were made by dilution with raw skim milk, from which "remade" skim milk and "remade" cream were made by centrifugal separation. The "remade" buttermilks obtained by churning the "remade" creams consisted of normal milk plasma and the fat globule adsorption "membranes" from the synthetic creams.

The buttermilks, containing the "membranes" from whey powder, gelatin, and calcium caseinate either failed to coagulate with rennet or produced very soft fragile curds. Essentially normal clots were obtained if both rennet and  $CaCl_2$  were added, but it was found that the restoration of normal coagulation was not due merely to addition of  $Ca^{++}$  to the system. Buttermilks containing adsorption "membranes" from skim milk powder and tissue fibrinogen gave normal or nearly normal clots with rennet. The failure of a "remade" buttermilk to clot normally with rennet was always accompanied by decrease in pH and in surface tension. Indications were obtained that this was an effect of certain free fat acids liberated from the butter fat in the preparation of the product with which the experiments were concerned.

1692. Electrokinetics. XXII. Electrokinetic potentials of barium sulfate in solutions of electrolytes and in fifty per cent ethanol. R. G. Ruyssen. *Journal of Physical Chemistry* 44:265-74. 1940.

The streaming potentials on precipitated and negatively charged barium sulfate show a charge reversal by barium chloride solution; the  $\zeta$ -potential-concentration curve is a typical one for the adsorption of a potential-determining ion. The adsorbed barium ions are liberated and desorption of barium ions takes place in a strong potassium chloride solution (M/10). The positive potential curve displayed a great charge increase in 50 per cent ethanolic solutions of barium chloride and barium nitrate. The charge reversal of the negative barium sulfate was also observed for potassium bromate and potassium chloride in 50 per cent ethanol.

1700. Studies of the usefulness of a motor-driven sheeter in test baking. P. P. Merritt, M. C. Markley, and Ernst Rothholz. *Cereal Chemistry* 17:384-87. 1940.

A flour of medium strength was used to determine optimum settings for the rolls for each pass of the dough, and settings of 9/32" for first pass and 3/16" for second pass were selected.

For inter-operator variability studies three flours of widely varying characteristics were used and three operators, one of whom had had slight training in experimental baking, the other two of whom were experienced bakers who had had very similar training.

The motor-driven sheeter was found to reduce the variability in replicate bakes by individual operators but did not account for all of the variability encountered. The sheeter was very useful as a time and labor saver.

In the opinion of the authors the motor-driven dough sheeter, fitted for at least two settings of the rolls, is an important piece of baking equipment and should be specified as official.

1703. Measuring fermentation rate and gas losses in dough. C. H. Bailey. *Cereal Chemistry* 16:665-71. 1939.

A simple and relatively inexpensive device is described for measuring in a thermostat the rate of production of gas in, and loss of  $CO_2$  from fermenting doughs. It provides a copper vessel in which the perforated beaker containing the dough is placed, which vessel is connected to a graduated gasometer that is manually operated and recorded. Sixteen or more such tests can be conducted by one technician, and the tests can be adapted to the study of various factors such as wheat and flour types, diastatic activity, and the effect of various bread improvers.

1720. Starch as a factor in dough formation. O. E. Stamberg. *Cereal Chemistry* 16:769-80. 1939.

The surface area per gram of wheat starch based on the average of 17 flours was calculated as 2,004 cm. The flours showed a variation of surface area of from 88.8 per cent to 116.7 per cent of the average surface area. In terms of numbers the small starch granules, below 7 microns in diameter, represent 81.6 per cent, but in terms of weight or total surface area the large granules, above 14.8 microns in diameter, are by far the most important and represent 93.0 per cent by weight and 76.4 per cent of the total surface area. The surface areas per gram of commercially prepared potato, wheat, corn, and rice starches were found to be 853, 1,907, 3,077, and 8,000 cm.<sup>2</sup>, respectively, or in approximate ratios of 1, 2, 3, and 8, respectively. Upon dilution of a flour with the various sizes of starch granules, the absorption necessary to produce doughs of a minimum mobility of 500 farinograph units at various protein levels was determined. It was concluded that for dough formation in the farinograph mixer the protein content of a flour must be over 7.5 per cent (15 per cent moisture), or on a dry basis the ratio of flour protein to starch must be greater than 0.1. It was calculated that the variation in starch surface area, as far as the 17 flours studied disclosed, can effect a variation in the absorption of as high as 2 per cent, but with the majority of the flours this would be 1 per cent or less. Injured starch granules were observed to in-

crease the absorption appreciably and may be of most importance. Some estimations of the thickness of protein films in doughs were made on the basis of the thickness of monomolecular protein films.

1719. Standardization of the scoring of test cakes. O. E. Stamborg. *Cereal Chemistry* 16:764-68. 1939.

Methods were proposed for the standardization of the scoring of volume, grain, and shape of the cakes made by the tentative A.A.C.C. test formula. A series of grain and shape pictures were prepared to be used as guides in scoring these properties, and a general discussion on cake scoring was included.

1724. Electrokinetics. XXIII. Electrokinetics as a tool for the study of the molecular structure of organic compounds. R. A. Gortner. *Transactions of the Faraday Society* 36:63-68. 1940.

The electrical forces in the double layer between homologous series of aliphatic alcohols, aliphatic acids, and aliphatic esters in contact with cellulose and  $Al_2O_3$ , as measured by the streaming potential method, are tabulated and discussed. It is pointed out that these values in some instances show greater physico-chemical differences between members of a homologous series than do any other physical or chemical value which has been reported, and that accordingly electrokinetic data offer an important and independent method for studying differences in molecular structure.

1730. The influence of dry milk solids as a bread ingredient upon bread consumption. C. H. Bailey. *Northwestern Miller and American Baker* 16(12):55. December 6, 1939.

Dry milk solids, not over  $1\frac{1}{2}$  per cent of fat, added to the bread formula resulted in an increase of  $3\frac{1}{3}$  per cent and 5 per cent, respectively, in the consumption of bread in two institutions feeding healthy boys and young men, when the population were not aware of the manipulations of the bread formula.

In a college cafeteria, 50 per cent more patrons selected the bread containing fat-free milk solids than bread made without any milk, when the plates of bread were plainly labeled.

1740. The density of dry milk solids. O. E. Stamborg and C. H. Bailey. *Food Research* 5:275-81. 1940.

Particles of dry milk solids made by the spray process vary in apparent density due to occluded air cells, but practically no air cells were observed in particles from roller products. A method was developed for the determination of the density index, which is a relative value for the distribution of particles of higher and lower apparent density than 1.250 by using a naphtha-carbon tetrachloride mixture. The density index approximates the percentage by weight of particles of higher density than 1.250. Numerous commercially made spray powders were found to vary widely in the density index.

1748. Studies on wheat starch. IV. Fractionation and amylase hydrolysis. O. E. Stamborg. *Cereal Chemistry* 17:372-78. 1940.

The amylopectin content of wheat starch and wheat erythrogranulose was determined by the electrodecantation method. The phosphorus content of the starch and the various starch fractions were determined as well as the susceptibility to alpha- and beta-amylase hydrolysis. The results indicated that beta-amylase action is not blocked, although perhaps retarded, by the phosphorus of the starch, and that the blocking of beta-amylase action on a certain portion of the starch is apparently due to the structure of the carbohydrate in the residual erythrogranulose of the starch.

1749. Plasticity of doughs. O. E. Stamborg and C. H. Bailey. *Cereal Chemistry* 17:34-44. 1940.

A plastometer of the extrusion type was designed and constructed for use in the study of the plasticity of bread doughs. The apparatus was so constructed that doughs maintained at a constant temperature were extruded through a 6-mm. aperture from a cylinder by means of air pressure equivalent to 500-mm. of mercury. Rate of flow per minute was used as an index of the relative plasticity of the doughs. The effect of various pressures and temperatures on the rate of flow was studied, and it was found that small temperature variations may affect the rate of flow to a greater extent than any probable variations in pressure, thus emphasizing the necessity of precise temperature control in making such measurements. The logarithm of the rate of flow was a linear function of the proportion of water to flour used in mixing the dough. The apparatus may be useful in studying relative absorptions of flours and other dough ingredients.

1750. Protein films and the susceptibility of raw starch to diastatic attack. R. A. Gortner and Carl Hamalainen. *Cereal Chemistry* 17:378-83. 1940.

Experiments are tabulated which show that when starch has been in contact with dilute sols of gelatin, gliadin, and egg albumin, and subsequently treated with diastatic enzymes, there is a decrease in sugar produced which may amount to as much as 70 per cent. The data are discussed in the light of known protein behavior in forming protein films on inert surfaces, and it is suggested that the varying susceptibility of starch to diastatic attack is, in all probability, due to the presence of more or less incomplete protein films surrounding the starch granules which prevent the enzyme coming in direct contact with the starch surface.

1753. The metaphosphoric acid-protein reaction. D. R. Briggs. *Journal of Biological Chemistry* 134(1):261. 1940.

The  $PO_4$  content of the protein-metaphosphate complex depends on the  $PO_4$  concentration of the equilibrium liquid in a manner described by the adsorption isotherm. A salt-like, low-ionizing combination between the polyvalent metaphosphate ion and the basic groups of the protein is, however, clearly involved.

Formation of this complex leads to a masking of the  $-NH_2$  groups of the protein and a shift in the dissociation constant of the  $-COOH$  groups to a pH region in which they may be readily titrated. At relatively low  $PO_4$  content of



the complex, this new buffer segment reaches a maximum value which closely approximates the acid binding capacity of the protein. Further increase in the  $PO_4$  content of the complex has no more effect on the titration curve.

The complex shows many of the characteristics of a complex coacervate. No similar reaction occurs between metaphosphate ion and amino acids or other low molecular weight substances containing single basic groups.

1815. White flour and vitamins. C. H. Bailey. *Modern Miller*. 3 pages. May 11, 1940. *Northwestern Miller* 202(5):23-25. May 15, 1940.

About 70 per cent of the thiamin or Vitamin  $B_1$  is in the pericarp and associated tissues of the wheat grain, about one seventh in the endosperm, and one sixth in the germ or embryo. Low income dietaries of Americans are apt to be low in this vitamin. Vitamin preparations or concentrates, including crystalline synthetic thiamin, wheat germ or germ preparations, and high vitamin yeasts can be used to supplement or restore the Vitamin  $B_1$  content of bread made from patent flour. New milling practices may result in the production of natural flour containing in the range of the equivalent of the thiamin content of entire wheat.

#### Soils

1708. Reliability of the proposed suction method of determining the moisture equivalent of soils. R. M. Pinckney and F. J. Alway. *Soil Science* 48(5):403-11. 1939.

Using 113 Minnesota soils of a wide range of moisture equivalent, nitrogen content, and pH value, the authors compared the Bouyoucos suction with the Briggs-McLane centrifugal method.

Though the relationships found are in general agreement with those reported by Bouyoucos, they do not fully support his conclusions as to the reliability and general desirability of the method. With loams and soils of still finer texture, the suction value averaged about one tenth higher than the moisture equivalent, whereas with the individual soils it varied from practically equal to one third higher. With the sands of coarsest texture it was twice as high, or still higher, but widely variable. Duplicate determinations by the suction method were found much less concordant than those with the centrifuge. Only where a moisture equivalent centrifuge is not available does the use of the suction method appear desirable, and the values so obtained should be referred to by some other designation than moisture equivalent.

#### Home Economics

1697. Evaluation of oxalate solutions for the determination of packed cell volume in human blood. Jane M. Leichsenring, Eva G. Donelson, and Lucille M. Wall. *Journal of Laboratory and Clinical Medicine* 25:3-12. 1939.

The use of heparin as control was affirmed by comparing results secured with heparin with those obtained with no anticoagulant. Analysis of variance demonstrated a highly significant difference among the means of packed cell

volume values secured with the several oxalate solutions and among the means of the individuals' packed cell volume values. Preliminary oven-drying of the salt was shown to be essential in preparing oxalate solutions. The 1.6 per cent potassium oxalate, prepared from the dried salt, was most nearly isotonic. Neither age nor basal or non-basal condition of the subject influenced tonicity of the blood.

1725. The diameter of red blood cells in healthy young women. Eva G. Donelson, Jane M. Leichsenring, and Lucille M. Wall. *American Journal of Physiology* 128:382-89. 1940.

Red cell diameter measurements were made using a wet film and the ocular micrometer on 250 blood samples taken from 80 healthy college women. The mean diameter was 7.35 microns; the range of means from 6.53 to 7.76 microns. The mean difference between the smallest and largest cells in each of these blood samples was 3.56 microns. A frequency distribution, based on the measurement of 20,000 cells, showed a maximum spread of 3.96 to 10.80 microns, with a mean and standard deviation of 7.31 and 0.62 micron, respectively. The dispersion in the red cell population was of essentially the same magnitude for blood samples with high and low mean diameters. Observations spaced a year apart on 28 individuals showed a mean increment of 0.20 micron, distributed equally between the summer and winter semesters. Twenty-seven observations on a middle aged subject over a 32-day period yielded a range of 6.91 to 7.25 microns, and a mean diameter of 7.06 microns.

#### Animal and Poultry Husbandry

1757. The chemistry and cytology of the sperm membrane of sheep. W. W. Green. *The Anatomical Record* 76:4 and Suppl. 3:455-73. 1940.

The purpose of this work was to find, if possible, a cytological measure of physiological activities of sheep spermatozoa. Chemical and cytological studies were made of the permanent limiting membrane of the sperm. This, as best seen under dark field illumination, was rather inert towards many routine laboratory stains. It was visibly insoluble in the common protein solvents and was not changed into a water soluble substance when treated with boiling water. The membrane was resistant to hydrolysis by hydrochloric acid, pepsin, and trypsin. It was classed as an albuminoid. A Van Slyke analysis of its protein revealed a high basic amino acid ratio. Cystine, histidine, and arginine were present in relatively high amounts, while lysine was absent. Aceto-carmin stain and dark field illumination made visible a small, hyaline vesicle at the anterior end of the sheep sperm. The presence of the vesicle varied in percentage from sample to sample and decreased when sperm were stored at 4° or 37° C. Frequent ejaculations also reduced the number of vesicles present. Pathology of the tail did not affect the number of sperm possessing the vesicle, but no sperm with an abnormal head exhibited the structure. A correlation of 0.7 was found between the presence of the vesicle and the glycolytic power of the sperm. The application of the aceto-carmin technic as a test for the quality of sperm is discussed.

