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Report of Progress in Solving Idaho's Farm Problems



Forty-seventh Annual Report for the Year
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Foreword

C. W. HUNGERFORD, *Vice Director*

THIS is the Forty-seventh Annual Report of the Idaho Agricultural Experiment Station. Each year a progress report is printed in order to summarize the results of the agricultural investigational program for the farmers of Idaho and for the use of investigators in the field of agriculture outside of the State. These investigations have been outlined to meet the needs of the Idaho farmers and to answer perplexing practical farm problems, as well as to contribute to fundamental research, which will form the basis for successful farming in the future.

This report has been written primarily for the farmers of Idaho, and each of the 12 departments of the Experiment Station has something to contribute toward better farming in the State. The report is divided under the headings: Beef Cattle, Horses, Sheep, and Swine; Dairy Production and Manufacturing; Poultry; Crops, Crop Breeding, and Soils; Fruit and Vegetable Crops; Agricultural Engineering; Farm Economics; Agricultural Bacteriology; Agricultural Chemistry; Insects; Plant Diseases; Nutrition; Utilization of Agricultural By-products; and reports of the work on the branch stations at Aberdeen, Caldwell, Sandpoint, and Tetonia. If you wish more detailed information regarding any of the projects discussed in this report, address the Idaho Agricultural Experiment Station, Moscow.

Report of Progress in Solving Idaho's Farm Problems

Introduction

THERE is nothing static about agricultural research. As in all scientific investigations, research in agriculture presents a constantly changing picture. New conditions present new problems. New agencies of our Federal and State governments call for new programs and new projects in order to coordinate more closely research efforts of all agencies to assist in solving important farm problems.

There is no panacea for all the ills of agriculture. Agricultural research has produced results which form the basis for progress in agriculture, and curtailment of this investigational program will cut off the source of supply of information so essential for both agricultural extension and the action programs.

During 1939, the members of the Idaho Agricultural Experiment Station research staff have inaugurated several new investigations. Some of these are primarily of local significance. Others of regional scope have been undertaken in cooperation with various Federal agencies.

Cooperative agreements with the Soil Conservation Service have been perfected, and three research projects have been approved and research started. These are: "Soil and Water Conservation and Hydrologic Investigations," under the leadership of Joseph P. Bonner; "Effect of Cropping Systems on Erosion Control," under the leadership of Hugh McKay; and "Seed Production of Grasses and Legumes Suitable for Soil and Moisture Conservation," with Russell Stark in charge. Mr. McKay and Mr. Stark have their headquarters at the Branch Station near Aberdeen, and these lines of research will be carried on in southeastern Idaho.

A bacterial disease of potatoes known as ring rot—new to Idaho—has been found recently rather generally distributed throughout the southern part of the State. A research fellowship has been established, sponsored by the Union Pacific Railroad, to investigate this disease and methods for its control. Mr. Edward Graves from the University of California has been engaged to assist in this new research project.

Recent evidence indicates that the soils of certain parts of northern Idaho are deficient in boron. The departments of Agronomy and Plant Pathology are investigating this problem and have established the fact that small amounts of boron, in the form of borax added to the soil, will help to correct yellowing and stunting of alfalfa plants and the condition known as drouth spot of apples.

Other projects which have been inaugurated during the year include: studies involving diseases of peaches, prunes, and other stone fruits; chronic swine erysipelas; the influence of irrigation

upon soil fertility; stabilized soil mixtures for farm roads and walks, and for footings, floors, and foundations for farm buildings; swine progeny testing and improvement; economic status of dry-land farms in eastern Washington county, and in Teton and Madison counties; effect of movement and distribution of irrigation on field crops; and germination, stand, and yield of seed potatoes planted at different dates as affected by temperatures and methods of handling immediately prior to planting. Various departments of the Experiment Station in cooperation with Federal agencies have cooperated with farmer groups in Land Use Planning research in Idaho during the past year. These studies are destined to assist materially in giving basic information necessary in making land use adjustments.

Time is an important element in all research. A large industrial company recently reported that 6 years was the average time elapsing between the beginning of new research projects in its laboratories and the obtaining of results which might be put to practical use. Many important projects on the Idaho Agricultural Experiment Station program are long-time projects which must be continued for many years and modified from time to time to meet changing conditions. Animal and plant breeding and improvement studies, crop rotations, feeding investigations, certain plant disease and insect studies, and vitamin investigations are problems of this character. Results from time to time may warrant recommendations, but the field of investigation may still be promising for further research.

Progress in Farm Research

The purpose of our agricultural research program is to help farmers meet problems which confront them. The hazards of farming, both in producing and marketing are many, and research has been the bulwark against these hazards and the source of information for the solution of farm problems for many years.

The fact that Idaho farmers realize this condition is indicated by the requests from farmers that our main station at Moscow and our branch stations at Aberdeen, Caldwell, Teton, Parma, and Sandpoint undertake research into new and perplexing problems threatening Idaho agriculture. Many of these requests must be denied because of lack of funds. Money available from Federal funds supplemented by a small State appropriation and by money received from the sale of livestock and crops produced on the Experiment Station farms is used to support agricultural research in Idaho. These funds must be made more adequate if the research program demanded by the farmers of Idaho is to be realized.

The reports which follow have been written by the research workers in the 12 departments of the Agricultural Experiment Station and by the superintendents of the Branch Stations. These reports are presented primarily to acquaint citizens of Idaho with the results of agricultural research in this State and in order that farmers may apply the results of these investigations to their own

farm conditions. Further detailed information will be supplied upon request.

Beef Cattle, Horses, Sheep, and Swine

Phosphorus Requirement for Fattening Steers Supplied by Home-grown Feeds

FROM a practical livestock feeding standpoint, research for the past 3 years on the phosphorus requirement of steers has shown that the phosphorus needs may be met by the proper use of home-grown feeds, such as alfalfa hay and grain. The results of



Figure 1.—Phosphorus-deficient steer. Fed on a low phosphorus ration containing 0.11 per cent phosphorus.



Figure 2.—Phosphorus-normal steer. Fed identically the same ration as the above steer (Figure 1) excepting ample phosphorus was provided (0.18 per cent phosphorus in ration).

these experiments have consistently shown that a steer calf requires approximately 2 grams of feed phosphorus daily per 100 pounds of liveweight. Therefore, it may be assumed for all practical purposes that the requirement for yearling and 2-year-old steers may be amply met by feeding the same amount of phosphorus per unit liveweight. In fact, the phosphorus requirement per unit body weight no doubt declines with maturity. Research is in progress at the Caldwell Branch Station to determine the minimum phosphorus requirement for fattening yearling cattle.

The phosphorus requirement may be met by feeding calves about 12 grams, yearlings 16 grams, and 2-year-old steers 20 grams of phosphorus daily.

Furthermore, the data have shown that rations containing 0.15 per cent or less phosphorus are definitely too low in this element to satisfy the growth and fattening needs of steers. Figures 1 and 2 illustrate very distinctly the effect of a low phosphorus ration on the condition and general thrift of steers. These steers were fed on rations containing the same amount of feed nutrients, excepting phosphorus. Wet beet pulp, molasses,

various kinds of straw and meadow hay contain less than 0.15 per cent phosphorus and, therefore, are definitely deficient in this mineral.

In fattening cattle a ration that is made up principally of beet pulp and molasses is most likely to be deficient in phosphorus, unless alfalfa hay is fed at about 2 pounds per 100 pounds of liveweight or the molasses is replaced with barley. This is the type of ration which produces aphosphorosis unless precaution is taken in amply supplementing it with feeds that are fair sources of phosphorus, such as alfalfa hay, grain, or cottonseed cake. Sufficient phosphorus is always provided when over half of the dry matter content of the ration is made up with these feeds. If phosphorus is the only food element lacking in the ration, this may be supplied economically by supplementing the grain mixture with $\frac{1}{2}$ per cent of steamed bonemeal or feeding 7 pounds of bonemeal daily per 100 steers, or giving the steers free access to a mineral mixture of 2 parts of bonemeal and 1 part of salt.

Cattle wintered for long periods on barley, oat, pea, bean, or wheat straw or meadow hay may become deficient in phosphorus if the daily ration is made up of any one or a combination of these feeds. To correct this deficiency, half of the phosphorus-low roughage should be replaced with alfalfa hay or the cows given free access to a mineral mixture of 2 parts of bonemeal and 1 part of salt.

Further interpretation of these results shows that the phosphorus requirement for beef cattle may be satisfied by feeding the following amounts of any of these feeds or feed combinations daily per 100 pounds of liveweight: 2.0 pounds of alfalfa hay; 1.0 pound wheat; 1.2 pounds barley; .03 pound steamed bonemeal; 1 pound of alfalfa hay plus 1 pound of grain; 1.5 pounds of alfalfa hay plus 0.50 pound grain; 1.0 pound of alfalfa hay plus 0.2 pound of cottonseed meal; 1.0 pound of feed straw plus .025 pound steamed bonemeal.

It required on an average about 60 days in the feed lot to produce typical symptoms of aphosphorosis, which brings out the fact that steers may be fed on rations low in phosphorus for short periods without apparent harmful effects, but feeding for longer periods on phosphorus-low rations causes distinct losses in weight and finish. (*W. M. Beeson, C. W. Hickman, D. W. Bolin, R. F. Johnson, E. F. Rinehart*)

Phosphorus Needs of Lambs May Be Met By Alfalfa Hay

For the past 3 years (1937-39) results repeatedly have shown that the phosphorus requirement for lambs can be amply satisfied by farm-grown feeds when alfalfa is used as the roughage or a cereal grain as the concentrate. Beet pulp is deficient in phosphorus, but lambs fed about 2 pounds of alfalfa hay per head daily will ingest ample phosphorus from this single source. Since the common Idaho lamb fattening ration contains large quantities of alfalfa hay, there is little danger of aphosphorosis occurring.

In 1938-39 at Caldwell, six lots of feeder lambs were fed 140 days on rations varying in phosphorus level from 0.11 to 0.23 per cent. The low phosphorus ration was composed of dry molasses beet pulp, 65.14 per cent; chopped alfalfa hay, 26.00 per cent; blood meal, 7.00 per cent; ground oyster shell, 1.36 per cent; and salt, 0.50 per cent. This mixture was fed according to the appetite of the lambs, plus 1 pound of corn silage per lamb daily. Some of the results were:

1. Lambs receiving a ration containing 0.11 per cent phosphorus developed aphosphorosis as indicated by slower gains, higher feed requirement, and low blood phosphorus levels. These lambs were ingesting only 1.24 grams of phosphorus daily.

2. The phosphorus requirement of lambs was met by rations containing from 0.135 to 0.226 per cent phosphorus. Lambs ingesting 1.70, 2.07, 2.55, and 2.80 grams of phosphorus daily made practically the same gains and maintained a normal blood phosphorus.

3. These data indicate that the minimum phosphorus requirement for fattening lambs in Idaho is approximately 0.135 per cent of the ration or a daily intake of 1.59 grams per lamb.

4. Three years of research has shown that sheep do not require as high a percentage of phosphorus in the ration as cattle to meet their body requirements, but they require about the same amount per unit of liveweight. This may be explained on the basis that sheep eat a larger percentage of feed in proportion to their liveweight, and, therefore, may ingest more of this element per unit liveweight on a lower phosphorus per cent in the ration. (W. M. Beeson, C. W. Hickman, D. W. Bolin, R. F. Johnson, E. F. Rinehart)

Effect of Maturity upon the Chemical Composition of Balsam Root and Blue Bunch Wheatgrass

A very detailed study was made on the variation in the composition of arrowleaf balsam root, *Balsamorhiza sagittata*, and blue bunch wheatgrass, *Agropyron spicatum*, at different stages of maturity in order to observe more closely the changes in plant composition and to determine more clearly the significance of the results already obtained on plant analysis. These are two of the major forage species found on Idaho ranges.

Balsam root is a tufted perennial of the sunflower family. It begins growth and produces flowers early in the spring, which makes it a valuable forage plant on spring ranges. This plant has a fair palatability for all classes of range livestock. Blue bunch wheatgrass is a perennial, drought-resistant and frequently constitutes the bulk of the spring, summer, and fall range forage. It is very palatable for range stock, except when it has not been grazed for a year or two so that the old growth is rank and tough.

The plants for the study were collected by the U. S. Forest Service and the results presented here for each of the species represent a collection of 20 plants each from 6 different plots,

making a total of 120 plants. Clippings were made at five different stages of maturity.

The protein and phosphorus percentages of balsam root decreased very rapidly with maturity, and crude fiber and calcium percentages increased with maturity. The same trend holds true for blue bunch wheatgrass, but the per cent decreases in protein and phosphorus and the per cent increase in crude fiber and calcium is more gradual as the season progresses in comparison with balsam root. Analyses were made by the Department of Agricultural Chemistry.

This difference between the balsam root and the wheatgrass may possibly be explained by the fact that the balsam root matures faster than the grass, and also in the early stages of growth of a grass, stooling takes place which produces a new young growth.

The calcium-phosphorus ratio widens with maturity which leads to a poor utilization of the minerals present, thus making mature plants more likely to be deficient in phosphorus. (*D. W. Bolin, W. M. Beeson, C. W. Hickman*)

Fall and Winter Range Plants Found to be Low in Phosphorus

Table 1 gives analysis of 682 species samples of weeds, browse, and grasses and shows a definite seasonal variation in the protein, calcium, and phosphorus content.

The analysis of palatable forage available for livestock feed on the fall and winter ranges definitely shows a deficiency of phosphorus but ample calcium. The average phosphorus content of 0.084 per cent as found in winter plants is too low a level to satisfy the phosphorus requirement of range stock. Studies at this Station have shown that beef cattle and sheep eating a feed containing 0.14 per cent or less phosphorus manifest clinical symptoms of aphosphorosis. The calcium-phosphorus ratio of winter forages is extremely wide, especially in weeds and browse, with tends to upset the mineral balance and bring on a mineral deficiency more rapidly.

Further interpretation of the analyses, (*Table 1*) from the standpoint of the natural forage supplying ample minerals and

Table 1.—Seasonal variation in the composition of range plants
1936-37-38-39

Type of Plant	No. of samples	No. of species	Protein per cent	Calcium per cent	Phosphorus per cent	No. of samples	No. of species	Protein per cent	Calcium per cent	Phosphorus per cent
Spring range						Early summer range				
Weeds	31	18	19.6	1.33	.371	61	16	19.7	1.27	.400
Browse	22	10	18.4	.83	.276	75	6	15.6	1.04	.320
Grass	74	9	12.9	.40	.195	49	10	13.4	.42	.210
Late summer range						Fall and winter range				
Weeds	110	7	9.4	2.09	.270	19	8	6.2	1.74	.094
Browse	98	5	11.8	1.62	.300	37	13	8.3	1.10	.111
Grass	52	9	7.2	.42	.140	54	17	3.9	.28	.046

protein for range stock, indicates that sufficient protein, calcium, and phosphorus is provided by the natural forage plants on the spring and summer ranges. Although the average composition of the late summer forages is ample in phosphorus, the grasses are too low in phosphorus (0.14 per cent) to meet the body requirement in case stock are feeding solely on grasses. There was a very definite reduction in protein and phosphorus and an increase in the calcium, as the season advanced. However, the change in the plant nutrients during the summer grazing period was not of sufficient magnitude to cause any malnutrition among the livestock on these areas.

The fluctuation in the protein content of the forage paralleled the phosphorus changes. From spring to winter the average protein content dropped from a maximum level of 16.9 per cent to a minimum content of 6.1 per cent. In the event of a necessarily long fall and winter range feeding period, a protein concentrate should be advantageous in providing the protein and phosphorus needed to supplement the winter forage.

These data show that weeds and browse have a higher percentage of protein, calcium, and phosphorus than grasses. Furthermore, browse is the best provider of mineral elements, especially during the winter grazing season.

Research is in progress to study seasonal variation in the phosphorus content of blood of range sheep and cattle to determine if a phosphorus deficiency exists among range stock. (*W. M. Beeson, C. W. Hickman, D. W. Bolin, E. F. Rinehart*)

Frequency of Nursing and Number of Pigs Influences Milk Production in Sow

Data have been secured from 43 lactations involving 35 sows of the Poland China and Duroc breeds. Some sows have been tested for more than one lactation. Daughter-dam comparisons, which have been made for as many as six generations, indicate that there is a variation between families.

The duration of each test was over an 8-weeks lactation period, and the test has been conducted 6 different years on spring litters only. The age of the sows varied from 1 to 8 years with 2- and 3-year-old sows producing the most milk while suckling their second, third, and fourth litters. The litter size varied from 2 to 11 pigs. The number of pigs directly influenced the total milk production. The natural nursing frequency was found to be approximately once every hour, with a variation of from 15 to 30 minutes immediately after birth to 2 to 3 hours at 8 weeks of age. Sows on a 1-hour nursing frequency gave approximately one-third more milk daily than those on a 2-hour frequency.

The average daily milk production for 43 lactations was 11.7 pounds per sow. The average composition of the constituents in sows' milk was total solids, 16.35 per cent; lactose, 5.28 per cent;

fat, 5.29 per cent; protein, 4.86 per cent; ash, 0.923 per cent; calcium, 0.216 per cent; and phosphorus, 0.125 per cent. (*Wade Wells, W. M. Beeson, D. E. Brady*)

Electrical Stimulation May Be Used for Collecting Semen from Old Rams

Investigations on artificial insemination have necessitated the use of various methods of collecting semen from rams. Three methods have been studied: (1) from the vagina of the ewe, (2) with the artificial vagina, and (3) by electrical stimulation of the ejaculate. It was found that the use of the artificial vagina generally serves as the most successful method of collecting semen from rams and that collection from the vagina of the ewe is generally least satisfactory. The electrical stimulation method has a very definite use in experimental work or in collecting semen from rams unable to serve the ewe.

During the breeding season of 1938, semen was collected by electrical stimulation from an imported Hampshire ram that was unable to complete the mating act. Twenty-two ewes were inseminated at 28 heat periods resulting in 16 conceptions and 21 lambs. This gave a ratio of 1 conception to 1.7 heat periods which is a comparable ratio to that found in natural service (*See Figure 3*).

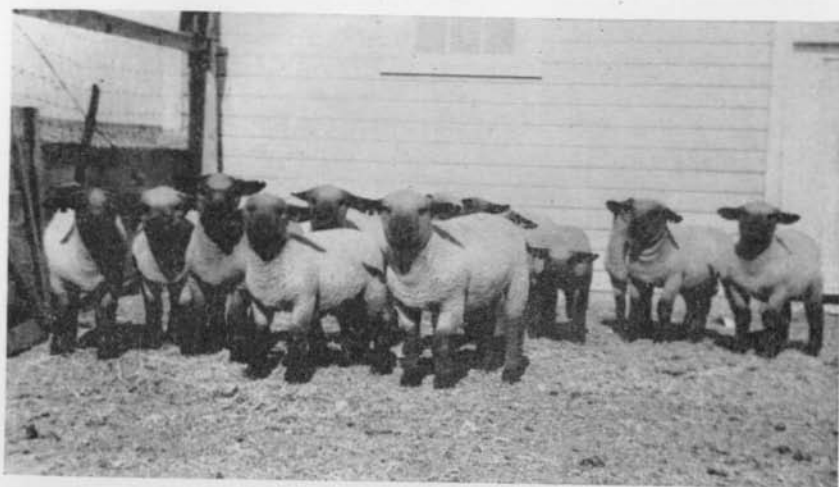


Figure 3.—Hampshire lambs produced by artificial insemination at the University of Idaho.

