Agricultural Research in Colorado

Fifty-First

ANNUAL REPORT

Colorado Experiment Station

1937-38

Colorado State College

Fort Collins

Letter of Transmittal

Fifty-First Annual Report
Colorado Experiment Station

Hon. Teller Ammons
Governor of Colorado
Denver, Colorado

Sir:

In compliance with the law, I herewith present the Fifty-First Annual Report of the Colorado Agricultural Experiment Station for the fiscal year of July 1, 1937 to June 30, 1938, inclusive.

E. P. Sandsten

Director

Fort Collins, Colo.
July 1, 1938

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Director's Annual Report

Fifty-First Fiscal Year, 1937-38

Colorado Experiment Station

To the President and the State Board of Agriculture:

The Director is submitting herewith the annual report of the Colorado Experiment Station sections. A careful study of these reports shows the extensiveness of the work in which the Station is engaged and its relation to Colorado's agriculture. Our efforts have been to organize and correlate our investigations to meet the present needs of our farmers and at the same time to make contributions to fundamental research on the basic problems upon which the future agriculture must be built.

It is not necessary for the Director to comment on the several reports submitted by the sections and included in this report; these should speak for themselves. However, he wishes to direct attention to the work of the Animal Investigations Section, particularly that done during the past year. In his last report, the Director mentioned the fact that the feeding experiments conducted at the home station during the past 20 or more years were practically duplications, and that while they were useful and important to professional feeders in the sugar-beet producing areas and to the economic utilization of the by-products of the sugar companies, it has been apparent to the Director that feeding experiments should be expanded so as to include the various farm feed crops grown in different parts of the State.

The Board concurred in this change, and as a result practical feeding experiments were set up in various sections. The report of the Animal Investigations Section indicates very plainly that this new line of work is important and may result in extending the feeding of livestock on the farm to a much greater degree than in the past. The utilization of farm products on the farm must be stressed as a necessary condition of permanent agriculture. The work this year has indicated that the steps taken were correct and will furnish leads that should be followed in conducting feeding experiments under controlled conditions in these different farming sections. The Station is planning for such experiments during the coming fiscal year.

The Director wishes also to call attention to the Seed Laboratory. This is supported by annual appropriations, uncertain and inadequate. After much trouble, we finally were able to obtain an appropriation with a 10-percent reduction. In the first place, the appropriation is far too small and cannot support more than a mere labor-

atory staff which makes the analysis of seeds sent in by the farmers and seed houses. There are no funds for the enforcement of the seed law on the farm nor with the dealers. The law itself is excellent, but like many laws it cannot be or is not enforced by the present meager appropriation.

The serious matter is this: Since we cannot make the seed inspection, the dealers, being only human, are selling not only inferior seed but seed containing large quantities of noxious weeds. These are distributed to the land, and the weed problem is becoming more and more serious. Our efforts in weed eradication, on which large sums of money are spent annually, are ineffective so long as we continue to permit seedsmen to sell weed seed and the farmer to reseed his fields with weed seed every year.

The farmer himself is as much to blame for this condition as the seed dealer. A survey made by our Extension Division on noxious weed seed in the grain and alfalfa seed used by the farmers on their own farms and sold to their neighbors shows an astonishing number of noxious weeds. These samples were collected by the extension agents and analyzed by the Seed Laboratory. So long as this condition obtains, our efforts in weed control and eradication are nullified. We must reach the seat of the problem which is, after all, the seed that the farmer plants, whether from his own, his neighbors', or the seed dealers' supply.

There should be adequate funds set aside for the inspection of seed sold by the dealers, and the county agents are in the best position to inform the farmer of the character of his own seed and help him to make an efficient cleaning of the seed or to locate a good seed supply. The Station has made considerable progress in methods of weed control on the farm, and we shall be able to present a weed eradication and control program that is both practical and reliable.

Substations

AVON.—The work at the Avon Substation is being continued as in the past. However, more attention is given to livestock and to pasturage improvement. This year some trials will be conducted experimentally to find grass and legume mixtures for higher altitudes where alfalfa is not adapted. This program for the mountainous sections should increase the yield of hay per acre.

The potato-breeding improvement work is continuing, and new varieties are being tested for distribution to the potato growers all over the State. The work with pod peas will be extended, and new introductions will be tried on an extensive scale to furnish the information to the growers of this vegetable.

The farm is in excellent condition and Mr. Ralph Manuel, the superintendent, is doing very creditable work.

AUSTIN.—Because of a ruling of the State Executive Council, the funds for the State Horticulturist at the Austin Substation were cut off on December 31, last. This directly affected the work at this substation. The salary of the superintendent, Mr. F. M. Green, who acted as deputy state horticulturist, must be borne by the Experiment Station, and additional funds for carrying on the work must also be provided. This substation belongs to the institution and cannot be abandoned without seriously affecting the fruit industry. The work done at Austin has been of great importance to our fruit growers, not only as a model in orchard management but also as a place where new varieties are being tested for the information of the growers. Experiments in fertilizers and cover crops that have been carried on for several years must be continued. This entails an extra expenditure of Station funds which must be taken care of, and these funds should be set aside for this purpose in the new budget.

ROCKY FORD.—As in the past, the work at the Rocky Ford Substation consists of conducting a number of experiments with Valencia onions, which is the principal truck crop in the Arkansas Valley. The Horticulture Section at Fort Collins has developed an outstanding variety of Valencia which has been grown in comparison with the standard varieties for the past 3 years. This new variety is far superior to those now used. Both seed stock and bulbs are being distributed to the growers, and the new variety will undoubtedly bring additional income to the valley.

Extensive tests are now pursued with hybrid corn, in cooperation with the Agronomy Section. Last year's results are very promising. This work will be continued and extended, with the idea of determining the best hybrids to be planted by the farmer. Breeding work and improvements on cantaloupes are also in progress. Tests of different strains of alfalfa to determine their value to the valley are being conducted. Variety tests with grapes and strawberries are being continued.

Mr. Fauber is showing his ability as a manager and as a practical grower. The farm is now a credit to the institution.

AKRON.—At Akron the work is in cooperation with the U. S. Department of Agriculture and is under the direct supervision of Prof. Alvin Kezer, the report of activities of that substation being included with the report of the Agronomy Section.

