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High Lights in Agricultural Research in Idaho

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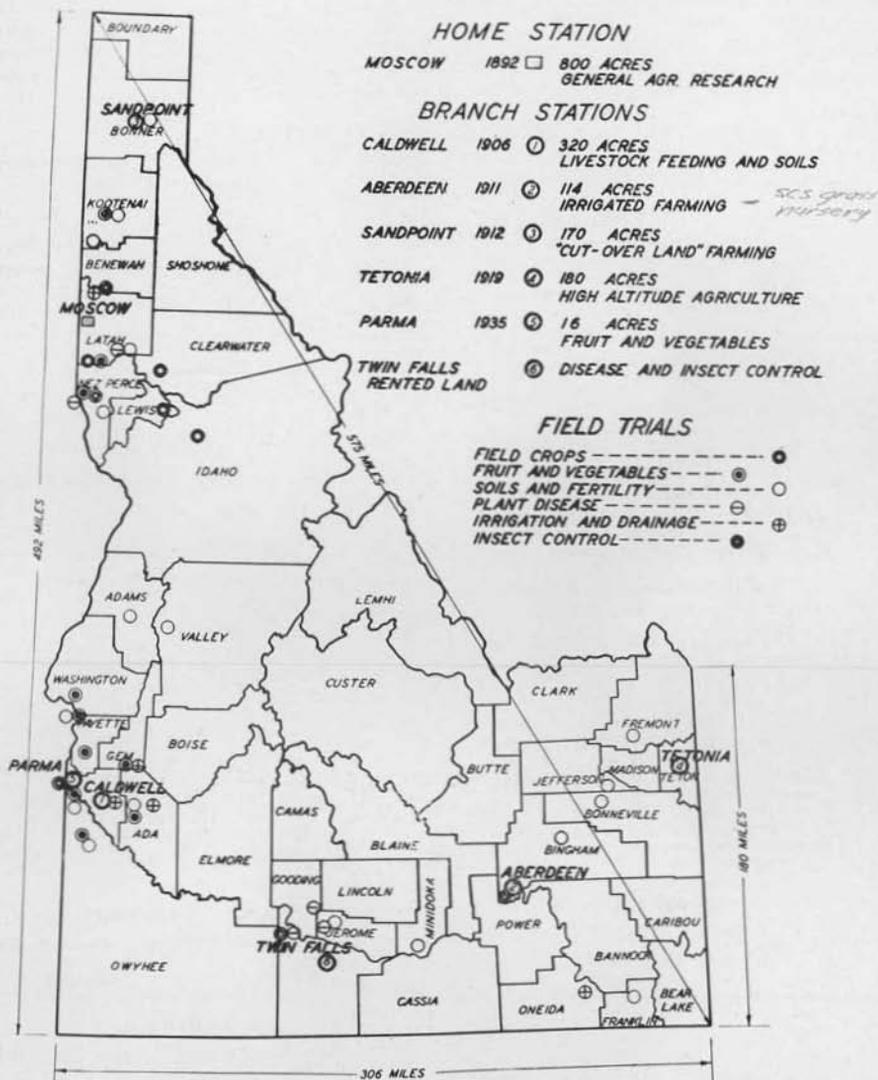
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Map of the State of Idaho showing the location of the Home Station, the Branch Stations, and the principal field trial plots in cooperation with farmers during 1938.

Foreword

C. W. HUNGERFORD, *Vice Director*

AT the close of each year a progress report of the research program is made by the Idaho Agricultural Experiment Station. The report this year is somewhat briefer than usual and emphasizes only the highlights and the more concrete results secured from investigations conducted in various parts of the state. These investigations have been outlined to meet the needs of Idaho farmers and to answer perplexing, practical farm problems, as well as to contribute to fundamental research which will form a 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; Farm Crops and Soils; Fruit and Vegetable Crops; Agricultural Engineering; Farm Economics; Agricultural Bacteriology; Agricultural Chemistry; Insects; Plant Diseases; Nutrition; 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.

High Lights in Agricultural Research in Idaho

Introduction

IN any well-organized program of agricultural research, some lines of investigation will be continued for a number of years before definite conclusions can be made. Others are short-time projects and, because of their nature, yield results in one or two years. A well-balanced program should be comprehensive and should include studies of marketing and market organizations, as well as production problems and the basic scientific problems involved in production. Furthermore, emphasis in agricultural research may change as the agricultural picture changes. As we review the Idaho program of agricultural research, we realize how much this program has been adjusted during recent years to meet changing conditions in agriculture. New projects dealing with prices and markets for Idaho produce, the industrial use of Idaho agricultural products, the conservation of Idaho soils by prevention of water and wind erosion through use of better cultural and cropping practices, land use and land classification, population shifts and trends in Idaho, and numerous other similar problems have been emphasized—not, however, to the exclusion of other types of research which must at all times provide the background for the intelligent solution of problems of agricultural adjustment.

In recent years soil conservation, land use, utilization of the by-products of the agricultural industry, and other similar problems have been developed on a national or regional basis. In order to conduct research more effectively in these fields having more general application, cooperation between various state and national agencies interested in these problems is essential. The Idaho Agricultural Experiment Station each year has an increasing number of memoranda of agreement with departments of the Federal Government and other public and private agencies in order that our work may be coordinated with efforts of these agencies in a united approach toward the solution of these more general farm problems.

On the following pages will be found a brief statement from each of the departments of the Station and from each of the branch stations, setting forth the major accomplishments of the last year. Attention is especially called to the work on the branch stations. This work, closely coordinated with that of the main station at Moscow, is intended primarily to serve the interests of the region where the branch station is located, although the results obtained usually have much wider application.

Experiments dealing with field corn, sweet corn, grasses, and fertilizers have been expanded at the Caldwell Branch Station. An account of these activities will be found under the report of this station and under the discussion of field crops and soils. Stockmen will read with interest the results of lamb-feeding and steer-feeding investigations reported under the Caldwell Branch Station and under the discussion of the work with beef cattle and sheep earlier in this report. At the Aberdeen Branch Station potatoes proved to be valuable feed for wintering lambs.

Extensive trials of grasses for forage and for soil building are conducted at all of the branch stations. In cooperation with the Soil Conservation Service, this work will be expanded materially at Aberdeen, where an extensive grass nursery will be grown, and on the High Altitude Branch Station, at Tetonia, where extensive experiments have been inaugurated in the control of soil erosion caused by wind and water.

The High Altitude Branch Station will be moved next summer to a site on the highway between Rexburg and Driggs, 3½ miles southwest from its present location. The new location makes the farm accessible at all times of the year and is ideal for the development of agricultural research to serve the nonirrigated, high-altitude farming areas of southeastern Idaho.

Beef Cattle, Horses, Sheep, and Swine

Livestock on Summer Range Receive Ample Mineral from Native Forage

FOR the past 3 years a study has been made on the composition of the major forage species of plants grazed by livestock on Idaho summer ranges, with special attention being given to the protein, calcium, and phosphorus content and the seasonal changes in these elements.

A summary of the analyses of 600 samples of weeds, browse, and grasses collected at different seasons is presented in Table 1.

Table 1.—Seasonal changes in the protein, calcium, and phosphorus content of range forage plants

RANGE		EARLY SUMMER*			LATE SUMMER*			WINTER**		
Years	Type of Plant	Protein	Calcium	Phosphorus	Protein	Calcium	Phosphorus	Protein	Calcium	Phosphorus
1936-37-38	Weeds	22.0	1.31	0.462	10.8	2.21	0.312	3.2	2.04	0.045
1936-37-38	Browse	16.1	1.00	0.305	11.6	1.58	0.282	7.0	0.49	0.118
1936-37-38	Grass	15.6	0.38	0.184	7.2	0.42	0.143	3.5	0.39	0.034
	Average	17.9	0.89	0.317	9.8	1.40	0.245	4.5	0.97	0.065

* Collected on the National Forests of Idaho.

** Collected on the Taylor Grazing Lands of Idaho.

Interpreting these data from the standpoint of livestock nutrition, it appears that ample protein, calcium, and phosphorus are provided by the natural forage plants on the early and late summer ranges. Forage plants collected the forepart of the summer grazing season had an average calcium content of 0.89 per cent and a phosphorus content of 0.32 per cent, in the late summer the plant calcium increased to 1.40 per cent and the phosphorus decreased to 0.25 per cent. 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. Stock grazing on areas where the average phosphorus percentage is 0.14 per cent or above and the average calcium content is 0.25 per cent or above are in no danger of a mineral deficiency of these elements.

Mineral content of winter plants collected from the desert sagebrush areas indicates a definite phosphorus deficiency but ample calcium (Table 1). The average phosphorus content of 0.065 per cent, as found in the winter forage plants, is too low a level to satisfy the phosphorus requirements of range stock. Previous work has shown that sheep and cattle on feed containing less than 0.12 per cent phosphorus cannot satisfy their phosphorus requirements.

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

Phosphorus Requirements of Lambs Can Be Met by Farm-Grown Feeds

In light of the best information at hand today, it appears that most of the Idaho lamb fattening rations receive plenty of

Table 2.—Phosphorus requirements of lambs

Lot No.	RATION	Phosphorus in ration, per cent	Daily phosphorus intake per lamb, grams	Average daily gain, pounds	Feed* per 100 lbs. gain, pounds	Blood phosphorus, minimum level, mg./100 cc.
I	Basal ration** plus low phosphorus alfalfa	0.12	1.33	0.21	1160	4.85
II	Basal ration plus high phosphorus alfalfa	0.14	1.65	0.26	995	5.15
III	Basal ration plus bonemeal	0.20	2.45	0.26	972	5.71
IV	Basal ration plus cottonseed meal	0.22	2.74	0.28	935	6.22
V	Basal ration with alfalfa reduced to 26 per cent	0.10	1.14	0.23	1053	3.40

* Corn silage converted to dry basis.

** All lots received corn silage.

phosphorus from farm-grown feeds, especially since the bulk of our rations are made up with alfalfa hay.

This statement has been corroborated by a series of experiments conducted with western lambs to study the actual amount of phosphorus needed in the ration. In 1937-38 five lots of feeder lambs (63 pounds), using 25 lambs per lot, were fed for 143 days on rations varying in amounts of phosphorus. The low phosphorus basal ration was composed of dried molasses beet pulp, 44.2 per cent; chopped alfalfa hay, 50.0 per cent; blood meal, 5.0 per cent; and limestone, 0.8 per cent. The mixture was fed ad libitum, plus 1 pound of corn silage per lamb daily.

Emphasizing the data in Table 2, the results show that lambs receiving rations with 0.12 per cent phosphorus or less show signs of aphosphorosis. Lambs on the deficient rations were ingesting only 1.1 to 1.3 grams of phosphorus per head daily, which is not sufficient to satisfy the body requirements. A deficiency of phosphorus was indicated by slower gains, higher feed requirements per pound of gain, and low blood phosphorus levels.

Rations containing 0.14 per cent phosphorus are on the borderline phosphorus level, which indicates that this is about the daily minimum requirement to prevent aphosphorosis in lambs.

Previous studies, as in this experiment, have repeatedly shown that the phosphorus requirements of lambs can be amply satisfied by natural 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 will receive ample phosphorus from this single source.

Phosphorus Requirements for Growing and Fattening Lambs

Further study on the phosphorus requirements for fattening lambs has indicated that lambs ranging in weight from 50 to 80 pounds require a daily intake of from 1.71 to 2.17 grams of phosphorus per lamb for normal health and growth.

In order to determine these requirements, phosphorus was added at four different levels, as disodium phosphate, to a low phosphorus basal ration of dried molasses beet pulp, 73 per cent; cane molasses, 10 per cent; alfalfa, 10 per cent; and blood meal, 7 per cent. Wheat straw was fed ad libitum as a source of roughage. Twenty-one lambs were fed individually in stanchions on the above rations.

Lambs receiving from 0.5 to 1.0 gram of phosphorus daily did not grow normally and developed an abnormal appetite for wool, wood, and other foreign materials. Low phosphorus intake retarded the growth and reduced the blood phosphorus from 2 to 3 milligrams per 100 cc. of plasma.

Practical application of these results to feed-lot conditions reveals that ample phosphorus can be provided in a lamb-fattening ration by the feeding of about 1 pound of grain per head daily or 2 pounds of good quality alfalfa hay. Good quality alfalfa hay

contains from 0.81 to 1.0 gram of phosphorus per pound of feed, and barley about 1.72 grams of phosphorus per pound.