The work dealing with artificial insemination of ewes with semen transported from the U. S. Sheep Experiment Station at Dubois, Idaho, and from Beltsville, Md., which has been reported previously, was continued during the past year. Considerable information regarding proper methods of carrying on this type of work has been accumulated. (*D. E. Brady, E. M. Gildow*)

Swollen Joints in Pigs may be Caused by Erysipelas Organism

A study of swine erysipelas in Idaho in cooperation with the Department of Bacteriology has revealed that swine erysipelas is present in certain sections of the State. It has been found that many chronic cases of this disease are manifested mainly by arthritis, or enlargement of the joints, as seen in the accompanying photograph.



Figure 4.—Pig affected with chronic arthritis, which may be due to swine erysipelas organism. Note swelling of the knee (carpal) joints and of the hocks (metatarsal) joints.

Swine erysipelas may be seen in three forms: First, the acute septicemic type in which the animals die after a severe, brief illness; second, the skin form in which diamond-shaped patches develop on the skin and may become necrotic and dry, and then slough off; third, the chronic type which may be associated with joint lesions. Heart lesions are occasionally present in the chronic form. Care should be taken to prevent the introduction of such diseased pigs to a farm as the elimination of the infection from diseased premises is difficult.

At present studies are in progress to determine the extent of the disease in Idaho and the most practical methods of raising healthy swine on formerly infected premises. Also being studied are the most satisfactory methods of diagnosing the condition and to determine if arthritis in pigs is caused by the swine erysipelas organism. (*E. M. Gildow, W. M. Beeson, G. C. Holm, R. L. Griffith*)

X-Ray Treatment for Mastitis in Cows

The use of X-ray treatments at daily intervals for acute and chronic mastitis has been tried at this Station in cooperation with the Department of Dairy Husbandry. Two cows were used in the study, one Holstein and one Jersey. The udders were milked out previous to treatment.

The use of 85 to 90 K.V. at 5 M.S., using a 1.5 mm. aluminum filter at 20 inches for 15-minute exposure over 15 days, did not eliminate the long chain streptococci, *Streptococcus mastitidis*, from any affected quarter.

In the chronic case (Holstein No. 55) the milk returned to normal macroscopic consistency and the affected quarter became soft, but on autopsy, the quarter showed considerable fibrosis, many buckshot-sized abscesses and a decrease in *parenchymatous* tissue.

In the acute case (Jersey No. 142) the secretion became scant and remained flaky in all three affected quarters. Distinct atrophy of the parenchyma of all affected quarters was evident at autopsy.

No apparent injury in the skin of the udder of the Holstein was present, but in that of the Jersey it was thickened and inflamed. (*E. M. Gildow, W. V. Halversen, D. L. Fourt, V. A. Cherrington*)

Dairy Production and Manufacturing

Continuous Use of Proved Sires Maintains Good Type and High Production in Holstein and Jersey Herds

THE Jersey and Holstein-Friesian herds owned by the University of Idaho each qualified during the year for the highest honor awarded by the respective national breed associations. Progressive Breeders' Registry Certificate No. 2 was awarded by the Holstein-Friesian Association of America, and the American Jersey Cattle Club awarded for the third consecutive year, the Constructive Breeders' Registry Certificate. The University of Idaho dairy herd is the only college herd in America where both herds have qualified for these high awards. Qualification is based on combined high achievement in production, type, number of animals bred by owner, and the observance of a satisfactory disease control program. These awards are the result of continuous use of proved sires.

Both herds are accredited as free of tuberculosis and Bang's disease, and were reclassified for type during the year with an average score for type of slightly higher than "Good Plus." During 1939, the average herd production, including dry cows, of the combined Jersey and Holstein-Friesian herds was 12,608 lbs. of milk and 482 lbs. of fat for 43.1 cows, calculated on a cow-year basis. The Holstein herd of 27.1 cow-years produced an average of 521.5 lbs. fat, and the Jersey herd of 16.0 cow-years produced an average of 416 lbs. of fat.

The success of the proved sire program is well indicated by the production records, presented in Table 2, from the foundation cows through five successive crosses of proved sires of the Holstein-Friesian herd. The data show the trend of average production from the 14 original cows in the herd in 1921. All were yearly Advanced Registry records made by first lactation heifers, without selection, milked three times daily and adjusted to mature basis for comparison. (*D. L. Fourt*)

Table 2.—Production records in the Holstein-Friesian herd showing the influence of proved sires

	No. cows	Lb. fat
Original cows.....	14	541
First cross.....	26	612
Second cross.....	33	684
Third cross.....	39	697
Fourth cross.....	27	686
Fifth cross.....	6	701

Stud Bull Associations Successful and Popular

At present ten stud bull associations owning 50 bulls and servicing 5,400 cows are operating in Idaho. The bulls are owned by individuals and cooperative associations have been formed by cow owners to purchase the services of the bulls. The bulls are transported to the various farms when needed. Since the average Idaho dairy herd consists of only 5.4 cows, the problem of supplying high quality bull service is serious. That the stud bull association has met this problem is indicated by the results of a 3-year study of the associations. The study shows that the stud bulls bred on an average 108 cows per year and had a breeding efficiency 19 per cent higher than the bulls in the standard bull associations. In addition small herds were served which previously had not used purebred dairy bulls. (*Ivan H. Loughary*)

Artificial Insemination of Dairy Cattle Successful

Using an insemination technique developed at the University of Idaho, very successful results were obtained in the University Holstein and Jersey herds, as well as in herds of local dairy farmers. With 4 bulls, 41 pregnancies were obtained in the University herds. One hundred and sixteen inseminations were made, which is an average of 2.83 inseminations per conception. Using 3 old bulls, 37 pregnancies, which required 111 inseminations, or 3.0 services per conception were obtained in herds of local dairy farmers. (*D. L. Fourn, F. C. Fountaine*)

X-ray and Diathermy Treatments for Mastitis Investigated

In cooperation with the departments of Animal Husbandry and Bacteriology, one Holstein and one Jersey cow having chronic mastitis were subjected to X-ray treatment. Improvement was noted in the physical condition of the udders and discolored milk became normal in appearance as a result of the treatment. Long-chained streptococci were not destroyed. Diathermy treatments were administered both alone and in combination with sulfanilamide. Results to date indicate that diathermy treatment is superior to hot water applications and in combination with sulfanilamide gives very good results in the treatment of acute mastitis provided the treatment is started immediately upon the detection of mastitis. Chronic cases of mastitis are helped but not cured by diathermy alone or in combination with sulfanilamide. (*E. M. Gildow, W. V. Halversen, D. L. Fourn, V. A. Cherrington*)

Quality Improvement Work Demonstrates Value and Need for Continuance

A summary of four summers' quality improvement work in cooperation with the Bureau of Dairying of the Idaho State Department of Agriculture and various creameries in Idaho shows definitely that the work has been responsible for an improvement in

the quality of milk delivered to the creameries. During the four summers, 11,318 samples of milk were examined for quality by the sediment and methylene blue reduction or resazurin tests. In addition, 2,229 farm visits were made for personal instruction in the improvement of quality. Comparable data from selected areas indicate that in the 4-year period the number of patrons producing first grade milk increased from 8.9 per cent to 28.7 per cent, while patrons producing fourth grade milk decreased from 32.0 per cent to 16.6 per cent. (*H. C. Hansen, Ivan H. Loughary*)

Differences Found in Vitamin E Requirements of the Male and Female White Rat

In cooperation with the Department of Home Economics, a difference was found in the vitamin E requirements of the male and female white rat. Whereas approximately 1.5 grams of pea germ meal furnished enough vitamin E for reproduction in the female, 3.0 grams were insufficient for the male. While one drop of wheat germ oil was sufficient to cause female rats of proved nutritional infertility, caused by lack of vitamin E, to give birth to litters, 20 drops daily was insufficient to develop normal fertility in the male. Doses of wheat germ oil ranging from 0.5 to 2.0 drops daily during gestation were associated with a greater birth weight of young, more young per litter, and a greater total birth weight. No deleterious effects were observed in females continued throughout their life-time on a vitamin E low diet only. However, histological studies on animals fed on pea germ meal and low levels of wheat germ oil indicated serious physical disturbances in the male on a vitamin E low regime. (*D. R. Theophilus, Ella Woods*)

Comparison Made of Production Records Determined With and Without Preliminary Milkings

Data on the 10 months' fat production of 6 cows (3 Holsteins and 3 Jerseys), determined from monthly fat tests with and without preliminary milkings, show that the average fat test was not materially influenced by leaving strippings in the cow's udder from the previous milking, and there was no appreciable or uniform difference in the total amount of fat produced when determined by either method. (*D. L. Fourn*)

Comparison Made of Production Records Determined By One-day Monthly Tests and Official Tests

Eighty-one lactation records (72 Jerseys and 9 Holsteins) determined by a one-day monthly test were compared with Register of Merit and Advanced Registry records. The data indicate that the Register of Merit and Advanced Registry methods of calculating lactation, milk and fat production, give on the average (3 out of every 5 records) a record slightly higher than the one-day monthly test method. (*D. L. Fourn*)

Service Work

A total of 2,632 cows from 16 different herds were officially tested for production during the past year. The supervisors spent a total of 213.5 days conducting the tests.

The calibration laboratory received 5,224 pieces of glassware, which were checked for accuracy and etched S.G.I. (Standard Glassware of Idaho), of which 0.95 per cent were found to be inaccurate.

During the past year 146 analyses of dairy products were made. (*H. C. Hansen, F. C. Fountaine*)

Poultry

Mortality Investigations Continued

THE pullet-year laying house mortality in the Experiment Station Flock of Single Comb White Leghorns has been reduced from 44.6 per cent in 1933-34 to 7.1 in 1938-39. Inasmuch as the paralysis complex has constituted the major disease problem, the rate of total mortality has decreased as paralysis mortality has diminished. A summary of results is given in Table 3 showing the mortality of progeny of all males used and of those males having the highest and lowest total mortality. It is to be noted that there were no deaths due to paralysis during the pullet laying year of 1938-39.

Table 3.—Average per cent laying house mortality of the daughters of all breeding males and from the males showing the highest and lowest total mortality for each of the 6 years from 1933 to 1939.

Year	Sires	Total	Mortality of daughters		
			Paralysis	Leukemia	Other
1933-34	Average all males.....	44.6	21.4	2.7	20.5
	High mortality male.....	60.0	33.3	11.1	15.6
	Low mortality male.....	34.2	18.4	0.0	15.8
1934-35	Average all males.....	37.0	11.1	9.4	16.5
	High mortality male.....	46.9	18.8	9.4	18.7
	Low mortality male.....	19.8	4.7	7.0	8.1
1935-36	Average all males.....	23.7	4.9	4.9	13.9
	High mortality male.....	40.9	6.8	8.0	26.1
	Low mortality male.....	8.3	2.1	2.1	4.1
1936-37	Average all males.....	27.9	6.0	7.2	14.7
	High mortality male.....	45.9	13.5	8.1	24.3
	Low mortality male.....	17.6	5.9	2.9	8.8
1937-38	Average all males.....	17.6	2.5	4.4	10.7
	High mortality male.....	31.5	11.1	5.6	14.8
	Low mortality male.....	6.6	0.0	0.0	6.6
1938-39	Average all males.....	7.1	0.0	2.5	4.6
	High mortality male.....	13.7	0.0	5.3	8.4
	Low mortality male.....	2.0	0.0	2.0	0.0

Note.—The figures under the headings "Paralysis mortality," "Leukemia mortality," and "Other mortality" are not comparative figures but show only the proportion of the total mortality due to each of those causes.

While a certain amount of specific resistance has been demonstrated in this flock by selective breeding, it is not definitely known to what extent this factor has been responsible or to what extent the decrease might have been due to a reduction in the virulence or disappearance of the disease from the stock and premises.

In order to check the influence of these factors, stock has been sent to, or introduced from, two other experiment stations (cooperating) and one private breeder. Progeny has been introduced as day-old chicks and as 4- and 8-week old pullets from the same flock which proved highly susceptible to the paralysis complex in 1934-35. At that time over 40 per cent of the pullets introduced from this source died from paralysis. In the case of the two experiment stations, paralysis has been the chief cause of high mortality



Figure 5.—Chicks from a pedigree hatch are being wing-banded; an important part of the progeny testing program for high livability.

during recent years. Hatching eggs from the Idaho Station flock were sent to each of these stations during the season of 1939 and from one of these hatching eggs were also obtained.

Complete records of mortality will not be available until the fall of 1940. Preliminary reports from the cooperating stations indicate that the progeny from the Idaho Station flock has demonstrated a marked resistance to the disease complex existing in their flocks.

With respect to the susceptible stock introduced onto the Idaho Station, approximately 7 per cent of the progeny introduced as day-

old chicks and 2 per cent of each of the groups introduced as 4- and 8-week old pullets had developed paralysis up to the time they were put in the laying house. Compared to this, only one pullet out of 1,177 or less than one-tenth of 1 per cent of the pullets from the Idaho Station had developed paralysis.

The results to date demonstrate that paralysis, as a disease complex, still exists on the Idaho Station poultry farm and the present low mortality of the Station flock can be attributed to resistance to this particular disease complex.

Inasmuch as the reduction in laying house mortality in the Idaho Experiment Station flock has been so marked and rapid, there has been some question as to whether or not this increased viability may not have been secured at the expense of egg production, body size, or egg size. At no time, however, were birds which made up the breeding pens selected on the basis of viability alone; just as much emphasis was placed on the production characters of the families as on their viability.

Table 4.—Average body weight, egg weight, per cent production, and average number of eggs per hen for 10-month period from October 1 to August 1 for each year from 1934 to 1939.*

	1934-35	1935-36	1936-37	1937-38	1938-39
Body wt., April 1.....	3.92	4.25	4.31	4.50	4.60
Egg wt., Mar. 1†.....	23.92	24.29	24.25	24.55	25.49
Av. % production.....	50.95	54.54	54.70	56.95	63.75
Av. no. eggs per hen (based on orig. no. of hens)	130.20	154.20	156.20	167.90	192.10
Av. no. eggs per hen (henday basis)	148.80	163.80	168.70	176.80	194.40

* Number of birds involved each year varied from 440 to 910.

† Average of all eggs laid first week in March.

Table 4 shows the average weight, egg weight, per cent production, and average number of eggs per hen for the 10-month period from October 1 to August 1 for each year from 1934 to 1939. The average number of eggs per hen are given on two different bases, one on the henday basis or average number of hens per pen and the other on the original number of birds in the pen. A definite improvement in all characteristics is shown each succeeding year. (*J. K. Williams, E. M. Gildow, C. E. Lampman, G. C. Holm*)

Vitamin A Requirements of Laying Hens Supplied by Alfalfa

Previous reports on this investigation have dealt with the utilization of carotene in terms of meeting the requirements of laying hens during the first year of egg production. The results, as summarized in Idaho Experiment Station Bulletin No. 229 and in Research Paper No. 175 (*Poultry Science*, 1939), showed that 0.2

mgs. of carotene per bird daily, as supplied by dehydrated alfalfa, gave results equal to higher levels.

During the past year, birds which had been used for the studies reported above were carried on through their second laying year on levels of 0.2, 0.3, and 0.5 mgs. of carotene per bird per day. It was thought that, if the low level was marginal, it should become apparent during the extended period. The results obtained, however, again have demonstrated the 0.2 level (approximately 333 U.S.P. units of vitamin A) to be adequate as measured by egg production, absence of lesions, mortality, and hatchability. Egg production during the second laying year (September 1, 1938, to August 31, 1939) was 42.8, 38.5, and 42.0 per cent respectively for 0.2, 0.3, and 0.5 levels of carotene. The average per cent hatchability of fertile eggs (4 hatches) was 73.9, 76.7, and 70.6 respectively. The lowest mortality was on the low level. Birds were examined each month, but no specific deficiency lesions could be found at any time.

The livability of the chicks from the hens on the low level was significantly lower. On marginal rations these chicks died from specific A-vitaminosis at an early age. These results demonstrate that the 0.2 mg. level was sufficient to meet the hen's own requirements and to promote good hatchability, but did not provide adequate carry-over in the chicks.

The above level is considerably less than the minimum requirements reported by other investigators. One possible explanation is the fact that the alfalfa used in this study was held in cold storage continuously until fed; a measured amount, based upon its carotene content, was mixed with the basal mash daily.

In field practices it has been found necessary to incorporate larger amounts of the vitamin A factor to protect adequately laying and breeding stock. The results of several years of study on this project and its various ramifications emphasize the fact that the unstable nature of both carotene and true vitamin A constitutes the greatest problem in this phase of poultry nutrition. There is a definite need for improvement in quality of alfalfa and other forage crops with respect to their carotene content, and for control measures to prevent the loss of carotene from the time it is mixed in the ration until the feed is consumed. (*J. K. Williams, C. E. Lampman, D. W. Bolin*)

White Grain Rations Give Good Results

Feeding trials conducted during the past year fully demonstrate that yellow corn may be entirely eliminated from the laying ration and various combinations of oats and barley used when adequately fortified with the vitamin A factor. The basal mash contained 10 per cent of dehydrated alfalfa of good quality and 0.5 per cent of cod liver oil concentrate (3000 A, 400 D). The mash used in the check lot contained 20 per cent yellow corn, 5 per cent oats, and

5 per cent barley. The corn was omitted in the rations for lots 2, 3, and 4; the mash for these groups contained 30 per cent ground oats, 30 per cent ground barley, and a combination of 15 per cent of oats and barley respectively. All groups received a scratch grain mixture consisting of 75 per cent whole wheat, 15 per cent rolled oats, and 10 per cent rolled barley. There were no significant differences in results in terms of egg production, body weight, and mortality between the various groups. The best results in the way of egg production and returns over feed cost were obtained in lot 4. This group averaged 65 per cent production for the 11-month experimental period and gave a return over feed cost of \$2.77 per bird. (C. E. Lampman, J. K. Williams.)

Protein Supplements in Turkey Rations Include Soy Bean Meal

In order to further check the value of soy bean oil meal as a part of the protein supplement in turkey starting rations, feeding trials were conducted on the same basis as the year previous. Two lots were used in duplicate, one receiving the usual protein combination consisting of meat and fish meal and dried milk, the other receiving soy bean oil meal to replace the above mentioned supplements to the extent of 6 per cent. There were no significant differences in body weights of birds at any time. At 8 weeks of age, they were almost identical.

From the results of the two years' work, it is concluded that the use of soy bean oil meal may be optional when the meat and fish meals are of good quality, with the matter of price being the deciding factor. If, however, the ash content of the meat meal to be used is unusually high, then the soy bean oil meal may be incorporated as a means of reducing the total phosphorus in the ration. Turkey starting formulas, with and without soy bean oil meal, are listed in Idaho Extension Bulletin No. 125, *Poultry Rations*. (C. E. Lampman, J. K. Williams.)

Miscellaneous Projects

Other projects in progress at present include a study of the efficiency of orchard grass as a source of manganese in the prevention of perosis in growing chicks and a comparison of white grain rations with and without carotene, as provided in alfalfa leaf meal, when the basal ration is fortified with cod liver oil. Both of these projects are in cooperation with the Department of Agricultural Chemistry.

This Department has cooperated with the Extension Service in re-issuing several Extension Bulletins including Extension Bulletin No. 119, *Prevention and Control of Poultry Diseases*; Extension Bulletin No. 125, *Poultry Rations*; and Extension Bulletin No. 133, *Housing Farm Poultry*. The Department has also assisted the Extension Division in the poultry improvement work in the State by conducting schools of instruction for poultrymen participating in the program.