College Farm

Since the Director took over the College Farm, two main objectives have been pursued. The first is to make the farm presentable to the public. This has necessitated a large amount of work at considerable cost. The improvements in this respect are, briefly, as follows:

Five miles of new fence of modern construction have been erected. The main roads have been graded and graveled from fence to fence, thus eliminating the usual road weeds and the unsightliness on farm roads; new streamlined bridges have been built, giving a pleasing view of the farm and a pleasing approach to the institution. The road-building program was completed during April. We were fortunate in obtaining Works Progress Administration assistance, which made gravel hauling comparatively inexpensive.

Among the improvements of the farm itself and to farm operation, the Director would mention, first, the irrigation system. Pipe lines have been installed from the ditches to the farm. Three of these have a combined distance of a mile and were completed last year, being now in use. They eliminated the loss of water and interference by farmers along the ditch, who were prone to utilize the water when opportunity offered. A number of shorter pipe lines have been installed in different parts of the farm to aid in the distribution and to prevent undue losses of water.

A large amount of grading or leveling has been done the past 3 years, but it will require many more years to complete this work, as it must be done by slow stages so as not to interfere with crop production. The fertility of the land is constantly being improved by the proper use of the animal manure available for the farm.

The second objective is, briefly, an attempt to make the farm self-supporting; that is, to make the farm pay for farm operation. The success of this effort will depend upon a number of factors. The principal one is the size of the farm. If we continue to withdraw land for other uses, our efforts will be handicapped. Thus far, despite the heavy costs of improvements, we are near our aim of making the farm self-supporting.

Without boasting, the Director feels that today the farm is a credit to the institution, and Mr. William P. Kintzley, in charge, deserves the credit for this accomplishment.

With the encroachment and expansion of several departments of the Federal Government, more and more land is diverted from the farm. This is serious from the economic standpoint. It results in larger outlay of money outside the institution, and will greatly interfere with the development of a better livestock program, a larger acreage for pasture, and particularly the development of the dairy industry. Our farm acreage is too small for economical operation, and we must give thought to the acquisition of more land before it becomes more costly to obtain. Under a proper setup and management, it is possible to pay for the land out of the sales of farm products.

Committee Suggested

The Director feels the necessity for a better understanding on the part of the Board of the problems of the Station and of agriculture in general. He would suggest that a small permanent committee be appointed as an agricultural committee of the Board, to confer with the Director on the policies of the station and to provide for a better understanding of the problems of agriculture. It would be a tremendous help to him, and a satisfaction to the Board itself. The present contact with the Board is too general to meet the problems we are facing, and the Director hopes the Board will see its way clear for the appointment of such a committee.

Personnel

The Station organization, both in personnel and accomplishment, continues to show improvement. New members of the staff are young men of excellent training and of high natural ability. While an ideal staff is a dream, our aim should be to approach the ideal.

It should be inferred that improvements cannot or should not be made in the present personnel, since some staff members who gave early promise later became merely routine workers and time servers. It is this type of man who lowers the standard and exercises a bad influence on the better workers. Our unwillingness or our lack of moral courage to eliminate these is a weak spot in our institution. It applies both to research and instruction. This kind of personnel is dead timber, useful for many purposes; but in our educational and experimental work they occupy the space that should be given to living and growing trees.

The pages which follow summarize the year's activities of the various sections of the Station as reported by their respective heads.

Agronomy Section

The Agronomy Section staff consists of Alvin Kezer, chief agronomist; D. W. Robertson, agronomist; Dwight Koonce, associate; Robert Gardner, associate; Lindsey A. Brown, associate; Ralph M. Weihing, assistant; and Otto H. Coleman, assistant. All these workers, except the chief agronomist, put in full time on research. Warren H. Leonard, associate, devotes part of his time to corn research. Robert S. Whitney, assistant, devotes part of his time to soils research.

Corn Improvement

The corn improvement project has been devoted mostly to trials of hybrid seed and to our own hybrid breeding program. There is an unusual demand for information on hybrid seed. The section has run trials at Fort Collins, Akron, and Rocky Ford on Experiment Station land, and on a private farm in Weld County. There is no doubt that hybrid corn is being over-emphasized. We are doing everything within our power to bring the information and practice into line.

Hydrocyanic Acid in Sudan Grass

The Adams fund project on factors responsible for hydrocyanic acid in sudan grass is going forward, using old self-fertilized lines. New lines are being self-fertilized and put in the tests. There are indications that the ability to produce hydrocyanic acid is inherited. There are also indications that environment influences hydrocyanic acid content.

Optimum Nutrient Balance in Soils

The project on determination of optimum nutrient balance in soils is giving special emphasis to a study of nitrogen and phosphorus relationships and their effect upon yield and quality of crops.

Availability of Mineral Nutrients

The greatest emphasis in the factors affecting the availability of mineral nutrients in soils is placed upon the factors which influence the availability of phosphorus and methods of laboratory determination of field availability.

Bacterial Wilt and Alfalfa Winter-Killing

Studies on control of bacterial wilt and winter-killing of alfalfa are being continued with self-fertilized lines apparently resistant to bacterial wilt and winter hardy. The section is attempting to get new lines through its own plantings and has made arrangements with the Federal Government and associated states of the Midwest, especially Wisconsin, Nebraska, and Kansas, for exchange of prospective breeding material. Some preliminary studies have been presented for publication.

Linkage Relationships in Barley

The technical genetic studies in linkage relationships in barley are examining the possibilities of barley inheritance and the mapping of genes and chromosomes into linkage groups. From some of the progenies some practical findings have arisen, such as the production

of strains of probable commercial value. One of these strains is in the increase stage at the present time.

Soil Resources and Land-Use Survey

During the past season detailed reconnaissance surveys were practically finished for Morgan County, a part of Weld County (in fact, all of Weld County except certain lands set aside for Federal experimental purposes), and a part of Phillips County. The Washington County detailed survey requires a little more work to complete. Federal cooperative agencies are supplying means for the survey of Federal holdings of the Farm Security Administration, the Bureau of Economics, and the Forestry Experiment Station. This will be undertaken as soon as weather permits fairly consistent continuity of the work.