Phosphorus Requirements of Steer Calves

More evidence has been found during the past year indicating that steer calves fattened on rations containing from 0.10 to 0.13 per cent phosphorus showed definite symptoms of aphosphorosis (Table 3). However, when the phosphorus level of the ration was raised to 0.18 per cent, normal health and gains resulted.

In the procedure used to investigate this problem, it was necessary to deviate from a typical Idaho fattening ration. Five lots of steer calves averaging about 432 pounds were fed rations comparable in every respect, excepting the phosphorus content. The low phosphorus basal ration was composed of dried molasses beet pulp, 68.2 per cent; chopped alfalfa hay, 26.0 per cent; blood meal, 5.0 per cent; and limestone, 0.8 per cent. Corn silage was fed to all lots at the rate of about 6 pounds per steer daily.

Table 3.—Phosphorus requirements of steer calves

Lot No.	RATION	Phosphorus in ration, per cent	Daily phosphorus intake per Steer, grams	Average daily gain, pounds	Feed* per 100 lbs. gain, pounds	Blood phosphorus, minimum level, mg/100 cc.
I	Basal ration**	0.10	5.91	0.99	1212	3.2
II	Basal ration plus 0.66 per cent bonemeal	0.18	11.20	1.74	780	6.1
III	Basal ration plus 1.0 per cent bonemeal	0.22	13.80	1.84	813	6.2
IV	Basal ration plus cottonseed meal	0.21	13.37	1.76	805	6.1
V	Dried beet pulp, 40 per cent; alfalfa hay, 60 per cent	0.13	8.56	1.31	1044	4.3
VI	Barley, meat meal, alfalfa hay	0.36	22.86	1.76	823	7.0

* Corn silage converted to dry feed basis.

** All lots received corn silage.

As indicated by Table 3, a definite phosphorus deficiency was manifested when steer calves were fed on rations with 0.13 per cent or less phosphorus. A low phosphorus intake reduced the rapidity and efficiency of gains, the blood phosphorus level, and resulted in a poorly finished and unthrifty animal. This is illustrated by Lots I and II of Table 3. Steer calves on the low phosphorus ration gained only 0.99 pound per day, while the calves receiving sufficient phosphorus gained 1.74 pounds per day.

Our results point definitely to the fact that a ration with 0.18 per cent phosphorus is ample for normal fattening and growth of steer calves, and an additional amount of phosphorus in the ration over this level is of no tangible value. These data strongly

indicate that there is little danger of a phosphorus deficiency in typical Idaho feed-lot rations, since the majority of the feeds and rations contain 0.18 per cent phosphorus or more.

Artificial Insemination

Artificial insemination in sheep with transported semen, in cooperation with the U. S. Department of Agriculture, was conducted during the winter of 1937-38. The semen was collected from ewes at Beltsville, Maryland, placed in small vials, covered with oil and packed in moist cotton above cracked ice in quart-sized, wide-mouth vacuum bottles and shipped by air and railway express to Moscow, Idaho, a distance of approximately 2,600 miles. The time in transit varied from 29.5 to 74 hours and averaged 45 hours. Upon arrival, the samples were checked for motility and activity and stored in an ice box at 45° F. Fifty-three ewes were inseminated, seven of them twice, making a total of 60 inseminations. Five ewes settled and produced five healthy male lambs. More details concerning the method of procedure can be obtained from the Idaho Agricultural Experiment Station Research Paper No. 223, "Artificial Insemination with Transported Semen," by E. M. Gildow and C. E. Terrill, *Journal of American Veterinary Medical Association*, N. S. 46, No. 3, pp. 157-159, September 1938.

Dairy Production and Manufacturing

Success of Continuous Use of Proved Sires Demonstrated by Holstein and Jersey Herds

DURING 1937 the average herd production, including dry cows, was 465.2 pounds of butterfat. The Jersey herd of 17.3 cows produced an average of 389.6 pounds of butterfat, and the Holstein herd of 24 cows produced an average of 519.6 pounds of butterfat.

The influence of the continuous use of proved sires in herd improvement is very clearly shown by the average production of successive generations from the original 14 cows in the Holstein-Friesian herd in 1921. When all records were adjusted to mature class B basis, the original 14 cows averaged 541 pounds of butterfat, while the present herd of 29 tested progeny averaged 717 pounds of butterfat. The butterfat increase by generations through six generations was 71, 31, 33, 13, 5, and 17 pounds, respectively, or a total increase of 170 pounds of butterfat in six generations. According to the latest available information, the Holstein herd ranks second among all Holstein herds in the United States in breeding and developing 30,000-pound milk cows, and during 1938 six new state records for production were made by members of the herd.

Since 1930 the Holstein-Friesian herd has been inspected and classified for type four times. It has never had a single individual classified either "Fair" or "Poor." The present herd shows an average classification of slightly higher than "Good Plus." The only three-generation group of "Excellent" cows of the breed and

the only "All-American" cows in Idaho (one All-American 3-year-old and one Reserve All-American 2-year-old) were bred and developed in this herd.

During the past year the Jersey herd has again qualified for the Constructive Breeder's Registry of the American Jersey Cattle Club. The University herd is one of three herds of Jerseys in the United States to qualify twice for the Constructive Breeder's Registry, and one of 18 herds to qualify since the Registry was inaugurated. Qualification for the Constructive Breeder's Registry is made on the basis of combined high achievement in production, type, number of animals bred by the owner, and the observance of a satisfactory disease control program. The winning of this award for the second consecutive year is indicative of the growing prestige of the Jersey herd as a result of the use of proved sires. The Jersey herd has to its credit 13 silver medal and 1 gold medal awards for production.

Sulfanilamide Proves Valuable as a Treatment for Mastitis

During the past year an intensive cooperative study has been made on the use of sulfanilamide as a treatment for mastitis. Results of the study indicate that sulfanilamide is a valuable treatment for mastitis but must be used with caution. Total daily doses of 5 grams per 100 pounds of body weight, administered in capsules in two or three equally divided and equally spaced doses for a period of 5 to 7 days, gave satisfactory results in the treatment of most new acute cases of mastitis. Some improvement in relieving the acute symptoms of old cases of mastitis was found when sulfanilamide was administered as mentioned. During the course of the sulfanilamide treatment, it was found that cows should be kept quiet, out of the sun, and the dosage reduced or discontinued if the cow went off feed or showed other toxic symptoms.

Influence of Some Factors Affecting the Solids-Not-Fat Content of Milk Established

Thirty-six months' data on the solids-not-fat content of the milk of 54 Holsteins and 41 Jerseys indicate: (1) Cows of the Jersey breed produce milk higher in solids-not-fat than those of the Holstein breed; (2) the solids-not-fat content of milk is not significantly influenced by either the season of the year or the stage of lactation of the cow; (3) bulls transmit to their daughters the ability to produce milk of high or low solids-not-fat content, but the percentage of solids-not-fat is independent of the percentage of fat transmitted; (4) further study is needed to determine the effect of mastitis upon solids-not-fat of milk; and (5) older cows produce, on an average, milk lower in solids-not-fat than do young cows.

Artificial Insemination of Dairy Cows Successful

A very satisfactory technique has been developed for the artificial insemination of dairy cattle. To date, 11 calves have been

dropped and 17 cows are safely in calf as a result of artificial insemination. Details of the method will be furnished upon application.

Miscellaneous Projects and Service Work Continued

Results of a study on the relative accuracy of daily testing of milk samples by the Babcock method versus composite samples conclusively showed that the daily tests were more accurate. Less fat is paid for when 5-day, 10-day, or 15-day composite samples were used as a basis of determining the amount of fat delivered. The 5-day composite is more accurate than the 10-day composite, and the 10-day composite more accurate than the 15-day composite sample.

Results of a study on the influence of some lighting conditions on the accuracy of reading the Babcock milk test indicate that a skilled operator is able to make satisfactory readings of the test with any of the common sources of light used in commercial plants.

A comparison of the accuracy of acidity determinations made on weighed and measured samples of 25, 30, 35, and 40 per cent cream showed that the weighed samples gave the most accurate results, especially at high acidity.

A total of 3,053 cows from 18 different herds were officially tested for production during the past year. The supervisors spent a total of 350 days conducting the tests. This was an increase of 751 cows and 96.5 tester days over 1937.

The calibration laboratory received 8,258 pieces of glassware to be checked for accuracy and etched SGI (Standard Glassware of Idaho). Of these 1.2 per cent were found to be inaccurate.

During the past year 64 analyses of dairy products were made.

Poultry

Vitamin A Requirements of Laying Hens Determined in Units of Carotene

THE past year's work on this project has completed a study which has extended over a 3-year period to determine the efficiency of carotene in dehydrated alfalfa as a precursor of vitamin A for laying hens. The levels of carotene used have ranged from 0.1 to 0.5 milligram per bird daily. Single Comb White Leghorn pullets were used during their first laying year. A daily intake of 0.2 milligram of carotene per bird proved sufficient to promote average egg production, maintain a normal state of health, and promote normal hatchability of eggs. This level of carotene is equivalent to approximately 333 U.S.P. units or 238 Sherman Munsell units of vitamin A. One-tenth milligram per bird daily proved markedly inadequate. The 0.5 level resulted in a slight increase in egg production and a marked increase in the vitamin A content of egg yolks, but the hatchability of eggs and the health of the birds did not appear to be benefited. An

investigation of the requirements of hens during their second-laying year is now being carried on, using daily intakes of 0.2, 0.3, and 0.5 milligrams of carotene. A summary of this project was reported at the last Poultry Science Association meeting and will appear in an early issue of the *Poultry Science Journal*. The frequent analysis of alfalfa required by this study has produced valuable information on the variation in the carotene content of alfalfa.

Cod Liver Oil Concentrate Compares Favorably With the Natural Grade of Oil

Duplicate pens of Single Comb White Leghorn pullets, receiving cod liver oil concentrate at the rate of one half of 1 per cent of the mash, were compared with duplicate pens receiving the natural U.S.P. cod liver oil at the rate of 2.5 per cent. Other sources of vitamin A in the basal ration included dehydrated alfalfa leaf meal at 6 per cent of the mash, ground peas at 10 per cent, and yellow corn at the rate of 12 per cent of the mash and 25 per cent of the scratch grain mixture. The concentrate proved as satisfactory as the natural grade of oil with the levels used in this trial, in protecting the birds from vitamin A and D deficiencies. The groups receiving the concentrate produced an additional increase in income over feed cost of 16 cents per bird.

Protein Supplements in Turkey Rations

In a study to determine whether or not soy bean oil meal improves the rations commonly used in Idaho for growing turkeys, two duplicate lots of turkeys were used. Lots I and III received a starting mash in which the protein supplements consisted of a combination of meat meal, fish meal, and dried milk. In Lots II and IV, soy bean oil meal replaced the meat and fish meal to the extent of 6 per cent of the mash. At 8 weeks of age, two of the groups were shifted so that from then on Lots I and IV received the regular mixture and Lots II and III the mash containing the soy bean oil meal supplement. The two groups receiving the soy bean oil meal supplement were slightly heavier at 8 weeks of age. The differences, however, were not significant. The results as a whole show a slight advantage in using soy bean oil meal in the starting ration but no significant advantage over the 28-week growing period, as judged by the final weight of bird and the number of pounds of feed required to produce a pound gain in weight.

Selective Breeding Decreases Mortality

The study of fowl paralysis previously reported, constituted one particular phase of an investigation at this Station on the general problem of laying flock mortality. Results reported last year demonstrated a marked reduction in paralysis mortality in the Station flock over a 4-year period.

Table 4.—Average per cent laying-house mortality of the daughters of all breeding males and the males showing the highest and lowest total mortality for each of the 5 years from 1933 to 1938

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

The data presented in Table 4 briefly summarizes the results obtained in reducing mortality in the pedigreed station flock of White Leghorns over a period of 5 years. The data are tabulated on the basis of families of different males used each year, listing the families with the highest and lowest mortality, and the average of all males used.

With the exception of 1936-37, there was a marked decrease in mortality in each succeeding year. The average per cent mortality of families of all males was 44.6 in the year 1933-34, as compared with 17.6 in the year 1937-38. The combined mortality resulting from paralysis and leukemia decreased from 24.1 to 6.9 and the per cent mortality from all other causes decreased from 20.5 to 10.7. It is to be noted that a wide variation exists in families from males with the highest and lowest mortality.