Crops, Crop Breeding, and Soils

Crop Year Low in Rainfall

THE crop year (September 1, 1938, to August 31, 1939) was characterized by low rainfall and higher-than-normal temperatures. Moisture conditions were fairly normal during the autumn months. The early portion of the winter was dry. February and March had above-normal moisture. April, May, and June were exceptionally dry with temperatures decidedly above normal. Precipitation for the entire crop year amounted to only 16.64 inches as compared to a normal of 21.91, a deficiency of 5.27 inches. Fortunately, timely rains towards the end of June and during early July together with temperatures below normal at that time corresponded with the critical period—flowering and early-filling stage—of fall-sown cereal crops. Due to this circumstance, the yields of winter wheat and other fall-sown crops were but slightly below normal. Spring-sown cereals and other crops were severely damaged by dry conditions. (*K. H. Klages*)

Drought Decreases Grass Hay and Seed Yields, but Ammonium Sulphate Increases Returns

Smooth brome and crested wheat yielding approximately 800 pounds of seed per acre under normal conditions produced low yields this year. However, even with the interference of drought significant increases in hay and seed production were obtained with variable spring applications of ammonium sulphate to different grass plats. Fall rather than spring applications of ammonium sulphate are recommended. Moisture during the fall and winter months carries the fertilizer down into the soil. The seed and hay yields obtained are presented in Table 5. (*K. H. Klages, G. O. Baker*)

Table 5.—Effects of ammonium sulphate applications on the hay and seed yields of grasses in solid and row plantings

Grass	Amounts of ammonium sulphate applied in pounds per acre						
	Solid stands of grasses					Cultivated rows	
	Check	50 lbs.	100 lbs.	150 lbs.	200 lbs.	Check	100 lbs.
Hay yields in tons per acre							
Orchard	.77	.93	.80	1.06	1.10	1.58	1.13
Smooth brome	.87	1.33	1.19	1.78	1.45	1.42	1.72
Crested wheat	1.46	1.50	1.70	1.92	1.71	1.80	1.83
Meadow fescue	.44	.70	.53	.79	.74	.73	1.05
Tall oat	.65	—	—	—	—	1.33	1.78
Seed yields in pounds per acre							
Orchard	155	179	140	197	183	223	298
Smooth brome	267	444	395	432	392	262	315
Crested wheat	276	262	337	420	311	236	372
Meadow fescue	38	73	43	30	113	156	188
Tall oat	114	—	—	—	—	127	179

Idaed Spring Wheat is Superior

The new spring wheat variety, Idaed, distributed by the department in the spring of 1937, was grown this year in sufficiently large acreages under farm conditions in northern Idaho to establish its superiority over Federation. Idaed matures on the average 10 days earlier than Federation, is shorter than Federation, and has a stiffer straw. The variety grades hard white when grown without irrigation, and soft white when grown under irrigated conditions in the southern part of the State. Idaed, in field plot tests on the University Farm, averaged over a 5-year period of comparison 3 bushels per acre more than Federation. The variety is especially recommended for the northern part of the State and in the irrigated sections of southwestern Idaho. (C. A. Michels)

Alternate Intensive Fallow and Cropping Produce Results in Bindweed Control

Alternate intensive fallow and production of winter wheat are giving promise of being effective in bindweed control. The so-called intensive fallow refers to the plowing of the stubble land immediately after harvest and cultivation of the area at regular intervals of 14 days through the next growing season, the fallow year, up until seeding time. The plowed land is left in the rough condition during the winter. Deep re-plowing of the fallow prior to seeding has resulted in material increases in the yields of winter cereals on bindweed infested land.

Sodium chlorate applied in the dry form, late in the fall continues to give more effective control than any other chemical tried in comparative tests. (C. I. Seely, K. H. Klages)

Two Promising Grass Selections Developed

Bulbous canary grass, *Phalaris tuberosa*, is known in Australia for its drought resistance. Its lack of winter hardiness excludes its use under Idaho conditions. However, a selection from a bulk lot of seed of this grass has been made that survives the winters in northern Idaho. This selection shows promise to be of value for pasture and range purposes. It is being increased.

A dwarf strain of crested wheatgrass has been developed. This selection is shorter, leafier, and has finer stems than the standard crested wheat. Its growth habits and ability to grow under dry conditions indicate possibilities as a dry land lawn, pasture, and range grass. A sufficient supply of seed is available for distribution in small quantities for demonstration purposes. Other forage strains are being developed in Grimm Alfalfa and Red Clover. (C. A. Michels)

Michels' Hybrid Grass Does not Always Have a True Perennial Growth Habit

More complete tests with Michels' (wheat-wild rye) grass indicate that this grass will survive for more than one year only in

cases where a fairly abundant supply of moisture is available. When this grass is grown under conditions of severe drought, a high percentage of the plants will survive for only one season. In other words, under conditions of drought most of the plants will behave as true winter annuals. In the early work with this grass the crop was grown in cultivated rows due to the small amount of seed available. This method of production insures a larger amount of water available for use of the plants. As a result, a high percentage of the plants behaved as perennials. (*C. A. Michels*)

Two New Varieties of Peas Developed

A new early maturing, high yielding, medium-sized, smooth, green-seeded strain of peas, suitable for canning and dry pea purposes has been developed from a cross between Wisconsin wilt-resistant Perfection and a Scotch Green strain. It has the vine and pod arrangement of the Perfection parent and the color and seed shape of the Scotch Green parent. The seed coat is thin and easily removed.

The other variety resulting from a cross between the Idaho selection of American Wonder and Laxton's Progress is an early market garden type. The vine, pod size, and green pea quality resembles to a marked degree that of the Laxton parent and combines with it the early maturity of the American Wonder parent. This variety matures somewhat earlier than Little Marvel. Field tests indicate fully as high a yielding capacity as found in Little Marvel. (*C. A. Michels*)

Hybrid Corns Not Always Superior in Yield to Selected Open Pollinated Varieties

The mere fact that corn of hybrid origin is planted does not mean that it will always yield more than other types. The yield test results at the Caldwell Branch Station gave the following results: Two Idaho selected open pollinated strains yielded 138.5 bushels, as compared to 109.1 for commercial hybrids, 111.5 for Idaho hybrids, 113.9 for Idaho three-way crosses, 114.3 for United States Department of Agriculture top crosses, 119.7 for Idaho top crosses, and 121.8 bushels per acre for Idaho single crosses. (*C. A. Michels*)

Bulletins on the Use of Phosphate Fertilizers Published

The results obtained from the phosphate investigations verified the findings reported last year—namely, that the most economic returns are obtained from the use of the more readily available phosphate fertilizers. The results of the phosphate investigations, conducted in various parts of southern Idaho, were published as Extension Bulletin No. 120.

The results of phosphate and other fertilizer investigations conducted at the Aberdeen Branch Station were published as Experiment Station Bulletin No. 230.

The most economic returns from treble superphosphate on alfalfa were obtained from 75 to 125 pound per acre applications. The residual effect from the more readily available phosphates have been sufficiently great to warrant consideration in determining the benefits obtained from their use. (*G. O. Baker*)

Applications of Borax Give Favorable Results in Many Sections of Northern Idaho

Definite responses have been obtained from the use of small amounts of borax on alfalfa in the cut-over sections of northern Idaho. In 1939, yields from the first cutting of alfalfa were obtained from 9 tests, which had been treated with 40 pounds of borax in the fall of 1937 and spring of 1938. Considering the average of these tests there was approximately a 50 per cent increase in yield the second year after application of the borax.

Excessive amounts of borax are toxic to plant growth, so only small applications should be used, and precaution should be taken to insure a uniform distribution over the field. Mixing the borax with Gypsum or soil before applying will aid in securing a uniform distribution. Not over 40 pounds per acre should be applied to alfalfa that will be left at least 2 years. If the alfalfa is to be left for only one year, the application rate should be reduced to 25-30 lbs. of borax. (*G. O. Baker, W. E. Colwell*)

Soil Management Practices Studied in Relation to Soil and Water Losses

The influence of various soil management practices on soil and water losses is being investigated in cooperation with the Soil Conservation Service. This work is carried on in southeastern Idaho and on the University Farm. At Moscow the application of 15 tons barnyard manure per acre every third year reduced water losses during the 1938 season by 45 per cent and soil losses by 65 per cent.

At the High Altitude Branch Experiment Station one-year investigations with tillage methods indicate that shallow working of the soil is desirable from the standpoint of moisture relations. (*G. O. Baker*)

Lime Content of Soil Influences Chlorosis

In the light of preliminary investigations on chlorosis—yellowing of leaves—it is recommended that the soil be tested for the presence of lime prior to the setting out of an orchard. If quantities of lime are present closer than 15 to 18 inches to the surface, the trees will in all probability be affected by chlorosis. (*G. O. Baker*)

Soil Survey Work is Progressing

The soil survey field work was completed during the past summer for Bonneville County, and work started in Gem County. The

soil survey is conducted in cooperation with the Bureau of Plant Industry, Soil Survey Division. (*G. O. Baker*)

Salinity Investigations Featured

Fundamental data regarding soil salinity (alkali) is being secured for the various sections of Idaho. A summary of 7 years' work on reclamation investigations will be found in Experiment Station Bulletin No. 233. The Experiment Station is cooperating with the U. S. Department of Agriculture Regional Salinity Laboratory, Riverside, California. (*G. O. Baker*)

Fruit and Vegetable Crops

Fall Planting of Bulbs for Onion Seed Production Favored

FACTORS important in the production of onion seed include the bulb size, spacing, and time of planting. It also has been shown that storage conditions influence the behavior of bulbs to be used for seed production.

Onion growers who produce their own seed will be interested in the results of tests at the Parma Branch Station which indicate certain advantages from planting bulbs in the fall for seed production.

General practices in onion production in Idaho include the carrying over of mature bulbs in storage; such bulbs being planted in early spring. In a few isolated cases, onions have been set in the field during the fall and carried over in the field instead of being



Figure 6.—General view of onion seed plots at the Parma Branch Station.

stored. Such a practice has much in its favor. Most of the work is done in the fall when other routine work is not so pressing; storage costs and losses likely to be incurred in storage are eliminated and greater yields of seed may be expected. To offset the above advantages is the fact that severe weather may cause serious damage to fall-planted seed stock.

In three years' experiments at Parma, onion bulbs have wintered over satisfactorily in the ground. Straw mulches have been of some benefit in protecting them but, under the conditions, have not been necessary.

Plantings made November 14, 1938, and duplicated March 17, 1939, gave the results found in Table 6.

Table 6.—Yields per acre in pounds of onion seed from plantings made at Parma, Idaho

Variety	Date planted	Lbs. seed per acre. Large bulbs ¹	Lbs. seed per acre. Medium bulbs ²	Lbs. seed per acre. Small bulbs ³
White	Fall*	1308	828	442
Portugal.....	Spring†	1006	766	321
Red	Fall	915	732	382
Wethersfield.....	Spring	749	817	401
Ebenezer.....	Fall	907	567	276
	Spring	968	715	310
Sweet Spanish.....	Fall	1271	783	333
	Spring	424	255	110

* Nov. 14, 1938. † March 17, 1939.

(¹) 3" and above. (²) 2¼"—3". (³) 1¼"—2¼".

From Table 6, it may be seen that in all but the Ebenezer variety, the advantage in yield is in favor of the fall-planted bulbs.

These figures also indicate an increase in yield from the use of large bulbs. Such increase in yield from the larger bulbs comes mostly through the production of more seed stalks per bulb. The data do not clearly indicate a greater production of seed per stalk from the large-sized bulbs.

Experiments are under way to determine the effects of planting distance on the production of onion seed. The data from the first year's work along this line are of such a nature that it is best to delay recommendations until more work can be done. (G. W. Woodbury, Carl F. Dietz)

Growers Interested in Head Lettuce Variety Trials

Growers in southwestern Idaho were much interested in approximately 100 varieties and strains of head lettuce which were grown for trial in Parma. These were planted August 1, 1939. While this variety trial practically marks the beginning of lettuce variety work at the Parma Branch Station, the results at least served to bring

out some of the problems confronting the grower of head lettuce, many of which do not relate directly to the selection of a variety.

Several of the varieties grown have been used previously by growers in the Boise-Payette region. Imperial 152 was probably as consistent in its performance as any of those tried. In these preliminary tests, the following varieties and strains were the most outstanding: Imperial 152, Colorado Special, New York 515, Imperial F, New York 199, and Imperial P. W. 44. (*Carl F. Dietz*)

Calcium Sprays Reduce Cracking in Sweet Cherries

Still in the experimental stage but of considerable promise as means of reducing cracking in sweet cherries, are sprays containing calcium in any one of several forms. Sprayed cherries and cherries that have been immersed for short periods in solutions of calcium compounds absorb water much more slowly, and, therefore, crack less readily than untreated fruit.

While several forms of calcium have proved more or less effective for this purpose, the most promising one from a practical standpoint seems at present to be calcium hydroxide (hydrated lime). Sprays containing 12 lb. of lime in this form in 100 gal. of water have materially reduced susceptibility of sweet cherries to cracking under field conditions. In this proportion only a small percentage of the lime goes into solution, but there is a definite advantage in having a surplus of lime that will leave a heavy residue on the fruit. In rainy periods following the application of the spray some of this residue goes into solution and the fruit is subjected to additional treatments with soluble calcium, which further reduces its rate of absorption of water.

Residues remaining on the fruit at harvest time following the use of calcium sprays constitute an objectionable feature of such treatments. Residues of hydrated lime are rather easily removed by a spray containing $\frac{1}{2}$ per cent of acetic acid, which must be followed immediately by a rinsing spray of water. A washing treatment consisting of a bath in a $\frac{1}{2}$ per cent solution of acetic acid followed by a water rinse also is effective, but under commercial conditions, it would be necessary to provide means of drying the fruit before packing. Until these problems are worked out and the sprays are made more effective, calcium treatments to reduce cracking cannot be recommended for commercial use. (*Lief Verner*)

Auxins Cause Widening of Crotch Angles in Fruit Trees

Investigations on the effects of synthetic growth substance or auxins on crotch angles in young fruit trees were continued in 1939. Both indole-acetic acid and indole-butyric acid were used in a wide range of concentrations on 1-year-old whips of apple, pear, sweet cherry, and prune. These growth substances in pure crystalline form were mixed with lanolin paste as a carrier. At planting time each tree was cut back to a height of approximately 30 inches and a 2-inch length of rubber tube was fastened over the cut end.

Enough of the auxin paste was then injected into the tube to cover the cut surface to a depth of about $\frac{1}{4}$ inch.

The growth substance, diffusing slowly into the terminal portion of the tree, induced development of abnormally wide angles in the new branches formed. Indole-butyric acid proved much more effective at a given concentration than did indole-acetic acid. At the highest concentration of indole-butyric acid used on apple trees (4 mg. per gm. of lanolin) even the uppermost branches, which ordinarily grow nearly upright, formed angles of nearly 90 degrees. However, the growth of the uppermost branches was greatly retarded by the higher concentrations of indole-butyric acid. For the development of moderately wide crotch angles without material depression of branch growth, 1 mg. of indole-butyric acid in 1 gram of lanolin appeared to be an optimum concentration for Delicious apple trees.

Branch angles were definitely wider in treated trees of apple, pear, and prune than in untreated trees; but there were no conclusive results in the tests with sweet cherry trees. (*Leif Verner*)

Agricultural Engineering

Land Reclamation and Conservation Research Continued

A STUDY of 26 pumping plants used for combination irrigation and drainage pumping in an irrigation district which operates a total of 36 plants indicated that 10 of the plants studied were below the modern, practical, attainable efficiency and that a possible saving of 17 per cent in power bills might be obtained through modernization of the pumping plants. The modernization costs for 10 of these plants were estimated at \$7,500. This expenditure would return a saving in power costs of \$2,861.85 with a net saving per year of \$1,811.85. During 1939, 1,337,574 kilowatt-hours were used in pumping 19,000 acre-feet of water with a loss of 138,834 kilowatt-hours due to low efficiencies.

The penetration of pumped irrigation water, canal water, and drainage water as applied to soils of varying alkalinity indicated that there was sufficient difference in rate and depth of penetration to be attributed to the source of water supply.

No effects were noted on the yield and quality of potatoes as influenced by small and large streams applied in shallow and deep furrows at the Aberdeen Branch Station.

In cooperation with the Soil Conservation Service, an investigation was made on the effect of elevation upon precipitation. This study indicated that although no large areas could be found where elevation was a reliable index to precipitation, smaller areas could use elevation as an index when such factors as exposure and distance from storm sources or storm paths were considered. (*Hobart Beresford, J. P. Bonner, Mark R. Kulp, James C. Marr, John L. Toevs, William Watson*)

Vegetable Seed Threshing Studied at Parma

The problem of threshing vegetable seed crops has not been met satisfactorily by the regular development of threshing equipment for grain crops. In cooperation with the Department of Horticulture, an experimental thresher was constructed and tried out at the Parma Branch Station. The machine was provided with three types of threshing mechanisms, including the conventional cylinder and concaves, a rasp cylinder and concave, and a rubber roll cylinder and flat belt held in contact with the roll by means of a driven pulley and an idler pulley in such a way as to produce a rubbing action between the face of the roller and the belt. Both the rasp-type cylinder and flat belt with the rubber face roller apparently have possibilities for threshing various types of vegetable seeds. These methods are not ordinarily found in the conventional type of threshing mechanism. (*Hobart Beresford, Carl F. Dietz, E. N. Humphrey, George W. Woodbury*)

Observations Made Upon Beet Harvesting Machinery

Field observation of beet harvesting equipment in the Twin Falls and Idaho Falls areas indicated that progress was being made in the development of mechanized harvesting methods. The beet combine, consisting of a lifter, topper, and loader, operates with a field speed of $2\frac{1}{2}$ miles per hour under favorable field conditions. The chief difficulty in the application of this type of machine was found



Figure 7.—The field loading of beets from the mechanical harvester requires eight times the truck travel required for hand topping and loading.

to be the alternate row spacing of 18 to 22 inches with furrows in the wide spacings. It was evident that mechanized harvesting would be benefited by a uniform spacing of rows with furrows between the rows.

Hand topped and loaded beets averaged 9 per cent tare, while machine topping and loading averaged 7.14 per cent tare under the same field conditions. With a four-man crew consisting of a tractor driver, a machine operator, and two men to clean up the beets left in the row, the machine topped and loaded at the rate of 100 feet of row per $\frac{1}{2}$ minute. The eight-man crew loaded the beets at the rate of 100 feet of single row in $\frac{1}{2}$ minute and topped at the rate of 100 feet of row in $\frac{3}{4}$ minute, making a total of $1\frac{1}{4}$ minutes per 100 feet of row for the hand method as against $\frac{1}{2}$ minute per 100 feet of row for the machine method. On the basis of eight men loading and topping 100 feet of row in $1\frac{1}{4}$ minutes and four men and the machine topping and loading 100 feet of row in $\frac{1}{2}$ minute, the machine has the advantage of 5 to 1 on a man-hours and time basis or a saving of 80 per cent of the hand labor involved in the beet harvesting operation, not counting the truck driver for either operation. The beet fields in which these trials were made averaged 19 tons per acre or 147 pounds per 100 feet of row on a row-count basis. The machine left 2.73 beets per 100 feet of row by breaking 0.77, missing 1.27, and dropping 0.69 beets during the operation. This amounts to a field loss of 6.6 pounds per 100 feet of row or 1,724.58 pounds per acre, which is 4.5 per cent of the yield and makes necessary the two-man cleanup crew.