High-Altitude Crops

The project on high-altitude crops is continuing. Small grains, peas, high-altitude dry-land and irrigated grasses, and alfalfa, with a minor list of forage crops, are under investigation. Bulletins have been published on peas and high-altitude grass experiments.

Plains Crops and Management

The 1937 crop season at Akron was fairly good. Our cooperative work with the Office of Dry-Land Agriculture is being continued. Experiments are under way on rate and dates to plant crops of wheat, barley, oats, and mixed-forage crop varieties. In forage-crop varieties are millets and sorghums. The Akron Substation is also used as an elimination and trial ground for new strains of grains, especially wheat.

Animal Investigations Section

Western Slope Tests

Collbran Cattle Fattening

In cattle-fattening tests at Collbran, Colo., one carload of yearling steers is being fed in two lots to show the advantage of barley, a home-grown grain, over shipped-in corn, when relative costs are considered. The demonstration is run in cooperation with Carl Porter of Collbran. This test has not been completed at the present time.

Delta Steer Fattening

The advantage of a succulent roughage in an otherwise dry ration for fattening cattle was demonstrated in cooperation with Hallock Brothers of Delta, Colo. One hundred twenty-six yearling steers were fed for 106 days in two lots, using corn silage as a supplementary roughage in one lot and cut corn fodder in the other lot. The results indicated a greater and cheaper gain when silage was used.

Delta Lamb Fattening

One carload of western feeder lambs was separated into two lots and fed 77 days, in lamb-fattening tests at Delta. In lot 1 corn was used as a grain concentrate, and in lot 2 barley was used along with a ration of cottonseed cake, wet pulp, and alfalfa hay.

Results of the test showed that the rate of gain was practically the same in the two lots; however, the cost of producing gain was slightly cheaper with barley than when corn was used as a concentrate. Slaughter figures showed an advantage for corn-fed lambs, since they showed a slightly higher dressing percentage and more uniform carcasses than the barley-fed lambs.

Wintering Ewes

Cost and gain records are kept on three bands of ewes, one of which is wintered on the Utah desert; another is wintered at home on home-grown feeds; and the third band is run on public domain part of the time and the remainder of the winter is fed on home-grown feeds. This test is in cooperation with Clair Hotchkiss, Paul Swisher, and J. P. McIntire of Hotchkiss, Colo.

Cortez Hog Fattening

A test on hog fattening, run in cooperation with John McConnel of Cortez, Colo., was completed on November 2. The test was so designed as to show the relative values of tankage, triple mixture, and buttermilk. Buttermilk showed the greatest advantage, followed by tankage and by triple mixture in the order mentioned. Thirty pigs, ten in each lot, were used in this 115-day demonstration.

Rocky Ford Cattle Fattening

Two carloads of steers which have been divided into two lots are being fed in cooperation with Charles A. Belier of Rocky Ford, Colo. The test demonstrates the value of beet molasses as a partial replacement for grain in a fattening ration for cattle. This demonstration had not been completed at the time of preparation of this report.

Alamosa Cattle Fattening

In cooperation with the Norton Ranch Company, one carload of yearling steers is being fattened at Alamosa, Colo., on a combination of home-grown feeds showing the value of cull potatoes when added as a succulent feed to that type of ration. The cattle are not finished at the time of this report.

Eastern Slope Tests

Sterling Heifer Fattening

Two carloads of heifers were fed 148 days, in cooperation with W. W. Brown of Sterling, Colo. The results of this demonstration, designed to show the relative values of "C" molasses and cane molasses, showed that the "C" molasses carried about 89 percent of the feeding value of cane molasses. The rate of gain of heifers produced by cane molasses was slightly greater; however, the cost of gain was also materially higher. Market figures covering shrink, dressing percentage, and carcass grade have not as yet been received from the Kansas City market, where these heifers were shipped.

Log Cabin Cow Wintering

In cooperation with George Weaver of Log Cabin, Colo., three lots of breeding cows are wintered as follows: Lot 1, on winter pasture, plus hay fed during stormy weather; lot 2, winter pasture, one-half pound of cottonseed cake, plus hay during stormy weather; lot 3, winter pasture, dried beet pulp, plus hay during stormy weather. Records are kept of gain produced during the winter, and records will be kept on subsequent summer gains as well. Percentage of calf crop and total pounds of beef produced will also be recorded.

Akron Hog Fattening

Three lots of 10 pigs each were fed for 95 days at the Akron Substation, in cooperation with C. J. Funk of Akron. The test was outlined to show the relative values of corn, hog millet, and rye as grain concentrate in the hog-fattening ration. Results obtained were as follows: Hog millet showed a value slightly greater than yellow corn; rye was worth only two-thirds as much as millet; introduction of rye into a fattening ration had a tendency to retard the rate of gain.

Range Management Experiment

The Range and Pasture Management Section and the Animal Investigations Section are cooperating in a grazing experiment com-

paring conservative with deferred and rotated grazing. The first year's test of this experiment was completed on September 12, 1937. Gains produced in the two lots of yearling steers were almost identical for the 120-day grazing period.

Educational Program

In addition to demonstrations carried on in various sections of the State, an educational program in the form of feeder schools has been conducted in the following counties: Prowers, Bent, Otero, Pueblo, Alamosa, Logan, Jefferson, Adams, Weld, Delta, Montrose, and Mesa.

Advanced Registry

Holstein-Friesian

While the national honor list for the Holstein-Friesian breed has not yet been published, a certificate has been received by Colorado State College awarding third place on this list in the 305-day division for 3-year-old cows to the cow Rose Columbine Wayne, for the production of 660.9 pounds of fat. This cow also placed twelfth for 365 days of production.

The cow Carnation Hazelwood Prospect, owned by the sanatorium of the Jewish Consumptives' Relief Society, Denver, made a new State record for junior 2-year-old cows by producing 631.7 pounds of fat.

Official notification of the standing of the various herds in the breed herd test division has not been received.

Guernseys

Two Guernsey cows in the herd of F. C. Kay of Pueblo, on semi-official test, have made new State records. Interlochs Gretta, a junior 4-year-old cow, raised the former State record in class CC from 501 pounds of fat to 611.5, while the cow Interlochs Beauty raised the State AA record for mature cows from 612.1 to 613 pounds of fat.