While it is believed that a certain amount of natural resistance may be developed by a flock, the records demonstrate that a selective breeding program can accomplish definite results in reducing general mortality resulting from a complexity of diseases. These data show that by using old hens as breeders, particularly those families which had good livability during their first laying year, and by selecting old cock birds who have proved themselves or cockerels who have a large number of sisters in the laying house which show little or no mortality prior to the start of the breeding season, progress in decreased mortality can be expected to a reasonable extent or to the same extent that progress in increased egg production or egg size can be expected.

Farm Crops and Soils

Promising New Spring Wheat Introduced

THIS year the Agronomy Department distributed a new variety of spring wheat under the name of *Idaed*. This variety is the result of a cross between *Sunset* and *Boadicea* made by V. H. Florell of the Bureau of Plant Industry, U. S. Department of Agriculture. The cross was made at Chico, California, in 1920. Progenies were grown at Davis, California, from 1922 to 1930. Florell was transferred to the Idaho Station in 1930. Several of the F_7 selections of the cross were grown in the Idaho observation nursery in 1931. The *Idaed* variety, selection 20172 Vii-4, was especially outstanding in this early test from the standpoint of agronomic characteristics and yielding capacity. It was tested on the University Farm at Moscow, Idaho, and beginning in 1933 at Pendleton, Oregon, and Pullman, Washington. On account of its record at Moscow, Pendleton, Pullman, and Davis, California, it was included in the uniform spring wheat nursery in the western region in 1935. This new variety has given good results not only in test plats but also under field conditions. It is, on the average 10 days earlier than *Federation*, has short stiff straw, is awnless, white glumed, and has hard white kernels. *Idaed* is especially recommended for the northern and for the irrigated sections of southwestern Idaho.

Grasses Important in Idaho Agriculture

Approximately 800 pounds of seed of a new perennial grass developed at this Station from a cross between *Mosida*, a variety of winter wheat, and a native rye grass, *Elymus condensatus*, were distributed to Idaho county agents this year for trial purposes. While the production and utilization of this grass is still in the experimental stage, a number of trials conducted in this and adjacent states during the past 2 years have given good results. The vigorous growth habits and adaptability of this grass to different soil and climatic conditions give indications that it may be used to advantage for forage, and especially pasturage production in regions with limited rainfall.

A winter-hardy strain of grass developed from a single plant selection of *Phalaris tuberosa* shows promise of being of value for pasture and range purposes. Seed of this grass is not yet available for distribution.

Tests extending over the past 3 years have demonstrated the practicability of seed production of such forage grasses as crested wheat, slender wheat, smooth brome, meadow fescue, orchard, timothy, and tall meadow oat in the Palouse area.

Bindweed Controlled by Cultivation and Competition

Progress is being made in experiments concerned with methods of eradicating perennial weeds, especially field bindweed. Very promising results are being obtained with cultivation and competition cropping methods. It has been demonstrated that more rapid

progress towards eradication can be made by cultivating every 2 weeks than by shorter intervals of cultivation. Normal wheat yields have been obtained on heavily infested bindweed land by summer-fallowing the area for 1 year and plowing this area to a depth of 8 inches early in the fall prior to seeding. For general uses, dry applications of sodium chlorate in the fall remain the most effective means of chemical control.

Soils and Fertilizers Studied

Preliminary studies indicate that certain Idaho soils are deficient in boron. A laboratory greenhouse method has been devised that shows promise as a rapid method of determining boron deficiency in soils. Field tests on alfalfa indicate that alfalfa yellows may be overcome by the use of boron. In a study of rate and time of application of borax, as a source of boron, fall application appears to be superior to spring application for the immediate year. On the coarser soils, 20 pounds was insufficient, and 60 pounds showed no signs of toxicity. Care must be exercised in using borax, however, as rather limited amounts may be toxic to plants. It must also be kept in mind that there is a difference in the tolerance limits of various crops. Alfalfa is one of the more tolerant plants.

Chemical analyses indicate that alfalfa showing yellowing, apples showing drought spot, and prunes showing gum spot have a lower content of boron than normal crops.

Phosphate investigations have been carried on in cooperation with the branch stations, the Idaho Agricultural Extension Service, Tennessee Valley Authority, and the Idaho Phosphate Commission. A carload of phosphates was obtained from the Tennessee Valley Authority for the purpose of comparison with the various phosphates available in the state. In all, over 100 tests were conducted in various parts of the state, the greater proportion being in the irrigated regions of southern Idaho. In general, comparable results were obtained with Anaconda treble and TVA triple super phosphates, using equivalent amounts of available phosphoric acid. TVA meta phosphate gave greater increases this year than in past years, but the increases were not so great as those obtained from the treble and triple. Very little, and in most cases no increases were obtained from either TVA fused or rock phosphate. The results obtained at the Aberdeen Branch Station and those obtained by the Extension Service and the Idaho Phosphate Commission will be published in the near future.

The soil survey program carried on in cooperation with the Bureau of Chemistry and Soils, U. S. Department of Agriculture, is progressing as rapidly as personnel permits. The survey of Bonneville County will be completed about the middle of next summer; according to present plans, work will then be started in the southwestern part of the state where no work has been done in over 25 years.

The crop rotation and management studies at the main station are being continued. The results of the rotations established on the University Farm in 1914, and rotation experiments at the Aberdeen, the High Altitude, and the Sandpoint Branch Stations have been published in Experiment Station Bulletin No. 227.

Chlorosis, or yellowing of various kinds of plants, is very prevalent in certain irrigated sections of southern Idaho and is being studied intensively by several departments of the Experiment Station. It has been found that there is an excellent correlation between lime content in the soil and the type of chlorosis found in this region.

New cooperative projects have been arranged with the Soil Conservation Service dealing with methods of prevention of water and wind erosion in the nonirrigated regions of southeastern Idaho and with the Federal Regional Salinity Laboratory at Riverside, California, in studies of the relation of salinity of irrigation water and of soil conditions to plant growth.

Fruit and Vegetable Crops

Chemical Treatments Modify Sprouting of Potato Tubers

PECULIAR to most terminal buds of plant stems is the fact that such buds usually develop at the expense of lateral or side buds on the same stem. The potato, being a true stem, exhibits this phenomenon referred to as apical dominance, especially during that period immediately after the rest period is broken. As time elapses, apical dominance becomes less pronounced, particularly if sprouts are removed from the tubers as they appear.

Seed potatoes used for production of table stock usually give rise to a minimum number of shoots per hill, accompanied by the production of a relatively small number of good-sized potatoes. If there are too few shoots per hill, the tubers may be too large for practical use.

In seed production it seems desirable to promote growth of a maximum number of shoots from a seed piece in order to insure the development of a fair number of medium-sized tubers, such tubers being more suitable for seed purposes than the larger ones.

Work at the Boyce Thompson Institute for Plant Research with Bliss Triumph potatoes, demonstrated the possibility of suppressing apical dominance by use of various chemicals, notably thiourea and potassium thiocyanate. As a result of treatments with various aqueous solutions, tubers exhibited marked tendency toward multiple sprouting or the development of two or more shoots from a single eye. It would follow, therefore, that seed pieces from tubers so treated would produce several shoots per hill, resulting in a greater number of tubers more suitable for seed use.

Under greenhouse conditions at Moscow, Idaho, with experiments started in early winter, Russet Burbank potatoes treated for 1 hour with 4 per cent solutions of either thiourea or potassium

thiocyanate, produced greater numbers of more vigorous shoots than did the untreated tubers. Effects of the chemicals were twofold: namely, development of a greater number of shoots per tuber, and a distinct shortening of the rest period.

To put the method to practical use, the work was continued under field conditions. One-bushel lots were treated with potassium thiocyanate and thiourea, cut, and planted according to usual field practice. The results of these treatments were not as striking as in the case of the greenhouse-grown material, but were sufficiently striking to indicate practical possibilities as far as chemical treatments are concerned. It seems safe to predict that by cutting the tubers before treatment, as was done in the greenhouse, greater differences could be expected. These results show some promise of the possibility of producing a more uniformly medium to small tuber for seed purposes without necessarily reducing total yield. This would be a distinct advantage to those who grow potatoes solely for seed.

Sprays Reduce Cherry Cracking

In studies of this problem during the current year, it was found that sprays of Bordeaux mixture, hydrated lime, and calcium acetate all greatly reduced the susceptibility of Bing, Lambert, and Royal Ann cherries to cracking. Apparently the effect of Bordeaux mixture in reducing cracking is attributable to the lime it contains, since equally good results followed the use of sprays containing only hydrated lime in water. It is evident, moreover, that only the dissolved portion of calcium is effective in this action, a spray consisting of a concentrated solution of hydrated lime in water having reduced cracking as much as did sprays containing a considerable excess of this material in suspension. Thus, a spray containing only about $3/5$ pound of hydrated lime in 50 gallons of water was just as effective as a Bordeaux mixture containing 9 pounds of hydrated lime in 50 gallons of water.

Under field conditions, cracking of Bing cherries in a rain of long duration was reduced as much as 60 per cent following the use of sprays containing small quantities of lime. Water immersion tests in the laboratory indicated even greater decreases in cracking following both spraying and immersion treatments with solutions of calcium hydroxide and calcium acetate. All of the sprays used in these experiments were objectionable in that they left conspicuous residues on the fruit. These residues were removed easily by washing the fruit in a 1 per cent solution of acetic acid, but this introduces an undesirable additional operation in handling the crop. There is evidence that these sprays are effective for 3 weeks or longer, and it may be possible to use them early enough in the season to avoid a residue problem.

Plant Hormone Controls Crotch Angles in Fruit Trees

Fruit growers frequently suffer serious permanent damage to their orchards as a result of breakdown of large scaffold branches or entire trees under the weight of a crop of fruit or as a result

of a windstorm. It has long been known that trees in which the scaffold branches form narrow crotch angles with the trunk suffer much more extensively from such breakage than trees in which the crotch angles are wide. The crotch tissues of narrow-angled branches are especially susceptible to winter injury, and this type of branch is objectionable also in that it tends to make an upright rather than a spreading tree.

In an effort to determine the causes of these narrow-crotch angles and to find some means of preventing them, a study of this problem was undertaken with young Delicious apple trees. It was found that injury to the bark, or phloem tissues, immediately above a dormant bud on a nursery whip would invariably result in development of a narrow angle by the branch arising from that bud. This, together with certain other observances, led to the conclusion that wide branch angles result from the action of a plant growth substance, or hormone, formed in the growing points of a tree and transported downward through the phloem to buds and young shoots below, where its presence causes the direction of growth of the shoots to incline towards a horizontal position and so induces the formation of wide-angled branches. When the movement of this hormone is blocked by injury to the phloem through which it moves, the shoot below the injury is unaffected by the hormone and a narrow-crotch angle is formed.

Tests were made on young Delicious trees with a commercially prepared plant growth substance, indole-butyric acid. This was mixed with lanolin to form a hormone paste that could be applied locally to different parts of the tree. Application of a small quantity of the paste to the upper surface of the basal internode of a young shoot while this internode still was elongating was followed by a marked widening of the crotch angle, which usually attained a magnitude of about 90 degrees following this treatment. When lanolin paste containing this hormone was injected into a short piece of rubber tubing fastened over the cut end of a nursery whip so that a continuous, small supply of the indole-butyric acid diffused slowly into the apex of the tree, abnormally wide crotch angles were formed by all of the branches. As crotch angles were observed to become firmly fixed very early in the life of a branch, it is evident these hormone treatments resulted in permanent benefit to the structure of these trees.

Other investigations dealing with apple breeding, orchard fertilization, and cover crops, variety testing of fruits and vegetables, fruit by-products, and vegetable seed production have yielded valuable information.

Agricultural Engineering

Land Reclamation and Conservation Projects Produce Results

DURING the past year a new project was added to the research program in agricultural engineering, consisting of a hydrologic study on small watersheds in cooperation with the Soil Conservation Service of the U. S. Department of Agriculture.

The continued observation of water tables on drained areas of irrigated land in southern Idaho showed that the use of open drains and drainage wells permitted a rise in the ground water, following the ample water supply of 1938. Existing drainage works held the ground water in check during the several preceding dry years. The observation of ground-water movement was extended to include adjacent land on which ground water was reported to be rising.