The custom rate for hand topping and loading beets varies with the yields obtained, ranging from \$0.90 per ton to \$1.35 per ton. One of the disadvantages of the single-row beet combine is found in loading. Under the present system of elevating directly into the field truck, there is an 8:1 factor of driving the truck back and forth across the field with the beet combine as compared with hand loading.

The ultimate mechanization of beet harvesting should include the development of a 2-row machine and hopper loading from the machine to truck, cutting down the field time and hauling distance required for the truck. Field observation of the single-row topper by the Department of Agriculture indicates that a satisfactory field topping mechanism has been developed. (*Hobart Beresford, E. N. Humphrey*)

Mechanized Dusting for Pea Weevil Promising

Following the introduction of rotenone dusting for pea weevil control in the Palouse area, considerable progress has been made in the development of mechanical dusting equipment. During the past year more than 200,000 pounds of rotenone dust have been applied in the Palouse area pea weevil control program. In cooperation with the U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine, a study has been made of the application

and management of mechanical dusting equipment, including commercial and farm-made machines, from the standpoint of effectiveness, management, technique of operation, mechanical principles involved, field losses resulting from the application of the machine, and the cost of dusting for pea weevil control.

The methods of field transport included two-wheel horse-drawn carts, four-wheel trailers, and the direct application of the dusting equipment on trucks, wheel tractors, and crawler-type tractors. The individually powered trailer units were pulled by horses or towed by tractors. The machines varied in width from 30 to 60 feet, using derrick, boom, and field caster wheels for carrying the nozzle and apron equipment.

High- and low-pressure distributing systems were used with little variation in the resulting distribution of dust. The power requirements for operating the blowers varied from $1\frac{1}{2}$ to 8 horsepower. Methods of measuring the area covered by the dusting



Figure 8.—Field damage is a factor in the mechanical dusting of peas for weevil control.

equipment included the use of bicycle wheels and counters, and in one instance, the mounting of a bicycle wheel and counter on top of the crawler track.

The custom rate for dusting was \$0.50 an acre for the application or \$2.50 per acre where the dust was furnished by the operator. Under this cost schedule 20 pounds of dust per acre was applied. Records of individual operators showed an average cost of \$1.50 per acre for dust. The cost of application varied from \$0.25 per acre to \$0.35 per acre, and the rate of dusting varied from 9 acres to 15 acres per hour, depending upon the size of the machine and field speed attained. The investment in equipment ranged from \$350 to \$1,000 per unit.

Records obtained from the operation of 10 machines indicated that 10,903 acres of peas were protected by dusting, the borders, draws, and infested areas totaling 3,300 acres. This amounted to 30.26 per cent of the total area of fields protected. Peas harvested from the treated fields showed a pea weevil dockage of 5 per cent or less, while peas harvested from the untreated fields under similar conditions showed an average of 15 per cent or higher dockage.

Timeliness of application and uniform field speed give the track-type tractor-drawn equipment the advantage over the truck- and team-drawn units. There is a direct relation between the field damage caused by the equipment during application and the width of tread of the individual tractor and trailer units. The optimum width of application from the standpoint of field damage due to dusting equipment was from 50 to 60 feet. The field damage from the use of dusting equipment for all of the machines studied varied from 2.44 per cent to 4.38 per cent based on a common width of 40 feet for all machines. Wide treads and narrow coverage widths are to be avoided for minimum field damage. The field damage also was increased where units were allowed to skid on sidehills or moved through the field to reach isolated infested areas.

The mechanical dusting equipment included in this study has been classified and the various principles of construction and operation are shown in detailed plans of typical machines used during the past year. The plans for duplicating this equipment may be obtained from the Department of Agricultural Engineering. (*E. N. Humphrey*)

Research in Rural Electrification Varied

An electric pig brooder design has been improved to include the use of insulation in the floor and top of the hinged cover and to eliminate the use of lamps as a heat source in favor of a commercial-type strip heater which offers less fire hazard.

A commercial-type feed mixer and grinder has been tested for grinding and mixing poultry feed. These small hammer mills differ from the larger machines in the size of the motor needed for power and the manner of feeding the grain into the cylinder. The mill is powered with a $\frac{1}{2}$ -horsepower, 3600 r.p.m., split-phase motor, which is protected from overloads by an automatic type shut-off. The motor operates on 110 volts and may be plugged into any convenience outlet. The energy consumption in kilowatt-hours per ton for grinding corn ranged from 1.00 to 17.05, or a ratio of 1 to 17. The rate of grinding varied from 602.00 pounds per hour with a fineness modulus of 3.99 and uniformity of 4:5:1, to 60.60 pounds per hour with a fineness modulus of 2.51 and uniformity of 0:6:4, or a ratio of 10 to 1. There was a very marked difference in the two grinds. A fineness modulus of 3.99 with a uniformity of 4:5:1 indicates a coarse grind with a high percentage of coarse and medium particles, while a fineness modulus of 2.51 indicates a fine grind almost flour-like in fineness and a uniformity factor

of 0:6:4 indicates that there are no coarse particles in the ground feed.

A supplementary 5-gallon supply tank has been designed for use with the standard 15-gallon Idaho farm water heater. The purpose of this unit is to make the Idaho farm water heater more applicable to water heating requirements in the farm dairy and milkhouse. By means of this supplemental tank, the hot water is displaced by the additional cold water supply and can be forced readily into the can-washing trays, thus eliminating double handling of the wash water.

Tests have been made on the use of compressed air and hot water for aiding the washing of dairy equipment and utensils. This application is similar to commercial car-washing equipment and uses an inexpensive engine washing gun with compressed air and a supply of hot water and suitable washing powder. A small $\frac{1}{4}$ -horsepower motor and compressor can be used to supply the air needed to operate the "wash gun," which furnishes a substitute for live steam without the expensive pressure-controlled equipment needed for a steam boiler or accumulator.

Tests have been made on a steam accumulator for supplying live steam for dairy sterilization and cleaning. A commercial unit was obtained on consignment from one of the leading manufacturers of this type of equipment. Where milk production regulations require steam for sterilization, this type of equipment promises to meet the needs of the dairy farmer.

The use of electric heat in cooking cull potatoes for stock feed has been developed by revamping a hot water tank and using a 3,000-watt clamp-on heater. The tank is equipped with a removable lid and mounted on center pins so that it can be tipped when loading and discharging the cooked potatoes.

Interest has continued in the application and use of electric fencing on the farms of Idaho. A study has been made on the safety features of electric fence controllers with recommendation for regulation by the Public Utilities Commission of the State of Idaho covering the installation and use of electric fences which obtain their power from light socket sources. The public regulation of unsafe commercial or homemade electric fence controllers is urged because of the hazard these devices present to human life through fatal shock.

Farm refrigeration requirements based on the present development and use of frozen locker storage is one of the major projects that will be continued for further study. The work has included a survey of frozen storage locker development in the State of Idaho and the relation between service and the possible development of frozen storage on the farm. Commercial equipment has been studied and designs prepared for farm-made units supplying 10-, 20-, and 30-cubic foot frozen storage space by means of lift-top boxes. The reach-in and walk-in types of frozen storage and cold storage units are being constructed for laboratory tests and farm application.

The use of electricity for insect control has advanced rapidly due to the availability of new types of light source.

Two new applications for electric hotbed soil heating cable have been reported. One makes use of the soil heating cable as an immersion heater for warming the milk fed to poultry or livestock. The other uses the cable for melting ice in roof gutters and downspouts. Soil heating cable has been used in hotbeds for a number of years and more recently has been popular with garden enthusiasts for forcing the early blooms of roses, especially in connection with contests or exhibits of flowers. (*Hobart Beresford, J. B. Rodgers*)

Farm Buildings Research Summarized

The results of work in the ventilation of animal and poultry structures were summarized and used as a basis for a professional engineering thesis entitled "Air Conditioning of Animal and Poultry Shelters" by J. B. Rodgers. The research work in ventilation and lighting is chiefly active with the Department of Poultry Husbandry and includes the testing of new ventilating equipment and the operation and management of the various systems of ventilation under normal laying house use.

A study of the relation of structural designs of farm buildings to their functional value for animal and storage shelters is being continued. (*J. B. Rodgers*)

Farm Economics

THE joint Land Grant College-Bureau of Agricultural Economics project on "Land Use Planning" has moved forward to a more dominant position in directing research in agricultural economics. This, however, has not greatly altered the type of projects which have been undertaken by the Department during recent years; but it has directed attention to problems in areas where there has arisen a local demand for these studies. This has marked advantages because immediate use will probably be made of the results. The first three area studies of this new type are described below. Other studies of a more general nature follow.

Farm and Community Reorganization

Dixie Community, Washington County.—A farm and community reorganization study has been started in Dixie Community of Washington County. The results of this study show that wheat production in this community is submarginal but that farmers can shift to livestock production and make a farm income comparable to that of most farm areas in the State. The study shows further that farms need be scarcely half as large in acreage as the present farms for fairly profitable units for livestock production. These smaller farms will permit closer settlement, improved roads, better schools, and more community enterprises in general. It is anticipated that as a result of this study, State and Federal agencies such

as the Extension Service, the Farm Security Administration, the Soil Conservation Service, and the Agricultural Adjustment Administration can direct their efforts toward building up farm units of a type which can yield a reasonable living for a farm family. In 1938, less than half of the farmers were making a reasonably satisfactory living from their farms. (*Arval Eriksen*)

Mann's Creek Community, Washington County.—This study is only partly completed at this time, but the more important problems which it is hoped to solve may be stated as follows: Will it pay to bond the land \$20 to \$30 per acre to build a reservoir for supplementary irrigation water? If it appears that it will not pay, how may farms be reorganized to yield an improved return? If supplementary water appears to be a paying venture, then how shall farms be reorganized to utilize a full supply of late summer water? How shall depleted range lands now used in connection with these farms be rehabilitated, improved, and still used as part of the farm and ranch economy? When the above questions have been answered, what means and methods shall be used in promoting these desired ends? (*Arval Eriksen*)

Teton River Basin.—The farm and community reorganization study in the Teton river basin in Teton County has been undertaken in cooperation with the Soil Conservation Service. The problem in this area is one of searching for a better method of operating large areas of dry wheat lands. Much of the privately owned land is farmed by operators who live in town. Thousands of acres of State land are farmed in the same manner. Wind and water erosion and lack of soil building practices have reduced yields and forced the question of better utilization. Much of the land is not farmed at all during certain seasons. What the solution should be is not now known. Determinations need to be made as to the feasibility of using some of the land for privately operated stock ranches, and how and where these should be set up. The question whether wheat production will be able to continue on the better lands needs to be studied. Policies for the State-owned lands need to be formulated with a view to help in devising policies for other State-owned lands. The effect of better utilization of dry lands on the National Forest is of importance, and should be studied. Finally, it must be determined what changes a better use of the dry lands will bring about in the organization of the irrigated farms in the valley. (*Leo J. Fenske, Paul A. Eke*)

Leasing Arrangements in the Palouse Area, Latah County

This study has described in detail the type of leases now in force in this area together with the characteristics of the land, landlords, and tenants. Net incomes per acre from share leases during recent years have been ascertained for three typical districts within the area. From the above information, together with other data, it is planned to suggest in detail more equitable leases for use in this area. An effort will be made to publish lease agreements

which will more nearly fit requirements for soil conservation and a more diversified agriculture. (*Paul A. Eke, George T. Schaefer*)

Relation of Tenancy and Ownership to Farm Crop Enterprises

Figures available on crop acreages by farms in the State A.A.A. files supplied basic data for this study. These data were classified and tabulated for over 50 types-of-farming areas in the State. These areas pretty well sample all the important types of agriculture in the State with the exception of tree fruits, cut-over general farms, and livestock ranching, for which insufficient samples were available. Some of the findings are: that tenancy tends to decrease the percentage of the land in soil building crops; that tenancy tends to prevail on the best producing soils where cash crops are grown; and that owned farms are nearly always a little smaller than rented farms in the same neighborhood and are frequently on poorer land. These are merely examples of relationships established.

It is hoped that lease agreements can be revised to prevent undesirable soil practices arising from tenancy. More equitable agreements can also be suggested for both tenant and landlord. (*Paul A. Eke*)

Economic and Sociological Study of Recent Settlement on Cut-over Land in Northern Idaho

Almost two hundred new settlers were interviewed. From the answers to these questions, the state from which the settlers came, their economic status on arrival, and the progress made since arrival were ascertained and tabulated. It was found that most of these people had only a meager capital of either goods or money upon arrival in Idaho. Most of them have been self-supporting since arrival and many of them have succeeded in adding to their possessions and security. However, many settled on poor land and now need to be resettled.

In general, these recent arrivals are intelligent and ambitious. Most of these settlers need guidance and credit for land clearing and for stocking their farms. If given time, most of them will become reasonably prosperous farmers; but they will arrive at that status sooner through education, careful planning, and some action by various government agencies in their behalf. (*C. O. Youngstrom*)

Map Locates Farmers' Cooperatives in the State

From a directory of Idaho farmers' cooperatives compiled by Ezra T. Benson, a map giving the location of farmers' cooperative purchasing and marketing organizations was constructed. These organizations were classified according to the commodities handled by them.

A few counties in the north seem to show a scarcity of cooperatives, which is due largely to the type of farming prevailing in these counties.

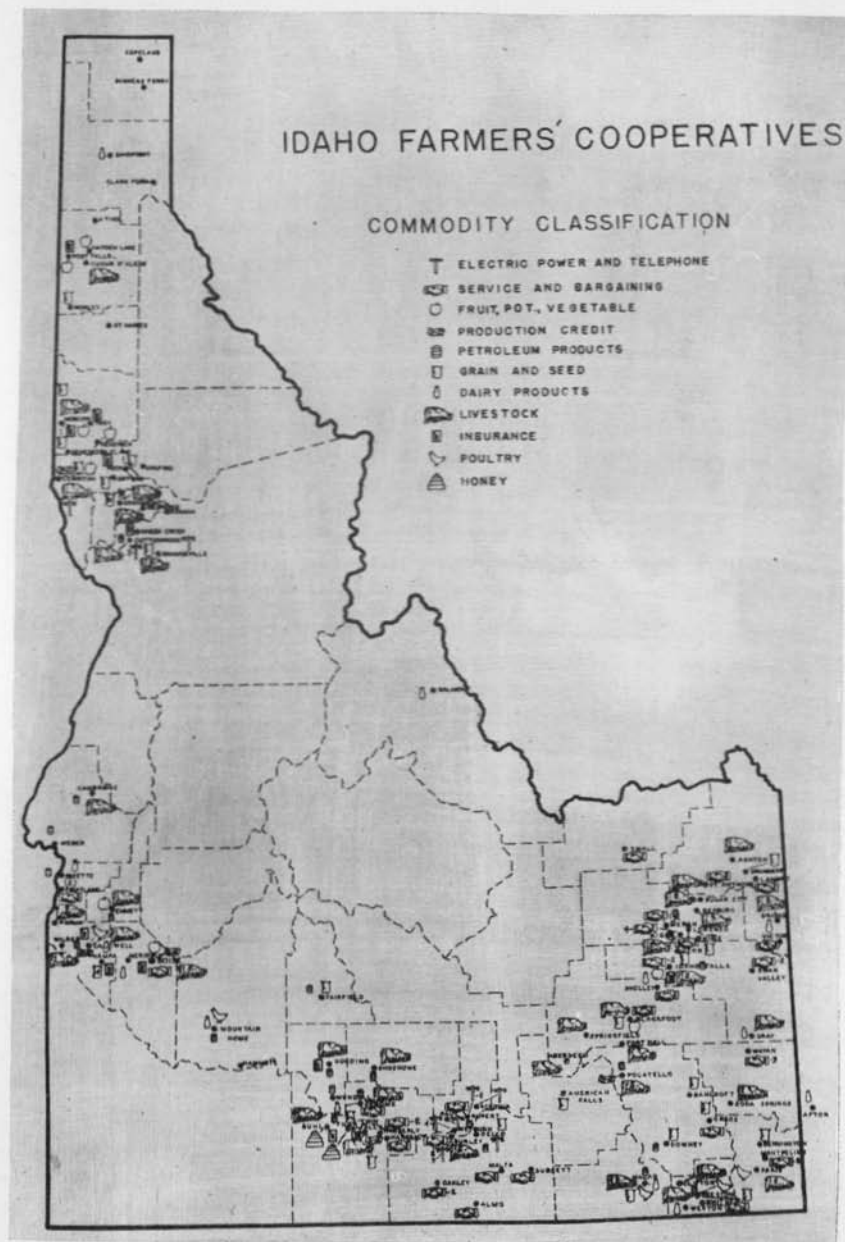


Figure 9.—Idaho farmers' cooperatives.

The growth in the number of farmers' cooperative marketing and purchasing associations in the State of Idaho was very rapid during the last decade. Over half of the existing cooperatives were organized during this period. In 1936 there were 122 farmers' purchasing and marketing cooperatives with a net worth of about \$2,800,000 and gross sales of about \$29,000,000. This gives a rate of turn-over of almost 10.4, which shows that the capital is quite active in these organizations. It should be noted, with a breath of warning, that 28 of these associations were not incorporated and, consequently, had not availed themselves of limited liability. Lately, there has, on the average, been more than one new association created each month. (*Norman Nybrotten*)

Agricultural Bacteriology

Cause and Control of Mastitis of Dairy Cows Studied

STUDIES are now in progress dealing with the etiology of bovine mastitis. In by far the majority of cases of bovine mastitis there may be found, associated with streptococci and in their absence, relatively large numbers of other types of bacteria whose exact relationship to the disease is not well understood. These studies are therefore designed to ascertain the role of these organisms in the production of mastitis.

A large number of organisms have been isolated from cases of bovine mastitis. These organisms, for the most part, appear to belong to the genus *Micrococcus*, although a number of gram-negative organisms resembling those of the coliform group have also been isolated. Culturally these organisms were found to be similar, but differed somewhat in their morphology, especially as to size and staining. The agglutinating ability of blood serum from the cows from which the organisms were isolated was determined against each of the organisms. In almost every case some agglutination took place and with certain organisms it was very marked, indicating that agglutinins may be produced for organisms not ordinarily associated with the disease. Similar tests are being conducted with organisms isolated from animals which are free from the disease in order to determine their relationship, if any, to those organisms isolated from mastitis-infected animals.

Bovine mastitis has also been studied in cooperation with the Department of Dairy Husbandry and the Experiment Station veterinarian with a hope of finding a cure for this malady. Sulfanilamide, X-ray, diathermy, vaccines, monocalcium phosphate, and acriflavine all have been used. Samples of milk from the cows under treatment have been examined for leucocytes and type of organisms predominating in the milk. In general, it may be said that no single treatment or combination of treatments was found to be effective in curing the disease. (*V. A. Cherrington, W. V. Halversen, E. M. Gildow, D. L. Fourt*)

Coniferous Timber Soil Investigated

Coniferous timber soils long have been studied with a view to determining those factors which were responsible for their traditional infertility when reclaimed for agricultural purposes. In these studies the lack of nitrates in samples of virgin forest soils and various combinations of forest soil and forest products composted and incubated under controlled conditions in the laboratory led to the conclusion that forest soils contained some substance which was inimical to the nitrification process.