In the Guernsey breed herd improvement division, the cow Sunset Golden Peggy set a new State record for junior 4-year-old cows by producing 14,739.4 pounds of milk containing 637.7 pounds of fat. This herd has completed its seventh successive year with an average production of more than 500 pounds of fat per cow.

Jerseys

The 4-year-old cow Romulus Lilac Roselle, belonging to E. L. Eden of Pueblo, set a new record for Jerseys in the 305-day division, class A, when she produced 547.4 pounds of fat.

Ayrshires

Only one herd of Ayrshires, that of John Knifton of Sterling, is being tested.

Summary of Testing

Following is a summary of the testing work done since May 1, 1937:

Month	Number cows on yearly test, one day per month	Number cows on yearly test in Herd Improvement Division	Number herds	Fees
May	26	123	12	$21.65
June	29	142	12	24.45
July	35	84	10	18.65
August	37	84	10	17.65
September	35	85	10	17.25
October	35	84	11	14.90
November	36	92	10	20.45
December	40	97	10	19.70
January	40	95	11	19.50
February	44	89	11	19.90
March	40	89	11	20.40
April	43	89	11	19.45
Totals	440	1,153		$233.95

Botany Section

Weed Control Project

Chemical Studies

The analysis of the carbohydrate content of bindweed and whiteweed under various cultural practices has been completed. It has been found that the maximum accumulation of these food reserves occurs about August 10, and that in uncultivated plants the starch content is from 10 to 12 percent of the green weight. Indications from results to date are that a few cultivations done at the proper time are more effective than was at first believed. In whiteweed the carbohydrate accumulation reached a maximum of 30 percent about the first of July.

Continued cultivation of bindweed, at 2-week intervals through two seasons, held the content of stored starch in the roots to less than 1 percent.

Evidence based on regrowth observations and chemical analysis substantiates the earlier conclusions that one early application of sodium chlorate, June 1 to July 1, following a single cultivation gave better control of bindweed than late applications.

The work on carbohydrate food reserves has been supplemented by more extensive tests for the nitrogen content of the storage roots. To date the results show negative correlation between nitrogen content and carbohydrate content. Low carbohydrate and high soluble nitrogen content are associated with the condition of regeneration from roots under frequent cultivation. The new ceric sulfate method of analysis for carbohydrates has increased the economy and efficiency of the tests being conducted.

A careful study of the structure and anatomy of the whiteweed has been made and a manuscript submitted for publication. Work of a similar nature has been started on other noxious weeds.

Field Tests

A clean-cultivation experiment designed to test the effect of depth of cultivation and length of interval between cultivations in the control of bindweed was carried through the second year. Cultivations were made at depths of 3 and 6 inches and at intervals of 3, 6, 9, 12, and 15 days after emergence. The resultant intervals between cultivations varied from 6 to 24 days for the 3-inch series and from 12 to 27 days for the 6-inch series. The number of cultivations per season varied from 22 to 7 for the shallow series and from 13 to 5 for the deep series. An experiment designed to test the effect of different dates of beginning a clean-cultivation program was carried through the second year, but complete results showing the comparative effectiveness of the tests are not yet available.

One season's clean cultivation of land heavily infested with bindweed more than doubled the yield of wheat, rye, and corn the following year as compared with the yield on similar land not so treated. The results indicated that the increased yield more than paid for the cost of the cultivation and the loss of crop during the cultivation period. The test is being continued to determine the effect on subsequent yields.

Tests under way indicate the use of the weed burner or torch in controlling bindweed to be comparable to very shallow cultivations, but at a much higher cost.

Several years' experimentation with the acid arsenical method lead to the conclusion that, although excellent results may be obtained under certain conditions, the results as a whole are not satisfactory, and the method in its present form cannot be generally recommended.

Sodium thiocyanate, a comparatively new herbicide, did not prove effective in controlling bindweed in preliminary tests. The tests are being repeated.

Limestone-chlorate, a chlorate compound especially adapted to dry application methods, is under test.

The control of crabgrass in lawns has been given some consideration during the past two seasons.

Three methods of determining the effects of control treatments were compared in a series of tests involving acid arsenical. These methods are based on the visual estimate of percentage kill, the number of shoots counted, and the increase in yield of barley. The first two methods were also compared in a series of tests involving sodium chlorate. The high correlation coefficients obtained indicated a very close relation existing among the three methods and suggests the dependability of each.

Diseases of Greenhouse Crops

Visits to Denver greenhouses have been made about twice a month during the year, and studies on the fusarium rot of carnations have been continued. It has been found that the fusarium organism may occur in plants showing no outward symptoms and may be carried through cuttings from such plants.

Twelve strains of the causal fungus have been isolated and are being tested for pathogenicity.

A black root rot disease of sweet peas was found this year in a Denver greenhouse. The causal organism proved to be a species of Thielavia. This is the first occurrence of this disease in this region.

Diseases of Other Crops

Onion Root Rots

Studies have been made of several species of fusarium pathogenic to onion seedlings. A classification of these species is being undertaken. The relation of temperature to Phoma invasion has been studied and the action of Phoma on onion seedlings has also been considered. It has been found that this organism produces a pink pigment. This has been extracted and found to have indicator value.

Beet Taproot Rot

On sugar beets an organism causing a rot of the beet taproot has been identified as *Pythium butleri*. A species of rhizoctonia has been found causing vascular necrosis of beet taproot. The work on these diseases has been published.

Pepper Blight

Phytophthora capsici, the causal agent of pepper blight in Colorado, will also attack cucumber fruits in the field, but not the mature plants. Peppers have been selected from plants in the field which appeared to show some resistance to the blight. Isolates of the fungus from cucumber exhibit a sexual reaction which differs from those isolates which have been obtained from dying pepper plants. Work on this phenomenon is almost completed and will soon be ready for publication.

In cooperation with the Horticulture Section, investigations have been started on the nature of a new and serious potato malady which is found primarily on the Western Slope. Last year the disease assumed epidemic proportions and severe losses were incurred, especially in the Olathe-Montrose regions. Work up to the present time indicates that the disease is of bacterial origin.

Studies on symptoms, variations of symptoms in different potato varieties, and means of dissemination are now in progress.