1760. Methods of semen evaluation. I. Density, respiration, glycolysis of semen. R. E. Comstock and W. W. Green. *Proceedings of the American Society of Animal Production* pp. 213-16. 1939.

Two characteristics of semen important to its proper evaluation are sperm density and viability.

Estimation of sperm density by comparison with opacity standards or by photo-electric determination of light transmission is more rapid than by the usual cell counting method. The first two methods are described, and the error involved in each compared to that of cell counts.

The rates of respiration and glycolysis of sperm have been found to be correlated with viability making them useful measurements for semen evaluation (Walton, 1938; Comstock, 1939). The relations between respiration, glycolysis, density, and viability are discussed in the light of both published and more recent unpublished data. Applications to problems of fertility and artificial insemination are discussed.

1761. Methods for semen evaluation. II. Sperm cytology in relation to viability. W. W. Green and R. E. Comstock. *Proceedings of the American Society of Animal Production* pp. 217-19. 1939.

Microscopic studies of sperm using aceto-carmin stain with dark-field illumination have brought to light a hitherto undescribed structure, present in some sperm cells. It can be described as a vesicular structure at the tip of the sperm and as a structure of the membrane surrounding the cell. Pictures will be shown demonstrating it. Our data indicate a relation between the presence of this structure and sperm viability. It is discussed in relation to age of sperm, male differences, passage through the female reproductive tract, glycolysis, and cell abnormalities. Its place in the cytological evaluation of semen is discussed.

1796. Failure of dietary magnesium imbalance to produce urinary calculi in wethers. D. W. Johnson, L. S. Palmer, and J. W. Nelson. *Veterinary Medicine* 35(6):353. 1940.

In a farm flock of 2600 wether lambs, approximately 10 per cent were lost from urinary calculi over a period of approximately six weeks. Analyses of stones from a lamb which had the disease and of the ration fed the lambs suggested that the high magnesium content of the ration was the cause of the trouble.

Twenty lambs were purchased from the flock and used in a study of the effect of a ration high in magnesium on the production of calculi. One half of the lambs received a ration the dry matter of which contained 1.5 per cent of magnesium. The remaining lambs received the same ration plus sufficient limestone to give a calcium content of 5.1 per cent. The rations were fed for 154 days. Urine specimens for pH determinations and observations as to crystal formation and blood samples for calcium, magnesium, and inorganic phosphorus analyses were obtained before the start of the experiment and at intervals thereafter.

There was a threefold increase in the blood magnesium of both groups of sheep as the result of feeding the experimental rations. In spite of this increase, which apparently was responsible for crystal formation in the urine of a few of the lambs, calculi were not produced.

#### Dairy Husbandry

1721. Comparative physiological responses of dairy calves fed rations having different levels of milk proteins. G. H. Wise, W. E. Petersen, and T. W. Gullickson. *Journal of Dairy Science* 23:91-102. 1940.

The responses of two major groups of milk-fed calves, one receiving a ration of normal nutritive ratio and the other of narrow nutritive ratio, were compared. All calves regardless of supplements possessed a depraved and erratic appetite. The consumption of abnormally large amounts of casein by calves did not adversely affect growth or general appearance, but induced lethargy and occasionally digestive disturbances. The most pronounced difference observed in the blood constituents of the two groups was in the plasma nitrogen, which was high in the calves receiving the protein-supplemented ration and comparatively low in the sugar-supplemented. The results do not substantiate the postulate that milk proteins constitute the principal etiological factor in the disturbance of the mineral metabolism of milk-fed calves.

1738. The density at 140° F. of the materials expressed as fat by various volumetric tests of cream. P. G. Miller, S. T. Coulter, and W. B. Combs. *Journal of Dairy Science* 23:285-88. 1940.

The density at 140° F. of filtered butterfat obtained from butter and of the materials expressed as fat in the various volumetric fat tests of cream was found to be less than 0.9. The error in the volumetric tests due to variation in the density at 140° F. of the materials read as fat was least with the Babcock test (about 0.55 per cent) followed in order by the N-butyl alcohol, the amyl alcohol, the Minnesota Nafis, and the Minnesota 202 test (about 1.8 per cent).

1743. High-temperature (steam-injection) pasteurization of cream for buttermaking. W. M. Roberts, S. T. Coulter, and W. B. Combs. *Journal of Dairy Science* 23:315-23. 1940.

Studies were made comparing the results secured using a high-temperature, steam-injection pasteurizer with those using the standard vat pasteurizer. Factors studied included efficiency in bacterial destruction, effect on fat losses in the buttermilk, and flavor and keeping qualities of the butter. A description of the equipment used is given. Essentially sterile cream as determined by the standard plate count was secured from either sweet or neutralized sour cream by pasteurization at 260° F., using a laboratory model high-temperature steam-injection pasteurizer. Essentially no difference was found either in the original scores or the scores after storage for three months at 40° F. of butter made from different lots of the same cream pasteurized at 260° F. flash and vat-pasteurized at 160° F. for 30 minutes. The fat lost in the buttermilk was much greater in churning cream flash-pasteurized at 260° F. in the high-temperature steam-injection pasteurizer.

1759. Blood volume changes in the mammary gland. J. C. Shaw and W. E. Petersen. *Proceedings of the Society for Experimental Biology and Medicine* 42:520-24. 1939.

Volume changes were calculated from hemoglobin values on arteriovenous blood samples taken simultaneously from the internal iliac artery and the subcutaneous abdominal vein. Excitation caused marked changes in the concentration of blood traversing the mammary gland of the cow ranging from a concentration of 14.49 per cent to a dilution of 9.65 per cent. Attempts to correct for blood fat losses to the mammary gland gave values that were untenable. Unpredictable amounts of fat passed in and out of the gland tissues with the fluid.

1762. Factors influencing the physical characteristics of chocolate milk. J. G. Brereton, W. B. Combs, and H. Macy. *Milk Dealer* 29(5): 38, 62, 64, 66, 68. 1940.

The factors responsible for certain physical characteristics of chocolate milk prepared from commercial cocoa powders and syrups were studied. The observations included the preparation of chocolate milks according to the recommendations of firms preparing the cocoa powders and syrups as compared with modifications of these recommendations. Sedimentation of chocolate milk was encouraged by slow cooling and by increasing the milk fat content. The fineness of cocoa had no effect upon the stability of chocolate milk. A method of detecting algal stabilizers was developed which consisted of staining the milk with a dilute aqueous solution of crystal violet.

#### Entomology and Economic Zoology

1635. Monograph of a new neotropical mutillid genus, *Pappognatha* (Hymenoptera: Mutillidae). C. E. Mickel. *The Annals of the Entomological Society of America* 32:329-43. 1939.

Proposes the new genus *Pappognatha* for 11 species of females and 2 species of males with *Mutilla pertyi* Dalle Torre as genotype. Five of the 11 species of females and one of the 2 species of males are described as new. The described species were formerly assigned to the genus *Hoplomutilla* Ashmead (= *Tillum* Andre). The geographical distribution of the genus ranges from Costa Rica to southern Brazil and Bolivia. Keys for the identification of the various species of females and males are included. Complete historical synonymy is given for each species.

1664. Comparative value of pollen and pollen substitutes. I. Bee bread and cottonseed meal-dry skim milk mixture. M. H. Haydak. *Journal of Economic Entomology* 32:663-65. 1939.

Having established by earlier work the fact that bees can utilize a mixture of cottonseed meal and dry skim milk as a pollen substitute, the author here presents a study of the value of such a mixture as compared with pollen as stored by bees. The food was prepared in such a manner as to make the ingestion of pollen and the food substance under investigation equal per volume intake. Three colonies were used for the testing of each food. One colony in each group did not start to rear brood at all. No adequate explanation has been found for this phenomenon. The rest of the colonies started brood-rearing and carried it to completion.

The results of the experiment indicated that there was practically no differ-

ence in the nutritive value of the bee bread and the cottonseed meal-dry skim milk mixture as judged by the development of bees, number and quality of the bees reared, and the mortality of the experimental bees.

1665. Rearing the caddice fly, *Limnephilus indivisus* Walker, and its hymenopterous parasite, *Hemiteles* sp. C. E. Mickel and H. E. Milliron. *Annals of the Entomological Society of America* 32:575-80. 1939.

Records the results of rearing experiments of a caddice fly larvae with a log cabin type of case that was identified from reared adults as *Limnephilus indivisus* Walker. Most of the adult specimens reared were secured from caddice cases placed in shallow tins and kept moist by capillary action of a small amount of water in the tins. This type of rearing was more successful than that in which the cases were submerged in water. It was also found that live caddice worms in their cases could be transported long distances packed in moist sphagnum moss, and that they could not be transported any great distance submerged in water in glass jar containers. Other aquatic insect larvae with tracheal gills were also successfully transported packed in moist sphagnum moss. A hymenopterous parasite, *Hemiteles biannulatus* Grav., was discovered and reared from this caddice fly during the course of the experiments. *H. biannulatus* had been recorded as a parasite of certain caddice flies in Europe but has not been so reported previously from North America.

1677. Indigenous malaria and its vectors in Minnesota. W. A. Riley. *Journal-Lancet* 59(7):311-12. 1939.

Indigenous cases of malaria occur very rarely in Minnesota, although there are four species of anopheline mosquitoes, *Anopheles maculipennis*, *A. quadrimaculatus*, *A. walkeri*, and *A. punctipennis*, each capable of incubating and transmitting the malarial parasite. Most of the clinical cases occur in the southeastern part of the state, where *A. punctipennis* is more commonly found. It is believed that the principal source of mosquito infection and hence of indigenous cases is the presence of malaria carriers among the million and a half summer tourists each season.

1679. The pest mosquito problem in the Minneapolis-St. Paul metropolitan area. W. A. Riley and William Chalgren. *Journal of Economic Entomology* 32:553-57. 1939.

Studies of the mosquito population in the Minneapolis-St. Paul area during the seasons of 1937 and 1938 showed that over 98 per cent of the annoyance was due to the migratory species *Aedes vexans*, which breeds chiefly in temporary pools in low-lying areas. The "rain barrel mosquito", *Culex pipiens*, was present in the catch only to the extent of 0.024 per cent. Four species of potential malaria carriers, *Anopheles maculipennis*, *A. walkeri*, *A. quadrimaculatus*, and *A. punctipennis*, were present in very small numbers.

The dominance of *Aedes vexans* in 1937 was attributable to the excess precipitation for the critical month of May, when it amounted to 5.42 inches, an amount for the month exceeded only once in the preceding 15 years. The record of 6.97 inches for May 1938 had been exceeded only five times before in the hundred years

that records had been kept. It was approximately twice the normal for the month.

Problems of control of the pest mosquitoes in this area are complicated by the migratory habits of the species, the extensive areas of low-lying ground which in the presence of temporary pools serves as breeding grounds, the fact that there are large areas set aside as game preserves, and particularly by the fact that the lowered lake levels and the water table would be seriously affected by extensive drainage operations.

1691. The possibility of intestinal myiasis in man. W. A. Riley. *Journal of Economic Entomology* 32:875-76. 1939.

A criticism of a recently expressed opinion that since insects obtain their air supply through tracheae they could not survive in the animal body. Attention is called to the fact that the larvae of botflies, warble flies, and various other insects and mites normally infest the tissues and cavities of man and animals.

1696. Further studies of methyl bromide as an insect fumigant. H. H. Shepard and A. W. Buzicky. *Journal of Economic Entomology* 32:854-59. 1939.

The laboratory studies of methyl bromide as an insect fumigant, reported in 1938 by F. W. Fisk and H. H. Shepard, were continued a second year, the results being included herein. Twelve species of stored-product insects were used, including both adults and larvae in some cases. The black carpet beetle larva (*Attagenus piceus*) was the most resistant to methyl bromide of all the insects tested. New data for other fumigants are given for the sake of comparison. Observations on the speed of action of several typical fumigants are reported; methyl bromide is slower than some other gases, but there appears to be less recovery from its effects. Methyl bromide was found to have no visible effect upon the baking qualities of flour.

1698. Food and development of the worker and the queen honeybee. M. H. Haydak. *Gleanings in Bee Culture* 67:740-42, 776-77. 1939. 68:24-26. 1940.

During their early stages of development all larvae of honeybees receive a special food. According to the accepted theory, after worker larvae attain the age of 2½ days, their food is changed, pollen and honey being added to it. The author cannot find in the literature convincing evidence supporting this belief. Rather, there are indications that the food change occurs in both cases and that the difference in development is due only to the amount supplied to worker or queen larvae. The worker larvae are undernourished. Histological findings of various authors supported this statement. The ovaries of young animals kept in a state of partial inanition remain underdeveloped, which is also true in the case of worker larvae.

On the basis of his own experiments and the available literature, the author postulates that the anatomical and physiological differences between the worker and the queen honeybee are, to a great extent, due to the ovarian hormone or hormones, which in the case of the queen larvae are likely to be secreted in a sufficient quantity to cause those structural and physiological changes which characterize the queen. In the case of worker larvae, which have the ovaries in a

rudimentary state, this does not occur. What is the interaction of this hormone with the activity of other hormones which possibly play a part in the determination of the queen honeybee cannot be answered at the present time.

1701. The maintenance of *Echinococcus* in the United States. W. A. Riley. *Journal of the American Veterinary Medical Association* 95:170-73. 1939.