Progress of knowledge concerning the principles of soil fertility as relating to the chemical, physical, and biological nature of forest soils gives new methods for attacking the problem. The problem also receives new stimulus because of the intense interest that now is being shown in reforestation. It is possible that the soil conditions which favor the germination and growth of agricultural crops are not materially different from those favoring the germination and growth of coniferous seedlings.

The study now in progress concerns the following points of attack: (1). The general characteristics of coniferous forest soils under virgin, logged-off, and burned conditions. In these studies, the moisture-holding capacity, the total nitrogen, the ammonia nitrogen, the nitrate nitrogen, the H-ion concentration, and the numbers of nitrifying bacteria were determined. (2). The effect of incubation period of enrichment culture media inoculated with multiple dilutions of field soil, forest soil, and duff upon the count of nitrifying bacteria. The enumeration of nitrifying bacteria on solid culture media has been generally unsatisfactory for quantitative work. By preparing flasks containing a synthetic liquid medium and inoculating these with multiple dilutions of the soil or duff, it was only necessary to test these dilutions qualitatively for nitrates after a suitable incubation period in order to determine the approximate numbers of nitrifying bacteria present in the original sample. (3). The rate of nitrogen transformation in these soils was studied by leaching them to remove all soluble forms of nitrogen, and, after the moisture had become adjusted to optimum, incubating the samples until ammonia and nitrates reappeared in measurable quantities. (4). The effect of fertilizer treatment and incubation period on the number of nitrifying bacteria in field soil and forest duff mixtures. The purpose of this experiment was to determine if the forest litter contained substances which depressed the normal nitrification process of a fertile soil. (5). Nitrate accumulation in mixtures of field soil and forest duff with and without the addition of bloodmeal. This study introduces the factor of variation in the carbon-nitrogen ratio as it affects nitrate accumulation. The original studies failed to differentiate between nitrate accumulation, which is determined by analyzing the sample for nitrates, the nitrification, which is a function of the numbers of active nitrate-forming bacteria. It was surmised that active nitrification may take place without resulting in any nitrate accumulations, for the reason that nitrate could be assimilated by biological processes as rapidly

as it was formed. (6). The effect of fertilizer treatment and incubation period on the number of nitrifying bacteria in field soil and forest soil mixtures. This experiment took into consideration that the forest soil may contain chemical or physical conditions inimical to bacterial processes although the overlying litter may not exert such effects. (7). The effect of forest soil, duff, extracted duff, and duff extract on the amount of nitrate accumulating in liquid cultures of nitrifying bacteria. Here the chemical and physical conditions of the soil were excluded so that the action of any soluble toxic substances could be determined independently.

The data resulting from these investigations are not complete at this time; yet, they are too voluminous to summarize in this report. It is planned to present them in the form of a bulletin or technical article during the coming year. (*W. V. Halversen, J. M. Hale, W. G. Hoge*)

Progress Made in Pullorum Disease Investigations

Continued progress has been made in the control and eradication of pullorum disease in poultry flocks used for breeding purposes in the State of Idaho. The official state agency of the National Poultry Improvement Plan has cooperated fully in promoting the research program and better cooperation has been received during the year from the hatcherymen associated with the agency.

The Extension Poultryman and county agricultural extension agents have promoted research by requesting poultry raisers to submit diseased chicks for postmortem studies. This close cooperation has brought the necessary diseased birds to the laboratory for study and also has been the means of locating diseased flocks which might serve as foci of infection. A natural outgrowth of this service is an annual inspection trip to the principal poultry breeders at which time comparative tests may be run and the general efficiency of the local tester may be evaluated. More than one hundred shipments of chicks were received for study during the year. Twenty-seven of these lots proved to be infected with pullorum, of which only seven were from Idaho hatcheries. Three of these seven outbreaks came from hatcheries not cooperating with the state testing program and three of the remaining four outbreaks in chicks sold by cooperating hatcherymen occurred 10 to 21 days after shipments were received. This would indicate that the infection was probably contracted on the premises of the owner rather than at the hatchery.

Comparative studies of the various commercial antigens used in making the whole blood test for pullorum have shown that no two were in perfect agreement. Several of the antigens were super-sensitive, producing false reactions, and as a result many pullorum-free birds were destroyed. This phase of the investigation is being studied and many false reacting birds have been autopsied and cultured. In nearly every case an agglutinable non-pathogenic organism has been found. To date three types of organisms have been observed and studied. The organism most commonly found is a non-pathogenic variety of the *Staphylococcus albus* group. Two

other organisms isolated in a few instances are *Alcaligenes faecalis* and *Alcaligenes marshalli*. Apparently the only possible similarity in antigenic properties would be the somatic fraction. Certain whole blood antigens most commonly used in this State tend to react to carriers of these organisms. A few of the nationally known antigens do not show this false reaction. Only a few cases were studied with the new experimental antigen put out by the U. S. Bureau of Animal Industry, making it unsound to draw conclusions from these limited data. All future tests will not only be confirmed by postmortem, cultural and tube testing, but also by the use of this new experimental antigen.

Testing schools were again conducted to refresh the memories and improve the technique of the cooperating hatcherymen. Several new candidates were examined for testing licenses. (*E. M. Gildow, G. C. Holm*)

Clinical and Laboratory Diagnosis Varied

Veterinarians and livestock owners are continuing to use this laboratory as an aid in the diagnosis of livestock diseases. Four hundred and thirty-three separate consignments have been studied, comprising twenty-seven hundred and ninety-three individual tests. These tests were made during the period of January 1 to December 1, 1939. The findings have been beneficial in determining the types and prevalence of livestock diseases in Idaho. The findings should also give an indication as to the disease problems that need investigation. (*G. C. Holm*)

Agricultural Chemistry

Studies on Clay Minerals and Organic Colloids Initiated

THE clay fraction has been separated from several important Idaho soil series in order to study its clay mineral composition. Since the clay fraction is the reactive part of the soil, many of the physical and chemical properties are directly related to the type of clay present. This information will be used as a basis for further soil chemistry studies.

Previous work has indicated that organic matter is chemically absorbed by soil clay under acid conditions. Work is now in progress to determine the amount of absorption of organic matter by clay under alkaline conditions such as occur generally in Idaho. (*L. E. Ensminger*)

The Influence of Irrigation Upon Movement of Lime and Salts Studied

Work is in progress, in cooperation with the departments of Agronomy, Horticulture, and Plant Pathology, to determine the influence of irrigation upon the transfer of lime and soluble salts within the soil profile. The high alkalinity of Idaho soils is due

in part to lime. Since some of the minor elements are insoluble in an alkaline medium, the chlorotic condition of many of the trees in the irrigated areas of southern Idaho may be due to the unavailability of such elements as manganese and iron. Carbonate accumulation probably renders phosphate less available to plants. (*L. M. Christensen, G. O. Baker, M. R. Kulp*)

Alkali Land Reclamation Investigations Completed

A 7-year study of soils representing some 35,000 acres of contiguous bottom land on the lower reaches of the Boise River has been completed and the results published. These soils are quite similar in characteristics to alkali soils encountered elsewhere in southwestern Idaho and in other sections of the western states, and aggregate an important potential agricultural area. Except for scant pasture, they are water-logged, alkaline, and worthless. They are high in alkali salts commonly having a reaction of pH 9 to 10.

Experiments showing the effects of drainage, irrigation, subsoiling, blasting, chemical treatments, manures, straw, and groundshading upon the establishment of various crops and shade trees and upon the permeability of the soils in this area have been completed.

This investigation, in cooperation with the Department of Agronomy, has revealed several procedures which can be economically applied to the reclamation of soils of this type. (*L. M. Christensen, G. O. Baker, M. R. Kulp*)

Yield and Protein Content of Wheat is Influenced by Soil Management

A progress report covering the period of 1924-1938 is now in preparation, bringing up to date the report on soil management and crop rotation practices as they influence yield and protein content of wheat. This investigation includes 15 years of study with 17 crop rotation systems.

Legumes have been of value in maintaining the soil nitrogen and improving the protein content of the wheat. Applications of manure continue to improve the organic matter and nitrogen content of the soil with corresponding increase in the protein content of the wheat.

A new series of 78 plats was started in 1938 to measure the effect of other rotations and management practices, over a long period of time, upon the chemical and physical nature of the soil in relation to yield and quality of crops. This program is correlated with similar programs at the Tetonia, Aberdeen, and Sandpoint Branch Stations, and is conducted in cooperation with the Department of Agronomy. (*R. S. Snyder, G. O. Baker*)

Phosphorus Requirements of Farm Animals Demonstrated

Feeding trials at several phosphorus levels conducted at the Caldwell Branch Station in cooperation with the Department of

Animal Husbandry during the past 3 years, for an average of 140 feeding days per year, show that a daily intake of 2 grams of phosphorus per 100 pounds of live weight is sufficient to maintain normal blood phosphorus, and permits the most economical gain per unit of feed. A ration containing 0.180 per cent phosphorus is required to provide a 2-gram daily intake of phosphorus per 100 pounds of live weight for growing and fattening steers of an average weight of 700 pounds.

Under similar conditions, feeding trials with growing and fattening lambs at several phosphorus levels were made. The phosphorus requirement was not as definitely indicated as in the case of steer feeding, but average daily intake of 2 grams of phosphorus per 100 pounds of live weight seemed sufficient for normal health and economical gains. A ration containing 0.135 per cent phosphorus will supply this average requirement. Investigations of the daily phosphorus requirement for lambs are being repeated in an effort to determine whether the phosphorus content of the ration should be varied during the feeding period to give a more uniform daily intake per unit of live weight. (C. W. Hickman, W. M. Beeson, D. W. Bolin)

Carotene and Vitamin A Requirements of Poultry Determined

Studies of the vitamin A requirements for laying hens have been continued in cooperation with the Department of Poultry Husbandry, using dehydrated alfalfa as the sole source of carotene. In previous years, the vitamin A requirement was determined for laying hens in their first year of production. These birds have now been carried over to the second year of production at the previous carotene levels to determine the level required to maintain normal health over the longer period of time. A daily intake of 0.2 mg. of carotene (335 I. U. or 238 Sherman Units) per bird was found to be sufficient during the second as well as in the first year.

In connection with this project, analyses were made of the yolks of the eggs from hens fed dehydrated alfalfa at 0.2, 0.3, and 0.5 milligram levels of carotene daily. Analyses show increases in vitamin A, carotene, and xanthophyll content in the yolk with the higher levels for carotene fed.

Vitamin A deficiency has been reported in Idaho flocks fed rations fortified with vitamin A and carotene concentrates far above the requirements as established in previous carefully controlled laboratory investigations. At the present time, it is difficult to account for such deficiency. Attention is being given to this problem, particularly to the factors which affect the carotene content of the sun-cured and dehydrated alfalfa, and the initial carotene content of green forages. (D. W. Bolin, C. E. Lampman)

Range Forage Analyzed

Arrowleaf balsam root, *Balsamorhiza sagittata*, a tufted perennial of the sunflower family, and Blue bunch wheatgrass, *Agropyron*

spicatum, a drought-resistant perennial, grow abundantly on the western grazing ranges.

Because of its early growth and fair palatability, balsam root is a valuable forage plant on spring ranges. Blue bunch wheatgrass frequently constitutes the bulk of late spring, summer, and fall range forage. New growth is very palatable, but old growth is rank and tough.

Since these two plants are particularly important to the range livestock industry, a study was made of the chemical composition and nutritive value in cooperation with the Department of Animal Husbandry. Growth yield data and content of ash, protein, fat, fiber, nitrogen-free extract, calcium and phosphorus were measured for the entire plant of both balsam root and Blue bunch grass at several stages of maturity.

Protein and phosphorus contents decreased and those of ash, fiber and nitrogen-free extract increased with maturity. From the growth yield data and composition, the total production of nutritive substances present was calculated at the various stages of maturity. There was an increase in the total amount of phosphorus and protein, followed by a sudden drop just prior to full maturity. The total amount of all the other constituents measured increased to maturity. The largest amount of nutritive feed value per unit area was obtained at 5-6 weeks growth for balsam root and 7-8 weeks growth for Blue bunch grass. The more mature the plant, the wider the calcium-phosphorus ratio. Balsam root collected in the late fall may have a calcium-phosphorus ratio as high as 60.

Again it may be emphasized that no phosphorus-deficient areas have been found in Idaho ranges, although seasonal deficiencies may sometimes occur. Protein deficiencies may also occur in certain seasons. Possible deficiencies of other nutritional elements in forage plants are being investigated. (*W. M. Beeson, D. W. Bolin*)

Spray Residues Compared

Work was completed this year in cooperation with the departments of Horticulture and Entomology, on the loads of arsenic, lead, and fluorine on Jonathan apples from the Entomological Field Station at Parma, including studies of lead arsenate sprays alone and in combination with cryolite. A comparison was made of two and three cryolite sprays in split schedules in regard to their effect upon lead, arsenic and fluorine loads.

Loads were determined following completion of each spraying schedule and at harvest. Arsenic and lead loads were found to decrease in amount with each additional cryolite spray, while the fluorine load increased. (*R. S. Snyder, W. E. Shull*)

Insects

Codling Moth Population High in 1939

THE codling moth population was high in 1939, resulting in considerable worm damage to fruit where full spray schedules were not used. There was more late season damage than usual due to continued warm weather through September.

Three spray treatments were applied in 1939 control experiments. Materials used per 100 gallons of water were as follows: (1) Check-Lead arsenate 3 lbs.; Fluxit spreader $\frac{1}{4}$ lb.; oil (1st C) 2 qts.; (2) Split schedule—1st. brood sprays the same as in check and 2d. brood sprays: cryolite 3 lbs.; herring oil 1 pint; (3) Nicotine bentonite—Nicotine sulphate 1 pint; bentonite 5 lbs.; herring oil 1 quart. The spray schedule consisted of the lead arsenate calyx spray, from first brood cover sprays and two second brood cover sprays. Results from the three treatments are given in Table 7. Treatment number refers to those given above.

Table 7.—Results of codling moth control experiments, 1939

Treatment number	Per cent wormy	Per cent stings	Per cent clean fruit
1	45	49	37
2	48	47	36
3	35	28	51

The best control was obtained with the nicotine bentonite spray. Residue analysis showed a reduced load of arsenic and lead at harvest with the split schedule; i.e., in No. 2 where cryolite was substituted for lead arsenate in the last two sprays. (W. E. Shull, R. W. Haegeler)

Biological Control of Fruit Insects Not Successful

There seems to have been little change with the codling moth parasites during the last year. Overwintering codling moth larvae were parasitized 29.7 per cent by *Ascogaster carpocapsae*, but the percentage dropped to 4.2 at the end of the first brood early in July. A specimen of the pre-pupal parasite, *Ephialtes extensor*, was observed. Other pre-pupal parasites have been introduced and are established, but are not readily recovered. The yield of fruit was good in the orchard for all three varieties, but worm injury was practically 100 per cent.

The San Jose scale parasite, *Aphytis mytilaspidis*, and the ladybird beetle, *Scymnus aterrinus*, continued to be abundant during the year. The scale damage to both trees and fruit was less than in 1937 and 1938. The scale infestation continues to be severe, but apparently may be partially checked by the parasite and predator mentioned. Attempts have been made for several years to introduce

and establish the scale parasite, *Prospaltella perniciosi*, but no insects were recovered this year. (R. W. Haegele, W. E. Shull)

Dry Lime Sulphur Plus Oil in Scale Control

A dormant spray of 15 pounds dry lime sulphur plus 1 gallon dormant oil emulsion in 100 gallons was applied on March 28 in two apple trees badly infested with San Jose scale. A scale count 12 days after spraying indicated a control of 93.3 per cent, and a second count 42 days after the spray application gave the control as 62 per cent.

A New Mite on Red Clover Discovered

A two-spotted mite, or "red spider," similar in appearance to the Pacific mite occurring on apple was found attacking red clover on the new land of the Owyhee project west of Homedale, Idaho. Infestations were so severe that large parts of some fields were killed. Most of the damage was done to the first crop, although the second suffered some loss. Specimens were sent to the Bureau of Entomology and Plant Quarantine, where they were identified as a new species belonging to the *Tetranychus*, or common "red spider" group. (W. E. Shull, R. W. Haegele)

Control of the Cabbage Maggot in Radishes and Cabbages

Dichlorethyl ether, ethylene dichloride, mercurous chloride, and carbon disulfide-naphthalene were tested as possible substitutes for mercuric chloride to control the cabbage maggot in radishes. Early season results indicated that dichlorethyl ether might serve this purpose. However, control with this material was poor in later tests during the summer, while good control was obtained with mercuric chloride solutions. Mercuric chloride must, therefore, continue to be recommended for the control of this insect in radishes.

The maggot infestation in an experimental cabbage plot was very low, making the comparison of various control treatments difficult. Indications are that crude naphthalene, if properly applied, may give very good control of this insect in cabbages. It will be necessary to test this material further before recommendations can be made. (R. A. Fisher, W. E. Shull)

Laboratory Tests with Insecticides for Control of *Lygus* Insects Continued

Derris dust, 1 per cent rotenone, and pyrethrum dust, 4 per cent petroleum extract of pyrethrum proved to be quite effective in laboratory experiments on the control of *Lygus* sp. Derris dusts were more effective than cube dusts containing the same amount of rotenone.

The pyrethrum dust acted much faster than did derris dust. Legume bugs treated with pyrethrum died within 24 hours, while those treated with derris died over a period of one or more days.

Both materials paralyzed the insects soon after treatment, and in no case did any of the insects recover.

The addition of peanut oil or mineral oil did not seem to change the effectiveness of cube dusts. Several carriers were tried for derris and cube including talc, sulphur, and diatomaceous earth, but with no noticeable differences observed. (*W. E. Shull*)

Laboratory Tests with Rotenone Containing Dusts For the Pea Weevil Promising

The resistance of pea weevils to dusts containing rotenone again has been shown to decrease during the winter months. Relative toxicity tests in the laboratory, therefore, must be conducted simultaneously over a short period of time for results to be comparable.

The addition of 5 per cent cryolite to a dust containing 1 per cent rotenone did not increase its toxicity to the insects. A limited number of tests has indicated that the size of the particles of the carrier may have an important effect upon the toxicity of dusts containing rotenone; a carrier composed of coarse particles appears to be much more effective than one composed of finely ground particles. Tests with a single sample of derris showed this sample to be much more toxic than any of the samples of cube used in other experiments. A dust containing 1 per cent of pure rotenone was not as toxic as a dust prepared from cube root and containing 1 per cent rotenone; other materials than rotenone in the root are, therefore, toxic to the insects. A cube dust in gypsum was not as toxic one month after being mixed as when fresh because of the alkaline character of the carrier. A finely dispersed rotenone dust in which the particles carried a negative electrostatic charge was no more toxic than a similar dust in which the particles carried no charge. (*R. A. Fisher*)

Pea Weevil Control Investigations Continued

Experiments on the control of the pea weevil conducted by the Bureau of Entomology and plant quarantine, Department of Agriculture, under a cooperative agreement with the Idaho Agricultural Experiment Station were continued.

Pea weevil populations in the northern Idaho seed pea producing areas were considerably higher during the 1938 crop season than during the preceding four years. Infestations, as recorded by the pea grading service, had gradually dropped from an average of 4.48 per cent in 1934 to 3.50 in 1937; however, during 1938 the average infestation jumped to 19.57 per cent. This increase in the damage done was due primarily to a winter favoring weevil survival and to a very marked reduction in the acreage of peas produced. The reduction in acreage combined with a low winter mortality caused a concentration of the insects on fewer acres, thus increasing the damage done.