Corn Smut

In cooperation with the Agronomy Section, work was started on smut of corn. This disease is gaining in importance in the State. Studies are being conducted on methods of artificial infection for experimental purposes, and strains of corn are being tested for possible resistance.

Fruit Diseases

Peach Mosaic

This project is in cooperation with the State Bureau of Plant and Insect Control and the Bureau of Entomology and Plant Quarantine, U. S. D. A.

In 1937, 3,517 new cases of the peach mosaic disease were eradicated as compared with 9,835 new cases in 1936, showing a decided decrease of the disease.

The Maynard plum variety has been found to be naturally infected in the orchards of the Palisade area, but it apparently shows no distinct symptoms of the disease.

Almonds, apricots, cherries, other varieties of plums, and flowering peach are being studied as possible carriers of peach mosaic virus.

Indexing of all plums in the Palisade area is now in progress. "Indexing" means the grafting of healthy Elberta peach scions into the plum tree. If the plum carries the virus, symptoms of the disease will be expressed on the peach growth. This will aid in identification and will further the control program.

Other Fruit Diseases

A new disease of apricots in the Palisade area is being studied; a study of a root disease of the Morello cherry variety found near Grand Junction also is in progress.

Investigations into the nature of "black root rot" disease of strawberries have been started. Special technique has been devised to isolate the primary causal agent.

Chemistry Section

One Chemistry Section project which carried over into the present fiscal year has been completed and the results of investigations published in the form of Technical Bulletin 21 in October 1937. It reports on the nutritional characteristics of some mountain meadow hay plants of Colorado, from the angles of organic and mineral nutrients as well as the vitamin factors A, B, and G, and should be of practical and economic value to the livestock industry of the State.

Projects in Progress

Of projects still in the course of investigation, there are two:

Potato Quality

This project of field and laboratory studies of factors which influence quality of Colorado potatoes is cooperative with the Horticulture Section. Six potato varieties, Cobbler, Triumph, Peachblow, Katahdin, Brown Beauty, and Rural New Yorker, from common seed stock, were grown in 12 potato sections of the State over a period of 4 years under different environmental conditions, particularly of soil and moisture.

It is well known that tubers from different sections of the State vary widely in composition and quality; viz., the Greeley district and the San Luis Valley generally grow tubers of lower starch content than the Montrose and Glenwood Springs districts. From a study of soil and plant relations, it was sought to discover some of the principal causes of these differences in quality and composition.

Based on the findings to date, it may be said that heredity, as well as environment, is an important factor in starch production. Small or even relatively large differences in the quality of soil nutrients do not produce corresponding differences in the composition of potato tubers. In other words, the plant adjusts itself to a considerable range of soil conditions, and only drastic differences in environment become readily apparent in the tuber composition. Of all these factors under Colorado conditions, moisture supply appears to be of predominant importance.

Four years of work have been completed on this project, and the results are being prepared for publication in two parts: Part I will deal principally with the starch, protein, and pH of potato tubers as they are affected by the quality and reaction of the soil solution, by moisture conditions, and by genetic factors; part II will present the purely mineral relationships between soil solution and tuber.

Part III of the project is being continued in a more restricted form to study the effects of dates of planting and the application of fertilizers upon the yield and composition of tubers. The work is located principally at the Avon Substation, and the Russet Burbank variety is being studied. Several years of experience have shown that the date of planting is of great economic importance, particularly in some sections of the State, and especially with reference to the composition, size, shape, and yield of tubers.

Rather extensive study elsewhere has been directed toward determining the effect of fertilizers upon yields. In Colorado we find that the application of certain mineral fertilizers has also a profound effect upon the composition, shape, and cooking quality of tubers, and that some difference of opinion still exists regarding these points. For that reason, further study should result in a clarification of these factors under Colorado conditions.

Soil Types

The second project is that studying effects of irrigation upon the colloidal complex and available soil minerals of some Colorado soil types.

"Arid" and "humid" climatic conditions give rise to distinct types of soil evolution. In humid climates the readily available cations are leached out of the soil, giving acid soils or soils whose colloidal fraction is saturated to a high degree with sodium ions. In arid climates the calcium, magnesium, and other cations are not leached out but tend to accumulate in excessive amounts in the soil. They first saturate the colloidal complex and then form chemical salts in excess, which salts are either relatively soluble or insoluble in water, depending upon whether they occur as chlorides, carbonates, or sulfates.

Under semi-arid conditions, where the soils are irrigated with waters which themselves carry a load of soluble salts, there is at all times a migration of salts within the soil. The interesting questions, and those of paramount importance to the future of agriculture in the semi-arid West, are whether these excess salts permeate the soil uniformly to a greater depth or whether they tend to precipitate to form strata (hard pan); and whether there is any marked and continuous accumulation of the more soluble salts at the surface to the extent of being detrimental to plant growth.

A study of some 26 profiles (in 4-inch sections) has been made, both with respect to their replacement value and also with respect to their solubility in carbonic acid solution. The work is being continued to include several more soil profiles along the eastern border of the State.

New Projects

The Chemistry Section is prepared to initiate one more major project and has tentatively drawn up four project outlines which are pending acceptance or rejection by the Director and the Office of Experiment Stations at Washington. They are as follows:

A preliminary survey study of the irrigation waters of the South Platte Basin of Colorado.

The composition of alfalfa in Colorado as affected by crop rotation and the character of the soil solution.

A study of the causes of urinary calculi in feeder lambs (cooperative with Animal Investigations Section and the Pathology and Bacteriology Section).

Changes in nutritional values of native range plants throughout the year (cooperative between Chemistry and Range and Pasture Management Sections).

Miscellaneous Work

Aside from these major sectional projects, the Chemistry Section has continued to cooperate with other sections of the Station in matters where chemistry is involved and where our laboratory facilities and personnel could be of assistance.

To the Entomology Section, the Chemistry Section has furnished equipment and collaboration in testing the effects of various fumigants, both under vacuum and normal pressure, upon fresh vegetables with respect to the quarantine laws.

With the Pathology and Bacteriology Section, the Chemistry Section has cooperated in matters of testing noxious weeds, studying cases of livestock poisoning, testing of urinary sediments, etc. With the Horticulture Section, it has cooperated in matters dealing with plant and soil relations in greenhouse floriculture, etc.