Methods of reducing canal losses are complicated by the necessity of mowing operations, and the practice of mowing with chains does not smooth or pack canal bottoms. A system of canal maintenance which tends to smooth the sides and bottoms such as the use of the bulldozer, appears to be more satisfactory than the chain method for some types of soils. Grouting of sink-holes in lava formations reduced losses in one large canal. Bituminous linings are being studied in experimental installations under Idaho conditions.

Power and Machinery Work Promising

Field operations were observed on the use of the press-type furrow drill under dry farming conditions, where a cloddy seed bed tended to prevent wind erosion of the furrow placement of the grain. The procedure also improved the crop stand and yield of barley, which averaged 20 bushels per acre under dry farming conditions in southern Idaho.

Assistance has been rendered individual farmers developing such equipment as crop cover transfer units used in producing trashy fallow, cultivating and harvesting equipment for peas and beans, and special threshing equipment for vegetables and garden crops. The small, high-speed combine has been used for the direct harvesting of alfalfa and alsike clover seed. Windrowing of beans and peas with minimum shatter has been made possible by the development of pusher-type equipment using both the conventional cutter bars and adapting the rod weeder in place of the usual bean cutter knives. When the wheel-type tractor is used for operating this type of equipment, it is run in reverse. However, the pusher type of header used with track-type tractor is carried in front of the machine on the usual type of push bars.

The field trials of the commercial-type beet combine which lifts, tops, and elevates the beets into trucks or wagons indicate that the problem of adapting adequate equipment for sugar-beet harvesting in Idaho is complicated by the weather conditions encoun-

tered in the Upper Snake River region. Gravelly soils and mud in the fields tended to destroy the rubber facing on the conveyor chains, and the interference of weeds and abundant top growth caused delay in the field operation of the equipment. The variability of beet sizes in the row and uneven placement of the tops made it difficult to adjust the equipment to avoid breaking tops, capping the large beets, dropping the small ones, or leaving streamers. With greater care in seed-bed preparation, planting, and cultivation which would tend to produce a more uniform size of beet and with a few refinements in construction and range of adjustment, the machines offered have promise of meeting the harvesting conditions for most of the sugar-beet producing areas in southern Idaho.

Considerable interest has developed in the bed method of seed-bed preparation and cultivation, especially for the irrigated production of sugar beets, beans, and potatoes. This method of planting, irrigation, and cultivation consists of forming deeper ditches and square shoulders for the confinement of irrigation water into relatively deep furrows without overflowing the plants or wetting the entire soil surface. The purpose of this system is to force the roots of the plants deeper and to obtain a better utilization of the irrigation water, thus producing larger yields and conserving all the irrigation water that is not absolutely required. Special equipment has been developed for producing furrows 4 to 6 inches deep and 4 inches wide for a 2-row bed of beets and beans. For potatoes the furrows are made 12 inches deep and 10 inches wide on the bottom. The new system of bed planting, cultivation, and irrigation is in the experimental stage and is adapted to certain types of soil where the bed formation can be maintained without erosion from irrigation.

A study of the operation and management of newly developed harvesting equipment was made in the wheat-producing area of the Palouse region in northern Idaho. Seven farms producing wheat and peas all used combines for harvesting a combined total of 3,542 acres. Six of the combines were of the hillside type, and three of the group were equipped with rubber tires. Track-type tractors were used to pull all of the combines, and one used a power take-off from the tractor to operate the combine. The grain was handled in bulk from three of the outfits and handled in sacks from the others. The average harvesting period for the group was 25 days, operating 9.5 hours per day and threshing 3 acres per hour. The machine operating cost, not including depreciation and taxes, ranged from \$0.18 to \$0.63 per acre, the average cost being \$0.37. This cost is a reduction over previous studies, due principally to the use of rubber tires on equipment and the use of low-cost fuel in the newly developed Diesel power units.

Farm Structures

Plans and specifications were prepared for a number of structures on the University Farm, including a judging pavilion for livestock and a poultry laying house, both of which were constructed during the past year. Additional plans and specifications have

been prepared for the proposed construction of a poultry feed storage building and a shed for field storage of equipment for farm crops.

Ventilation equipment has been installed in the new poultry house where different systems of ventilation are being adapted to the three 20-foot-section units. Automatic thermostatic control for ventilation inlets and supplemental heat for ventilation from electric heaters and fans are being used in an attempt to control temperature, humidity, and air movement. A project closely allied to the ventilation study is the practicability of heating laying houses electrically. This project is being continued for further data on the use, management, and design of electric heaters for poultry house heating.

Farm Economics

Valuable Information Secured Through Study of Land Classification

FURTHER progress has been made in assembling and publishing basic data essential for land classification and better land use. Four projects have been carried forward to promote these ends.

The project entitled "Idaho Land Classification" has been completed, and the results of this study have been published as 44 separate mimeographed pamphlets. In addition to these pamphlets, separate maps of letter-page size and maps on a scale of 1 inch to the mile are available to the public. Field sheets of every surveyed township are kept on file for future reference. The fund of information collected is complete and should be very useful.

During the years 1934, 1935, and 1936, maps were prepared showing public and private service facilities for each county. The classes or grades of facilities vary from 15 on some more remote counties to about 40 for the more developed counties.

The location of every private and public ownership for each county is shown on ownership maps. Appropriate symbols indicate their classification. A number placed on each private ownership can be used in finding the name of each owner from township lists. These lists are kept on file in Moscow and can be obtained at a nominal cost. Tables are included which give the acreages of each class of private land as well as all public lands. Other tables give the acreages of privately owned farm land by tenure classification. For each of these classifications, percentages of totals have been calculated. Dependence upon assessors has been necessary for much of the data on private lands, and their accuracy is as limited as the assessor's information. Figures on public lands have had more checks as to accuracy.

From assessors' classifications, the proportion of each section in agricultural or plow land has been mapped and appropriately classified with cross hatch symbols.

Average wheat yields per acre, as given in A. A. A. records, have been mapped in place. All tax delinquent lands of certain wheat-yielding capacities have been grouped and average assessed values calculated by years. These tables have shown that assessors have not assessed wheat land sufficiently according to income-yielding capacity. For immediate improvement in assessing wheat lands, this map points the way.

Assessed values of agricultural lands have been mapped by sections. These maps reveal the illogical uniformity of assessment rates over large bodies of land which differ very markedly in income-producing capacity.

Tax delinquency was traced back to 1928 and the status of each 40 acres of privately owned land is shown for the years 1933, 1934, or 1935. These data are in map form. A tabulation giving the acreages and percentages of delinquency for each year back to 1928 for each major class of privately owned land is published.

Leasing Agreements and Tenancy Studied

The project dealing with "The Determination of Comparative Returns Accruing to Landlord and Tenant under Various Common Leasing Agreements in the Major Types of Farming Areas in Idaho" resulted in a complete statement of leasing arrangements as they prevail on the better wheat lands in Latah County. Estimates were also made available on net income under various types and kinds of leases.

A study of "The Relation of Tenancy and Ownership to Farm Crop Enterprises by Types of Farming Areas of Idaho" has gone forward to the extent of making a complete card file of all farm and crop data found for each farm cooperating with the A. A. A. in the State for the years 1936 and 1937. Tabulation of these data is proceeding for a limited number of types of farming areas.

An economic and sociological study of recent settlement on the cut-over lands in northern Idaho is being organized and field work has been nearly completed. It is hoped that this study will assist the Farm Security Administration and other agencies in coping with the forced migration of the dry plains people into the Pacific Northwest.

Idaho Potato Has Strong Competition

A study concerned with marketing in the broadest sense and entitled "Idaho's Competitive Position in the Potato Industry" has brought to light some interesting facts. The Idaho potato is widely known for its high qualities. Since 1929, however, these qualities have not always commanded a premium over all other potatoes. For example, the average price in Chicago for Idaho Russets was above that for Colorado Red McClures only 4 years out of 9. Further study reveals that on a weekly basis Idaho Russets were above Colorado Red McClures just a little over one half the time. The Russets brought a premium 128 weeks out of 235 during the period 1929-37. The price-spread between these two potatoes ranged from a premium of 47 cents for Russets in

April 1930, to a premium of 64 cents for McClures in January 1935.

The volume of Red McClures, although small compared with that of Idaho Russets, is increasing. Approximately 40 per cent of the total Colorado potato production was Red McClures in 1937. Since Chicago is one of the principle markets for both McClures and Idaho Russets, it is certain that direct competition exists between these two high-quality potatoes. Apparently it is becoming increasingly important that Idaho potato producers exert every effort to improve the marketing and quality of their product, otherwise it is entirely possible that Idaho potatoes will suffer further loss of advantage in the large consuming centers.

Agricultural Bacteriology

Pullorum Disease of Poultry Studied

DEFINITE progress has been made in cooperation with the official state agency of the National Poultry Improvement Plan in the control and elimination of pullorum disease in the poultry of Idaho. The methods and also the technique of the licensed operatives have been improved.

The rapid whole blood method of testing poultry for pullorum disease, as recommended by the U. S. Bureau of Animal Industry, has drawn a great deal of criticism from serologists. An effort has been made to confirm or disprove some of the technical aspects of the criticism.

Serologists most seriously objected to the use of the rapid whole blood test because: (1) there was doubt concerning its accuracy in the hands of even skilled technicians; (2) when this test was performed by the poultryman there was doubt not only concerning the ethics of permitting the poultryman to perform the tests, but also concerning the accuracy of the test in the hands of untrained technicians; (3) because of the lack of trained technicians, would it be possible to train unskilled persons in a short time so they could make tests in the field with sufficient accuracy that the flock could be certified or accredited legitimately? (4) rapid whole blood antigens offered for sale by biological supply houses exhibit such a wide variation in sensitivity and reliability that the results lead to confusion in the mind of the field operative. This leads the poultryman to doubt the efficacy of any biologic test as a diagnostic aid in a poultry certification program.

As a result of a recent field trip throughout the State, observations tend to confirm the belief that the rapid whole blood method of detecting pullorum reactors is not reliable in the hands of the majority of operatives. The animal pathologist cooperated with the operatives on approximately 5,400 tests and took aliquot samples for comparison, using the rapid serum test. It was found that as a group the operatives were less than 50 per cent efficient in detecting reactors. Some operatives showed unusual skill in

detecting all reactors, while others missed 100 per cent of the reactors.

Large numbers of samples of poultry blood have been tested by the rapid whole blood (stained antigen), the rapid plate, and the tube agglutination methods. These samples have been submitted by operatives and poultrymen from all over the State. Operatives have been encouraged to submit these samples and also urged to submit reactor birds for post-mortem studies.

Schools have been conducted for the training of technicians who have been authorized to make rapid whole blood tests in the field. It seems imperative that more practical and extensive examinations be given with the thought that many of the testers now authorized are not qualified to carry on this work.

It seems desirable that a standardized antigen be used by the poultry industry and that a standard procedure and uniform equipment be adopted so that uniform results may be obtained by all operatives.

Sulfanilamide Inhibits Bovine Mastitis

Studies have been continued, searching for a method to control bovine mastitis. During the present year seven cows have been treated with sulfanilamide (para-amino-benzene-sulfonamide) administered orally. Observations have been made concerning the effect of various rates of treatment upon the amount of the drug present in the blood, urine, and milk, and also concerning the effect of this medication upon the clinical status of the disease.

Sulfanilamide was found to be tolerated by cows in doses twice the amount recommended for treating human beings (that is, 1 gram of sulfanilamide for each 10 pounds of body weight). Immediately after the drug appeared in the milk flow the streptococci disappeared, the leucocyte count remained approximately the same, and the appearance of the milk improved in cases where the udder was swollen and the milk had been abnormal. It is significant that within 3 or 4 days after sulfanilamide had disappeared from the milk, the streptococci would reappear, thus indicating that the infection had not been eliminated.

The therapeutic value of Krueger's Undenatured Vaccine for the control of mastitis was tested by preparing the vaccine from cultures of *Streptococcus mastitidis (agalactiae)* which had been isolated from cases of bovine mastitis selected for treatment. The vaccine was prepared through the courtesy of Eli Lilly & Company, Indianapolis, Indiana. This vaccine was administered to five cows by subcutaneous hypodermic injection. The animals showed no increased respiration or fever as a result of the treatment. The milk of the lactating animals was examined daily to note any change in the status of the disease. It seems safe to conclude that under the conditions of this experiment no measurable benefit was derived through the use of the vaccine.