The studies on the diseases of our native moose, *Alces americanus*, conducted cooperatively by the Division of Veterinary Medicine and the Division of Entomology and Economic Zoology, have revealed a remarkable incidence of hydatid infection in the lungs of these animals from northeastern Minnesota. Cysts were found in 11 out of 21 of the moose autopsied. One infection in a white tailed deer, *Odocoileus virginianus*, was found. In two instances cysts from the moose were fed to dogs and the adult *Echinococcus granulosus* reared.

Since thousands of examinations of dogs for parasites in this country have revealed only a single authenticated case of infestation by the adult worm, search was made for other possible carriers. In the course of this work there have been examined, from Minnesota, 12 timber wolves, *Canis lupus lycaon*, 26 coyotes, *Canis latrans*, 25 gray foxes, *Urocyon cinereoargenteus*, and 25 red foxes, *Vulpes fulva*. Of the 12 timber wolves, 8 were from the area in which the infected moose were found and 5 of these harbored the adult worms. The other animals examined were negative.

It is highly probable that wolves are the principal source of infection in the southeastern sections of the United States where most of the reported cases of infection of domesticated animals have occurred, though the possibility of dogs and of foxes playing a more important role than has been demonstrated should be kept in mind.

1702. The need for data relative to the occurrence of hydatids and of *Echinococcus granulosus* in wildlife. W. A. Riley. *Journal of Wildlife Management* 3:255-57. 1939.

In this country the dangerous hydatid disease caused by the larval form of the tapeworm, *Echinococcus granulosus*, occurs not infrequently in swine, cattle, and sheep, and rarely in man. In recent years it has been found to occur in Minnesota moose and in the white-tailed deer. In all probability, this larval form occurs in other wild animals.

In other countries where the infection is prevalent, the chief carrier of the adult worms is the dog, but although thousands of examinations of dogs have been made in the United States, there is only a single authenticated record of one harboring the adult *Echinococcus granulosus*. In sections of Minnesota timber wolves are proved carriers. Coyotes and foxes may play a role though no instances have been reported for the United States. Students of wildlife have opportunities to add greatly to knowledge regarding the distribution of the hydatid infection and its wildlife reservoirs. All carefully checked data should be put on record.

1707. A monograph of the neotropical mutillid genus *Hoplomutilla* Ashmead (Hymenoptera: Mutillidae). C. E. Mickel. *Revista de Entomologia* 10(fasc. 2):337-403. 10(fasc. 3):641-717. 1939.

A monographic treatment of the mutillid genus *Hoplomutilla* Ashmead. The geographic distribution of the genus extends from Nicaragua to southern Brazil, Paraguay, and northern Argentine Republic. Forty-one valid species were described prior to this study which treats of 87 species, two subspecies, and two varieties. The study is based on 772 specimens, and the data accompanying these specimens are all itemized and recorded for each species. There is an historical account of the taxonomy and nomenclature of the genus, a description of the diagnostic characters for the males and females, a discussion of the relationships with other genera, and a discussion of the taxonomic characters used for differentiating species within the genus. The 87 species, two subspecies, and two varieties are arranged in two groups, *spinosa* and *derosa*. The group, *spinosa*, is made up of eight subgroups, and *derosa* of four subgroups. The following information is given for each species: Complete historical synonymy; data concerning the type specimen and its present location; description of the species or descriptive notes; and remarks concerning specific relationships. Keys for the separation of the species of males and females are presented. A geographical catalog of the species and a bibliography conclude the paper.

1710. A parthenogenetic new species of the genus *Perimegatoma* Horn (Coleoptera: Dermestidae). H. E. Milliron. *Annals of the Entomological Society of America* 32:570-74. 1939.

*Perimegatoma vespulae*, a new species of Dermestidae, was discovered infesting a wasp nest (*Vespula arenaria* [Fabr.]) kept in the laboratory for class demonstration. A description of the adult dermestid (♀) is given as well as that of the larva.

Careful studies of the genitalia of all specimens collected did not reveal any of the male sex. By isolating individual pupae and observing the adults which emerged, it has been found that the species reproduces parthenogenetically.

The source of infestation is not definitely established.

1716. Correction of type locality for two species of Mutillidae described by Frederick Smith. C. E. Mickel. *Proceedings of the Royal Entomological Society of London* 8(9):192-94, (Ser. B). 1939.

Correction of type locality for *Timulla* (*Trogaspidia*) *auroguttata* (Smith) and *Ephuta notabilis* (Smith) is recorded. The first change removes *T. (T.) auroguttata* from the South American fauna to the Chinese fauna, the second from Tasmania to South America. The facts necessitating the corrections are fully explained. Complete historical synonymy of the two species is included, and a redescription of the type specimen of *E. notabilis* is given.

1722. *Diplogynia americana*, a new species of cestode (Hymenolepididae) from the eastern little green heron (*Butorides virescens virescens* [Linn.]). O. W. Olsen. *Transactions of the American Microscopical Society* 59:183-86. 1940.

A single specimen of this rare cestode genus heretofore known only from a single species in Australia was collected from the little green heron from Minnesota and is here described as *Diplogynia americana* n. sp.

1728. *Tatria duodecakantha*, a new species of cestode (Amabiliidae Braun, 1900) from the pied-billed grebe (*Podilymbus podiceps podiceps* [Linn.]). O. W. Olsen. *Journal of Parasitology* 25:495-99. 1939.

*Tatria duodecakantha* was collected from the pied-billed grebe in Iowa, United States America. It differs from the four known species of the genus in the number, the size, or the shape of the rostellar hooks as follows: *T. appendiculata* Fuhr., 1908 has hooks of the same size, differ in shape, and are fewer in number; both *T. acanthorhyncha* (Wedl, 1856) and *T. decakantha* Fuhr., 1913 differ in that the ventral root of the rostellar hooks is much longer than the dorsal; while *T. duodecakantha*, with 12 hooks 25-27  $\mu$  long, resembles *T. biremis* Kowal., 1904, with 10 hooks 44-50  $\mu$  long. A key is appended.

1732. *Deltokeras multilobatus*, a new species of cestode E (*Parauteriniinae*: Dilepididae) from the twelve-wired bird of paradise (*Seleucides melanoleucus melanoleucus* [Daudin]: Passeriformes). O. W. Olsen. *Zoologica* 24:341-44. 1939.

Specimens of *Deltokeras multilobatus* n. sp., were submitted for study through the courtesy of Dr. C. M. Herman of the New York Zoological Society. It is suggested that the genus *Deltokeras* with its reduced and variable parauterine organ may represent a transitional stage between those genera of cestodes having no parauterine organ, on the one hand, and those having a strongly developed and highly specialized one on the other.

1733. Food habits of the ring-necked pheasant in Minnesota. L. A. Fried. *Journal of Wildlife Management* 4:27-36. 1940.

This paper deals with the analysis of the crop and gizzard contents of 659 Minnesota pheasants collected in every month of the year. All analyses and computations are based upon the volumetric method used by the United States Biological Survey. The kind of food eaten by pheasants in each month of the year is shown in the form of a graph. Included also are two tables and a taxonomic list of all species of plant and animal food taken. There is a bibliography of 18 titles.

The results of this investigation show that cultivated grains, such as corn, oats, wheat, and barley comprise 80 per cent of the annual food. Corn is by far the most important food in the pheasant's diet for it alone made up nearly 50 per cent of the total volume of food.

The excessive damage that pheasants are believed to do to growing corn is shown to be greatly exaggerated for only .5 per cent of all the corn eaten is sprouted.

Pheasants affect the annual weed crop but very little even though they consume large numbers of weed seeds.

Grasshoppers and crickets were the most important animal food eaten for they made up nearly 75 per cent of the total volume of animal food. Grasshoppers were consumed in the largest amounts in April and July when they were in the egg and nymphal stages, respectively.

1741. Rate of metabolism in *Microtus* and *Peromyscus*. D. M. Hatfield. *Murrelet* 20:54-56. 1939.

Apparatus was devised to determine the CO<sub>2</sub> output of individual mice for half-hour periods. The air exhaled by a mouse was passed through a solution of barium hydroxide; this was titrated with hydrochloric acid.

*Peromyscus*, 14 individuals, averaged an output of 3.182 mg. of CO<sub>2</sub> per gram of body weight per half-hour. *Microtus*, 15 individuals, averaged 4.464 mg. per half-hour. This seems to show a higher metabolic rate in *Microtus* than in *Peromyscus*.

1747. Activity and food consumption in *Microtus* and *Peromyscus*. D. M. Hatfield. *Journal of Mammalogy* 21:29-36. 1940.

The races studied were *Microtus p. pennsylvanicus* (Ord), the meadow mouse, and *Peromyscus maniculatus bairdi* (Hoy and Kennicott), the prairie white-footed mouse. An attempt was made to ascertain the relation between amount of food eaten, at various temperatures, and the activity exhibited in obtaining this food. Emphasis was placed on consideration of the meadow mouse.

The meadow mice showed a two-to-four-hour rhythm of food-getting activity at temperatures of from 0° to 28° C.; at 30° C. and above this was obscured—the mice were active nearly all the time. Food consumption increased at lower temperatures and decreased at higher temperatures. The white-footed mice showed only a nocturnal-diurnal cycle of activity; cold caused a decrease in activity and food consumption in this species while heat caused increase in activity but decrease in food consumption.

1763. Vitamin content of bee foods. II. Vitamin B<sub>1</sub> content of royal jelly and bee bread. M. H. Haydak and L. S. Palmer. *Journal of Economic Entomology* 33(2):396. 1940.

Royal jelly exhibits vitamin B<sub>1</sub> activity towards polyneuritic rats equal to about 3 of thiamin chloride per gram of fresh and 9 per gram of dry matter. Bee bread shows vitamin B<sub>1</sub> activity towards polyneuritic rats corresponding to that of 4.5 and 6.4 of thiamin chloride per gram of fresh and dry matter, respectively.

1766. Comparative value of pollen and pollen substitutes. II. Bee bread and soy bean flour. M. H. Haydak. *Journal of Economic Entomology* 33(2):397. 1940.

Colonies consisting of young bees which have never eaten pollen were kept under controlled conditions and fed bee bread, various brands of soybean flour, and soybean flour-dry skim milk mixture, respectively. The development of bodies of the bees in the experimental colonies proceeded normally, except in the colony which was fed the soybean flour of high fat content and low temperature treatment where the development was retarded. Mortality in the colonies fed pollen substitutes was, on an average, higher than that in the control colonies. The number of bees reared by the experimental colonies varied considerably, being lower in the colonies fed soybean flour and higher than that in the control in the colony which was supplied with soybean flour-dry skim milk mixture. The weights of emerging bees produced by the experimental colonies, on an average, compared favorably with those of the control.

1778. The emergence of a neotropical mantispid from a spider egg sac. H. E. Milliron. *Annals of the Entomological Society of America* 33:357-60. 1940.

A brief review of emergence records of North American Mantispidae is given. A male specimen of *Mantispa viridis* Walker emerged from the egg sac of *Cupiennius sallei* (Keyserling), a clubionid spider taken from bananas which were probably from Central America. The adult parasite, its cocoon and pupal exuviae are briefly described. The parasite lived more than a week during which time observations were made of some of its habits.

1780. *Podalonia* (Hymenoptera: Sphecidae) of North and Central America. W. D. Murray. *Entomologica Americana* 20: (n.s.) (1, 2) 1-77. 5 pls. 1940.

The genus *Podalonia*, as revised in 1927 by H. T. Fernald, contained seven species and one subspecies. Fernald was unable to account for the fact that in the species *luctuosa* a very long series of females had been seen but only one male which he could consider as belonging to this species had come to his attention. Several mated pairs, the males of which had a red and black abdomen as in the species *violaceipennis* while the females had an entirely black abdomen as in the species *luctuosa*, led Fernald to conclude in 1931 that *violaceipennis* was a dimorphic species, usually with the abdomen red and black in both sexes but frequently with it entirely black in the females, producing the form *luctuosa*. Extremely rarely the male had a black abdomen.

The writer, on the basis of a study of the male genitalia and other structural characters, has refuted Fernald's conclusions, showing that they were based on erroneous determinations. *Luctuosa* and *violaceipennis* are recognized as distinct species, while many species not recognized by Fernald are raised from synonyms to the rank of good species or are described as new. There are now considered to be 20 species and 3 subspecies in this genus, of which 9 species and 2 subspecies are described as new in this paper. These wasps have been frequently reported as parasitizing some of the caterpillars which defoliate our forest trees.

1807. The relation of subterranean insects to the raspberry crown gall. A. A. Granovsky. *Hoosier Horticulture* 22(5):67-69. 1940.

Periodic diggings in several commercial raspberry plantations were made in the course of three years in order to determine the abundance of soil insects and their influence on the incidence of raspberry crown gall. At the time of harvesting the plants in the fall, one thousand plants from each plantation were carefully examined for galls. The results suggested very close correlation between the number of insects found in the soil and the abundance of crown gall in a given field. Soil insects, especially white grubs, proved to be active carriers of the crown gall organism as demonstrated by the experiments under laboratory conditions. The type of ground cover and the history of crop rotation practiced before the planting of raspberries are found to be the chief factors in determining the abundance of soil insect populations. Insects in turn pave the avenues for bacterial infection, resulting in the incidence of crown gall. The old bluegrass pasture gave a greater percentage of crown gall, while the fields after legumes

and small grains show a low percentage of crown gall. Judicious rotation and careful selection of ground for raspberry plantations, coupled with good cultural practices, will reduce the abundance of crown gall.

#### Veterinary Medicine

1614. Lesions of hog cholera: Their frequency of occurrence. H. C. H. Kernkamp. *Journal of the American Veterinary Medical Association* 95:159-66. 1939.

The gross pathologic changes observed in 268 hog cholera stricken swine which had contracted and developed the disease under natural or field conditions are compared with the lesions occurring in 48 cases of hog cholera that were artificially induced. The latter represent the most "pure" cases of cholera that could be produced. In both series, the organs and parts showing lesions most frequently were the kidneys, lymph nodes, urinary bladder, spleen, and larynx. The lesions are produced by disturbances in the flow of blood and are manifested as small, circumscribed, punctate hemorrhages and hemorrhagic suggillations that often reach 1 cm. in diameter. A description and discussion of the lesions in the different organs and tissues are included.