The first field dusting operations with dust mixtures containing rotenone on canning seed peas were carried on during 1938. The

average infestation on one of the dusted fields at harvest was 9.59 per cent, and on a second was 2.79, whereas the infestation on the check field was 69.16 per cent. The per cent control was 86.28 per cent on the first and 95.96 per cent on the second.

As a result of the 1938 experiments, over 200,000 pounds of rotenone-containing dust was applied in the seed-producing sections of the Northwest during the 1939 crop season.

The average infestation in all dusted fields was 5.2 per cent and on all undusted fields it was 11.3 per cent. These results are considered highly satisfactory since many of the undusted fields were those having such low populations that dusting was not considered practical.

A field study was conducted to determine the amount of damage done to seed peas by four types of dusting equipment. The damage, assuming the machine to be 40 feet wide in each case was as follows: (1) a horse-drawn machine on a trailer with 3½-inch rubber tires reduced the yield 2.44 per cent; (2) a horse-drawn machine on a steel-wheeled cart with 2-inch treads caused 2.57 per cent damage; (3) a machine on a crawler-type tractor with 11-inch treads damaged 2.48 per cent; (4) a machine on a crawler-type tractor with 22-inch treads damaged 4.38 per cent.

The emergence of weevils from hibernation at Moscow lasted from April 19 to July 20; approximately two-thirds of the total emergence occurred during June. Peaks of emergence coincided closely with periods of high temperature.

A total of 19,300 individuals of a parasite *Triaspis thoracicus* were released in 1938 in an attempt to establish the parasite. No data were accumulated to show that parasite releases made during the preceding years had become established. (W. E. Shull, T. A. Brindley)

Alfalfa Reduces Wireworm Populations

Cooperation was continued with the Bureau of Entomology and Plant Quarantine in the investigation of cultural control of wireworms. Field plot studies are being conducted with a local farmer in Canyon County with the object of discovering a crop rotation which will aid in controlling wireworms and in minimizing crop losses due to the presence of these pests. The rotation under study is as follows: 1st, 2d, 3d, and 4th year alfalfa; 5th year, early potatoes, plowing land first of August; 6th year, corn (with sugar beets, peas and beans as alternates); 7th year, wheat (or other grain) without legume, again plowing land first of August. This rotation includes alfalfa for maintaining soil fertility as well as reducing wireworm numbers. Plowing the first of August should destroy a high percentage of transforming adults, thus reducing the next season's brood of wireworms. These studies are only in their third season, but already substantial reduction in wireworm numbers has occurred in the alfalfa plots.

Further work was conducted this past season with a fungus disease found destroying some of the wireworms in the rotation plots. Cultures of the fungus (*Metarrhizium anisopliae* Metsch) and another (*Metarrhizium* n. sp.) from Oregon were prepared by Mr. L. P. Rockwood of Forest Grove, Oregon, laboratory of the Bureau of Entomology and Plant Quarantine. In tests of soil cages, the native Idaho species killed 36 per cent of the wireworms exposed while the new species from Oregon killed 72 per cent with only 1 per cent mortality in the controls. It is doubtful, however, if these could be used as a practical control in the field against wireworms. Attempts to convey the fungus to wireworms in field plots by covering potato seed pieces with fungus spores did not produce any significant incidence of the disease above that normally found. (F. Shirck, W. E. Shull)

Beet Leafhopper Populations Low

A pyrethrum-oil spray consisting of 1 part pyrethrum, 10 parts oil and 20 parts kerosene was effective in reducing curly-top injury in plots of sugar beets. Observations made before and after spray applications showed a decrease in leafhopper populations on treated plots over the untreated plots of from 73.2 to 92.4 per cent. Disease counts made July 11 showed a difference in favor of the treated plot over the check of 37.0 per cent total disease in one experiment, and 27.0 per cent total disease in another experiment. Disease counts made August 12 gave differences of 22.3 and 18.0 per cent total disease favoring the treated over the check. The per plot yield was 2.33 tons higher for the treated plot over the untreated in one experiment and 3.75 tons higher for the treated over the check in another. Very low leafhopper populations made this protection possible with two spray applications. However, it is doubtful in a season of higher leafhopper populations if the increase in tonnage would compensate for the increase in spray applications.

Beets grown under conditions of controlled infestation increased in average weight per beet for each 5-day period the leafhoppers were kept off the beets. (W. E. Shull, Ed. L. Turner)

Mechanical Protection of Tomatoes from Beet Leafhoppers Effective

Two types of individual plant covers removed from the plants at weekly intervals following peak movements of the leafhopper averaged 11.7 per cent curly top as compared with 55.5 per cent curly top in unprotected plants. Yields were good under both types of cover, being the heaviest from plants grown under the cloth and wax-paper type. Different distances of spacing the transplants gave different amounts of curly top and varying yields. The wider the spacing, the higher per cent curly top. The smallest per cent curly top and the highest yield was from double transplants 12 inches apart. Barriers failed to afford much protection from curly top although yields were satisfactory. Tomatoes grown where the entire

row was covered with cheesecloth until after the peak movement of leafhopper had no curly top and gave satisfactory yields. Tomatoes grown under a shelter that was not removed during the entire season developed no disease, and produced a yield equivalent to 36.5 tons per acre. A willow shelter gave 100 per cent protection from curly top, but the yield was reduced by too much shade. (*W. E. Shull, Ed. L. Turner*)

Plant Diseases

Potato Disease Research Varied

APPROXIMATELY 1300 potato seedlings were grown and studied in detail, and observations made as to their reaction to virus infection. This completes the fifth year's observation for some of these seedlings. The source of the seed varied. Some was collected from the Katahdin variety, some from an unknown variety, some from a Bliss Triumph X Katahdin cross and some from a Russet Rural X Katahdin cross. Detailed notes were taken on the agronomic characteristics of each seedling. Of 1307 seedlings grown, 552 were discarded as undesirable.

During the 1939 season, bacterial ring rot of potatoes was definitely recognized in Canyon, Elmore, Twin Falls, Cassia, Bingham, Bonneville, and Teton counties. Because of the seriousness of this disease, and the importance of the potato industry in the State, a project for the investigation of the disease has been outlined and work has been started.

In cooperation with the Aberdeen Branch Station, the result of one year's seed treatment tests showed an increase in the production of No. 1 potatoes from 3 per cent, in the case of hot formalin following presprinkling, to 8 per cent when seed was treated with New Improved Semesan Bel following presprinkling and cutting. (*J. M. Raeder*)

Important Fruit Diseases Investigated

Tests show that a serious leaf spot of Italian prune, common in Idaho for many years, can be perpetuated on budded stock. The spots on the leaves vary in size from very small, 1-2 mm., to large blotches and irregular dead areas. Shot holing and defoliation may occur. The trials indicate that the trouble may be either virus-like in nature or the result of genetic factors.

Surveys in several fruit districts of southern Idaho have shown that a particular leaf spotting, shot holing, and defoliation of peach trees occur commonly on peaches growing on soils from which apple trees have been removed. It is suggested that the spray residues in the soil are toxic, causing symptoms on peach trees.

Applications of borax in cooperation with the Department of Agronomy in late February 1939 to soil around apple trees at Coeur d'Alene and St. Maries materially reduced the incidence of drought spot and corky core on Rome Beauty and McIntosh varie-

ties. The lateness of application may be responsible for the failure in complete control, since the amount of borax was considered adequate according to results of other investigators.

Additional data have been collected regarding the location, symptoms, and origin of peach trees which bear fruit affected with peach wart. This disease has been noted as becoming increasingly prevalent. Affected trees in several scattered orchards have been traced to the origin of certain nursery stock. See Figure 10.

Inoculation tests on Slappy peach trees in the greenhouse showed that abundant leaf spotting could be produced by *Coryneum*



Figure 10.—Peaches affected with "wart", a disease found in several Idaho peach orchards. The cause of the trouble is not known.

beijerinckii Oud., the organism causing peach blight, isolated from the following sources: (a) Slappy peach twigs; (b) Moorpark apricot twigs; (c) Wild cherry twigs (*Prunus emarginata* Dougl. Walp.); (d) Royal Ann cherry fruit; (e) Prune fruits (probably Italian var.). The appearance and extent of spotting produced varied among the isolates, but in all cases the disease was severe and symptoms characteristic. (E. C. Blodgett)

Development of Disease Resistant Varieties of Beans Progressing

The program for the development of varieties of beans resistant to the serious bean diseases in Idaho was continued through 1939 on a similar basis as that of previous years. Bean experiment plots located in Twin Falls, Jerome, and Gooding counties were established and a large number of hybrid bean selections were grown. Records were taken throughout the growing season on the prevalence of the different bean diseases and the habits of plant growth on all selections.

Results this season indicate that many hybrid selections grown on the trial grounds are resistant now to some of the important bean diseases found in Idaho. The most promising selections after further trials may be ready for release to the bean farmers of the State. The varieties of beans under study and for which an active program is carried on to develop resistant selections include Great Northern, Red Mexican, Red Kidney, Pinto, and many wax and green pod type garden bean selections, which are important to the seed trade.

Crosses of selected plants were made in the greenhouse where two generations were obtained, thus permitting a more rapid development of a promising selection. The most recent selection of a disease resistant variety resulting from the bean breeding program was introduced this season. Great Northern U. I. 15, which is resistant to the viruses of common bean mosaic and curly top, will be grown on a few seed farms next season and will be ready then for general distribution to the growers. It is thought that Great Northern U. I. 15 will have a special value when grown on those farms near the breeding grounds of the beet leafhopper, the carrier of the curly-top virus.

The principal bean variety grown in northern Idaho on a commercial basis is the small flat white. This variety appears to be a mixture of several types of white beans. It is also susceptible to common mosaic. Three hundred selections of small flat white beans were made from various fields in the northern Idaho bean growing area, and three of the selection proved to be of the desired seed type. These three selections have been crossed with Norida, a mosaic-resistant medium-sized white bean in an attempt to develop a mosaic-resistant small flat white bean of the desired type. (Donald M. Murphy, Walter Virgin)

Pea Disease Investigations Produce Practical Results

Investigations on the near-wilt disease of peas have shown that the character or characters for the expression of near-wilt resistance can be combined with the desirable characters of near-wilt susceptible varieties. Selections from a Wisconsin Perfection X Rogers K cross have been secured which are as resistant to near-wilt as Rogers K and are quite similar morphologically to the susceptible Wisconsin Perfection parent.

Pea seed treatment tests were conducted at 5 different locations using four varieties of peas. Different lots of each variety were treated with Cuprocide, 2 per cent Ceresan, and Semesan. It was found that the Cuprocide treatments gave an 11 per cent increase in stand, the 2 per cent Ceresan gave a 22 per cent increase, and Semesan gave a 27 per cent increase over the checks. From these data it is evident that seed treatment was quite beneficial; however, these figures are the results of only one year's test. Two per cent Ceresan is recommended in preference to Semesan since the cost of the former is considerably less than the latter.

A study of the cause of poor germination in pea seed has shown that bacteria within the seed may be an important factor in reducing germination, especially in the large seeded wrinkled varieties. (Walter J. Virgin)

Tomato and Watermelon Diseases Studied

A wild tomato, *Lycopersicon chilense*, has been found which appears to be resistant to the curly-top virus. This wild tomato has been successfully crossed with the common tomato. An attempt is being made through further hybridization to develop a tomato variety resistant to curly-top virus.

Tests conducted in cooperation with several Idaho growers have shown that the watermelon variety, wilt-resistant Klondike R-7, developed by the California Agricultural Experiment Station is adaptable to Idaho conditions, and should be used where watermelon growers are experiencing losses from the wilt disease. (Walter J. Virgin, J. M. Raeder)

Fungi Causing Cereal Smuts Have Various Forms

Cereal disease investigations have been continued in cooperation with the Division of Cereal Crops and Diseases, U. S. Department of Agriculture. Studies on bunt of wheat and on covered smut of barley have been emphasized.

Sixty-two collections of bunt, of which 32 were caused by *Tilletia tritici* and 30 by *T. levis*, were tested on the differential wheat varieties. Six physiologic races of *Tilletia tritici* and 5 of *T. levis* were observed. The bunt races were determined from bunt collections made in the following counties: Race T. 1—Latah, Nezperce, Lewis, and Idaho; T. 8—Latah, Nezperce, Lewis, and Oneida; T. 16—

Latah, Lewis, and Idaho; T. 14—Lewis; T. 9—Lewis and Idaho; T. 7—Latah; L. 1—Benewah, Latah, Lewis, Lincoln, Oneida, Bannock, Madison, and Teton; L. 7—Bonner, Nezperce, Idaho, Franklin, and Madison; L. 8—Bonner, Power, Bannock, Oneida, Franklin, Madison, and Bonneville; L. 10—Bannock; and L. 11—Lewis. The so-called "short smut" caused very little loss in southern Idaho in 1939. There was, however, a high percentage of "short smut" found in the eastern part of Latah county. The percentage of infection ranged from a trace in some fields up to 40 or 50 per cent in others.

Of the 47 collections of covered smut of barley caused by *Ustilago hordei* tested for physiologic specialization, 7 definite physiologic races were observed. All of the described races except No. 2 were represented.

A fungus attacking field bindweed (*Convolvulus arvensis* L.) has been found in the experimental plots and adjacent farming area of the Genesee, Idaho, Bindweed Field Station. Isolations from diseased material first were made in 1937. Subsequent isolations were made in 1938 and 1939 and used to reinoculate seedling plants in the greenhouse. From these isolations, 3 have been found to be parasitic on field bindweed and have been re-isolated from artificially inoculated seedlings. The causal organism has been identified as *Rhabdospora* spp. A species of *Rhabdospora* has been described on Canadian thistle (*Cirsium arvense*) and further study may prove that the two are identical. Experimental evidence indicates that the fungus is soil-borne. (Wayne Bever)

Nutrition

Ascorbic Metabolism of College Men Studied

A PROJECT in human nutrition dealing with the "ascorbic acid metabolism of college students" was outlined in cooperation with Northwestern Educational institutions. The phase of the problem investigated this year at the University of Idaho deals with the ascorbic acid metabolism of college men.

There is evidence in nutrition literature that a diet rich in ascorbic acid (vitamin C) can so saturate the body tissues with this substance that a greatly increased excretion in the urine will follow large doses of ascorbic acid. When the tissues are near the saturation point as much as 50 per cent of the dose may appear in the urine in 24 hours. On the other hand if the tissues are depleted it may require the administration of large doses for several days before any response is obtained. To test the nutritional status of students at the University of Idaho, as well as to secure further information on this method of study, this investigation has been carried on at the Idaho Experiment Station with college men as subjects.

Each test requires five days to complete. Twenty-eight tests were made with 25 different individuals who volunteered for the

study. The data from each test include a record of the food eaten and the ascorbic acid content of the urine samples. In only two tests did the response, as judged by the above standard, indicate approximate saturation and in each of these cases the food record showed that a generous supply of ascorbic-acid-containing foods were in the diet. In eight cases there was little or no response even after three large doses. This study will be continued next year with blood tests supplementing the urine analyses. (*Ella Woods, Floyd Claypool*)

Water Soluble Fraction of Russet Burbank Potato Tested

The study on the water soluble fraction of the Russet Burbank potato was continued this year with further confirmation of the presence of a growth-promoting substance, or substances, in the water extract. This project has been under investigation at intervals for several years because better growth in rats occurs when cooked potato is added to a purified basal diet which supplies calories, protein, minerals, and vitamins in amounts which permit general well being and slow growth. The factor, or factors, which supplements this basal diet is contained in the water extract but not in the ash. Various fractions of this extract have been made available by the Chemistry Department of the University for the feeding of rats in this laboratory. Although the factor may not be a new one in nutrition, it seems desirable to identify it, if possible, so that the supplementing value of the potato may be better understood. (*Ella Woods*)

Vitamin A Value of Pasture Plants Investigated

In the course of a project carried out with the cooperation of the Department of Dairy Husbandry over the past several years, studies have been reported on the vitamin A value of pasture plants, including Kentucky bluegrass, white clover, alfalfa, smooth brome, redtop, orchard grass, meadow fescue, timothy, and sweet clover. Ladino clover was added to the list of plants investigated during the year. The biological method of analyzing for vitamin A value gave results considerably higher than the chemical spectrophotometric method of carotene would account for, and further study of this plant is probably desirable. The analyses for carotene were made by the Department of Agricultural Chemistry with samples from the same supply used in the feeding tests. (*Ella Woods, D. R. Theophilus*)

Vitamin E Investigations Continued

The investigation of the vitamin E requirements of male and female rats in cooperation with the Department of Dairy Husbandry, was continued from last year until male rats receiving large doses of wheat germ oil were one year of age. These animals were

killed and the testes from a representative group of litter mates were sent to Dr. Roger D. Reid of Johns Hopkins University for microscopical examination in the same way as had been done for rats receiving smaller doses of wheat germ oil and pea germ meal. Those animals receiving 5 drops (approximately 125 m.g.), or more, daily had normal testes while the litter mate on the vitamin-deficient diet showed complete disappearance of spermatogenesis. The results from this investigation show that the vitamin E requirement for the normal development of the male rat is greater than that required by the young female for the production of a normal litter. (*Ella Woods, D. R. Theophilus*)

Utilization of Agricultural By-products

THE Idaho Falls Laboratory of the Agricultural Experiment Station is concerned with the utilization of waste and surplus agricultural products, principally cull potatoes. The annual production of about 25,000,000 bushels of potatoes in Idaho yields between 1,000,000 and 2,000,000 bushels of culls for which there is little commercial or other satisfactory demand. Any consideration of the cull potato utilization program must include their use for food products, livestock feed on the farm, and commercial feeds, as well as the industrial use of the potato starch, especially its conversion and fermentation for the production of industrial alcohol.

All uses for cull potatoes are competitive from the standpoint of the raw material supply, each tending to stabilize the value of the culls to the farmer. Culls required for food products are necessarily of the commercial grade, requiring additional sorting to insure freedom from decay. The production of potato flour from such culls requires about 500 pounds of culls for 100 pounds of product. The production of riced potatoes from commercial culls requires about 900 pounds of culls for 100 pounds of product.

The value of cull potatoes for livestock feed depends upon their worth in replacing other feeds, and although this method of utilizing waste and surplus potatoes brings one of the highest returns, the stock feed outlet for cull potatoes probably never will take any large percentage of the culls available. The livestock feeding program of cull utilization opens a field for investigations, including the cooking and ensiling of potatoes, the crushing and drying of potatoes in combination with the storage of ensiled potatoes for industrial alcohol production, and using the pressed pulp and liquor for the same purpose. In this connection it requires 1,000 pounds of cull potatoes to produce 100 pounds of dried stock food and 100 pounds of potato pulp solids for conversion and fermentation into 5 gallons of alcohol. By-products from fermentation, including the still residue, may be reverted to the stock feeding program. Thus the waste and surplus utilization of cull potatoes is involved with food, feed, and fuel in the form of industrial alcohol, including the problems of raw material supply, storage, and processing techniques, dependent upon demand and related factors for each system of utilization.

The Idaho Falls Laboratory was completed late in 1938, and a permit to put the plant into operation received in November of that year.

The first 12 months' operation resulted in the processing of about 400 tons of cull potatoes and in the production of 6,500 gallons of denatured and fuel alcohol, which have been made available to the anti-freeze and fuel markets.