Previous researches reported have dealt with the possibility of preventing or controlling bovine mastitis by sanitary or other

therapeutic measures. Mineral metabolism in relation to the control of mastitis is being studied. Ten cows are being fed 2 ounces of mono-calcium phosphate with their grain each day. This is being supplied in addition to the usual amount of steamed bone meal. Ten cows as nearly comparable as possible are being observed to detect any preventive or curative value of the mono-calcium phosphate.

Clinical Tests for Livestock Diseases Numerous

During the past year poultrymen have been encouraged to submit specimens to the laboratory for examination. This is not only a service to the industry, but it gives the animal pathologist information concerning the prevalence of the various poultry diseases. The extent of this service can be realized by the fact that 437 birds were autopsied and several thousand blood tests were made to detect pullorum disease or to check antigens which are being used by technicians in the field.

Many autopsies and various clinical tests have also been made on horses, hogs, cows, sheep, dogs, game birds, and predators.

Agricultural Chemistry

Protein, Phosphorus, and Calcium Content of Range Forages Important

FORAGES have been collected from several grazing areas in Idaho. Analyses for calcium, phosphorus, and protein at different grazing periods and at different stages of growth show interesting trends. Forages in the early stages of growth are relatively high in protein and phosphorus. As the plant matures there is a constant decrease in protein and phosphorus and an increase in calcium. Forages collected in the late summer were 45 per cent lower in protein and 22 per cent lower in phosphorus, while those collected in the late fall were 75 per cent lower in protein and 80 per cent lower in phosphorus than the early summer forages. The variation in the phosphorus content in forages from different areas was insignificant in comparison to the variation of the phosphorus content with maturity.

Phosphorus Requirements of Livestock Tested

Feeding trials at different phosphorus levels were repeated this year to check the 1936-37 results. Favorable comparisons were obtained. For those animals on a phosphorus deficient ration the blood phosphorus dropped in a shorter period of time than last year. Rations containing less than 0.12 per cent phosphorus do not meet the phosphorus requirement of a growing and fattening animal using the blood phosphorus level as an index. The feeding trials on different phosphorus levels are being repeated again this year.

Carotene Content of Commercial Dehydrated Alfalfa Improved

Carotene analyses of commercial dehydrated alfalfa show that a more uniform and better product is being put on the market than in former years. Sun-cured alfalfa samples were found to be low in carotene with the exception of a few samples. These were found to contain 10 milligrams or more of carotene per 100 grams. This indicates that it is possible to produce a sun-cured alfalfa product that will warrant its use in poultry rations on the basis of its carotene content.

Studies of vitamin A requirements of laying hens have been made using dehydrated alfalfa as the only source of carotene. In connection with this project, the yolks of the eggs were analyzed from hens fed dehydrated alfalfa at 0.2, 0.3, 0.4, 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 of carotene fed.

Chemical Soil Studies Continued

Additions of insoluble phosphorus to soils has resulted in negligible crop responses and has shown no increases in the phosphorus content of alfalfa. The need of a soluble form of phosphorus, particularly on high lime soils has been shown more conclusively. More frequent applications and larger amounts of phosphorus are being applied in an effort to determine their influence on yield and composition of plants grown.

The influence of various systems of management on the rotation plots continues to show the value of legumes in the rotation for maintaining the nitrogen content of the soil and improving the protein content of wheat. The application of manure is still giving satisfactory results both as to maintaining the organic matter of the soil and improving the yield and protein content of wheat.

Greenhouse experiments with sodium-saturated slick spot soils indicate that the improvement in the physical condition of the soil through the replacement of sodium by calcium and the subsequent removal of the sodium has materially improved the crop production of the soil. Slick spots are appreciably lower in organic matter than normal soils and contain more magnesium.

Repetition of the 1935 treatments with iron citrate on chlorotic trees showed less striking response than formerly. Comparison of summer applications with dormant tree applications are being made. New studies of the relation of the depth of the lime layer in certain soils to the chlorotic condition of the trees are in progress.

Insects

Dusts Promising for *Lygus* Insect Control on Alfalfa Seed

PYRETHRUM dust diluted with diatomaceous earth to the pyrethrum content of 0.25 per cent was used experimentally for the control of legume bugs, *Lygus* sp., on alfalfa. Sweeping records indicate a sharp reduction in the numbers of insects present immediately after application of the dust, followed by as sharp an increase in populations the following few days. Continuous sweeping records throughout the season, however, indicate that the populations quickly decreased to a low point and remained there throughout the season in dusted fields while they increased until the middle of August in fields not dusted. Parasites of the nymphs of *Lygus* were obtained and determined by the U. S. Department of Agriculture, Division of Insect Identification, as *Euphorus pollipes* (Curtis).

Rotenone Promises Control of Garden Insects

Experiments were carried on during the season of 1938 to determine the effectiveness of rotenone-bearing dusts against garden insects. Rotenone is specific in its action on insects; that is, it will control some insects and not others of closely related species. Its use, therefore, must be tested for each insect. This season's work shows the insecticide to be effective against flea beetles and cabbage worms but not against cabbage aphids. Preliminary observations indicate a possible effectiveness against celery looper and blister beetles.

Dust and Trap Crops Used for Pea Weevil Control

The use of dusts containing 1 per cent and 0.75 per cent rotenone gave good control of the pea weevil when applied at the rate of 20 to 40 pounds per acre. Experiments on garden plots indicated that control to the extent of 97.02 per cent in peas of table size could be accomplished with rotenone-bearing dusts.

The proper use of border trap crop strips in commercial peas, used in conjunction with dusting operations, materially reduced the acreage of peas that otherwise would have needed dusting. Experiments conducted to determine the influence of burying weevil-infested peas on the emergence and survival of the contained weevils showed that weevils in infested peas stand little chance of survival in the peas that are buried to a depth of at least 6 inches.

Control of Insects by Parasites Tested

In 1938, at the end of the first brood of the codling moth, parasitism by *Ascogaster carpocapsae* had increased to 4.2 per cent. The percentage of parasitism by the other codling moth parasites will not be available until observations are made on the over-wintering codling moth larvae. One additional codling moth parasite was liberated for the first time in 1938, a pre-pupal parasite, *Gambrus*

stokesii. One air express shipment of this species was received from New Jersey on July 3, from which 296 females and 481 males were released. Early in September a few individuals of this species were observed in the orchard, indicating its establishment and the completion of one generation.

One shipment of San Jose scale parasite material was received in April from New Jersey from which emerged 862 individuals of the species *Prospaltella perniciosi*. The species *Aphytis mytilaspidis* continues to be abundant in the station orchard, and the predator *Scymnillus aterrinus* is present in very large numbers.

Codling Moth Population Heavy in 1938

The following materials were used in the experimental tests in 1938 for codling moth control. In amounts per 100 gallons of spray they are: lead arsenate 3 pounds, summer oil $\frac{1}{4}$ gallon in casein ammonia emulsion, casein ammonia spreader 1 pint; lead arsenate 3 pounds, summer oil $\frac{1}{2}$ gallon in monoethanolamineoleate emulsion, Fluxit $\frac{1}{4}$ pound; calcium arsenate 4 pounds, zinc sulphate $\frac{1}{4}$ pound, calcium hydrate $\frac{1}{2}$ pound, summer oil $\frac{1}{2}$ gallon in casein ammonia emulsion; Cryolite (Kryocide) 3 pounds, herring oil 1 pint; nicotine bentonite 5 pounds, summer oil $\frac{1}{2}$ gallon in casein ammonia emulsion; and phenothiazine 3 pounds, $1\frac{1}{2}$ pints sticker In-1488-A-8 Grasselli. The calyx and four cover sprays were applied, the spray schedule being completed June 30, which was at the end of the first brood. The purpose of the experiment was to determine the amount of spray residue that would remain on the fruit from a first brood spray program until harvest, and the effectiveness of first brood sprays only against the worms in a year of extremely heavy infestations.

Data on worm counts are not yet available, but indications are that poor control resulted from all sprays. This was to be expected, due to the large codling moth population and the light fruit crop. Following the mild winter of 1937-38, the codling moth population was unusually large. The fruit crop resulted in a high percentage of wormy apples. The combination of these factors always results in heavy worm damage in commercial orchards even though a full spray schedule of 8 to 10 sprays has been applied.

Chemical analyses for spray residues at the completion of the spray schedule showed a heavy load of lead and arsenic on the fruit, and the fruit at that time was practically free of worm injury.

Spider Mites Identified

Spider mites collected late in the summer of 1937 were determined by E. A. McGregor as *Tetranychus pacificus*. The problem then was to determine whether the two-spotted mite also was involved. Spider mite collections were made from apples in two districts, Parma and Payette, in 1938. All mites were identified by E. A. McGregor as *Tetranychus pacificus*. This confirms the one identification of 1937 and indicates that the mite infesting apples in southwestern Idaho is not the common red spider *Tetranychus*

telarius or the two-spotted mite *T. bimaculatus*. A high percentage of control of spider mites was obtained by powdered sulphur, Kolofog, summer oil and a maximum of powdered sulphur, and by liquid lime-sulphur.

Cooperative Wireworm Investigations Continued

The cooperative relationship with the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, on the cultural control of wireworms has been continued this season. Plot studies are being conducted to study the effect of a normal farm rotation on the wireworm numbers over a period of years. Withholding irrigation waters from alfalfa fields in one section of Idaho has reduced wireworm populations somewhat, but not enough to render them safe from damage to potatoes planted the next season. One application of crude naphthalene plowed under on August 25, 1937, at Idaho Falls at 800 pounds per acre gave nearly a 99 per cent reduction in wireworm numbers. Observations in one district, mostly in alfalfa fields, have indicated that the female wireworm adult beetles fly more freely than the males and at such heights as would allow considerable dispersal. Laboratory tests have shown that while most of these females taken in flight have oviposited the larger proportion of their eggs, enough eggs are retained to cause some infestation in another field.

Studies on the growth of wireworms in cages with different plant food showed again that wireworms survived best on potatoes and made the poorest growth on alfalfa. Wireworm beetles oviposited about twice as many eggs in cages near red clover as they deposited near alfalfa when both plants were equally available. The majority of wireworm eggs were laid in the surface 3 inches of soil and none below 6 inches. An entomophagous fungus (*Metarrhizium*) has been found attacking wireworms near Parma, Idaho, and an attempt will be made to study its efficiency as a factor in the control of wireworms.

Plant Diseases

New Beans Possessing Disease Resistance Developed

IMPORTANT commercial varieties of field and garden beans now being grown in Idaho were again found susceptible to curly top and common bean mosaic in the bean experimental program in southern Idaho. Forty-two hybrid selections of the Great Northern type have been developed that are completely resistant to the curly top and common bean mosaic diseases. Seven of these selections possessed desirable Great Northern plant characteristics and gave excellent yields in areas where commercial varieties encountered serious damage. These selections merit further attention and will be increased and studied in the trial grounds. The best of these selections may be released to bean growers after the 1939 season. In addition to the above, over 300 promising Great Northern selections will also be tested for their resistance to curly top and

mosaic and for desirable Great Northern bean characters. Many selections of Red Kidney and Pinto beans that show resistance to these diseases have been saved for further trials. Several hundred promising hybrid garden bean selections of green and wax podded types have been saved for further trials in the experimental program to test their resistance to curly top and common bean mosaic. Many of these garden bean selections were resistant during the past season to these most destructive bean diseases and show promise of development into commercially important garden bean varieties for Idaho.

Seed Transmission of Near-Wilt of Peas Demonstrated

Major emphasis of the pea investigations was placed on breeding for near-wilt resistance. Eighty selections from various crosses were grown in the greenhouse in near-wilt infested soil. About 45 of these selections exhibited some degree of resistance; the rest were completely susceptible. The resistant material was planted in the field in order to study type. None of these resistant selections was found to possess both the desirable type of vine and pods. A few of the selections did possess, however, the desirable vine characters of the Perfection variety but lacked desirable pods. These were back-crossed to Perfections and other large-podded varieties.

Seed of three varieties, Wisconsin Perfection, Prince of Wales, and Alaska, raised on near-wilt infested soil in Wisconsin, was planted at Moscow in order to determine the amount of seed transmission of the near-wilt disease. Out of 140 plants of Wisconsin Perfection, 16 became diseased with near-wilt; of 656 plants of Prince of Wales, 10 were diseased; and out of about 1,500 plants of Alaska, none was diseased. Further evidence of seed transmission is the fact that from 54 crosses made in the greenhouse on near-wilt infested soil, 3 plants resulting from these crosses became diseased with near-wilt.