1737. Results of blood cultures on seven heifers artificially infected with *Brucella abortus*. C. P. Fitch, Lucille M. Bishop, W. L. Boyd, and Margaret D. Kelly. *Journal of the American Veterinary Medical Association* 95(753):683-89. 1939.

All animals were calves nine to ten months of age. These were held in isolation for a period of five to six months and bred before exposed to infection. Exposure was made by drenching with suspensions of placenta or stomach contents of aborted fetuses from which *Brucella abortus* had been isolated, or by dropping a saline suspension of *Brucella* into the conjunctival sac. Single exposures to infection were made at different stages of pregnancy. Each animal was held in a separate box stall wherever precaution was taken to avoid infection from sources other than a known exposure. Daily blood cultures and tests for agglutinins of *Br. abortus* were made after exposure. The period of time after exposure to the first isolation of *Br. abortus* from the bloodstream varied from 6 to 71 days, the average time being 29 days. There appeared to be little difference in the method of exposure and the appearance of the organism in the blood stream. With the exception of one case, *Br. abortus* was isolated from the blood near the time the agglutination titer reached 1:100. A definite bacteremic period was demonstrated which appeared shortly after exposure and near the time agglutinins were beginning to appear in the blood stream. This bacteremia continued in some cases until the time of calving or abortion. It was demonstrated after parturition from two animals only. Differences in resistance to infection were demonstrated as well as a wide difference in incubation period.

1742. Studies on the photoelectric and volumetric methods for the determination of the density of *Brucella abortus* antigen. M. H. Roepke and C. P. Fitch. *The Cornell Veterinarian* 30(1):1-13. 1940.

Two photoelectric instruments were used to compare the relative densities of various suspensions of *Brucella abortus* with the relative densities obtained by

the volumetric or centrifuge method. Discrepancies up to 36 per cent were found between the photoelectric and volumetric methods for different strains of *Brucella abortus* suspensions prepared in the same manner. Variations in the concentration of phenol in the suspension from zero to 1 per cent affected the photoelectric densities up to 30 per cent with no significant effects on the volumetric densities. The effect on the densities obtained by the two methods varied with method of preparing the suspensions. Concentrated suspensions of *Brucella abortus* heated to the boiling point in the presence of media constituents caused an increase in turbidity of 22 per cent as determined by the photoelectric method and a decrease in density of 8 per cent as measured by the volumetric method. The combined effects of variations between strains, the effect of phenol, and method of heating gave rise to discrepancies up to 100 per cent between the photoelectric and volumetric methods. When suspensions of *Brucella abortus* which showed marked discrepancies between the photoelectric and volumetric densities were adjusted to the same density by the volumetric method and tested on bovine serums, the sensitivities of the antigens were much more uniform than when adjusted to the same densities by the photoelectric method.

1746. Studies on the preparation of *Brucella abortus* plate antigen and some factors affecting the sensitivity of the antigen. M. H. Roepke and C. P. Fitch. *Journal of Infectious Diseases* 66:17-22. 1940.

Temperatures obtained in the autoclave convert a considerable portion of agar into a very soluble form of agar (termed soluble agar). Relatively large amounts of soluble agar are present in the supernatant fluid of bacterial suspensions obtained by washing cultures from agar media. The amount of soluble agar present depends upon the volume of fluid used to wash the cultures off of the medium, and the length of time the fluid is in contact with the agar medium. The variations in the composition of the supernatant fluid result in antigens with marked variation in sensitivity or agglutinability. Antigens prepared by the removal of the supernatant fluid and its replacement with saline show a more uniform sensitivity.

The variations in sensitivity of antigens due to changes in bacterial concentration are greater in the presence of the supernatant fluid than in the presence of saline solutions. Normal agar has much greater effects on the sensitivity of antigens than does soluble agar. Antigens prepared by suspending *Br. abortus* cells in phenol saline or in phenol-saline-gelatin solutions show uniform sensitivities.

1774. Attempt to demonstrate a filtrable form of *Brucella abortus*. C. P. Fitch and A. G. Karlson. *Journal of the American Veterinary Medical Association* 96(757):501-502. 1940.

The existence of a filtrable form of *Brucella abortus* was suggested by Sarnowicz (Compt. Rend. Soc. Biol. 129 [1938] pp. 129-132), who reported that Chamberland L<sub>2</sub> and L<sub>3</sub> filtrates of *Br. abortus* cultures containing tuberculin would produce specific agglutinins and lesions in guinea pigs. The finding of a virus-like form of *Br. abortus* would be an important contribution to the bacteriology of brucellosis. *Br. abortus* was grown in tubes of broth containing phenol-free tuberculin in amounts of 10, 15, and 20 per cent. After incubation under 10 per cent CO<sub>2</sub> for one week the cultures were passed through Berkefeld N and Chamberland L<sub>2</sub>, L<sub>3</sub>, L<sub>5</sub>, and L<sub>7</sub> filters. The filtrates were cultured and

inoculated into guinea pigs but the cultures remained sterile and no specific agglutinins or lesions were demonstrable in the guinea pigs. Cultures of their spleens were negative. Unfiltered material revealed the presence of *Br. abortus* by culture and guinea pig inoculation. It was not possible to demonstrate a filter-passing form of *Br. abortus* by growing the micro-organism in the presence of tuberculin.

1790. Castration of boars under chloroform anesthesia. Report of Cases. W. L. Boyd and H. C. H. Kernkamp. *North American Veterinarian* 21(5):287-88. 1940.

The general use of anesthetics when operative surgery is performed on animals is strongly advocated. The castration of large male swine under chloroform anesthesia minimizes efforts expended in restraint, permits free access to the surgical field, and alleviates pain in the animal. The surgical stage of deep narcosis is produced within three to five minutes according to the procedures described. The results with four cases are recorded.

#### Rural Sociology

1829. Action programs for the conservation of rural life and culture. Lowry Nelson. *Rural Sociology* 4(4):414-32. 1939.

This paper represents an attempt to answer the question "What is it in American rural culture that we wish to conserve?" It postulates two sets of values which are worthy of preservation. These are (1) survival values and (2) values inherent in familism and territorial localism. The hypothesis is that democracy, self reliance, and individuality have historically derived from the primary groups, and that weakening the primary groups will tend to weaken these qualities. Conversely, action to strengthen the primary groups will tend to conserve these qualities. The various federal programs are appraised in the light of their contribution to improved health and life-saving values and tendency to which they affect adversely or favorably the rural primary groups.

#### Agricultural Engineering

1713. A flow method for determination of the effects of soluble chemicals on concrete. D. G. Miller, C. F. Rogers, and P. W. Manson. *Proceedings of the American Society for Testing Materials* 39:900-12. 1939.

The conclusions of this paper are based on results obtained by allowing weak solutions of acetic and lactic acids to flow across flat slabs of concrete and mortar set nearly vertical (17 deg. departure). In most cases paraffin dykes restricted the flow of acid to an area 1½ inches wide and 14 inches long. In other cases, laboratory made bars 2½×3×15 inches were cast with slightly depressed 1½-inch lengthwise channels. The hydrostatic head on glass capillary tubes was adjusted to deliver to each channel 2 liters of acid every 24 hours. Each channel was brushed with a flat steel brush about the size and shape of a one-inch paint brush, and the loosened material was caught in filter paper lined funnels, oven-dried and weighed.

Concrete with a modulus of rupture from 800 psi. upward displayed resistance to corrosion of weak acids three times that of concrete with a modulus of rupture of 500 psi. under the conditions of exposure used in these tests.

Mortar made of the least resistant of nine standard portland cements yielded a quantity of loosened material 1.6 times that released by mortar made of the most resistant of these nine cements.

Within the range of characteristics of the specimens used in the tests, the acid consumption was surprisingly uniform for all specimens.

1718. Laboratory tests of concretes and mortars exposed to weak acids. D. G. Miller, P. W. Manson, and C. F. Rogers. *Journal of the American Society of Agricultural Engineers* 20(11):427-30. 1939.

The test method described in this paper was devised primarily to facilitate laboratory studies of the durability of portland cement mortars and concretes exposed in farm silos to the corrosive action of silage. The method and equipment seem to be well adapted to the study of the corrosive action of soluble materials in general on products of various types.

It is generally assumed that the common acids of corn silage are volatile acids consisting very largely of acetic acid, and non-volatile acids generally calculated as lactic acid, although not necessarily wholly lactic acid. The degree of acidity of good silage, expressed in pH values, will range between pH 3.40 for the most acid and pH 3.90 for the least acid. Solutions of acetic acid 0.1N (normal), lactic acid 0.1N and the two acids combined in approximately equal parts to give 0.1N were used in the tests but results obtained only with the mixture are reported in this paper. The acidity of this mixture is pH 2.5 at room temperature.

The general scheme of the test is to flow acid solutions across flat slabs of concrete set nearly vertical (17-deg. departure). Halves of concrete silo staves have been used in some cases, while in other cases special laboratory made bars of standard Ottawa sand were used. The bars measured 2½×3×15 inches and were cast with recessed panels for the acid flow. The flow of acids on the specimens is confined between paraffin dykes so spaced that the area of contact is 14 inches long and 1½ inches wide. The rate of flow through a channel is fixed at 2 liters per 24 hours. Each 24 hours the channels are cleaned of loosened material by brushing with a one-inch flat brush of steel wire. The brushings are caught in 5-inch funnels lined with filter paper, oven-dried and weighed. The brushing is done under a small water jet and ordinarily about 400 cc. of water is caught with the material released by each channel.

The solutions are applied to the specimens at the upper ends of the channels by a drip method using glass capillary tubes. A convenient head for the setup is about 13 inches, and by experiment it was found that one-inch lengths of capillary tubing with an opening of 0.009 inch delivered the desired quantity. Only minor adjustments of head are necessary to effect the 24-hour, 2-liter flow.

The degree of acidity was determined for many samples of the solutions flowing over the surfaces of the specimens, in order to study the possible correlation of the quantity of acid consumed with known characteristics of the concrete or mortar.

It appears that consumption of acid has no particular relation to the quality of the concrete unless greater acid consumption is indicated in extremely low grade concrete. As this test was applied, it would seem that the constituents of the cement available for the acid requirements were about equal in all the speci-



mens, although a greater quantity of aggregate was loosened by deeper penetration of acid into the more permeable lean mixed staves than was loosened in the rich mixed and relatively impermeable staves.

The weaker specimens yielded about three times as much material as did the stronger ones. Stating it in another way, the depth of corrosion in the weaker specimens was about three times that of the stronger ones. A practical inference of this fact is that the low quality specimens could not last more than one third as long as those of high quality under conditions of exposure represented by these tests.

1785. Tests of 100 commercial cements for sulphate resistance. D. G. Miller and P. W. Manson. *Symposium on Specifications for and Additions to Portland Cement of the American Society for Testing Materials*, Committee C-1, pp. 36-41. March, 1940.

Results of observations of the sulphate resistance of 100 commercial cements are here reported based on tests of six thousand 2×4-inch concrete cylinders some of which were continuously immersed for four years in the laboratory in one per cent solutions of magnesium sulphate ( $MgSO_4$ ), some in one per cent sodium sulphate ( $Na_2SO_4$ ), and some in the water of Medicine Lake, South Dakota. This lake has averaged, during the four-year period, 12 per cent total salts of which two thirds are magnesium sulphate and one fourth sodium sulphate. All cylinders were made of aggregates from a single source, with a maximum screen size of  $\frac{3}{8}$  inch and of fineness modulus of 4.67. The mix was 1-3 and the water cement ratio 0.60-0.66, around  $4\frac{3}{4}$  gallons of water per sack of cement. All cylinders exposed to the laboratory solutions were immersed in the solutions at 21 days following curing in the moist closet for 24 hours and water for 20 days. The Medicine Lake cylinders were similarly cured plus 35 days in air.

Resistance of the cylinders in the laboratory solutions was determined by volume changes as indicated by length changes. Any cylinder increasing in length by as much as 0.01 inch is assumed to have completely failed and the corresponding age in weeks recorded. Resistance of Medicine Lake cylinders has been determined on the basis of the strengths at three years compared with the strengths at one year of cylinders stored in tap water in the laboratory.

Equal weight has been given to the three tests, namely, (1) length increases of cylinders in the one per cent sodium sulphate solutions in the laboratory, (2) length increases of cylinders in the one per cent magnesium sulphate solutions in the laboratory, and (3) the strength ratios of the Medicine Lake cylinders. The cements were rated from best to poorest from 1 to 100 under each test and the ratings for each cement totaled. It has been assumed that the cement with the lowest total scored highest in resistance.

Based on tests as applied to 100 commercial cements, specifying an upper limit of 5.5 per cent for the calculated compound  $3CaO \cdot Al_2O_3$  would have come as near to securing cements of high resistance to attack by magnesium and sodium sulphate as reasonably could be expected of a specification and at the same time this limit would have eliminated all cements of low resistance. This conclusion is known to be in line with the trend of thought of research workers in this field for a number of years. Results of these extended tests of commercial cements are here offered in summarized form as confirmatory evidence of the correctness of

relying chiefly on this method of approach for the selection of a cement to be exposed to the action of these sulphates until such time as a reliable short time laboratory test may be devised.

1797. Sulphate resistance of 94 commercial cements. P. W. Manson. *Journal of American Society of Agricultural Engineers* 21(4): 135-37. 1940.

About 1920 the attention of the United States Department of Agriculture and the University of Minnesota was called to a number of failures of concrete tile in drains in southwestern Minnesota. A field study revealed a marked correlation between the concentration of magnesium and sodium sulphate, in solution, and concrete tile failures. Early research showed a wide difference in the resistance of cements from different mills.

This report deals with tests carried out on a series of concrete cylinders identically made except for the brand of cement used. In this investigation 94 different commercial brands of portland cement were used and subjected to comparable treatments and observations.