The Chemistry Section has also rendered service to the farmers and citizens of the state in matters of stock feeds, water supply, and advice in miscellaneous matters dealing with farming.

In September, October, and November, 1937, the Section again cooperated with the Office of State Fruit Inspection in testing for spray residues. The apple crop was larger than in 1936, and a total of some 275 tests was made.

W. T. Newcomb, assistant chemist, was hired to substitute for Earl Balis, who is on leave for advanced study. No other changes in personnel were made during the fiscal year.

Civil Engineering Section

Study of Seal Coats

From July 1 to August 1, 1937, the tests necessary to complete the project on seal coats for bituminous surfaces were made, and the computations and compiling of data on this project were begun.

With the beginning of college on September 13, the time of the testing engineer was occupied with teaching duties and details connected with the publication of the bulletin on seal coats. This bulletin was published in December.

During the Christmas holiday period, some of the details for a continuation of the seal-coat study were worked out. After Christmas vacation the time was again occupied with teaching duties for the remainder of the semester. The same is true for the second semester.

Study of Concrete Reinforcement

At the beginning of spring vacation, a project was outlined on bond strength and anchorage of cold-drawn wire reinforcing in concrete. Some specimens were made and tested during this week as preliminary steps in the investigation. It is also planned to carry the seal coat study at the same time the project in concrete is in progress, with the idea of obtaining enough data for a short bulletin.

Mechanical Engineering Section

Work in the Mechanical Engineering Section has been conducted in cooperation with the Bureau of Agricultural Engineering, U. S. Department of Agriculture.

Sugar-Beet Machinery

Fertilizer Tests

In northern Colorado, where soils have been tested showing phosphate deficiencies, there has been some belief that the soil would not respond to the application of phosphate fertilizers. The mechanical applications at various distances from the seed have given proof that the location of the phosphate with reference to the seed is probably an important factor. Tests this year have shown in some of these borderline deficient fields that the yield was significantly increased

when the phosphate was placed close to and lower than the seed, in contrast to the fact that no increase was obtained when it was placed with the seed or broadcast. In some cases actual loss has been sustained when phosphate was placed with the seed.

Ridge vs. Flat Planting

In connection with studies on equipment necessary for ridge planting as compared with the more common method of flat-planting beets, records on yield showed no differences in yield between the two methods, the principal difference being easier irrigation of the ridged beets.

Beet Planter Furrow Openers

Studies for several years have shown an average of 16 percent better germination stand following the use of the disk opener instead of the shoe-type opener. Tests this year showed as much as 40 percent better stands for the disk opener. Never have any of the tests shown a superior stand by the use of the shoe-type opener.

Mechanical Thinning

Tests on mechanical thinning of beets planted with the standard beet planter have led to demonstration of the desirability of having the seeds placed more uniformly in the furrow. During the year a single seed-ball planter has been developed. The object has been to place individual seed balls at regular spaces in the furrow. The expected stand should include a larger percentage of single plants than is customary with the standard planter. Results this spring have been very encouraging.

Entomology Section

Because of changes in personnel, Dr. George M. List having been relieved of all Station work and Mr. L. B. Daniels having been granted leave of absence for 1 year of study for an advanced degree, this section was without workers other than those who work only during the summer months on Station projects, the remainder of their time being spent on resident instruction.

Insect Pest Control

Grasshoppers, Crickets

During the past season, Colorado, in common with several other western states, experienced a most severe outbreak of grasshoppers and Mormon crickets. Because of a lack of available experienced

help, this section was called upon to assist the Colorado Extension Service in the grasshopper campaign. All available State and Federal agencies were used in this campaign, at an estimated cost of $517,240.

The Mormon cricket campaign cost the U. S. Government and the State more than $14,000. A total of more than 21,000 farmers used bait on at least 2,500,000 acres of crop lands. These efforts protected more than 4,750,000 acres of crops, the results netting a saving to Colorado farmers of approximately $11,000,000.

Fumigant Tests

A recent quarantine issued by the Bureau of Plant and Insect Control of Colorado regarding pinworm prohibits the importation of tomatoes from infested districts unless the shipments are treated with some fumigant. The deputy state entomologist agreed to accept tomatoes that had been fumigated with HCN gas. This fumigation resulted in the loss, to certain Denver shippers, of about 10 car lots of tomato fruits.

The State Department of Agriculture requested that this section make certain investigations on the effect of fumigation on tomatoes. These experiments were conducted in cooperation with Denver shippers and the Station chemist, under various conditions, such as different types of fumigants; in vacuum; at asmospheric pressure; and, under various temperatures, different dosages and lengths of exposure. The principal fumigant tested was HCN gas; however, other materials were used. The following conclusions were made as to HCN gas:

1. Hydrocyanic acid gas cannot be used as a fumigant for tomatoes.
2. In moderately large doses, it injures the fruit immediately.
3. The duration of fumigation, and not the dosage, is an important factor in the effects on fruits and cyanide deposits.
4. Cyanogen is deposited in all parts of the tomato: seeds, pulp, and skin.
5. There is little or no difference in the deposits of cyanide in tomatoes fumigated in vacuum and under atmospheric pressure.
6. As little as one-half ounce to 100 cubic feet for 4 hours' duration will cause cyanogen to be deposited in the fruits.
7. Tomatoes in all stages—green, yellow, or ripe—are equally susceptible to destruction and deposition of cyanogen when treated with HCN gas.
8. There is no difference in wrapped or unwrapped fruits as to cyanide deposition or fruit destruction.
9. All types of fumigants that contain cyanide are injurious to tomatoes.

10. Tomatoes treated under vacuum did not deteriorate quite so rapidly as those fumigated at atmospheric pressure.
11. Taking a vacuum of 20 inches after fumigation does not tend to remove the cyanide to any appreciable degree.

Methyl bromide, and methyl bromide and carbon dioxide, were also tested. There were no ill effects on tomato fruits from these fumigants, except a retarding of ripening.

Ethylene dichloride and carbon tetrachloride mixtures were also used, but these materials had the same blistering effects on tomatoes as HCN gas; hence, they cannot be used.