Investigations were begun to determine why some varieties of peas give consistently low germination. Indications are that certain bacteria are involved and that they have a decided difference in varietal effect.

Fruit Disease Investigations Give Results

Further surveys indicate that mottle leaf of cherry is widespread in Idaho. This virus disease has been transmitted readily by budding, and extensive tests are now in progress regarding variation in symptoms.

Liquid lime-sulphur and dry lime-sulphur in 2 treatments for gooseberry mildew at Genesee gave about 99 per cent clean fruit, while the checks showed less than 9 per cent.

Drought spot or gum spot of prunes has been a factor in the prune industry for many years. Surveys indicate that it is more prevalent in certain years when the moisture supply is inadequate and in certain localities. The exudation of gum and internal, corky

tissues affect the grade of both the fresh and dried products. Preliminary studies show that drought spot of prunes and drought spot and corky core of apples are associated with low boron content of fruit tissue.

Extensive surveys have shown that serious damage to strawberry plantings is associated with cyclamen mite infestation. Previously the cause of this trouble had been overlooked.

Seedling Potatoes Show Promise

The control of potato virus diseases presents a very serious problem to potato growers in Idaho. Emphasis has been placed, therefore, on the matter of securing resistance to these troubles. The picture is complicated by the fact that there are a number of virus diseases, some of which are caused by various combinations of separate and distinct viruses, while other diseases are due to a single distinct virus. For example, rugose mosaic is the result of two different viruses. If either virus is present in a plant by itself, symptoms entirely different from the rugose symptoms result. On the other hand, leaf roll is caused by a single virus. This latter virus possesses qualities that are entirely different from either of the two viruses causing rugose mosaic. This can be said of approximately eight virus diseases of potatoes which are recognized in the State.

To secure resistance to such a group of viruses is a difficult problem. The Katahdin potato, a variety produced and distributed by the U. S. Department of Agriculture, possesses resistance to mild mosaic. A number of seedlings grown from seed of Katahdin plants have been tested, some of which have been grown for 4 successive years and are still devoid of any virus symptoms. Detailed notes have been made of each seedling. During the year approximately 1,500 additional seedlings were started. These will be studied in detail during the next season.

Nutrition

Vitamin Investigations Continued

THE investigation of the water-soluble factors stable to heat or the vitamin G complex of potatoes has been continued. In the tests carried on this year the same starch-free basal diet which was used the year before, supplemented with thiamin, riboflavin, and an autolysate of white corn, has been used. The corn autolysate, when given in amounts equivalent to 2 grams of corn daily, prevented dermatitis in the rats.

With this basal diet, studies were carried on to find the effect of the addition of nicotinic acid and of trigonelline. Slight difference in growth was observed over the usual 8-week period. Nicotinic acid seemed to cause little if any better growth than trigonelline. However, when cooked potato or a water extract of potato was added to the basal diet, plus nicotinic acid or trigonelline, growth was increased about 70 per cent. This confirmed previous

findings of this laboratory that potatoes contain a water-soluble factor or factors which improve diets for rats on a starch-free diet supplemented with the identified substances of the vitamin B complex.

In connection with this same project, black tongue in dogs was produced in 5 dogs. Cures were made twice with nicotinic acid but trigonelline given in two cases appeared to be of no effect. Failure to cure resulted also from the administration of potato extract.

Work on the vitamin E project has been continued with special reference to the difference in the requirement between male and female rats for this factor. Normal litters were obtained from females when given 1 drop of wheat germ oil during pregnancy, but males with this amount of vitamin E are sterile as determined by mating tests.

Through the continued cooperation of Dr. Roger D. Reid of Johns Hopkins University, formerly of the University of Idaho, microscopic examination of the testes of some of the males at about 1 year of age have been made. The changes seen in the tissues of the different animals on the basal diet showed remarkable constancy, indicating that the change is specific. Animals fed on the basal diet, and those fed the basal diet supplemented with 3 grams of peas daily or with 1 drop of wheat germ oil daily, showed very little difference in the tissue change, thus confirming the mating results.

Animals having larger doses of wheat germ oil are now under observation in the laboratory and will be examined when 1 year of age.

Human Nutrition Work Started

A project applied directly to human nutrition was approved this year. The investigation is one in cooperation with all the home economic departments of the states of the Pacific Northwest and should add to the information now available on the nutritional status of students in respect to vitamin C. The contribution of the Idaho Agricultural Experiment Station to the investigation is the special emphasis which is being placed on the use of men students as subjects at this Station.

The problem involves the determination of the amount of ascorbic acid in the blood and the amount excreted daily in the urine, as well as the response in these amounts to known doses of the vitamin. This work called for the addition of some chemical equipment and the transformation of a corner of the office into a small chemical laboratory. Most of these additions have been made and titrations have been started.

Aberdeen Branch Station

Potatoes Prove Valuable Feed for Wintering Ewe Lambs

THE ewe lambs used in this experiment were purchased in August from a range flock of Panama breeding. They were pastured until the early part of December, at which time they were divided into three equal lots and fed the following rations: Lot I received alfalfa hay and potatoes; Lot II, alfalfa hay; and Lot III, alfalfa hay and red clover chaff. Lambs in Lot I receiving potatoes did exceptionally well and long before the end of the feeding experiment the lambs in this lot were outstanding in appearance and condition. As the experiment progressed Lot I consumed more feed proportionally than either of the other two lots. In appearance and gain the lambs in Lot III ranked last. Gains were poorer than would ordinarily be anticipated in this lot which received approximately half hay and half clover chaff.

Table 5 gives the daily ration, per cent wasted, daily gains, and wool weights. It will be noted that 2.25 pounds of potatoes per day replaced 0.66 pound of alfalfa hay. In determining the amount of hay to be fed an attempt was made to gauge the requirements by the amount wasted. For the entire feeding period 284 pounds of potatoes replaced 83.8 pounds of hay per lamb. Hay at \$7.00 per ton gives the potatoes a feeding value of 10.3 cents per hundredweight, without any credit or allowance given for extra wool sheared or increased body weight. More time is required to determine whether or not the ewes of Lot I will maintain a weight and wool advantage over Lots II and III. However, credit should be

Table 5.—Results of a feeding experiment at Aberdeen, Idaho, giving the daily rations, percentage waste, daily gains, and wool weights for several lots of ewe lambs wintered on various combinations of alfalfa hay, potatoes, and red clover chaff

Ration	Lot I Alfalfa hay and potatoes	Lot II Alfalfa hay	Lot III Alfalfa hay and red clover chaff
Alfalfa hay	3.30 lb	3.96 lb	1.74 lb
Potatoes	2.25 lb		
Red clover chaff			2.47 lb
Per cent waste			
Alfalfa hay	11.4	11.5	12.8
Potatoes	None		
Red clover chaff			20.0 (est.)
Average daily gain	0.212 lb	0.135 lb	0.076 lb
Wool weights (av.)	12.51 lb	11.40 lb	10.96 lb

given the potatoes for the extra wool sheared the first year. The lot receiving the potatoes sheared 12.51 pounds of wool, while the lot receiving only alfalfa hay sheared 11.40 pounds, a difference of 1.11 pounds. In calculating the value of potatoes on the basis of hay replaced and increased wool production, the potatoes had a feeding value of 18.2 cents per hundredweight.

New Lemhi Wheat Shows Promise in Irrigated Sections of Southern Idaho

A new wheat which has been given the name of Lemhi, developed at the Aberdeen Station by the Office of Cereal Crops and Diseases, U. S. Department of Agriculture, in cooperation with the University of Idaho, will probably be released in the near future. This new wheat, a Federation-Dicklow cross, C. I. 11415, has some of the desirable qualities of both parents. All milling tests to date indicate that it is practically equal to Dicklow in quality and color of flour produced. Lemhi has a stiff straw which is very desirable where high yields are common, and where wheat is used as a nurse crop. In stiffness of straw it is nearly equal to Federation. It matures or ripens about 5 days earlier than Dicklow, or about the same as Federation. In other words, it resembles Dicklow in quality and color of flour and in color of chaff and straw, and Federation in height and stiffness of straw and early maturity. Table 6 gives the average yield for the 6 years that it was tested in 1/40-acre plots at the Aberdeen Branch Station, along with the yield produced by its parents.

Table 6.—Six-year average in bushels per acre of Lemhi wheat compared with Federation and Dicklow

Variety	C. I. Number	6-year average yield
Federation x Dicklow	11415	75.7
Federation	4734	72.7
Dicklow	8855	70.3

Federation wheat has been gradually replacing Dicklow, even in the Twin Falls area, once the stronghold of Dicklow. The reason for this trend has been twofold. First, Federation has a shorter, stiffer straw which makes it more desirable as a nurse crop, and, second, the yield of Federation has averaged somewhat higher than that of Dicklow. The production of Dicklow has declined to a point where some of the mills are becoming concerned about the future supply. A special flour trade has been developed by some of the Idaho mills which calls for a quality of flour produced by Dicklow wheat. 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 of Federation and maintains a yield equal to or slightly above that of Federation.

Phosphate Fertilizers Experiments Extensive

Work dealing with the various phosphate carriers was enlarged upon. A farm was located for fertilizer tests in the seed-growing area where much of the land is very deficient in available phosphate and where phosphate fertilizers are not used extensively.

Table 7.—A test of various forms of phosphate fertilizers used in an experiment near Aberdeen, Idaho, during the summer of 1938

Treatment	Rate of application	No. of plats	Yield in tons*
Check		14	1.14
Treble	125	2	2.76
Treble	250	2	2.97
TVA triple	117	2	2.71
TVA triple	234	2	3.07
TVA Meta	90	2	2.19
TVA Meta	180	2	2.24
TVA fused	208	2	1.22
Bureau calcined	164	2	1.91
Rock phosphate	300	2	1.34
Rock phosphate	1350	2	1.08

* In order to be significant, these differences based upon probable error should be at least $\frac{1}{4}$ of a ton.
Yield data include the second and third cutting.

In general, the results given in Table 7 correspond very closely to the visible differences in the growth of the alfalfa on the various plots. This set of plots made an excellent demonstration and was viewed by a large number of visitors during the summer. The experiment very clearly illustrates the necessity of having the phosphate in a soluble form. The yields from the plots receiving TVA triple and treble superphosphate were practically identical.

Similar results but not so striking were also obtained from a corresponding set of plots on the Station farm. These plots were started in 1937 and the residual effect was noted in 1938. TVA triple and treble superphosphate gave approximately the same increase over checks in 1938 as in 1937.

Other fertilizer work on the Station consists of various rates of application of treble superphosphate on alfalfa and placement of fertilizers on potatoes. This work must be continued for a number of years before definite recommendations can be made. From all indications, a practical rate of application for treble or triple superphosphate is about 125 to 150 pounds every 2 years while the land is in legumes and about 80 to 100 pounds when planted to sugar beets.

New Oat Distributed

A new oat named Bannock, developed by the Office of Cereal Crops and Diseases, U. S. Department of Agriculture, at this Station, was released in the spring of 1938. The new oat is a selection from a Markton-Victory cross and has some of the

desirable qualities of both parents. In yield it is equal to either parent. Bannock oats were increased in 1937. During February and March of this year, a total of 52,000 pounds was distributed to 127 farmers located in 25 counties in Idaho. Very favorable reports have come in from the farmers growing this oat.

Cooperative Work Extensive

A large part of the program at the Aberdeen Branch Station is in cooperation with other agencies. The Office of Cereal Crops and Diseases of the U. S. Department of Agriculture is continuing with an extensive breeding project both from the standpoint of developing new varieties, as well as for genetic studies. New strains of red clover and alfalfa are being tested in cooperation with the Office of Forage Crops and Diseases. New varieties of sugar beets are tested for the Office of Sugar Plant Investigations and the Utah-Idaho Sugar Company. Experiments are also conducted in the production of grass seed, the production of spring lambs, treatment of seed potatoes, date of planting potatoes, and the variety testing of potatoes, beans, peas, and corn. Interesting and worthwhile results are being obtained from the rotation experiments.

Although no special field day was held this year many people visited the Station. There are certain advantages in taking smaller groups over the Station and now that the roads are improved, less time is required. Twin Falls and Cassia Counties asked for special days for viewing the experimental work.