The sulphate resistance of a cement was measured by volume changes when the concrete was exposed to one per cent solutions of magnesium and sodium sulphate. A correlation between some characteristics of the cement and its resistance to sulphate waters was attempted from the chemical analyses, calculated compounds, fineness, and the alumina-iron ratio of the 94 cements herein reported upon. The tests show that the most consistent index of a cement's resistance to sulphate attack is its calculated percentage of tri-calcium aluminate ( $3CaO \cdot Al_2O_3$ ). The cements that did not exceed 5.5 per cent of this compound were, generally speaking, the most resistant of those tested. By limiting the percentage of the tri-calcium aluminate to 5.5, the low sulphate resistant cements are eliminated and nearly all of the more resistant are included.

In recent years modified cements have been commercially produced in which the alumina content has been lowered and the ferric oxide content raised, thus reducing the tri-calcium aluminate content. The results obtained from these tests seem, in general, to support this practice.

The high-early strength cements from a given mill tested about the same in this investigation under similar sulphate exposures.

1819. Durable concrete silo staves. P. W. Manson. *Journal of American Society of Agricultural Engineers* 21(6):229-30, 234. 1940.

The Agricultural Engineering Division of the University of Minnesota has been making extensive studies relative to the durability of concretes and mortars exposed to weak acids, silage juices, and severe weathering conditions. The making and testing of about 4,000 commercial concrete silo staves from 30 different silo plants located in Minnesota, Iowa, and Wisconsin has been done under the supervision of the concrete products laboratory. This article deals only with silos made of dry tamped concrete staves.

An apparatus has been devised in the laboratory by means of which it is now possible to measure the relative resistance of different types of concrete staves to the action of weak acids. This test supports the importance of having concrete of high transverse strength and low absorption.

The available freezing and thawing data indicate that concrete staves of high transverse strength and low absorption will exhibit a resistance, when exposed to freezing and thawing action, many times that of inferior quality.

Some surface treatments may help to protect the interior surface of a silo for a few years, but they will not indefinitely protect staves of poor quality concrete. It is more effective and reliable procedure to use high quality concrete in the erection of a silo wall than it is to attempt later to protect a wall built of poor materials. If a special interior treatment is to be used, it is better to apply it on a good stave.

High quality concrete staves are durable. A concrete stave of durable aggregates, testing in transverse strength 140 pounds per inch of width, having a 10-minute absorption not in excess of 2.5 per cent and a 48-hour absorption not in excess of 5.5 per cent, should give long, satisfactory service. Many manufacturers are now selling staves of this high quality. The purchase of those of poorer quality is not recommended.

### Miscellaneous Journal Series Papers

#### Horticulture

395. The Mingold tomato and the Duluth snap bean. T. M. Currence. *The Minnesota Horticulturist* 67:65. 1939.

Two new strains of vegetables, the Mingold tomato and the Duluth snap bean, have been developed at the Minnesota Agricultural Experiment Station.

The derivation and pedigree of the Mingold is given, the pedigree being made up of crosses between two numbered selections and the varieties Viking, Bonny Best, and Danish Export followed by six generations of selecting after the last cross. Mingold was compared for fruit size, fruit shape, early yield, total yield, weight of seeds per ton of fruit, percentage of cull fruits, and vitamin C content, with the well known Marglobe variety. Marglobe was not definitely superior in any of these characters except a lower percentage of culls which was 4.8 for Marglobe and 5.7 for Mingold.

A series of backcrosses between white podded selections and the well known variety Brittle Wax led to the new white podded bean named Duluth. It is a snap bean resembling Brittle Wax in general, but has a pod length approximately one inch shorter and the pods are not as round in cross section as are the pods of Brittle Wax.

410. Herbs—Some notes on winter hardiness. A. E. Hutchins and L. Sando. *Minnesota Horticulturist* 67(8):148. 1939.

Observations on the winter hardiness of herbs grown at University Farm from 1936 to 1939, inclusive, together with a grouping of these herbs into hardy, semi-hardy, and tender classes.

413. The "Greengold"—A new family size squash. A. E. Hutchins. *Minnesota Horticulturist* 67(12):148. 1939.

A description of a new, early, family size squash developed at the Minnesota Agricultural Experiment Station and introduced as the "Greengold."

415. The "Midget"—A new bush cucumber. A. E. Hutchins. *Minnesota Horticulturist* 68(1):8. 1940.

A description of a new bush type of cucumber of determinate growth habit developed at the Minnesota Agricultural Experiment Station and introduced as the "Midget." Some data are also given comparing yields of standard varieties at standard planting distances to those of the "Midget" at several different planting distances.

417. A comparative test of some cabbage varieties in 1939. A. E. Hutchins. *Minnesota Horticulturist* 68(2):28. 1940.

Twelve varieties were tested for one season, including several new varieties. Golden Acre appeared to be very early, uniform, and ranked second in yield. As a whole, the new varieties tested did not appear to be outstanding.

418. A comparative test of some bean varieties in 1939. A. E. Hutchins. *Minnesota Horticulturist* 68(2):52. 1940.

Seven varieties were tested for one season. Of these, Giant Stringless Greenpod was most productive. Varieties producing the largest total yield were, in general, the same as those producing the largest yields at the first harvest.

424. A new apple and pear. W. H. Alderman and A. N. Wilcox. *The Minnesota Horticulturist* 68(3):45. 1940.

Two new varieties of fruits which have been developed at the University of Minnesota Fruit Breeding Farm are announced and described briefly. The Prairie Spy apple is a winter apple of high quality for dessert purposes. The Bantam pear, which has early, small fruit of high quality, is blight resistant and exceptionally hardy and is consequently intended for regions too cold for culture of present day standard varieties.

#### Plant Pathology and Botany

394. A dry-bright wax for apples. R. C. Nelson, *Minnesota Horticulturist* 67(7):131. 1939.

A method of applying wax emulsion to apples before storage to decrease shrinkage and to enhance the polish is described.

414. Waxing vegetables. R. B. Harvey. *Minnesota Horticulturist* 67:173. 1939.

A discussion of methods used in commercial waxing and in waxing vegetables in the home which gives instructions for the preparation of vegetables for waxing, for storage after waxing, and for the use of waxed vegetables in cooking.

416. Common weeds of lawns. Descriptions and drawings of weeds that are pests in lawns and methods of control or eradication. R. B. Harvey and A. H. Larson. *Seed Trade Buyers Guide*, 23rd Edition, pp. 70-87. 1940.

Popular description of weeds of lawns and illustrations together with methods of eradication and control.

425. Use of chemical stimulants, hormones, and vitamins in plant culture. R. B. Harvey. *Minnesota Horticulturist* 68(3):48, 50, 51. 1940.

A popular article intended to correct false ideas created by advertising of hormones and vitamins for use in plant culture.

431. Plants poisonous to livestock. R. B. Harvey. *The Farmer* 58(8):14. 1940.

A series of popular articles on seven of the most common poisonous weeds.

#### Agricultural Biochemistry

401. On the use of dry milk solids in sponge cake. O. E. Stamberg and C. H. Bailey. *Bakers Helper* 73:918-19. 1940.

The effect on specific volumes of the beating mix, the batter, and of the cake; the compressibility, tensile strength, and final score of sponge cakes with various amounts of dry milk solids were studied. A medium mixing speed was found to give best results.

#### Home Economics

381. A study of certain factors related to consumers' choices in the purchase of "silk" street dresses and silk yard goods. Ethel L. Phelps, Florence E. Petzel, Allene Sewell Loring, and Eleanor Anderson Nielson. *Journal of Home Economics* 31:393-98. 1939.

Data regarding the influence of employment outside the home, age, income, and other factors upon consumers' choices in the purchase of these materials was obtained from 294 personal interviews and observation of 303 sales in a large store as a contribution to our knowledge of what people buy. The average number of such dresses and the fiber used in the fabric; the type of fabric most commonly used and whether it was plain or printed; the choice between ready-to-wear, dressmaker-made, or homemade dresses and the number of years such are worn were determined from interviews. The kind, amount, and price of silk fabrics purchased by the yard and the intended use was obtained by observation of sales. At the time of the investigation women were wearing on the street chiefly dresses thought to be silk, over half of them made of crepe, plain in color, and bought ready-to-wear. It is evident that reliable standards and dependable labeling are needed as guides to quality of both workmanship and material for garments so widely used.

#### Dairy Husbandry

411. Microscopic examination of pasteurized milk. H. Macy. *Association Bulletin of the International Association of Milk Dealers* 4:97-106. 1939.

Comparisons were made between the microscopic, standard plate, and thermophile counts of considerable numbers of samples of milk before and after pasteurization and of pasteurized milk as it was delivered to the consumer. There is a general tendency for high microscopic counts of pasteurized milk to be associated with high plate counts or high thermophile counts. The majority of samples gave lower microscopic counts after pasteurization. In some instances the microscopic counts of pasteurized milk may reflect the quality of the raw milk or in other cases the development of thermophiles or excessive contamination from equipment.

The results, in general, indicate that the microscopic examination of pasteurized milk may yield helpful information, especially when there has been regularly a similar check upon the raw milk supply.

#### Entomology and Economic Zoology

402. Insulation not always what it seems (Thousands of insects may emerge from wrong materials). H. H. Shepard. *Pests* 8:13-14. 1940.

A wide variety of insulating materials has been reported as used in homes, including hair, wool, sweepings, and oat hulls all of which may become sources of large numbers of insects. It is important never to use animal fibers or vegetable materials containing seed parts. One should insist upon the use of pure mineral or vegetable fibers which are not liable to insect attack.

405. Possibilities of pollen substitutes. M. H. Haydak. *Proceedings of the Eighteenth Annual Meeting of the North Central States Entomologists*. 1939. 3 mimeographed pages.

Extensive experimental studies have demonstrated that there are various foods which may serve as substitutes for the pollen normally fed to developing bee larvae. For practical purposes only those substitutes which are cheap and easily obtainable can be used. Of such, cottonseed meal or soybean flour, mixed in each instance with dry skim milk in the proportion of one part in five, is important. The question of the most desirable method of feeding is still unsolved. The Farrar method is the most promising of those tried but it is suggested that practical beekeepers experiment with various procedures and report their results.

406. Laying workers. M. H. Haydak. *American Bee Journal* 80:163. 1940.

To test the reaction of the worker bees, two colonies, consisting each of several three-pound packages of bees, were established just at the beginning of the honey flow. One colony was left queenless, the other had the queen caged in the hive. Thirty-one days after the first colony was formed, an abundance of open drone brood was found in the hive. The second colony, in which the queen was caged, did not have either eggs or brood for 65 days. On September 3 the queen was released, and seven days later there were plenty of eggs, and larvae up to two days of age were found in the hive.

This observation shows that one cannot so easily explain all the phenomena in the life of a bee colony on the basis of a preconceived pattern. The author is

inclined to say that psychological factors may play an important role in the reactions of the bee colony toward the internal and external stimuli.

412. Lead shot: its danger to water-fowl. T. L. G. Osmer. *Scientific Monthly* 50:455-59. 1940.

A discussion of the seriousness and importance of waterfowl lead poisoning in waterfowl management and a report on the incidence of lead shot in waterfowl refuge areas. The practical value of making lead shot surveys on any waterfowl area which is being considered as a refuge is emphasized. Tables showing incidence of lead shot and gravel in the lake bottoms studied and of seeds collected in the course of the survey are presented.

421. Moles. D. M. Hatfield. *Minnesota Horticulturist* 68:72. 1940.

Control of these insectivores is restricted to one of three methods: drowning, gassing, or trapping. The last is by far the most effective. The best of the several types of traps designed for moles seems to be the javelin type, which may be purchased for around one dollar.

423. Some tree-boring insects. A. G. Ruggles. *Minnesota Horticulturist* 68:56. 1940.

A general statement of the wood-boring families with particular reference to the flat headed borers.

426. The boring insects, continued. A. G. Ruggles. *Minnesota Horticulturist* 68:90. 1940.

A continuation of the study of the flat headed borers and their control.

430. Minnesota forest insect survey for 1939. A. C. Hodson. *Department of Conservation, Division of Forestry*, 11 mimeographed pages. 1940.

The forest insect survey was conducted through the cooperation of the Division of Entomology and Economic Zoology of the University of Minnesota, the Division of Forestry, State Department of Conservation, and the State Entomologist. The report includes a general summary of the forest insect situation in 1939 and a discussion of the damage, distribution, and abundance of the important pests.

433. Some tree-boring insects, continued. A. G. Ruggles. *Minnesota Horticulturist* 68:116. 1940.

A continuation of the study of the wood-boring insects with a discussion of the round headed borers and their control.

#### Northwest Experiment Station

427. A record of performance for sheep. R. J. Christgau. *Thirty-Second Annual Proceedings of the American Society of Animal Production*, pp. 342-47. 1939.

The value of present records of performance for cattle and hogs is discussed and the need for a similar plan for sheep is emphasized.

A plan for ewe and lamb identification, systematic records, and standardized management is presented.

A method of determining productive efficiency is suggested for use by both practical and scientific breeders; such efficiency to be expressed in the form of a performance rating, which gives the rates of product per 100 pounds of maintenance T.D.N.

A method of correcting for the effect of grade of both wool and lamb is included as well as a composite ewe rating including both wool and lamb proportionately weighted.

An individual ewe life time record card, an annual flock Master Chart, and a performance rating chart are presented to complete the plan, which is recommended as a guide to sheep selection for improving flock efficiency.

#### Rural Sociology

403. Distribution and extent of unemployment of farm laborers in the United States. Lowry Nelson. *Social Forces* 18(2):180-87. 1939.

Unemployed farm laborers registered in the census of unemployment of November, 1937 were added to the estimated number of farm laborers employed as of comparable date. This made possible an estimate of the total number of wage laborers in the agricultural population. These were distributed according to the type of farming areas in the United States. Unemployment was found to be highest in the small grain region, where it amounted to over 30 per cent. The next most important area for unemployment was the cotton sections of the Southern states. The least unemployment was found in the corn region and in Florida and California. The favorable showing of Florida and California is attributed in part to the manner in which the unemployment census was taken, i.e., through the post-office department. Many of the migratory workers would not be reached through the postoffice during the week in which the census was taken.