The insects used in these experiments were bulb mites, white fly, thrips, red spiders, etc., which were obtained from infested plants in our own greenhouse. It was found that methyl bromide will undoubtedly prove a very satisfactory control for various greenhouse pests. This material, in doses sufficient to kill, does little or no damage to even the most tender greenhouse plants. More work on this subject is needed.

Plants examined after fumigation with methyl bromide, 2½ pounds to 1,000 cubic feet in 20-inch vacuum for 90 minutes, showed a 100-percent kill of bulb mite on lilies, with no injury to the plant. Plants were examined 4 days after fumigation. A 100-percent kill of a mite on African violets, believed to be the cyclamen mite, was obtained by this treatment. The same results were obtained on these plants with the same dosage at atmospheric pressure, the exposure being 90 and 120 minutes long.

Methyl bromide, 2½ pounds to 100 cubic feet of space, with exposure of 90 and 120 minutes, gave a 100-percent kill of red spider on verbena and hydrangea and of mealy bugs on coleus, with no injury to the plants.

Projects Continuing

Plant Louse Investigation

The project on plant louse investigation has been continued by Miss Miriam A. Palmer on collecting, identification, and preparing the laymen's key to aphid classification.

Peach Mosaic, Potato Insects

The peach mosaic vector project and potato insects projects are being conducted by the section head, in the absence of Mr. Leslie B. Daniels, who is studying at the University of Minnesota. He will return to duty July 1.

Greenhouse Studies

Mr. John L. Hoerner is still working on cucurbit insects, particularly the squash bug. During this school year, Mr. Hoerner's re-

search has been on greenhouse pests. With the limited time at his disposal, he has experimented on the control of the chrysanthemum gall midge in the Hansen Greenhouse at Greeley. Dry pyrocide and talc, 1-9, has been used every second day since March 2. No new galls have developed; while a few midges have emerged, they have been killed before the females deposited eggs. A few early cuttings made from infested plants are showing gall development. These infested cuttings are being dusted every other day. The treatment will continue for 2 or 3 weeks, or until the plants are free from galls.

One test of two applications of dry pyrocide and talc, 1-9, applied each week has given almost a 100-percent control of the onion thrips on chrysanthemum. This dust was also very efficient on the chrysanthemum leaf tyer. A light application gave 99 percent control of the green-peach aphid on snapdragons.

One application of pyrocide, copper oxychloride, and talc, 1-1-8, gave a 99-percent control of the pea aphid on sweet peas. This dust also killed numerous sow bugs and millipeds under the plants.

In the case of Easter lilies infested with bulb mite, treatments of soil on March 25 with .35-percent CS_2 emulsion, $HgCl_2$, 1 ounce to 10 gallons, and lime sulphur, 1-9 and 1-7, gave practically no control, and all injured the plants to some extent.

Peach Borer Tests

Cherry trees treated last September with paradichlorobenzene for the peach borer were examined on April 5. There was a 100-percent kill on the 20 trees examined. Several dead borers, but no live ones, were found on the treated trees. Untreated trees near the plots treated showed from three to seven live borers per tree. It is planned to make a more extensive examination later in the season.

Home Economics Section

Progress on Projects

Flour Mixtures at High Altitudes

YELLOW SPONGE CAKE.—After considerable difficulty in the management of methods and variables, equations for yellow sponge cake have been worked out that stand up fairly well at various altitudes under practical tests by housewives. Work remains to be done on this unit.

BUTTER CAKE.—This year's work on the butter-cake type of product has been carried on by Mr. Gestur Johnson, research assistant.

A preliminary study, completed in the fall, showed that the baking powder must be changed according to an equation in which altitude is expressed in thousands of feet.

The study of the effect of altitude on the tenderness of butter cakes is well started, and this constitutes the final step of the series of altitude studies originally planned.

Certain mechanical devices have been constructed whereby there may be more accurate control in procedures and in making objective tests.

Potato Quality

Nothing of significance in the studies of culinary qualities of potatoes can be reported, beyond what has appeared in previous reports.

An interesting observation was that electrical resistance during cooking is decreased. Just what physical or chemical changes cause this decrease has not been properly explained.

Exploratory Work

Vitamin C Content

Results of exploratory work on vitamin C content of Colorado grown vegetables and fruit would indicate that the vitamin C content of the varieties tested, when grown at high altitudes, is no greater than that of those grown at low elevations.

Four varieties of apples and eight varieties of peaches grown at Austin, and three varieties of peas grown at Avon and at Fort Collins, were analyzed for vitamin C by the indophenol titration method.

Personnel

Through resignation of the associate in research, the section suffered a distinct loss. Dr. Mark A. Barmore, who had been a member of the staff since July 1, 1932, accepted a position with the Bureau of Plant Industry of the United States Department of Agriculture. Recommendation of a successor to Dr. Barmore will be made soon.

Horticulture Section

The work on Station projects in horticulture has been well taken care of and satisfactory progress made during the year.

Progress Reports

Six papers were presented before the American Society for Horticultural Science and the American Potato Association this year. These are progress reports on the major sectional projects and will be published soon. The results of the work are of an applied nature and should be useful to growers. The function of this work is to minimize the risk and stabilize production of horticultural crops in the state by assisting growers to produce maximum yields of quality products at the lowest possible cost.

Reducing Costs

It is becoming more important each year, as surplus crops are produced, to reduce the costs of growing and handling perishable crops. Several horticultural sections in the West are devoting projects to the study of the utilization possibilities of surplus fruit and vegetables in industry. This movement has as its purpose the widening of market possibilities. Under present conditions here, it is not possible to devote time and money to utilization projects. There is a possibility that quick-freezing of vegetables may be started in Colorado this year, and if it develops, studies on that may be necessary.

Canning companies need help on some of their chemical problems in packing and on production problems. There are now some 16 canning factories in Colorado, and Station work has been requested on some of their numerous problems.

Projects in Progress

Cooperative projects are carried on with the Agronomy, Botany, Chemistry, and Entomology Sections. The importance of having specialized workers on sectional projects is becoming more and more a decided necessity, if satisfactory and complete results are to be obtained.

Potato Projects

TESTING NEW VARIETIES AND SEEDLINGS.—This project has been in collaboration with the U. S. Department of Agriculture since March 1938. Several new varieties of potatoes have been introduced in Colorado as a result of testing varieties and new seedlings. The

Red McClure, introduced in 1930, is still gaining popularity. It has largely replaced the Peachblow and is replacing the Brown Beauty to a considerable extent. It again commanded the highest price on the Chicago market during the winter of 1937-38.