Caldwell Branch Station

WORK for the past year has consisted principally of livestock feeding experiments and is reported herein by the Department of Animal Husbandry. Other cooperative projects not of a livestock nature are those pertaining to breeding hybrid field corn, testing varieties of sweet and popcorn, testing commercial fertilizers on corn, alfalfa, and pastures with the Department of Agronomy, and studying the vitamin qualities of alfalfa hay and pasture grasses with the Department of Agricultural Chemistry. The reports of these projects are either paralleled or reported entirely by the respective departments.

Protein Supplements Valuable in Lamb and Steer Feeding

The results of a second year trial to determine the value of adding proteins in the form of meat meal, 5 per cent; cottonseed meal, 6 per cent; linseed oil meal, 8 per cent; and cull peas, 13 per cent to a ration of barley and alfalfa hay for fattening 64-pound range lambs concurred with the results of the previous experiments. In all cases, the protein supplement increased the average daily gains 0.02 pound per head and reduced the feed cost of gains 50 cents per hundredweight. In the same trial, blackface lambs gained 0.05 pound per head more than whitefaced feeder lambs that were fed a ration of alfalfa hay and barley.

A protein supplement consisting of cottonseed meal proved more beneficial in a ration of alfalfa hay, barley and corn silage when fed to 482-pound Angus steer calves than to 768-pound Angus yearling steers. The steer calves consumed 8.6 pounds of alfalfa hay, 6.8 pounds of barley, 7.9 pounds of corn silage, 0.4 pound of cottonseed meal, and gained 2.19 pounds per head daily. The feed cost of gains was \$7.48 per hundredweight. With the same feeds, the yearling steers ate 12.7 pounds of alfalfa hay, 8.6 pounds of barley, 10.2 pounds of corn silage, 0.5 pound of cottonseed meal, and gained 1.88 pounds per head daily. The average cost of feeds per hundredweight was \$11.58.

Steer Feeding and Pasturing Study Continued

In a summer feeding test with the cut-back yearling steers from the mineral feeding experiment extending from May 12 to July 1, the relatively high rate of average daily gains and conservative feed costs during a period of warm weather when flies are more or less bothersome were significant. The steers were fed in open lots without shade. The steers weighed 725 pounds each, made 2.31 pounds gain per head daily and consumed a total of 21.2 pounds of feed consisting of alfalfa hay, barley, oats, and dried beet pulp.

Twenty-eight steer calves of Hereford, Angus, and Shorthorn breeding, with an average weight of 409 pounds, were wintered 70 days, pastured 143 days, and fed in the dry feed lots 86 days, to finish with an average weight of 934 pounds. During the wintering period they were divided into three lots and fed as follows: Lot I, alfalfa hay 5 pounds per day and wheat straw ad libitum; Lot II, cottonseed meal 1 pound per day and wheat straw ad libitum; Lot III, alfalfa hay. During the summer all steers were together on bluegrass, white clover, and mixed grass pastures and were fed approximately 5 pounds of barley per head daily during the last 33 days they were on pasture. Rations for the finishing period consisted of alfalfa, barley and oats, and corn silage and were fed alike to all lots. During the wintering period, the calves fed alfalfa gained over twice as much as the calves fed alfalfa and straw or those fed cottonseed meal and straw. Although all calves had a thrifty appearance, the calves fed on alfalfa were less paunchy and carried more flesh when they were turned on pasture. The feed costs of wintering per 100 pounds of gain were as follows: alfalfa and straw, \$3.78; cottonseed meal and straw, \$2.99; and alfalfa, \$4.70. Eleven acres of bluegrass and white clover pasture were not sufficient to maintain the 28 steers and were supplemented with 4 acres of mixed grass pastures at two intervals during the summer. The average daily gain during the whole pasture season was 1.65 pounds per day. On grass alone it was 1.48 pounds per day, and on grass with ground barley fed in addition it was 2.20 pounds per day. The alfalfa and wheat straw-wintered calves whose gains were poorest during the wintering period were the best on pasture and amounted to 1.82 pounds per head daily. They were followed by the cottonseed meal and wheat straw-wintered and al-

alfalfa hay-wintered calves with average daily gains of 1.66 pounds and 1.55 pounds per head. The feed cost of 100 pounds of gain was inversely proportional to the rate of gain. During the finishing period of 86 days these steers consumed an average of 13.5 pounds of alfalfa, 1.3 pounds of oats, 8.5 pounds of barley, 6.9 pounds of corn silage and gained slightly in excess of 2 pounds per head daily. To the livestock feeder interested in finishing steers according to a system used in this experiment, two significant factors are revealed by the feeding and killing data that were secured. First, calves that are properly wintered with alfalfa hay as part or all of the ration go to market with the most weight and the highest degree of finish. Second, the killing data showed that there was a prevalence of carcasses of mixed coloring, which is often referred to as "grassy coloring." The causes of this condition may be attributed to the character of the feeds used during the finishing period or to the insufficient length of the finishing period. The need for additional information concerning this phase of feeding is apparent.

Commercial Fertilizers for Alfalfa, Corn, and Pastures Tested

Sodium nitrate, treble superphosphate, potassium chloride, and gypsum, alone and in combinations, were applied on 0.27-acre plots of 2-year-old alfalfa during the fall of 1936. The land had received applications of manure at seeding time and at 3-year intervals for the preceding 12 years. No increases of yields were obtained from the applications of single materials, but in combinations slight increases were secured. The yields for 1938, which should show the residual effect of the applications, were comparatively the same as the preceding year.

Applications of ammonium sulphate and treble superphosphate, alone, on corn grown for silage increased the yields 8.3 per cent and 5.5 per cent. Triple phosphate and fused phosphate did not increase the yields.

On irrigated bluegrass and white clover pasture, the application of 100 pounds of triple phosphate and 100 pounds of ammonium sulphate per acre increased the production of butterfat 7 per cent.

Tonnage of Chopped Alfalfa Hay Computed

Over a period of 4 years, in which 11 stacks of chopped hay were measured and weighed, there were 150 cubic feet of chopped hay per ton. This hay was cut in $\frac{1}{2}$ -inch lengths and had a fineness modulus of from 3.0 to 3.5. With a trend toward the use of finer cut hays, it is probable that a reduction of from 15 to 25 cubic feet per ton from the above figure will be necessary in computing tonnages of stacks of chopped hay.

Sandpoint Branch Station

THE generally unfavorable climatic conditions of 1938 were directly reflected in low crop yields. New seedings of alfalfa, as well as older stands that had been too closely pastured the previous fall, fared badly over much of the area in the vicinity of the Branch Station. The greater share of the damage was due to smothering resulting from the formation of ice sheets. Some winter wheat was similarly affected, particularly the late-seeded fields. Marked rainfall deficiencies occurred during every month of the growing season, depressing yields of spring-planted crops. The total precipitation of May, June, July, and August was only 2.25 inches, the lowest for that period since 1922, and more than 2 inches below average. The lighter soils produced only one crop of alfalfa, pastures were exceedingly poor, and spring cereals, potatoes, and other crops suffered. Except for August, summer temperatures were well above average. Maximum readings of 95°, 96°, and 95° F. were observed on the first 3 days of September, and the mean and mean maximum for that month were the highest on record. There were 14 days when the temperature reached 90 or above, with a maximum of 99 on July 22. The lowest reading was four above on January 30. The growing season extended from May 6 to October 14, a total of 161 days. This was the longest frost-free period on record, and approximately 11½ months longer than normal.

Winter Wheat Yields High

The fall-seeded wheat varieties went through the winter with only an occasional trace of injury. Yields were the highest on record for the Station, ranging from 50.3 bushels with Fortyfold to 71.4 bushels with Rex. Rosen rye, Triplet, and Turkey all produced well over 60 bushels, with the remaining varieties running between 52 and 60 bushels. The turning under of a green manure crop of alfalfa on the range on which the plots were seeded resulted in a rank growth and exceptionally long straw. Redit, Turkey, and Mosida lodged approximately 40 per cent, and the other varieties to a lesser extent. Rex was the only variety in which there was no lodging, accounting in some measure, no doubt, for the high yield. Three additional varieties, Rex M1, Fortyfold x Federation, and Fortyfold x Hybrid 128, have been included in the plot trials for 1939. All have given very good yields in nursery trials and have demonstrated their ability to withstand lodging under very adverse conditions.

Rex M1, Rex M2, Fortyfold x Federation, and Fortyfold x Hybrid 128 were the leading varieties in the winter wheat nursery, all producing upwards of 60 bushels per acre. As has been usual in the past, Jenkin winter-killed badly, resulting in a yield of only 21 bushels. Lodging was rather extensive, particularly in the Turkey types and the Jenkin hybrids.

Spring Wheat, Oat, and Barley Yields Low

In direct contrast to the winter wheat, spring varieties produced the lowest yields on record. Conditions were such that there was practically no stooling, so that stands were very thin. Marquis ranked first with 13.6 bushels, followed by Bluestem with 10.6 bushels. White Federation was low with 7.1 bushels. *Idaed*, a cross between *Sunset* and *Boadicea*, in its first year on the Station, made 8.2 bushels. Yields from the spring wheat nursery ranged from 6.2 bushels to 11.4 bushels.

Oat yields were approximately half those of last year and 20 per cent below normal. *Victory* was high with 37.7 bushels, while *Bannock*, tried here for the first time, was low with 31.9 bushels. *Silvermine* x *Markton*, C.I. 2999, was high in the nursery with 45.9 bushels.

Hannchen maintained first place in the barley varieties with a yield of 26.2 bushels, followed by *Union* and *Beldi* with 22.8 bushels each. *Wisconsin Barbless* and *Hannchen* led in the nursery with 16.6 and 14.1 bushels, respectively.

Legume Experiments Continued

Sulphate of ammonia continued to show a slight advantage over gypsum as a fertilizer for alfalfa, the average yields for 2 years being 13,240 and 12,930 pounds per acre, respectively. Nitrogen and potassium, in combination, have given the lowest production in both years in a series of fertilized plots. Oddly enough, the same combination has given the highest yields of both barley and wheat in the same years. Initial investigations indicate that a boron deficiency may exist, at least in some areas. Characteristic symptoms, which were notably lacking in a boron-treated plot, include yellowing and premature shedding of the alfalfa leaves, and a sparsity of blossoms. Additional work on this problem is underway.

There was a great difference in stand, vigor, and yield of alfalfa and red clover seeded with and without a nurse crop. Alfalfa with oats as a nurse crop showed a stand of 25 per cent and an acre yield of 2,620 pounds per acre. Stands in the four checks varied from 70 to 90 per cent, and the average acre yield was 5,950 pounds per acre. Yield variations in the clover were due primarily to a difference in the vigor of the plants, the stands being much more uniform than was the case with alfalfa. Five clover check plots averaged 9,792 pounds, while a nurse crop of flax reduced the yield to 4,480 pounds per acre. Peas showed the least retarding effect in all cases. Results with the other crops were not entirely consistent throughout but would probably rank as follows for consideration as nurse crops—barley, wheat, oats, and flax.

Results from Fertilizer Experiments Vary

In contrast to last year, only slight increases were obtained in wheat yields through the application of commercial fertilizers, a fact that was anticipated because of the dry season. Six check

plots averaged 7.5 bushels, while 125 pounds of sodium nitrate and 100 pounds of muriate of potassium raised the yield to 10.3 bushels, the highest of the lot. Trial plots established cooperatively with a number of farmers were not harvested owing to the fact that there was no apparent fertilizer effect. In testing for residual effect, a plot that was manured in the fall of 1936 produced 15.3 bushels per acre, compared with an average of 8.7 bushels from three checks. Commercial fertilizers applied at the same time showed no significant carry-over. Applications made in the spring of 1937, however, were still of some benefit this year. The nitrogen potash plot produced 18.3 bushels per acre; the nitrogen phosphorus, 19.8 bushels; while three check plots averaged 14.1 bushels. No manure was used in the latter series.

Grass Seed Production Investigations Continued

Tall oat grass has, for the past 2 years, given higher seed yields from rows 3 feet apart than from either closer or wider spacings. The table below gives a 3-year summary of the effect of row spacing on seed yield.

Table 8.—Three-year summary showing effect of row spacing on tall oat grass seed yields in pounds per acre at the Sandpoint Branch Station

Row spacing	1936	1937	1938
1-foot spacing	375	216	302
2-foot spacing	219	224	307
3-foot spacing	190	292	413
4-foot spacing	72	228	
Solid stand			259

A solid stand of slender wheat produced 342 pounds of seed, compared with 428 pounds per acre from rows 3 feet apart. Crested wheat without fertilizer made a yield of 218 pounds per acre, while a top dressing of manure plus 100 pounds sulphate of ammonia and 50 pounds treble superphosphate raised the yield to 385 pounds.