404. Government aid for low-income farm families. Lowry Nelson. *Social Education* 3(6):375-80. 1939.

Paper summarizes the available facts concerning the number of farm families that are receiving low incomes of various sizes, and reviews the development of various governmental programs designed to meet their needs.

420. Migration of Minnesota rural youth. Lowry Nelson and Don Mitchell. *Rural Sociology* 5(2):229-32. 1940.

This is a survey of 189 rural young men and 281 rural young women, between the ages of 15 and 29, who migrated from farms in three counties of the state. Nearly 40 per cent of the boy migrants went to other open country areas. Only slightly over 30 per cent of the boys went to the cities, compared with 43 per cent

of the girls. Boy migrants go predominantly into the unskilled labor class, (especially when they migrate to cities, towns, and villages) or become farm operators or farm laborers. Girls, on the other hand, overwhelmingly go into domestic service. With such large numbers of young people leaving the country for the city, the question arises as to the type of preparation for city life that rural migrants ought to have. For example, it is a noteworthy fact that unskilled labor has a high rate of unemployment. The rural migrants tend to swell this unskilled class. The study suggests that something might be done to raise the level of skill among country boys in anticipation of ultimate migration to the cities.

## SUMMARY OF PUBLICATIONS

Kind of publication	Number issued	Number of pages	Number of copies in edition
Reports .....	2	115	3,500
General Series Bulletins.....	6	227	51,500
Technical Series Bulletins.....	5	191	10,000
Extension Series Bulletins.....	11	180	185,000
Pamphlets .....	7	92	86,200
Folders .....	11	78	166,000
<b>News Letters</b>			
Dairy Herd Improvement Letter.....	12	73	31,505
Engineering News Letter.....	12	12	13,900
Minnesota Farm Business Notes.....	12	48	28,625
News Letter .....	52	104	73,950
Poultry News Letter.....	12	27	3,620
Turkey News Letter.....	8	19	43,800
Rural Program Helps.....	10	79	13,225
4-H Club News Letter.....	10	70	27,735
Minnesota Extension News.....	1	2	300
Sheep News .....	6	6	19,665
	<b>177</b>	<b>1,323</b>	<b>758,525</b>
<b>Papers</b>			
		Scientific Journal Series	Miscellaneous Journal Series
Agronomy and Plant Genetics.....		3	.....
Forestry.....		10	.....
Horticulture.....		8	7
Plant Pathology and Botany.....		10	5
Agricultural Biochemistry.....		15	1
Soils.....		1	.....
Home Economics.....		2	1
Animal and Poultry.....		4	.....
Dairy Husbandry.....		5	1
Entomology and Economic Zoology.....		24	9
Veterinary Medicine.....		6	.....
Northwest Station.....		.....	1
Rural Sociology.....		1	3
Agricultural Engineering.....		5	.....
		<b>94</b>	<b>28</b>
Total publications.....	<b>299</b>		

## 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. S. Dunham, R. E. Hodgson, R. O. Bridgford, A. R. Schmid, D. U. Harvey) (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. (Dormant)

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, 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 eradicans 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, 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. (Dormant)

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) (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, 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, 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) (E. R. Ausemus, H. K. Hayes, C. L. Alexander, D. U. Harvey, Catherine Harrington, R. E. Hodgson)

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, the Division of Soils, 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, the Division of Soils, and the Southeast, West Central, Northwest, and North Central experiment stations) (A. C. Army, D. U. Harvey, R. E. Hodgson, 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 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. Army, D. U. Harvey, C. L. Alexander, 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, R. P. Murphy) (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. Army, D. U. Harvey, R. O. Bridgford, R. S. Dunham, O. W. Swenson, M. J. Thompson)

110. Studies in the classification of farm crops. (Cooperative with the Bureau of Plant Industry, United States Department of Agriculture) (A. C. Army, 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, I. J. Johnson, 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. Army, W. W. Brookins, D. U. Harvey, R. E. Hodgson, R. O. Bridgford, R. S. Dunham, O. W. Swenson, M. J. Thompson)

Subproject: Classification. (Dormant)

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, 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 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)

Subproject: Variety testing.

Subproject: Competition studies. (Closed)

Subproject: Genetic studies.

120. Alsike clover seed production. (Cooperative with the Division of Entomology and Economic Zoology, the Division of Soils, the North Central and Northeast experiment stations, and with the county agents and farmers of Koochiching and Lake of the Woods counties) (H. K. Wilson, M. J. Thompson, O. W. Swenson, R. E. McMillen, George Berggren) (Closed)

Subproject: Rate of seeding and companion crop.

Subproject: Breeding.

121. Crop rotation investigations. (Cooperative with the divisions of Soils and Agricultural Extension, and the Northeast, Northwest, and West Central experiment stations) (A. C. Army, 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 Northwest Crop Improvement Association, the Minnesota Crop Improvement Association, and farmers) (Carl Borgeson)

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, H. K. Wilson, E. R. Ausemus, A. C. Army, E. H. Rinke, R. P. Murphy, I. J. Johnson, 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. Army, C. L. Alexander, Catherine Harrington)

127. Emergency fodder, hay, and pasture crops. (Cooperative with the West Central Experiment Station) (A. C. Army, 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)

130. Physiology in relation to corn improvement. (Cooperative with the Department of Botany, University of Minnesota) (I. J. Johnson, E. S. Miller) (Purnell) (Closed)

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)

## 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)
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)
129. Silvicultural aspects of the farm woodlot management in the hardwood region of Minnesota. (Dormant)
133. A study of the causes of deterioration of windbreaks and shelterbelts in western Minnesota, and how they may be rehabilitated. (Henry L. Hansen) (Closed)
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)
137. A study of the factors affecting the durability of wood. (Henry Schmitz)
139. A study of the structure of wood and wood products. (Dormant)
140. A study of the chemistry of cellulose, lignin, wood, wood components, and wood products. (A. J. Bailey) (Closed)
141. Problems in wood utilization. (Cooperative with the American Creosoting Company, Louisville, Kentucky) (S. J. Buckman, L. W. Rees)  
 Subproject: The effect of steaming on the strength of shortleaf pine and slash pine.

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) (New)

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) (Jack Newville, Charles White, T. Schantz-Hansen) (New)

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

## 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) (F. A. Krantz, W. L. Bartholdi) (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: Test of vegetatively-propagated creeping bents and other grasses suitable for lawns, parks, golf courses, and playgrounds. (Dormant) (Closed)

Subproject: Test of seed-propagated grasses. (Dormant) (Closed)

Subproject: Weed eradication.

103. Forcing of bulbs under greenhouse conditions. (L. E. Longley, L. Sando) (Closed)

Subproject: Forcing of narcissus bulbs from various localities of the United States. (Dormant)

Subproject: Forcing of tulip bulbs from Holland and from various parts of the United States. (Dormant)

Subproject: Effects of various treatments on forcing of bulbs. (Dormant)

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) (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, J. D. Winter, R. H. Landon)

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, J. D. Winter, J. H. Neal, R. E. Nylund, Harold Andrews, H. B. Roe) (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 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, A. G. Tolaas, Z. M. Fineman) (Adams)

Subproject: Development of improved varieties of potatoes through in-breeding 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, Bernice Lehner, B. R. Ledin, Philip Hamm, Donald Dodge, A. L. Richardson) (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, T. W. Graham, E. W. Hanson)

Subproject: Imperfects of cereals.

Subproject: Smut treatments.

Subproject: Scab of cereals. (Dormant)

Subproject: Miscellaneous diseases of flax.

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

Subproject: White-pine blister rust. (Dormant) (Closed)

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, Thomas Laskaris, E. A. Andrews, A. R. Downie, E. W. Hanson)

Subprojects: Spring wheat (Cooperative with the Office of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture), winter wheat, oats, barley, rye, flax (Cooperative with the Office of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture), corn, timothy (dormant), red clover, sweet clover, 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. Dossall, A. E. Eagle)

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

Subproject: Diseases of small fruits and methods of control. (Dormant)

Subproject: Diseases of tree fruits and methods of control. (Dormant)

Subproject: Nature and causes of strawberry degeneration in Minnesota.

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

110. Plant-disease survey. (Louise T. Dossdall)
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, 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, Helen Hart, M. B. Moore, I. W. Tervet, M. F. Kernkamp, A. E. Eagle, M. A. Petty, W. Martin, W. Cherewick) (Purnell)
116. Garden-truck diseases. (Cooperative with the North Central and Northwest experiment stations) (C. J. Eide, A. E. Eagle)
- Subproject: Potato diseases.  
 Subproject: Miscellaneous truck crop diseases. (Dormant)  
 Subproject: Etiology and control of purple-top wilt of potatoes.  
 Subproject: Etiology and control of hair-sprout of potatoes. (Dormant)  
 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. (Dormant)  
 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, T. R. Wright, L. A. Schaal) (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, J. L. Allison, L. Henson, 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. (Cooperative with the Division of Forage Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture)
121. Aerial dissemination of allergens and pathogens. (Cooperative with the University Health Service) (E. C. Stakman, D. A. Preston)
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.
204. Light relations of plants. (R. H. Landon, R. B. Harvey) (Dormant)
- 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.

- Subproject: Storage optimum temperature and humidity.  
 Subproject: Length of holding in storage in relation to stage of maturity of fruit.  
 Subproject: Ripening in storage.

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

- Subproject: Temperature as a factor in self-fertility. (Dormant) (Closed)  
 Subproject: Effect of fertilizer treatments upon self-fertility. (Dormant) (Closed)  
 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.  
 Subproject: Salt nutrition.

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

- Subproject: Weed seed cases. (Dormant)  
 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, F. C. Fountaine, C. P. Fitch, W. L. Boyd, L. D. Matterson) (Purnell)

- Subproject: The calcium and phosphorus requirements for maintenance and for maintenance-plus-milk production in dairy cattle. (Dormant)  
 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. (Dormant)

Subproject: The relationship of the skeletal reserves of calcium and phosphorus laid down during growth to the future productiveness of dairy cows.

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 necessity for and the advantages of adding mineral supplements to typical dairy rations fed in Minnesota and the proper basis for the economic evaluation of the most common forms when their use is necessary or advantageous. (Dormant) (Closed)

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 Frascch Foundation) (New)

Subproject: The sulfur compounds of plants, their formation and intermediary products in the plant, and their role in plant metabolism. (R. A. Gortner, C. H. Bailey)

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. (C. H. Bailey, G. S. Taylor, W. F. Geddes, J. L. Jensen)

103. Investigations of proposed official methods of analysis.

- Subproject: Determination of flour pigments. (W. F. Geddes)  
 Subproject: Experimental baking methods. (C. H. Bailey, O. E. Stenberg)

104. The strength of wheat flour. (Adams)

- Subproject: Effect of flour and dough constituents on flour strength.  
 (a) Wheat protein survey. (C. H. Bailey)  
 (b) Effect of wheat type, protein content, and malting conditions on the properties of malted wheat flour. (W. F. Geddes, C. H. Bailey)  
 (c) The relation between diastatic activity and flour gassing power. (W. F. Geddes, P. Noznick)  
 Subproject: Role of enzymes in flour strength. (W. F. Geddes, L. F. Jents, C. H. Bailey)

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

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. (W. F. Geddes, P. P. Merritt, C. H. Bailey)

Subproject: Baking and macaroni manufacture.

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

(b) Determination of flour absorption. (C. H. Bailey, O. E. Stamberg, P. P. Merritt)

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

(a) Carotinoid pigment content of wheat varieties. (W. F. Geddes, C. H. Bailey)

(b) Relation between carotinoid pigment content of wheat and flour. (W. F. Geddes)

(c) Carotinoid pigment content of durum wheats. (W. F. Geddes)

(d) Relation between protein content, apparent specific gravity, and test weights per bushel of wheat varieties. (W. F. Geddes, P. P. Merritt)

(e) A chemical method for the determination of moisture in cereal products and dry milk powders. (C. H. Bailey, O. E. Stamberg)

(f) Viscosity of starches as determined by the amylograph. (W. F. Geddes, C. Anker)

Subproject: Dough ingredients other than wheat products.

(a) Factors involved in the heat improvement of milk for baking purposes. (C. H. Bailey, O. E. Stamberg)

(b) Dry milk solids in cake making. (C. H. Bailey, O. E. Stamberg)

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

Subproject: Development of experimental techniques.

Subproject: Industrial quality of varieties.

Subproject: Inheritance of drying properties.

Subproject: Biochemistry and physiology of the flax plant.

202. Chemical and biological studies in animal nutrition.

Subproject: The fundamental food requirements of animals.