The cost of construction of the plant as summarized by Marvin Aslett, superintendent in charge of construction and operation, follows:

Construction of building.....	\$4,614.09
Wiring	384.88
Painting woodwork of building.....	169.20
Installation of water and heat to and in building.....	873.12
Plant equipment and installation.....	15,050.79
Storage cellar	626.66
Total.....	<hr/> \$21,718.74

During the operation of this research project on the utilization of waste and surplus agricultural products, improved yields of alcohol have been obtained until the present 3-day-week schedule of plant operation is producing more alcohol than can be disposed of readily to local anti-freeze and industrial markets. The records of the plant's operation show that the best performance to date produced a yield of more than 20 gallons per ton of cull potatoes. This requires an over-all plant operation efficiency for malting, fermentation, and distillation of about 80 per cent. The theoretical yield of alcohol from potatoes varies with the starch content of the potatoes and should be approximately 25 gallons per ton where all plant operations function with a high degree of efficiency. Research on the methods for developing yeast inoculum, new methods for converting the potato starch to fermentable sugars, simpler and more economical methods of cooking potatoes, on new distillation procedures, and on new methods for incorporating the alcohol in motor fuels is in progress.

Additional funds recently have been made available from the research budget of the Idaho Advertising Commission with which the plant changes necessary to place the project on a 5-day-week production schedule are being planned. Included in the improvements for the plant are the construction of a storage shed for disposing of the product, improved facilities for handling the cull potatoes, a storage tank for making the still waste available for stock feeding, and a mash cooler which will reduce the time of daily operation by about 3 hours.

With initiation of regular production, it becomes possible to undertake the development of markets for by-products and of methods of raw material procurement designed to solve the problem

of seasonal cull potato supply. Local oil companies and cooperatives are selling the approved formula for anti-freeze under the trade name of Tatol. This is also the name of the fuel treatment fluids, for which three formulas have been approved by the Government for the disposition of specially denatured alcohol 28-A. These formulas utilize specially denatured alcohol as a base for the compounding of a fuel treatment fluid which is used to improve the antiknock rating of the gasolines to which they are added in amounts varying from 5 to 20 per cent. However, these blends have not been made available for public consumption but are being used in connection with research in cooperation with the fuel producers and distributors.

As soon as the anticipated plant changes have been made and the 5-day-week schedule is in operation, cost data on the production of alcohol from cull potatoes will be assembled. The cull potatoes used by the plant have been purchased for \$2 per ton, which represents a raw material cost of \$0.10 per gallon when a yield of 20 gallons per ton is obtained. This is, no doubt, the minimum value that should be placed on cull potatoes in a waste and surplus utilization program.

Government bonding, denaturing, and packaging costs for handling the small-volume production have been relatively high. However, the sale of Tatol at \$0.40 per gallon, which is the base wholesale price for denatured alcohol in this area, helps to meet the operating cost of the experimental plant, which is not expected to show a profit in its operations owing to its small capacity and the research nature of the project. In addition to the solution of the problems involved in the utilization of potatoes for alcohol production, the plant is training men in the technique of plant operation and is furnishing much valuable data on problems related to the procurement of raw materials, storage and processing technique, and the ultimate disposal of the product to the public. (*Marvin Aslett, Hobart Beresford, L. M. Christensen, Eugene Graham, Gerwin Taylor.*)

Aberdeen Branch Station

JOHN L. TOEVS, *in charge*

Federal Cooperation Secured

NEW work initiated during the year includes a cooperative project with the Nursery Section of the Soil Conservation Service of the U. S. Department of Agriculture. A forage nursery consisting of 153 strains and varieties of grasses and legumes was planted in April on the Branch Station.

Excellent stands were obtained in most cases. In the fall two other plantings were made; one on alkali land near the Branch Station for the purpose of finding grasses that will tolerate high concentrations of alkali; the other on nonirrigated land near Aberdeen to test grasses for drouth resistance. Forty acres were secured

through the cooperation of the Aberdeen Chamber of Commerce for experimental purposes. This area was fenced to keep out rabbits. The materials and labor for fencing were furnished by the Soil Conservation Service.

Cooperative work with the Division of Cereal Crops and Diseases of the U. S. Department of Agriculture was continued on about the same basis as in the past except that the work on the development of smut resistant cereal varieties was enlarged considerably. The virulence of different smut strains is being tested with different varieties of wheat.



Figure 11.—Grass nursery operated in cooperation with the Soil Conservation Service on the Aberdeen Branch Station.

Testing of sugar beets was continued in cooperation with the Division of Sugar Plant Investigations of the U. S. Department of Agriculture and the Utah-Idaho Sugar Company. New strains and varieties of alfalfa are being tested for hay and seed production, and susceptibility to diseases and insects in cooperation with the Office of Forage Crops and Diseases of the U. S. Department of Agriculture.

A new project dealing with different methods and rates of irrigation of potatoes was started in cooperation with the Department of Agricultural Engineering. The work this year was more or less of a preliminary nature and will help in formulating a better project for another year. The object is to determine the minimum amount of water that is most economical for production of potatoes.

Concentrates Important in Spring Lamb Production

Experimental work was continued with the production of spring lambs. Results so far indicate that palatability of concentrates used as creep feed is of primary importance in the creep feeding of lambs. The more palatable the concentrates, the more feed will be consumed, which in turn makes for bigger gains and better finish; and, if feed costs are not excessive, net returns should be greater.

Fertilizer Work Continues to Give Interesting Results

The residual yield data obtained in 1939 from plants fertilized with the various phosphate carriers, were very similar to the results obtained in 1938, the year the fertilizers were applied. Soil-Aid,

Rock Phosphate, and the T.V.A. fused continued to give little or no response. It would appear that they are not adapted to the soil conditions found in this area.

The yields of potato continue to respond more to fertilizers containing nitrogen than to straight phosphate fertilizers; however, phosphate produces heavier netting of tubers. While the percentage of No. 1's was somewhat higher for the plats receiving phosphate fertilizers, the yield of No. 1's per acre was slightly in favor of the nitrogen carrying fertilizers.

Ammonium Sulphate Stimulates Grass Seed Production

Grass seed yields on the Branch Station have decreased materially since 1937. This was especially true of the broadcast seedings. Ammonium sulphate was applied to one-half of each plat at the rate of 300 pounds per acre. Results in Table 8 indicate that nitrogen fertilization plays an important part in maintaining seed yields of grasses.

Table 8.—Effect of ammonium fertilizer upon the yield in pounds per acre of grass seed on Aberdeen Branch Station

Variety	Broadcast Seeding Yield per acre				Row Seeding Yield per acre			
	No. of plats	Fertil- ized*	Check	In- crease	No. of plats	Fertil- ized*	Check	In- crease
Meadow fescue.....	3	632	348	284	2	760	634	126
Orchard.....	3	212	117	95	2	377	229	148
Tall oat.....	3	131	95	36	2	245	171	74
Brome (smooth).....	3	308	144	164	2	778	506	272
Crested wheat.....	3	193	92	101	2	684	655	29
Slender wheat.....	3	393	198	195				

* 300 lb. Ammonium sulphate applied in spring of 1939.

Box Storage of Commercial Russet Potatoes Not Economical

A comparison of storing potatoes in boxes and in bulk the past two seasons indicates that the former method is impractical. The boxes for this experiment were furnished at no cost to the Branch Station by the Wooden Box Institute. The potatoes stored in bulk were harvested in the customary manner. The potatoes stored in boxes were picked directly into the boxes and remained in these containers for the storage season.

Table 9.—Comparison of bulk and box storage of potatoes on the Branch Station at Aberdeen, Idaho

	No. 1's cwts.	No. 2's cwts.	Culls cwts.	Total cwts.	Per cent No. 1's	Per cent No. 2's	Per cent culls
Box.....	399.3	29.9	20.6	449.8	88.8	6.6	4.6
Bulk.....	410.5	28.0	24.5	463.0	88.7	6.0	5.3

During the 1938-39 season, the experiment was conducted with potatoes grown and stored on the Branch Station. Alternate rows were stored in bulk and the remaining rows in boxes. The potatoes were sorted March 21, 1939.

Hauling and storing potatoes requires about 30 per cent more labor. The extra labor costs consist of the extra labor involved in distributing the boxes for the pickers and the additional weight of the containers which reduces the net tonnage hauled per load. For every 100 pounds of potatoes the box weight is $16\frac{1}{2}$ pounds compared to $11\frac{1}{2}$ pounds of sack weight or a difference of 15 pounds.



Figure 12.—Threshing small lots of grain from cereal nursery at the Aberdeen Branch Station.

Box storage entails a heavy investment. To store a 10,000-sack (100 lbs. per sack) crop in boxes would require about 18,000 boxes or an investment of \$3,960. Pickup sacks required to harvest a similar crop would not exceed \$60 per year when the price of pickup sacks is 5 cents each and no allowance is given for sacks left at the end of the season.

Box storage would require approximately 25 per cent more floor space when boxes are stored at the same height as bulk potatoes. To utilize the same floor space as bulk potatoes, boxes would have to be stacked about one-fourth higher than bulk potatoes and this could not be done in many cellars.

Potato Seed Treatments Prove Effective

The experiment dealing with potato seed treatments in 1939 was conducted in cooperation with the Plant Pathology Department. Materials used were acid mercury, formaldehyde, and New Improved Semesan Bel. In all but one formaldehyde treatment, the potatoes were pre-sprinkled. All but one Semesan Bel treatment was made before cutting.

Each treatment was replicated four times for each of the five dates of planting. Alternate rows were planted with untreated potatoes and used as checks. Plantings were made on May 6, 11, 29, and June 6. All treatments gave better results for the earlier plantings.

The lowest stand appeared in the plats receiving the formaldehyde treatments. Control as shown by the number of sclerotia of

Rhizoctonia on tubers was good for these treatments. Both total yields and yields of No. 1 potatoes were slightly below those of other treatments, but the percentage of No. 1 potatoes as well as the yield of No. 1 potatoes per acre was considerably better than in the check row.

The plats treated with the acid mercury ranked second in stand count and yield of No. 1 potatoes per acre and very good control of Rhizoctonia infection was secured.

On the two plats treated with Semesan Bel stands were equal to those of the check plats, and these plats produced the highest yield of No. 1 potatoes per acre. The control of Rhizoctonia infection on stems and tubers was not as good for this treatment as for the others.

Table 10.—Summary of potato seed treatments for five dates of plantings on Aberdeen Branch Station for 1939

Treatment	No. of plats	Stand No. plants per row	Acre Yield		Per cent 1's	Relative No. sclerotia on tubers*
			1's cwts.	Total cwts.		
Bordering checks.....	40	148.7	162.1	239.7	68	3.98
Pre-Spr. formaldehyde..	20	132.6	171.2	239.7	71	2.05
Bordering checks.....	40	148.9	160.5	242.3	66	4.07
Pre-Spr. Acid Mercury..	20	139.2	181.0	247.1	73	1.95
Bordering checks.....	40	147.4	158.3	239.3	66	4.05
Pre-Spr. Semesan Bel....	20	149.4	178.4	250.8	71	3.65
Bordering checks.....	40	146.9	161.1	241.8	67	3.95
Formaldehyde.....	20	133.1	176.6	244.0	72	1.70
Bordering checks.....	40	147.3	162.4	241.3	67	4.00
Pre-Spr. S. B. after cutting.....	20	146.7	186.6	249.5	75	3.05

* Relative number of sclerotia on tubers was determined by rating tubers 0, 1, 2, 3, 4, 5. 0—all tubers clean; 5—all tubers quite heavily speckled; numbers in between represent degree of infection.

Lemhi Wheat Released

In the 1938 annual report it was indicated that Lemhi wheat showed promise and that it would probably be released. Lemhi wheat was developed at the Aberdeen Branch Station by the Office of Cereal Crops and Diseases, U. S. Department of Agriculture. It was also tested in Utah, Montana, Colorado, and Washington in cooperation with the Office of Cereal Crops and Diseases. Results in these states are very similar to those obtained at Aberdeen. Lemhi, a Federation-Dicklow cross, has some of the desirable characteristics of both parents and its advantages can be summarized by quoting from the 1938 report: "From all indications this new wheat promises to meet the requirements of the miller, as well as

those of the grower, in that it has the milling characteristics of Dicklow and the short stiff straw and early maturity of Federation and maintains a yield equal to or slightly above that of Federation."



Figure 13.—Harvesting Lemhi wheat on the Aberdeen Branch Station.

Lemhi wheat was released to 32 farmers in 12 counties under a conditional contract. The contract provided that further distribution was contingent upon continued favorable performance in 1939 and the contract also provided a maximum selling price of \$2.25 per cwt. of cleaned and sacked wheat.

Thirty-one replies were received from the 32 questionnaires sent out. At least 90 per cent reported very favorable results and believed this wheat an improvement over standard varieties grown in their respective counties. The few criticisms generally conformed with those observed by the research workers, but were not of sufficient significance to delay distribution. Efforts will be concentrated to make further improvements.

Table 11.—Yields of Lemhi C. I. 11415, Federation and Irwin Dicklow grown in field plats at Aberdeen, Idaho, in 1934-1939

Variety	C. I. Number	Acre yield in bushels						Average
		1934	1935	1936	1937	1938	1939	
Lemhi	11415	83.3	89.3	79.1	79.3	62.2	84.6	79.6
Federation	4734	84.1	89.1	71.1	75.0	58.6	81.5	76.6
Irwin Dicklow	8855	78.3	87.2	61.9	76.0	61.4	82.1	74.5

The data in Table 12 was obtained through the courtesy of C. A. Suneson, Associate Agronomist, and workers at the Stations where Lemhi was tested.

Table 12.—Average yield, expressed as a percentage of Baart of the spring varieties in the uniform nursery grown under irrigation at four experiment stations in the years 1931-1937

Variety	C. I. Number	Yield in percentage of Baart for same years.					No. of station yrs.
		Aberdeen, Idaho	Logan, Utah	Hesperus, Colo.	Bozeman, Mont.	Average	
Lemhi	11414	119.2	114.0	120.3	98.5	113.5	27
Irwin Dicklow	8855	116.2	95.4	108.2	95.2	104.1	27
Federation	4734	113.8	104.1	104.4	85.9	102.6	27
Baart	1697	100.0	100.0	100.0	100.0	100.0	27

Caldwell Branch Station

R. F. JOHNSON, *in charge*

Sugar Beet By-Products Useful in Feeding Program

WITH the advent of sugar beet growing in the Boise Valley, making available large quantities of beet tops and wet beet pulp for livestock feeding, experiments were inaugurated to obtain additional information on their value and most efficient use. For silage purposes, the sugar beet tops were gathered from the field and stacked with alternate layers of straw in ricks approximately 12 feet wide and 8 feet high. From a field yielding 21 tons of beets per acre, 1 ton of beet tops was gathered for every 3.2 tons of sugar beets harvested. The wet beet pulp was trucked from the refinery at Nyssa, Oregon, to the Branch Station and stored in an above-ground straw-covered crib while fed. The wet pulp lost 35 per cent of its weight during hauling and while it was in storage over a 6 weeks' period.



Figure 14.—Air view of Caldwell Branch Station.

The first year when wet beet pulp was fed with chopped alfalfa hay and ground barley to 640-pound yearling steers, the beet pulp appeared to be unpalatable and the average daily feed was only about 50 per cent of the expected consumption. A ration of 15.4 pounds of alfalfa, 6 pounds of ground barley, and 0.6 pounds of wheat bran contained 5.1 per cent more total dry matter than a ration of 8.6 pounds of alfalfa hay, 6.5 pounds of ground barley and 21 pounds of wet beet pulp and increased the average daily gain 0.2 pounds daily per steer.

When fed to steers in a ration of chopped alfalfa hay and ground barley, beet top silage proved as palatable as corn silage. The average daily gains were two pounds per steer for each of the rations. On a feed requirement basis corn silage had a higher value than the beet top silage. Four hundred sixty-nine pounds of corn silage replaced 171 pounds of alfalfa hay, but required 33 pounds additional barley to produce 100 pounds of gain. When chopped alfalfa hay sells for \$8 per ton and ground barley for \$1.10 per hundred-weight, the corn silage would have a value of \$1.51 per ton. On the same basis, 536 pounds of beet top silage took the place of 146 pounds of chopped alfalfa hay but required 32 pounds additional barley and a value of \$0.98 per ton. Indications of digestive disturbances or of bloat were not evident among the steers in the pens where succulent feeds were a part of the ration. Bloat is a common occurrence among steers fed on rations composed of alfalfa hay, barley, and wheat. Although the silages apparently have a low feed replacement value, they are valuable in improving the palatability of the ration and in the prevention of bloat.

When wet beet pulp was fed at the rate of 3.2 pounds with 1 pound of barley and 0.9 pounds of chopped alfalfa hay, 75-pound range lambs gained 0.3 pounds daily. One ton of beet pulp replaced 87 pounds of barley and 643 pounds of alfalfa hay and had a value of \$3.44 per ton. In these trials, the substitution of one-tenth of the grain allowance with cottonseed meal to provide additional protein and phosphorus did not increase the average daily gains, but raised the cost of producing 100 pounds of gain 19 per cent.

Beet top and corn silage were fed at the rate of 3.4 pounds with 1.4 pounds of alfalfa hay and 1 pound of barley to 75-pound range lambs. More rapid and economical gains were made by similar lambs fed 1.6 pounds of alfalfa hay and 1 pound of barley per day. Beet top silage saved 20 per cent of the hay, but due to the increased requirement of barley for the production of 100 pounds of gain, the feed replacement value was only \$0.71 per ton. With corn silage an actual loss occurred for every ton fed. The relatively poor results secured in these trials from feeding either beet top silage or corn silage as a succulent supplement for alfalfa hay and barley to range lambs conform with results of previous experiments. These indicate that the silages may be of questionable value as a feed for fattening range lambs that have been farm pastured from 45 to 60 days prior to their feedlot confinement.

Yearling Steers Make Satisfactory Gains in Dry Summers

Thirty-four 740-pound yearling steers were grain fed in a dry lot without shade from May 15 to July 30. These steers consumed 23.6 pounds of hay and grain containing 13.9 pounds of total digestible nutrients and gained 2.22 pounds per head daily. In comparison, ten 640-pound yearling steers similarly fed during the previous winter ate 22.1 pounds of hay and grain having 15.9 pounds of total digestible nutrients and gained 2 pounds per head each day. The labor and expense of feeding and caring for the summer-fed steers was lower because the work necessary to keep the bedding in proper condition for the steers in the winter was eliminated.

Wintering, Pasturing, and Finishing Calves a Satisfactory System

Weaner calves weighing 370 pounds per head were fall pastured 97 days, fed wintering rations 83 days, grazed on irrigated pastures for 129 days and grain fed in a dry lot for 89 days, and marketed at a weight of 957 pounds. The fall pasture consisted of corn stalks, alfalfa meadow aftermath and dried grass which was along the ditch banks and fences. Although the calves did not make marked gains during the fall pasture period, they made a perceptible growth. The calves, which were fed 15 pounds of alfalfa hay per day as their wintering feed gained 1.61 pounds per day at a feed cost of \$3.76 per hundredweight, while those fed 15 pounds of alfalfa hay and 3.75 pounds of ground barley and oats gained 2.15 pounds per head, with a feed cost of \$4.81 per hundredweight. During the summer the steers were grazed at the rate of 2 steers per acre on irrigated pasture of bluegrass and mixed grasses. The pasture was charged at the rate of 10 cents per head each day and the gains were 1.32 pounds per steer daily and cost \$7.61 per hundredweight. After moving from the pastures to the dry feed lot, the steers were finished on chopped alfalfa hay, corn silage, and ground barley. In addition to placing beef cattle production on a yearly basis on the irrigated farm, this system requires a minimum outlay for cash for the purchase of feeder stock, conserves fall feed that would not otherwise be utilized, and, because the animals become accustomed to the farm during the wintering and pasture periods, they do not receive the setback when brought into the winter fattening pens like yearling steers brought in from the range.