Pasture Mixtures Studied

A project dealing with various pasture mixtures included 17 different combinations. The plots were cut with a mower in early July, the forage allowed to cure, and plot yields taken. While the results were probably not very comparable to pasture conditions, the information gained was of value. Timothy and alsike gave the highest yield, by a very small margin, but made very little growth during the 3 months following harvest. Orchard grass, brome grass, and tall oat grass remained in a much better condition during the dry months. Slender wheat appeared quite promising in some mixtures but did not stand the competition very well in others. Crested wheat was somewhat disappointing in most mixtures. Since this species is frequently rather slow to become established,

however, it may show to a better advantage next year. Spring seedings of pasture grasses, followed by harrowing and rolling, were uniformly good, while seeding on the snow in October and March and depending upon natural agencies to cover the seed gave very sparse stands.

High Altitude Branch Station

Season Favorable, Although Some Damage Caused by Frost and Wind

THE season of 1938 was favorable as far as moisture was concerned. The total rainfall to December 1 was 16.97 inches, compared to 10.75 inches, which is the average for the last 20 years for the same months. Nineteen hundred twenty-five was the only year during this period when this amount of precipitation was exceeded. During that year there were 18.33 inches of precipitation before December 1 and a total of 19.86 inches for the entire year.

Considerable damage was caused to alfalfa and some of the more tender crops by frosts during June. High winds in August damaged winter wheat by shelling the grain. Some varieties shelled badly, while others broke off at the base of the heads. High humidity was conducive to rust development which evidently weakened the straw and caused the heads to break off more easily.

The winter wheat crop was good this year, and there was an extra heavy growth of straw. Lodging was common, and considerable loss of grain resulted at harvest time. Frost caused considerable damage to spring wheat throughout the Teton Basin.

A new spring wheat, *Idaed*, which is a cross between *Sunset* and *Boadicea*, developed at the main Station at Moscow, has been one of the highest-yielding varieties in the cereal nursery for several years. This year it was grown in the field plots and ranked second, being outyielded by a hybrid, *Hard Federation x Baart*. The new wheat is the earliest variety grown in the nursery, has a high protein content, and shows promise of replacing some of the varieties now grown. In the winter wheat nursery *Fortyfold x Federation* gave the highest yield, while *Fortyfold x Hybrid 128* was second. These are both white winter wheats and usually sell for less on the market than the hard red winter varieties. However, both varieties have yielded well and may be adapted to certain areas where considerable wheat is used as feed. Of the hard red winter wheats, *Rio* and *Kharkof* gave the best yields. *Oro* dropped to fourteenth place this year on account of loss due to a high wind which came just as the wheat was ripening and caused many of the heads to be broken off. *Fortyfold* and *Golden* shattered badly and consequently gave very poor yields.

In general, commercial fertilizers did not prove beneficial on the branch station farm. A slight increase in yield resulted from the use of fertilizer on some crops, but decrease resulted on others. Indications pointed to better results from lighter applications of

fertilizers. From 35-50 pounds per acre gave better results than 100 pounds per acre in most cases.

Grass Variety Tests Important

An extensive study of grass varieties for seed and forage, inaugurated several years ago, has been of more than usual interest to those visiting the branch station farm. A number of these grasses are well adapted to nonirrigated, high altitude farming conditions in southeastern Idaho. Smooth brome grass, crested wheat grass, and a new grass originating from the Idaho Agricultural Experiment Station, which is a cross between giant wild rye grass and Mosida wheat, are especially promising for use in this section. Brome grass has made a very good hay crop, especially when seeded with alfalfa. This combination makes a good grade of hay, is easily handled, and retains the stand longer than brome grass when planted alone. The new hybrid grass was first planted on the branch station in the fall of 1937. The grass this year attained a height of 5 feet or more, produced seed at the rate of 27 bushels per acre, and the first crop of hay amounted to 5,445 pounds per acre. When this grass was planted in the spring of 1938, it made a fine growth but did not come into head. From appearances, however, it should make very good fall pasture as livestock eat it readily. The yield of clover seed was low this season due to poor stands. The grasses, especially crested wheat, brome and meadow fescue, gave fair yields.

Arrangements have been completed for moving the High Altitude Branch Station farm $3\frac{1}{2}$ miles southwest of the present site to an area adjoining the highway between Rexburg and Driggs. This will be a much more favorable situation for experimental work and will be much more accessible for farmers of the Upper Snake River Valley.

Changes in Station Staff Summarized

Higher salaries paid elsewhere have again made serious inroads upon our Experiment Station staff. Claude Wakeland, head of the Department of Entomology, resigned October 31, 1938, to accept a position with the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture; W. E. Shull was made head of the department, and Robert Fisher has been appointed as Assistant Entomologist. Julius E. Nordby, Associate Animal Husbandman, resigned March 1, 1938, to become director of the Bankhead-Jones Regional Sheep Breeding Laboratory at Dubois, Idaho. W. M. Beeson was recalled from the University of Arizona to assume charge of animal nutrition research as Associate Animal Husbandman, and D. E. Brady has been secured to serve as Assistant Animal Husbandman. Fred D. Maurer resigned as Assistant Bacteriologist, June 20, 1938, and Glen Holm was secured to fill the vacancy. Donald Corless, Field Superintendent in Agronomy, resigned July 31, 1938, and Ralph Samson resigned November 7, 1938, as Federal Pea Inspector. Through a reorganization of the work in the Department of Agronomy, W. E. Colwell was appointed as Assistant Agronomist, Howard Roylance as Federal Pea Inspector, and Russell Stark as Assistant Agronomist. George Schaefer served as Assistant Agricultural Economist from July 1, 1937, to May 31, 1938, during the leave of absence of C. O. Youngstrom, Associate Agricultural Economist. Theron B. Hutchings, Assistant Agricultural Chemist, resigned May 18, 1938, and L. E. Ensminger has been secured to fill this vacancy.

After a lingering illness of several months, H. P. Magnuson passed away September 14, 1938. Professor Magnuson had served as a member of the staff of the Department of Agricultural Chemistry since 1920 and as acting head of the department for over 10 years. His successor has not yet been chosen.

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 1938 follows:

Bulletins

223. *Idaho bull associations.*
224. *Flax production in Idaho.*
225. *Forty-five years of service to Idaho agriculture.* Annual report of the Experiment Station for the year ending December 31, 1937.
226. *Fertilization of apple and prune orchards in Idaho.*
227. *Crop rotation studies.*

Circulars

78. *Measuring stacks of chopped alfalfa hay.*
79. *Publications available for free distribution.*

Mimeo-Leaflets

19. *Insects and mites attacking horses, cattle, hogs, and sheep.*
20. *County agricultural planning—Why?*
21. *Summary of Minidoka experimental county farm survey by soil types.*
22. *Extension of farm management.*
23. *Spray recommendations for Idaho, 1938.*
24. *Artificial insemination of dairy cattle.*
25. *Dormant sprays for peach and apricot, 1938.*

Research Papers

159. *Reaction of wheat, barley, and rye varieties to stripe rust in the Pacific Northwest.* Wayne M. Bever. U. S. Dept. of Agr. Circular No. 501, pp. 1-14. Dec. 1938.
160. *Structural analysis of farm buildings by moment loading of models.* Woodrow Arrington. Agr. Engineer. Jour., Vol. 19, No. 5, pp. 199-200. May, 1938.
162. *A mosaic-resistant small red bean.* Donald M. Murphy and W. H. Pierce. Phytopath., Vol. XXVIII, No. 4, pp. 270-273. April, 1938.
163. *Relationship between the number of fruit carpels and the number of seed cotyledons within an apple variety.* Lowell R. Tucker. Proceed. Amer. Soc. Hort. Sci., Vol. 35, pp. 9-11. May 1938.
165. *A skull-defect in cattle.* A. O. Shaw. Jour. of Heredity, Vol. XXIX, No. 8, pp. 319-320. Aug. 1938.
166. *Trend studies in relation to the analyses of yield data from rotation experiments.* K. H. Klages. Jour. Amer. Soc. Agron., Vol. 30, No. 7, pp. 624-631. July 1938.
167. *A precise method for the determination of carotene in forage.* Donald W. Bolin and Assad M. Khalapur. Industrial and Engineer. Chem., Vol. 10, p. 417. Aug. 15, 1938.
168. *Histology of apple fruit tissue in relation to cracking.* Leif Verner, Jour. Agr. Res., Vol. 57, No. 11, pp. 813-824. Dec. 1, 1938.
170. *Sulfanilamide in the treatment of streptococcal mastitis.* E. M. Gildow, D. L. Fourt, and A. O. Shaw. Jour. Dairy Sci., Vol. XXI, No. 12, pp. 759-766. Dec. 1938.

HOME STATION DISBURSEMENTS

Detail of Expenditures of State Appropriations*
Idaho Agricultural Experiment Station
January 1 through December 31, 1938.

	Salaries	Help	Expense & Supplies	Equip-ment	Total
Administration	\$	\$1,164.42	\$1,839.74	\$ 68.40	\$3,072.56
Agr. Chem.		521.03	947.78	322.18	1,790.99
Agr. Econ.	166.63	328.13	222.38	47.98	765.12
Agr. Engr.		195.55	372.75	393.43	961.73
Agron.		2,398.16	405.63	306.64	3,110.43
An. Hus.		552.34	174.79		727.13
Bacter.		170.27	63.69		233.96
Dairy Hus.		1,055.15	2,229.99	15.00	3,300.14
Entom.		176.85	394.37	185.89	757.11
Home Econ.		164.65	90.59		255.24
Hort.		314.09	527.32	253.33	1,094.74
Plant Path.		171.60	294.48		466.08
Poultry		819.66	3,526.41	240.75	4,586.82
Soil Survey		454.77	190.45	42.50	687.72
TOTAL	\$ 166.63	\$8,486.67	\$11,280.37	\$1,876.10	\$21,809.77

* Includes general appropriation and institutional funds.

SUBSTATION DISBURSEMENTS

January 1 through December 31, 1938

	Aberdeen	Caldwell	High Alt.	Sandpoint	Total
Salaries	\$ 3,300.03	\$ 2,210.03	\$ 1,800.00	\$ 3,079.95	\$10,390.01
Help	1,948.65	2,568.17	585.16	688.45	5,790.43
Expense and supplies	4,085.16	3,928.04	1,143.47	1,164.40	10,321.07
Equipment	1,956.72	358.95	37.50	633.90	2,987.07
TOTAL	\$11,290.56	\$ 9,065.19	\$ 3,566.13	\$ 5,566.70	\$29,488.58

FINANCIAL STATEMENT

Detail of Expenditures of Federal Appropriations
Idaho Agricultural Experiment Station
July 1, 1937, to June 30, 1938.

	Abstract	Hatch	Adams	Purnell	Bankhead-Jones
Salaries	1-A	\$ 8,136.96	\$11,577.30	\$43,128.60	\$ 5,613.94
Labor	B	2,504.62	1,631.24	8,547.95	1,919.12
Stationery and office supplies	2-A	329.94	2.21	192.93	39.89
Scientific supplies	B	254.21	1,448.71	1,992.75	123.14
Feeding stuffs	C	231.17		1,304.01	1,362.25
Sundry supplies	E	73.61	18.55	84.81	14.23
Communication service	5	611.64	1.50	217.87	2.31
Travel expense	6	1,169.21	62.22	1,942.90	722.50
Transportation of things	7	19.70	50	106.01	18.02
Publications	8	951.15		395.61	10.90
Heat, light, water and power	10	26.05	15.34	133.99	
Contingent expense	13		9.60	130.46	2.60
Furniture and fixtures	30-A	102.00		252.42	
Library	B	28.46		54.08	3.40
Scientific equipment	C	415.18	174.28	1,067.70	170.72
Tools and machinery	D	107.90	48.55	214.71	23.40
Livestock	E			60.00	
Buildings and land	31	38.20	10.00	173.20	262.50
TOTAL		\$15,000.00	\$15,000.00	\$60,000.00	\$10,288.92

crossed jurisdictional standards of various laws.

Parley says that policy must be established in research. He wants to see a field as progressing constantly to the south.

W. H. H. - Planning & Action programs need to be brought close together.

Irving, N. S. - Water pollution coming along well.