(a) Inheritance of efficiency of food utilization. (L. S. Palmer, Cornelia Kennedy)

(b) Physiological and metabolic factors related to the efficiency of food utilization for growth. (L. S. Palmer, Cornelia Kennedy, Paul Westwig, Richard Luecke)

(c) Efficiency of metabolism for maintenance of mature animals differing in efficiency of food utilization for growth. (L. S. Palmer, Cornelia Kennedy, C. O. Lohn)

Subproject: A study of the nutritive value of fresh-water plants. (L. S. Palmer, J. W. Nelson) (Closed)

Subproject: A comparison of chemical and biological methods for determining nutritive value of proteins. (L. S. Palmer, F. C. Olson) (Closed)

Subproject: The use of the flour beetle (*Tribolium confusum* Duval) in nutrition research. (Dormant)

Subproject: Studies on the availability of calcium in foods. (Dormant)

Subproject: Calcium and phosphorus nutrition of growing horses. (Cooperative with the Division of Animal and Poultry Husbandry and the Division of Veterinary Medicine) (L. S. Palmer, A. L. Harvey, H. C. H. Kernkamp)

Subproject: The effect of additions of protein concentrates to a ration of prairie hay and salt upon the growth and breeding efficiency of yearling ewes. (Cooperative with the Division of Animal and Poultry Husbandry) (Dormant)

Subproject: A study of day to day variations in Ca, inorganic P, and phosphatase in whole blood and plasma of dairy cows. (L. S. Palmer, J. W. Nelson)

Subproject: Studies on biochemical and nutritional factors causing bladder stones in wethers. (Cooperative with the Division of Animal and Poultry Husbandry) (L. S. Palmer, D. W. Johnson, J. W. Nelson) (Closed)

Subproject: Studies on biological methods for assay of vitamin B<sub>1</sub>. (L. S. Palmer, Cornelia Kennedy) (Closed)

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, C. L. Hankinson)

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

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, C. L. Hankinson)

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, B. B. Migicovsky, Wayne Kielley) (Bankhead-Jones) (New)

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

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

Subproject: The 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. (W. M. Sandstrom, H. V. Lindstrom)

Subproject: Selenium analysis of cystine and the organic selenium compounds in plants. (R. A. Gortner, E. P. Painter)

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

Subproject: The effects of djenkolic acid and of thiozolodine-4-carboxylic acid on humin formation. (W. M. Sandstrom, H. A. Lillevik)

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

Subproject: The preparation of salmin and salmon nucleic acid. (W. M. Sandstrom, H. V. Lindstrom)

Subproject: The action of the Grignard reagent on proteins and amino acids. (R. A. Gortner, F. L. Greenwood)

## 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)

(c) The influence of sol-gel transformation on the cataphoretic migration velocity of coarse particles. (R. A. Gortner, H. Freundlich, M. Fishman)

Subproject: The properties of matter in a state of orientation.

(a) Studies on the adsorption of organic substances (dyes and, in particular, enzymes) on various grades and makes of filter papers. (R. A. Gortner, D. R. Briggs, K. E. Dykoski)

(b) Dielectric constant studies. (R. A. Gortner, D. R. Briggs)

(c) Protein films on starch as affecting diastatic values. (R. A. Gortner, Carl Hamalainen)

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

(a) Changes in the length-diameter ratio of tung oil molecules during the bodying processes indicated from viscosity studies on solutions of the oil in carbon tetrachloride. (D. R. Briggs, J. P. Hollihan)

(b) Studies in the electroviscous effect. (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) (R. A. Gortner, Henry Schmitz, A. J. Bailey) (Bankhead-Jones)

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

(2) The mode of formation of lignin sulfonic acid in sulfite cooks. (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 amount, chemical composition, and state of occurrence of the lipids present in starch from the seed of *Zea Mays*. (D. R. Briggs, J. W. Evans)

(2) Studies on the oxydative properties of oils and fats, together with an investigation of influences of various antioxidants and inhibitors upon the oxydative process. The natural antioxidants in vegetable oils. (D. R. Briggs, En Chu Yen)

(3) 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 1-sorbose. (W. M. Sandstrom, Sister M. Urban Stuart)

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

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

(4) Studies on pepsin. (W. M. Sandstrom, F. D. Mann)

## 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, Northwest, and West Central experiment stations) (F. J. Alway, G. H. Nesom, Irene Mattson)

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

105. Movement of water in soils. (F. J. Alway, E. V. Miller) (Adams)

106. Peat soils. (F. J. Alway, Irene Mattson)

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

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)
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, K. A. Maehl)
114. Soil-erosion factors. (C. O. Rost, C. A. Rowles, 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, H. W. Kramer) (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, and the Health Service of the University of Minnesota) (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.
- 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, Olga Dorn)
- 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 (formerly "A study of the serviceability of woven materials used for men's and women's underwear"). (Ethel L. Phelps, Gypsy Frankenberg, Anne Becchetti, Clarice Engstrom)
106. A study of the qualities of meat which affect its palatability, methods of cooking, and utilization. (Isabel T. Noble, Margaret V. Davis, Ruth Carr) (Bankhead-Jones)
- Subproject: A study of juiciness, tenderness, and flavor of meat.

107. A survey of purchasing habits in the selection of silk street dresses. (Ethel L. Phelps) (Purnell) (Closed)
109. A study of the culinary quality of Minnesota potatoes. (Cooperative with the Northwest and North Central experiment stations) (Isabel T. Noble, Margaret V. Davis, Frances J. Major) (Bankhead-Jones)
110. Quality and utilization of Minnesota fruits. (Cooperative with the Division of Horticulture) (Isabel T. Noble, Lillian Norvold) (Bankhead-Jones)
- Subproject: A study of Minnesota varieties of apples.
- Subproject: A study of Minnesota varieties of plums.
- Subproject: A study of Minnesota varieties of grapes.
112. A study of the properties and serviceability of cotton materials used for professional garments. (Ethel L. Phelps, Marion Fuller, 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, Catherine Barrett Mulvehill, 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)
- (1) Proportion of roughage to grain for yearling steers. (Closed)
- (2) Soybean products as a protein supplement for fattening cattle.
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) (Bankhead-Jones) (New)
302. Sheep feeding. (Cooperative with the West Central Experiment Station) (W. H. Peters, P. S. Jordan)
- Subproject: Self-feeding fattening lambs. (Closed)

304. A study of the inheritance and the relative economic advantages of single- and twin-lamb production. (Cooperative with the Northwest Experiment Station) (O. M. Kiser, L. M. Winters) (Closed)
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)
404. A study of the cause of the unpalatability of rye. (Cooperative with the Division of Agricultural Biochemistry) (D. W. Johnson, L. S. Palmer)
410. Feeding scabby barley to pigs. (Cooperative with the Division of Plant Pathology and Botany) (E. F. Ferrin, J. J. Christensen) (Closed)
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.
- Subproject: The value of alfalfa hay when added to a ration of shelled corn and creamery buttermilk. (Dormant)
- Subproject: A comparison of pasture crops and creamery buttermilk as sources of protein for growing pigs.
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) (Dormant) (New)
501. Genetic reactions in the fowl as influenced by various systems of breeding. (Cooperative with the West Central, Northwest, and Northeast experiment stations) (H. J. Sloan, A. W. Edson, A. M. Pilkey, A. F. Dahlberg, T. H. Canfield, H. G. Sandhoff) (Bankhead-Jones)
- Subproject: Continuous full brother-sister matings.
- Subproject: Continuous half brother-sister matings.
- Subproject: A closed flock.
- Subproject: A flexible system of inbreeding.

503. The use of distillers' feed as a supplement in poultry rations. (Cooperative with Hiram Walker & Sons, Inc.) (H. J. Sloan)
- Subproject: The use of distillers' feed in rations for growing chicks.
- Subproject: The use of distillers' feed in rations for laying and breeding hens.
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, Catherine Barrett Mulvehill, R. E. Comstock, W. W. Green, J. J. Bulik, I. C. Brady) (Adams, Purnell, Bankhead-Jones)
- Subproject: The prenatal development of the bovine and the sheep. (Catherine Barrett Mulvehill)
- Subproject: The physiology of the sperm cell. (R. E. Comstock, A. W. Nordskog)
- Subproject: The cytology and chemical analysis of the sperm cell. (W. W. Green, I. C. Brady)
- Subproject: Artificial insemination. (W. W. Green, R. E. Comstock)
- Subproject: Environmental factors affecting sperm production. (R. E. Comstock, W. W. Green, A. W. Nordskog)
- Subproject: Variations in male hormone production and its relation to fertility. (W. W. Green, D. F. Jordan)

### Dairy Husbandry

12. A genetic study of the bovine. (Cooperative with the Division of Animal and Poultry Husbandry and the Division of Agricultural Biochemistry) (W. E. Petersen, A. A. Spielman, 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, Harold Macy, A. G. Karlson) (New)
- 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 Division of Agricultural Biochemistry and the Northwest and West Central experiment stations) (N. N. Allen, W. E. Petersen, J. B. Fitch)
- Subproject: Sweet-clover pasture experiments. (Dormant)



- Subproject: Acid preservation of silage. (Cooperative with the Division of Agricultural Biochemistry)  
 Subproject: Reed canary grass hay as feed for dairy cows.  
 Subproject: Pasture studies with dairy cows.
103. Food requirements for cattle. (T. W. Gullickson, J. B. Fitch, F. C. Fountaine, A. A. Spielman)  
 Subproject: The maintenance requirements of mature cows. (Dormant)  
 Subproject: Problems in calf raising.  
 Subproject: The protein requirements of cattle.  
 Subproject: Normal growth of dairy cattle.  
 Subproject: Problems in raising dairy heifers.
104. Factors influencing the quantity and quality of milk. (W. E. Petersen, N. N. Allen, J. B. Fitch)  
 Subproject: Blood-fat studies.  
 Subproject: The effect of food fat upon milk fat.  
 Subproject: Feed and barn odors and flavors in milk.
107. 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)
108. A study of the blood precursors of milk. (Cooperative with the Division of Veterinary Medicine and the Department of Physiology) (W. E. Petersen, J. C. Shaw, J. B. Fitch, W. L. Boyd, M. G. Visscher, L. T. Samuels, T. M. Ludwick) (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)
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, S. A. Lear) (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) (Dormant)
212. Investigations concerning the manufacture and utilization of cheese. (W. B. Combs, H. Macy, S. T. Coulter, J. C. Olson, Jr., J. F. Duncan, S. A. Lear)  
 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, D. I. Thompson, S. A. Lear, Hyman Love)  
 Subproject: Relation of ice cream ingredients to the market qualities of ice cream.  
 Subproject: The use of Minnesota fruits in ice cream.  
 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. Ereksen, S. A. Lear, J. C. Olson, Harold Fournelle)  
 Subproject: Methods to be used for reducing the extraneous matter in cream and for determining sediment in cream. (Dormant) (Closed)  
 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.  
 Subproject: Effect of salt upon the keeping quality of cream. (Closed)
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. (Co-operative with the Division of Veterinary Medicine) (W. A. Riley, A. B. Ereksion)
111. Insect collection. (C. E. Mickel, H. E. Milliron, H. T. Peters, H. P. Nicholson, Tamarath Knigin)  
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. Ereksion)
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.  
Subproject: Armyworms. (Dormant) (Closed)  
Subproject: Chinch bugs. (Dormant) (Closed)
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. (Dormant)  
Subproject: Fumigants.  
Subproject: Miscellaneous, as repellants, etc.

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. Ereksion) (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, A. C. Hodson, J. T. Medler)  
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. (Dormant)  
Subproject: The relation of insects to the storage rot of apples. (Dormant)  
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, J. T. Medler) (Adams)
142. Use of pollen substitutes by bees. (M. C. Tanquary, M. H. Haydak)
145. The food value of honey. (Joint project with Agricultural Biochemistry Project No. 208) (M. H. Haydak) (Dormant)
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, E. L. Thomas) (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.

151. Biological and systematic studies on the tapeworms of the genus *Hymenolepis* infecting poultry. (O. W. Olsen) (Closed)

152. Minnesota game and fur-bearing animals. (Cooperative with the Soil Conservation Service, United States Department of Agriculture; and with the State Department of Conservation) (Gustav Swanson) (New)

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, C. P. Fitch, Margaret Kelly, A. G. Karlson, J. W. Geiger, R. G. Sanders) (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: Suspicious reactors to the agglutination test for Bang's disease. (Closed)

Subproject: Causes of nonspecific abortions.

Subproject: *Corpus luteum* and its relation to the ovarian and oestral 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, C. P. Fitch, B. S. Pomeroy, M. H. Roepke, A. G. Karlson, 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 (formerly "Diagnosis of hog cholera"). (H. C. H. Kernkamp, M. H. Roepke, Florence Jones) (Purnell)

### Agricultural Economics

3. A study of adjustments in farming by type-of-farming areas, from the standpoint of agriculture and planning, including soil conservation. (Cooperative with the divisions of Agronomy and Plant Genetics, Animal and Poultry Husbandry, Dairy Husbandry, Soils, and Agricultural Extension, Minnesota Agricultural Experiment Station; and with the Bureau of Agricultural Economics and the Agricultural Adjustment Administration, United States Department of Agriculture) (S. A. Engene, G. A. Pond) (Closed)

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

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

104. An accounting study of farm organization for beef production. (Cooperative with the Division of Animal Husbandry, 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) (Closed)

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) (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)
114. Taxation in relation to agriculture. (Dormant) (Closed)
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)
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, A. M. Myrom) (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, George Wilkens) (Purnell)
127. Land utilization. (Cooperative with the Bureau of Agricultural Economics, United States Department of Agriculture) (O. B. Jesness) (Closed)
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. (Dormant)

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, B. M. Miller, B. 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, W. P. Ranney, T. R. Nodland) (Purnell)
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)
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) (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.

114. Rural community organization in Minnesota. (Lowry Nelson, E. C. McVoy, D. J. Mitchell) (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.

### Agricultural Engineering

103. Farm building ventilation. (H. B. White, L. W. Neubauer, 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, P. W. Manson, H. B. Roe, C. G. Snyder)

111. Investigation of farm buildings. (H. B. White, L. W. Neubauer, C. H. Christopherson)

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

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

Subproject: Preparation of stump land pasture. (Dormant)

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

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. (Dormant)

Subproject: Influence of frost in lifting stone.

Subproject: Land-clearing machinery.

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

Subproject: Economics of stump removal for pasture crops. (Dormant)

Subproject: Relation of livestock to brush control. (Dormant)

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. (Dormant)

Subproject: Agricultural use of explosives. (Dormant)

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, A. J. Schwantes) (Dormant)

Subproject: The wearing quality of leather and metallic belt fasteners.

Subproject: The weather-resisting qualities of different kinds of rope.

127. Plow-performance studies. (A. J. Schwantes) (Dormant) (Closed)

128. Investigations of draft and power requirements for field machinery. (A. J. Schwantes, John Strait) (Dormant)

Subproject: A study of draft and power requirements for field machinery.

129. Investigations in farm development and farm operating practices. (Cooperative with the Division of Agricultural Economics, Minnesota Agricultural Experiment Station; and with the Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture) (O. W. Howe, M. J. Thompson, A. J. Schwantes, H. B. Roe, H. B. White, G. A. Pond) (Closed)

Subproject: Progressive farm-development investigations.