Commercial Fertilizers for Alfalfa Increases Yields

Third-year yields of alfalfa from plots receiving one application of single and combined dressings of sodium nitrate, treble super phosphate, potassium chloride, and calcium sulphate did not vary essentially from previous yields. The yields were somewhat higher from the plots having applications of potash, but not significant

enough to warrant recommending it generally for alfalfa until further investigation has been made.

Hybrid Corn Useful for Silage

Equal tonnages of green fodder were harvested per acre from adjoining fields of Hybrid silage corn and Minnesota No. 13. In general appearance, the Hybrid corn was different from the Minnesota No. 13 in that the stalks were 2 feet higher, the ears were placed higher on the stalk, and the foliage was of a darker color.

Sandpoint Branch Station

R. E. KNIGHT, *in charge*

Weather Conditions Not Favorable

THE winter of 1938-1939 was unusually mild in this area. The minimum temperature for December was 10° F. It was 1 degree lower for January, which was the third highest mean temperature on record. The only temperatures of zero Fahrenheit or below came on three successive days in February, with a low for the winter of minus 17 degrees. Snow cover was intermittent until the middle of January, when there was good coverage until late March, and winter wheat and hay crops emerged in excellent condition. Rainfall during the growing season was far short of normal, with marked deficiencies occurring in April, May, July, August, and September. January, February, and June were the only months showing an excess of precipitation. The total for the first eleven months was 18.62 inches, 5.8 inches short of normal.

Summer temperatures were generally somewhat above average except for June. Late July and August were particularly warm.



Figure 15.—Clearing operations under way on cut-over land near Sandpoint.

There were 22 days when the temperature reached 90 or above, with a summer high of 100 on July 27 and 28.

The period between killing frosts extended from April 14 to September 7, a total of 146 days. A light frost on July 17 did some damage to potatoes and some of the more tender vegetable crops.

Cereal Investigations Emphasized

Winter grains in the variety tests followed a green manure crop of Rosen rye. Stands were rather thin because of light stooling, but the heads were well filled and yields were the next highest on record—second only to those of 1938. The average for all the 15 varieties tested was 50.1 bushels per acre. Golden, with 59.5 bushels, gave the highest yield, closely followed by Mosida, Forty-Fold X Federation, and Rex M1. Jones Fife, the only variety to lodge, gave the lowest yield with 41.4 bushels. Forty-Fold X Federation, Rex M1, and Forty-Fold X Hybrid 128 were seeded for increase this fall, on land following a green manure crop of alfalfa. One of these varieties may replace Mosida on the more fertile soils of the regions which are unsuited to Mosida because of the tendency of that variety to lodge when grown on soils with high fertility. Jenkin was the highest yielding in the uniform nursery with a yield of 54.1 bushels. Rex M1 and Golden were the next highest yielding varieties while Rio was lowest with 33.7 bushels.

Spring grains were much better than anticipated in view of the extremely dry season, producing yields slightly above average. Jenkin and Dicklow made 31.7 and 31.4 bushels per acre, respectively. As has been true in the past, the late-maturing varieties gave the highest yields. Idaed and White Federation, the two earliest varieties, each produced slightly over 22 bushels per acre. Union and Federation 47 were the highest in yielding varieties in



Figure 16.—Typical cut-over land before clearing operations were begun.

the nursery. Yields of the oat varieties ranged from 58.6 to 64.6 bushels, while the oat nursery, a Markton X Swedish Select cross produced 92.3 bushels. Barley varieties made record yields which in most cases were at least double the ten-year average. The yield of Beldi, for example, was 54.2 bushels as compared with the average of 24.4 bushels for that variety.

Fertilizers Increase Yield of Potatoes

Results in the past from fertilizer applications to potatoes have been very inconclusive, due in a large measure to the fact that the fertilizers were broadcast. This year furrows were plowed and the materials distributed in them by hand and mixed with the soil, after which the potatoes were planted and covered. Contrary to expectations, larger, more vigorous vines resulted in every case where phosphate was used, and after the plants were a few weeks old, it was possible to pick out the phosphated plots at a glance. Unfortunately, an error occurred in harvesting, and yields were secured from only 7 of the 17 plots. A number of unfavorable factors combined to make all yields exceptionally low. Two check plots averaged 3685 pounds per acre, while the application of a complete fertilizer resulted in 6593 pounds per acre. On peat land at Clark Fork, three plots fertilized with 200 pounds of 2-20-20, 7-16-16, and 7-13-19, respectively, averaged 183 sacks per acre compared with only 144 sacks per acre from two checks.

A Variety of Legume Experiments Conducted

Ladak gave the highest production of hay in the alfalfa variety test with 9640 pounds per acre, while Grimm and Turkestan were next in order. The Argentine variety produced the lowest yield



Figure 17.—Plowing under alfalfa for “green manure” on the Sandpoint Branch Station.

with 6560 pounds. Ladak made an exceptionally good first crop, but no shoots appeared for the second cutting until the other varieties were three or four inches tall. On the soils more subject to drouth where normally only one crop per year is produced, there would probably be some advantage in growing Ladak instead of Grimm.

Symptoms of boron deficiency in alfalfa were widespread over the area this year, becoming more pronounced in the second crop. In some cases entire fields were affected; in others, only the drier slopes and knolls. In a number of trials, both at the Branch Station and on cooperating farms, such symptoms have been successfully eliminated through the use of borax at the rate of 40 pounds per acre. A decided residual effect was noted during the second year in a boron-treated plot on the Branch Station farm. Applications of borax, ranging from 20 to 80 pounds per acre, were made on a new seeding of alfalfa this year, and results will be checked next season. Yields of alfalfa and clover seeded with various nurse crops in 1937 were much higher than last year, in some cases quite comparable to the check plots. The increases were due to the great improvement in growth and vigor over the preceding year.

Other Projects Listed

A number of additional projects will be given only brief mention at this time. Borax alone, at rates ranging from 2 to 5 pounds per square rod, proved ineffective as a weed poison, while $2\frac{1}{2}$ pounds borax and $1\frac{1}{2}$ pounds sodium chlorate resulted in a 90 per cent kill. Records on several land clearing demonstrations with a bulldozer showed costs ranging from \$10.95 to slightly over \$22 per acre, exclusive of the farmer's labor. On one 25-acre project, the total cost for powder and fuse for shooting the larger stumps, for clearing and piling by the bulldozer, and for all labor except picking up the small pieces after the machine, was \$15.60 per acre. One-half bushel per acre was the most economical rate for seeding flax, while early spring seedings, as soon as the frost danger is past, gave higher yields than the later seedings. Semesan was effective in promoting a higher germination of seed peas in a test conducted in cooperation with the Department of Plant Pathology. Four varieties treated with this product produced an average stand of 80.7 per cent, while the average stand in the corresponding checks was only 52.1 per cent. Treatment with Ceresan and Cupro-cide resulted in much higher stands than the checks, but lower than those treated with Semesan. Slender wheatgrass in rows 3 feet apart yielded 510 pounds seed per acre as compared with a yield of 430 pounds per acre from a solid stand. Additional work on reseeding burned-over land was started to supplement the results of work already conducted. Two series of plots on the area recently burned over near Spirit Lake have been seeded to various grass and legume forage species, and a third seeding will be made in the early spring.

High Altitude Branch Station

W. A. MOSS, *in charge*

Growing Season Unfavorable

THE growing season in the vicinity of the High Altitude Branch Station was not favorable during 1939. The year was one of the driest since 1933 and a severe frost on August 10 caused considerable damage to grains and potatoes. The potato crop was as nearly a failure as it had been since the farm was first operated in 1919. Due to the fact that plentiful fall rains occurred in 1938, the winter wheat crop was better than normally would be expected with a rainfall of only 9.48 inches for the year.

Oro Best Yielding Winter Wheat

Oro winter wheat produced the best yields of the varieties tested in the field tests while Turkey produced the best yields in the nursery. A hybrid spring wheat, Baart x Hard Federation, produced the best yields among the spring wheats included in the variety tests in both field and nursery trials. This hybrid has performed well for the past three years and may become a desirable variety for distribution for use in the high altitude dry farming areas.

Idaed, Onas, Baart, and Marquis also have yielded well on the High Altitude Branch Station.

Alfalfa Hay Yields Reduced

The cold dry spring was not conducive to good yields of alfalfa. The varieties tested this year were similar in order of yields per acre as in previous years. Ladak produced the highest yield. Over

Table 13.—Six-year average yield of hay of alfalfa varieties at the High Altitude Branch Station, 1934-1939

Variety	Pounds per acre
Ladak.....	3988
Cossack.....	3766
Gov. Grimm.....	3649
Baltic.....	3456
Hardigan.....	3364
Canadian Variagated.....	3331
Kansas.....	3305
N. D. Grimm.....	3243
Idaho Grimm.....	3147
Utah Common.....	3074
Hardistan.....	2962
Dakota Common.....	2884
Turkestan.....	2842
Argentine.....	2663
French.....	2539
Arizona Common.....	2428

a six-year period, this variety has out-yielded, by an average of 222 pounds of hay per acre, all of the sixteen varieties of alfalfa included in the test. Cossack, Grimm, Canadian Variegated, Baltic and Hardigan also produced good yields. Table 13 gives the average yields in pounds per acre of 16 varieties of alfalfa when grown for 6 years in plots on the High Altitude Branch Station. The difference in yield between the better yielding and the poorer yielding varieties indicates the desirability of using only these better varieties for planting in the high altitude nonirrigated areas.

New Location for Farm Developed

A new location for the High Altitude Branch Station farm was selected and the buildings were moved to a location $3\frac{1}{2}$ miles southwest from their former site, on the bank of the Teton River, to the highway between Sugar City and Driggs. An oiled driveway was constructed from the highway to the buildings, a new cistern was made, and plans developed for landscaping the grounds surrounding the buildings. Native plants and shrubs will be used when possible for planting in developing a landscape plan on the new location.

New rotation and soil management plots have been developed and some grass and winter wheat seeding has been done on the new farm.

An extensive series of cooperative experiments with the Soil Conservation Service of the U. S. Department of Agriculture have been initiated on the new farm to study the effect of various cropping systems and tillage methods upon wind and water erosion of soil under the nonirrigated conditions found on the Branch Station. In order to properly equip the Branch Station for efficient work on the program under way, and carry out other work which has been requested, additional funds will be needed. These needs include new machinery, additional money for labor, and a new potato storage cellar.

Changes in Station Staff Summarized

SEVERAL changes have taken place in the Experiment Station staff during the past year. Dr. Leo Christensen was appointed Head of the Department of Agricultural Chemistry and Agricultural Chemist on September 16, 1939, to fill the vacancy caused by the death of Prof. H. P. Magnuson. C. O. Youngstrom resigned as Associate Agricultural Economist on March 1, 1939, to become Extension Agricultural Economist with headquarters in Boise, Idaho. Norman Nybrotten was appointed to fill the vacancy. O. L. Mimms, Assistant Agricultural Economist, resigned February 15, 1939, to enter the employ of the Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C. Leo Fenske was appointed to fill this vacancy, September 15, 1939. Russell Stark resigned as Assistant Agronomist on May 31, 1939, and is now located at Aberdeen, Idaho in the employ of the Nurseries Division

of the Soil Conservation Service. V. A. Cherrington and John M. Hale, Assistant Bacteriologists, secured leaves of absence in order to take graduate study. W. H. Hoge and W. B. Ardrey were employed to assist in the Department of Bacteriology during the absence of these two men. O. A. Shaw, Assistant Dairy Husbandman, resigned August 15, 1939, in order to accept a position at Kansas State College. F. Chas. Fountaine was hired to fill the position formerly held by Dr. Shaw. L. R. Tucker, Assistant Horticulturist at the Parma Branch Station, resigned October 30, 1939, and Carl F. Dietz was employed to carry on the horticultural research on the Parma Branch Station.

Publications

THE results of investigations by the Station staff are published as bulletins, research bulletins, circulars, and mimeo-leaflets by the University and as research papers by various scientific journals. The list of publications for 1939 follows:

Bulletins

228. *Managing Farm Flock Sheep for Greater Profit in Southern Idaho.*
229. *High Lights in Agricultural Research in Idaho.*
230. *Progress Report of Phosphate and Other Fertilizer Investigations at the Aberdeen Branch Experiment Station, University of Idaho.*
231. *Markets and Market Preferences for Idaho Potatoes.*
232. *Basic Data for Land Classification.*

Circulars

80. *Diseases of Potatoes in Idaho.*
81. *Publications Available for Free Distribution.*

Mimeo-Leaflets

26. *The Cyclamen Mite, a Pest of Strawberries in Idaho.*
27. *Waste and Surplus Utilization: Alcohol from Cull Potatoes.*
28. *A Mechanical Grasshopper-Bait Spreader.*
29. *The Control and Eradication of Wild Morning Glory (Convolvulus arvensis L.)*
30. *Spray Recommendations for Idaho—1939.*
31. *Wheat-Wild Rye Hybrid Grass.*
32. *Hybrid Corn and Its Apparent Advantages over Open-Pollinated Varieties.*
33. *Utilization and Production of Smooth Brome.*
34. *Index Numbers of Idaho Farm Prices.*
35. *Bacterial Ring Rot and Wilt of Potatoes.*
36. *The Curly Top Disease of Vegetables and Ornamental Flowering Plants in Idaho.*
37. *Dormant Sprays for Peach and Apricot.*
38. *Idaho Falls Laboratory.*
39. *Does Sour Cream Test More than Sweet Cream?*
40. *Wheat, Wild Rye, Hybrid Grasses.*
41. *Spray Recommendations for Idaho—1940.*
42. *Disease Resistant Bean Varieties for Idaho Growers.*

Research Papers

171. *The Calcium:Phosphorus Ratio of the Skins of Canning Peas and Its Relation to Maturity.* Donald W. Bolin and Wilbur Schroeder.
172. *Field Experiments for the Control of the Beet Leafhopper in Idaho, 1936-1937.* J. R. Douglass, J. A. Gillett, and Claude Wakeland.
173. *Stability of Carotene in Green Grasses and Alfalfa Stored at 5° F.* D. W. Bolin.
174. *Inequalities in the Digits in Swine.* J. E. Nordby.
175. *The Efficiency of Carotene as Supplied by Alfalfa Meal in Meeting the Vitamin A Requirements of Laying Hens.* J. K. Williams, C. E. Lampman and D. W. Bolin.
176. *Reduction in Cracking of Sweet Cherries by the Use of Calcium Sprays.* Leif Verner.
177. *Effects of Certain Chemicals on Apical Dominance and Rest Period of Russet Burbank Potatoes.* George W. Woodbury.
178. *Reinoculation of Resistant Varieties of Wheat with Purified Physiologic Races of *Tilletia tritici* and *T. levis*.* Wayne Bever.
179. *The Effect of a Plant Hormone on Crotch Angles in Young Apple Trees.* Leif Verner.
180. *Boron Studies on Idaho Soils.* W. E. Colwell, G. O. Baker.
181. *The Steam Pressure Cooker is no Better than Its Gauge.* W. V. Halversen.
182. *Relation of the Near-Wilt Fungus to the Pea Plant.* W. J. Virgin and J. C. Walker.
183. *The Repellency of Pyrethrum Dust to the Beet Leafhopper on Tomatoes.* B. F. Coon and Claude Wakeland.
184. *A Preliminary Report on a Fungus of the Field Bindweed (*Convolvulus arvensis*).* Wayne Bever and C. I. Seely.
185. *A Great Northern Bean Resistant to Curly Top and Common Bean Mosaic Viruses.* Donald M. Murphy.
186. *Icterus in a Garbage-Fed Hog due to a Foreign Body.* G. C. Holm.

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HOME STATION DISBURSEMENTS
Detail of Expenditures of State Appropriations*
Idaho Agricultural Experiment Station
January 1 through December 31, 1939.

	Salaries	Help	Expense & Supplies	Equip-ment	Total
Administration	\$.....	\$.....	\$ 204.93	\$.....	\$ 204.93
Agr. Chem.	3.84	23.99	27.83
Agr. Econ.	101.66	4.54	106.20
Agr. Engr.	34.85	.....	34.85
Agron.	713.35	714.65	205.70	1,633.70
An. Hus.	5.06	.....	5.06
Bacter.
Dairy Hus.	15.00	842.64	47.37	905.01
Entom.	225.83	.....	225.83
Home Econ.	1.05	.....	1.05
Hort.	303.41	7.00	310.41
Plant Path.	51.00	.....	51.00
Poultry	565.02	1,513.42	72.78	2,151.22
Soil Survey	233.85	339.23	.....	573.08
TOTAL.....	\$.....	\$1,527.22	\$4,341.57	\$ 361.38	\$6,230.17

* Includes general appropriation and institutional funds.

SUBSTATION DISBURSEMENTS
January 1 through December 31, 1939

	Aberdeen	Caldwell	High Altitude	Sandpoint	Total
Salaries	\$ 3,459.96	\$ 3,290.00	\$ 1,800.00	\$ 3,080.00	\$11,629.96
Help	3,134.06	2,468.40	974.34	572.30	7,149.10
Expense & Supplies	3,449.09	5,462.15	1,501.65	817.07	11,229.96
Equipment	519.85	29.50	1,405.51	122.98	2,077.84
TOTAL.....	\$10,562.96	\$11,250.05	\$ 5,681.50	\$ 4,592.35	\$32,086.96

FINANCIAL STATEMENT
Detail of Expenditures of Federal Appropriations
Idaho Agricultural Experiment Station
July 1, 1938 to June 30, 1939

	Abstract	Hatch	Adams	Purnell	Bankhead-Jones
Salaries.....	1-A	\$ 9,195.29	\$11,353.94	\$42,450.53	\$ 6,537.22
Labor.....	B	1,277.11	2,036.31	8,071.40	2,023.02
Stationery, office supplies.....	2-A	71.52	12.71	304.19	13.85
Scientific supplies.....	B	190.48	872.56	1,659.22	296.35
Feeding stuffs.....	C	292.00	5.00	862.28	1,632.60
Sundry supplies.....	E	7.62	17.41	30.39	.68
Communication service.....	5	1,439.30	.....	872.52	35.64
Travel expense.....	6	1,116.17	159.85	2,196.02	608.28
Transportation of things..	7	6.58	48.66	125.17	8.62
Publications.....	8	1,259.12	.....	195.01	.....
Heat, light, water, power..	10	.....	.....	111.57	.....
Contingent expense.....	13	21.17	1.10	53.85	30.57
Furniture and fixtures.....	30-A	84.75	.....	155.15	.....
Library.....	B	.....	.....	39.34	17.00
Scientific equipment.....	C	30.29	404.41	1,986.23	19.98
Tools and machinery.....	D	8.60	72.15	701.52	15.28
Livestock.....	E	.....	.....	55.00	.....
Buildings and land.....	31	15.90	130.61	764.65
TOTALS.....		\$15,000.00	\$15,000.00	\$60,000.00	\$12,003.74

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