Subproject: Farm-operating efficiency investigations in those Minnesota counties included in the Southeast Farm Management Service.

Subproject: Farm-operating efficiency investigations in all Minnesota counties not included in subprojects 1 and 2.

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, Evan Allred, Niels Anderson)

131. A study of the effect of deep tillage on the yield of potatoes and other root crops. (Cooperative with the Northeast, North Central, and Northwest experiment stations) (A. J. Schwantes, J. B. Torrance) (Closed)

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. (L. W. Neubauer, H. B. White, C. H. Christopherson)

135. Paint testing by exposure. (C. H. Christopherson, H. B. White, L. W. Neubauer)

#### 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, wild-fruit culture, and raspberry 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: Normal growth rates for 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, 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. Army, R. F. Crim)

Subprojects: Grain variety tests, legume studies, hay crops not legume, crop rotations, corn improvement, sunflower improvement, outlying field tests, crop succession (dormant), and seeding and cultural practices.

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. (Dormant)  
 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.  
 Subproject: Mosaic determinations. (Dormant)  
 Subproject: Date of harvest. (Dormant)  
 Subproject: Deep tillage.  
 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, C. P. Fitch, F. J. Alway, A. C. Army)

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. (Dormant)

Subproject: Pasture fertilization.

Subproject: Sunflower fertilization.

Subproject: Rutabaga fertilization.

Subproject: Fertilization of rotation plots.

Subproject: Fruit land fertilization.

Subproject: Cooperative work with county agents and Smith-Hughes instructors.

Subproject: Clover failure. (Dormant)

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, Nos. 112, 131; Agronomy and Plant Genetics, Nos. 6, 101, 102, 103, 104, 105, 107, 109, 112, 114, 120, 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 Soils, 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.

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. Treatment of fowl for internal parasites. (A. M. Pilkey) (Closed)

110. Poultry feeding investigations. (A. M. Pilkey) (Closed)

Subproject: Use of Proso millet to replace corn.

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, 304, 306, 501, 601; Dairy Husbandry, No. 102; Home Economics, No. 109; Horticulture, Nos. 304, 408; Soils, Nos. 102, 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)

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, 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. Army)

105. Crop-rotation investigations. (Cooperative with the Division of Agronomy and Plant Genetics and the Division of Soils) (F. J. Alway, A. C. Army, 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. Army)

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.....	28	28	0	2	0
Forestry .....	20	18	2	2	3
Horticulture .....	23	23	0	1	0
Plant Pathology and Botany.....	23	22	1	0	0
Agricultural Biochemistry .....	18	17	1	0	3
Soils .....	13	12	1	0	0
Home Economics .....	8	8	0	1	0
Animal and Poultry Husbandry.....	15	14	1	2	2
Dairy Husbandry .....	16	15	1	0	1
Entomology and Economic Zoology	26	25	1	1	1
Veterinary Medicine .....	3	3	0	0	0
Agricultural Economics .....	24	21	3	4	1
Rural Sociology .....	3	3	0	0	0
Agricultural Engineering .....	21	18	3	3	0
North Central Station .....	4	4	0	0	0
Northeast Station .....	6	6	0	0	0
Northwest Station .....	8	8	0	2	0
Southeast Station .....	3	3	0	0	0
West Central Station .....	7	7	0	0	0
Total.....	269	255	14	18	11



**FINANCIAL STATEMENT**

**Expenditures**

Classification	University Farm	Branch Stations					Total
		Crookston	Morris	Grand Rapids	Duluth	Waseca	
Salaries and labor .....	\$372,069.19	\$23,757.39	\$22,562.97	\$ 9,603.20	\$ 8,657.19	\$12,393.54	\$449,043.48
<sup>a</sup> Stationery and office supplies .....	3,877.28	567.44	487.19	82.99	102.93	80.73	5,198.56
<sup>a</sup> Scientific supplies .....	26,229.70	544.53	674.81	259.45	335.97	92.76	28,137.22
<sup>a</sup> Feeding stuffs .....	13,387.95	2,289.69	1,064.60	2,200.96	1,511.37	1,240.47	21,695.04
<sup>a</sup> Fertilizers .....	78.85						78.85
<sup>a</sup> Sundry supplies .....	2,535.83	1,919.54	1,908.40	840.54	813.12	1,820.97	9,838.40
Communication service .....	1,469.69	464.36	343.25	164.01	112.86	122.04	2,676.21
<sup>f</sup> Travel expenses .....	10,384.99	232.80	256.36	261.49	316.95	340.44	11,793.03
Transportation of things .....	1,507.27	330.88	174.23	57.92	9.54	111.12	2,190.96
<sup>e</sup> Printing .....	2,227.71	146.64	174.11	53.59			2,602.05
Heat, light, water, power .....	12,219.18	2,644.79	2,504.22	926.55	619.53	674.28	19,588.55
Contingent expenses .....	5,102.30	681.08	411.82	1,038.74	966.36	849.27	9,049.57
Furniture, furnishings, and fixtures.....	1,936.16	397.60	585.29	26.69	68.25		3,013.99
<sup>a</sup> Library .....	2,487.94	45.22	92.40				2,625.56
<sup>f</sup> Scientific equipment .....	11,193.86	89.99	217.64	77.28	42.63	45.27	11,666.67
<sup>g</sup> Tools, machinery and appliances.....	5,527.27	1,124.76	1,252.02	907.65	755.10	984.96	10,551.76
<sup>a</sup> Livestock .....	2,036.98	281.20	958.50	15.00	54.75	1,828.53	5,174.96
Buildings and land .....	12,373.30	2,828.91	1,269.60	541.15	230.94	636.30	17,880.20
<b>Total</b> .....	<b>\$486,645.45</b>	<b>\$38,346.82</b>	<b>\$34,937.41</b>	<b>\$17,057.21</b>	<b>\$14,597.49</b>	<b>\$21,220.68</b>	<b>\$612,805.06</b>

**FINANCIAL STATEMENT**

**Income**

Source of Revenue	University Farm	Branch Stations					Total
		Crookston	Morris	Grand Rapids	Duluth	Waseca	
Federal appropriations:							
Hatch fund .....	\$ 15,000.00						\$ 15,000.00
Adams fund .....	15,000.00						60,000.00
Purnell fund .....	60,000.00						56,797.64
Bankhead-Jones fund .....	56,797.64						
State appropriations:							
General University support .....	247,277.24	\$32,142.94	\$27,511.57	\$13,597.62	\$ 9,785.01	\$ 3,505.89	333,820.27 ✓
Special appropriations .....	50,302.76						50,302.76
Endowments, fellowships and other similar grants .....	19,091.14						19,091.14
Fees, sales, and miscellaneous .....	23,176.67	6,203.88	7,425.84	3,459.59	4,812.48	17,714.79	62,793.25
<b>Total</b> .....	<b>\$486,645.45</b>	<b>\$38,346.82</b>	<b>\$34,937.41</b>	<b>\$17,057.21</b>	<b>\$14,597.49</b>	<b>\$21,220.68</b>	<b>\$612,805.06</b>

## EXPERIMENT STATION STAFF

## The Board of Regents

The Hon. GUY STANTON FORD, President	- - - - -	<i>Ex officio</i>
The Hon. JAMES F. BELL, Minneapolis	- - - - -	1945
The Hon. DANIEL C. GAINNEY, Owatonna	- - - - -	1943
The Hon. RICHARD L. GRIGGS, Duluth	- - - - -	1945
The Hon. GEORGE W. LAWSON, St. Paul	- - - - -	1945
The Hon. ALBERT J. LOBB, Rochester	- - - - -	1941
The Hon. E. E. NOVAK, New Prague	- - - - -	1943
The Hon. A. J. OLSON, Renville	- - - - -	1943
The Hon. ALBERT PFAENDER, New Ulm	- - - - -	1941
The Hon. RAY J. QUINLIVAN, St. Cloud	- - - - -	1945
The Hon. F. J. ROGSTAD, Detroit Lakes	- - - - -	1943
The Hon. FRED B. SNYDER, Minneapolis	- - - - -	1941
The Hon. SHELDON V. WOOD, Minneapolis	- - - - -	1941

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C. H. BAILEY, Ph.D., Vice-Director
W. T. MIDDLEBROOK, A.B., M.C.S., Treasurer
T. M. MCCALL, M.S., Superintendent, Northwest Experiment Station, Crookston
T. H. FENSKE, M.S., Superintendent, West Central Experiment Station, Morris
R. L. DONOVAN, B.S., Superintendent, North Central Experiment Station, Grand Rapids
M. J. THOMPSON, M.S., Superintendent, Northeast Experiment Station, Duluth
R. E. HODGSON, M.S., Superintendent, Southeast Experiment Station, Waseca
*T. SCHANTZ-HANSEN, Ph.D., Director of the Forestry and Biological Station, Itasca Park
F. E. HARALSON, Assistant Superintendent, Fruit Breeding Farm, Zumbra Heights
H. L. HARRIS, B.S., Editor
HARRIET W. SEWALL, B.A., Librarian
R. A. GORTNER, Ph.D., Chief, Division of Agricultural Biochemistry
O. B. JESNESS, Ph.D., Chief, Division of Agricultural Economics
*A. J. SCHWANTES, C.E., Acting Chief, Division of Agricultural Engineering
H. K. HAYES, D.Sc., Chief, Division of Agronomy and Plant Genetics
W. H. PETERS, M.Agr., Chief, Division of Animal 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
E. M. FREEMAN, Ph.D., Chief, Division of Plant Pathology and Botany
F. J. ALWAY, Ph.D., Chief, Division of Soils
*C. P. FITCH, D.Sc., D.V.M., Chief, Division of Veterinary Medicine
*W. L. BOYD, D.V.S., Chief, Division of Veterinary Medicine

<sup>1</sup> Appointed February 1, 1940.

<sup>2</sup> Appointed July 1, 1939.

<sup>3</sup> Died January 11, 1940.

<sup>4</sup> Appointed March 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
*I. J. JOHNSON, Ph.D., Associate Plant Geneticist
C. R. BURNHAM, Ph.D., Associate Plant Geneticist
R. F. CRIM, B.S., Assistant Agronomist
R. P. MURPHY, B.S., Assistant in Agronomy and Plant Genetics
H. K. SCHULTZ, M.S., Assistant in Agronomy and Plant Genetics
C. R. BORGESON, M.S., Assistant in Agronomy and Plant Genetics
*E. H. RINKE, M.S., Assistant in Agronomy and 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, M.S., 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
R. M. BROWN, M.S., Assistant Forester
L. W. REES, Ph.D., Assistant Forester
*A. J. BAILEY, 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

<sup>5</sup> Resigned December 31, 1939.

<sup>6</sup> Appointed January 1, 1940.

<sup>7</sup> Resigned September 30, 1939.

<sup>8</sup> Appointed July 1, 1939.

*Section of Floriculture and Ornamental Horticulture*

L. E. LONGLEY, Ph.D., Assistant Horticulturist  
L. SANDO, Assistant in Floriculture

*Division of Plant Pathology and Botany*

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

*Section of Plant Pathology*

\*E. C. STAKMAN, Ph.D., Plant Pathologist  
J. J. CHRISTENSEN, Ph.D., Plant Pathologist  
LOUISE DOSDALL, Ph.D., Assistant Plant Pathologist  
C. J. EIDE, 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, B.S., Assistant in Plant Pathology  
I. W. TERVET, B.S., Assistant in Plant Pathology  
T. H. KING, B.S., Junior Chemist, Firestone Plantations Company Fellowship

*Section of Plant Physiology and Agricultural Botany*

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, B.S., Agent

*Division of Forage Crops and Diseases*

LAWRENCE HENSON, M.S., Agent

*Division of Fruit and Vegetable Crops and Diseases*

L. A. SCHAAL, M.S., Associate Pathologist

*Division of Sugar Plant Investigations*

ANDREW DOWNIE, B.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. T. LOEGERING, B.S., Agent

*Detailed by the State Department of Agriculture for Cooperative Work*

A. G. TOLAAS, M.S., in Charge, Office of Seed Potato Certification  
RUBY CROULEY, Seed Analyst  
J. L. LARSON, in Charge, Seed Germination  
H. C. REGNIER, Deputy, Office of Seed Potato Certification

\* Cooperating with the Division of Plant Disease Control, Bureau of Entomology and Plant Quarantine.

*Division of Agricultural Biochemistry*

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

*Section of Proteins and Colloids*

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ETHEL L. PHELPS, M.S., Associate Home Economist  
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<sup>10</sup> Appointed April 1, 1940.  
<sup>11</sup> Resigned June 30, 1940.  
<sup>12</sup> Appointed October 1, 1939.  
<sup>13</sup> Resigned June 15, 1939.  
<sup>14</sup> Resigned March 31, 1940.  
<sup>15</sup> Appointed April 1, 1940.  
<sup>16</sup> Appointed March 1, 1940.

**Division of Animal and Poultry Husbandry**

W. H. PETERS, M.Agr., Animal Husbandman  
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**Section of Animal Feeding**

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**Section of Animal Genetics**

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**Section of Poultry Husbandry**

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**Section of Dairy Bacteriology**

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**Division of Entomology and Economic Zoology**

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<sup>17</sup> Resigned June 30, 1940.

<sup>18</sup> Resigned June 30, 1940.

<sup>19</sup> Appointed July 1, 1939; resigned December 31, 1939.

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**Rural Sociology**

LOWRY NELSON, Ph.D., Rural Sociologist

**Division of Agricultural Engineering**

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**Section of Farm Power and Machinery**

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**Section of Farm Structures**

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 L. W. NEUBAUER, M.S.C.E., Assistant in Agricultural Engineering

<sup>20</sup> Died January 11, 1940.

<sup>21</sup> Appointed July 26, 1939.

<sup>22</sup> Appointed July 1, 1939.

<sup>23</sup> Appointed December 16, 1939.

<sup>24</sup> Resigned September 30, 1939.

<sup>25</sup> Appointed April 1, 1940.