The Katahdin is also increasing in popularity. It is now a standard variety in the San Juan Basin, in northern Colorado, and on the Western Slope; it is also showing some promise in the San Luis Valley. Most of the increase in Katahdin acreage has been at the expense of the Rural New Yorker. It is one of the best varieties for dry land.

The Chippewa was grown in all parts of the State in 1937. Results were very satisfactory in all cases. Further testing over the State is necessary before it can be recommended above Katahdin. It is a little earlier than Katahdin, but it has not yielded quite so well.

Houma produced excellent yields in all test plots in the State in 1937. It sets heavily and tolerates adverse conditions. Further testing is necessary before definite recommendations can be made. Earlaine, a new U. S. Department of Agriculture early white, was tested by 10 growers in 1937, after 3 years of preliminary tests at the Mountain Substation. It is smoother than Cobbler and will be more extensively tested in all Cobbler districts in 1938.

In addition to the varieties mentioned, 158 seedlings from the U. S. Department of Agriculture, the University of Minnesota, and Cornell University are being tested for yield and market quality, and 85 of these are being tested for scab resistance.

POTATO BREEDING.—Parent stocks consist of 53 varieties, seedlings, and inbreds. As a result of various combinations of these stocks, about 800 seedlings are now being carried. Of these, some 40 or 50 show excellent commercial possibilities and are being increased for further testing. Enough seed was obtained by hybridization and inbreeding in 1937 to grow 1,000 seedlings in the greenhouse during the winter of 1938-39.

COMMERCIAL FERTILIZERS FOR POTATOES.—The project on commercial fertilizers for potatoes is conducted in cooperation with the Chemistry and Home Economics Sections. It includes a study of the effect of commercial fertilizers on yield, grade, tuber shape, skin texture, maturity, plant and tuber development, chemical composition, and cooking quality of potatoes. The results of 2 years of investigation indicate that commercial fertilizers will not affect yields when a rotation including alfalfa or sweetclover and barnyard manure has been followed. The largest and most consistent responses to commercial fertilizers have been obtained in the San Luis Valley. Ammoniated phosphate and complete (4-12-4) fertilizer have shown the most promise to date.

From four tests, phosphate, complete, and potash increase the yield of U. S. No. 1's, while ammoniated phosphate and nitrogen decrease the yield of U. S. No. 1's.

Phosphate seems to produce a slight increase in starch, while ammoniated phosphate, complete, and nitrogen decreased the starch content of tubers in the order named. All formulas containing phosphate increased the dry-matter content of tubers, phosphate most, and ammoniated phosphate and complete following in order. Potash and nitrogen decreased the dry-matter content.

Phosphate has the greatest effect on general appearance, maturity, and handling qualities, and, in the Russet Burbank, on russeting or netting. Potash has the greatest effect on tuber shape, and in 1938 a heavy application of phosphate plus a light application of potash produced the most desirable tubers. Ammoniated phosphate produces the poorest shaped Russet Burbank tubers.

DATES OF PLANTING RUSSET BURBANK.—Two years' results of tests of dates of planting for the Russet Burbank variety show that the highest yields and the best quality potatoes were produced at the Mountain Substation by planting Russet Burbank variety between May 18 and May 25.

FACTORS AFFECTING CHEMICAL COMPOSITION AND COOKING QUALITY OF POTATOES.—The project on factors affecting the chemical composition and cooking quality of potatoes is conducted in cooperation with the Chemistry and Home Economics Sections. Despite wide fluctuations in individual constituents, statistically significant differences in starch, dry matter, protein, and ash have been demonstrated in different varieties of potatoes, in potatoes grown in different localities, and in potatoes grown in different years. Irrigated potatoes are higher in starch and dry matter but lower in protein than dry-land potatoes.

The results indicate that the decline of the older potato-producing districts is due to a decline in market quality rather than to a decline in cooking quality or changes in chemical composition of potatoes.

SOIL TREATMENTS.—For the past 2 years, the soil at the Mountain Substation has been treated with calomel, yellow oxide of mercury, zinc amalgam, copper amalgam, red copper oxide, and copper sulphate to determine the effect of these chemicals on reducing the amount of scab. No significant decrease in the amount of scab was obtained, but copper amalgam and red copper oxide have produced significant increases in yield of nearly 25 percent.

EFFECT OF PSYLLIDS ON SEED STOCK.—Preliminary observations and trials indicate that tubers from fields damaged by psyllids should not be used for seed. Tests under controlled conditions are being conducted at Fort Collins.

BACTERIAL WILT OF POTATOES.—This project is in cooperation with the Botany Section. Bacterial wilt caused serious losses in the early potato district near Olathe, in Montrose County, in 1937. It has been observed also at Greeley and in the San Luis Valley. Tests to determine the source of infection, method of distribution, and methods of control are under way.

Fruit Tests

TREE-FRUIT VARIETY TESTING.—The tree-fruit testing project is under way at Fort Collins. Several new varieties of apples, crab apples, plums, and sand cherries of northern origin were planted this spring. The older trees came through the winter with practically no damage. Present prospects indicate that many of the varieties will bloom this year. While the tree-fruit variety testing is a long-time project, some fruit was produced in 1937 on trees set in 1935 and 1936. Plum varieties which produced some fruit are La Crescent, Monitor, Omaha, and Underwood. Compass, a sand-cherry hybrid, has a heavy crop. Three crab apples—Dolgo, Young America, and Transcendant—produced some fruit, as did the apple variety Melba.

CULTURAL METHODS WITH SOUR CHERRIES.—Montmorency cherries on Mazzard roots, while definitely making less growth than this variety on Mahaleb roots, have shown no significant difference in the number of trees injured or lost from cold weather. The use of straw mulch for some of the trees has been started. Comparisons of soil moisture, temperatures, and fertility and tree growths under mulch will be made with trees under continuous clean cultivation.

SOUR-CHERRY ORCHARD MANAGEMENT.—In a project conducted in cooperation with the Agronomy Section, significant increases in yields have been obtained in the Harvey orchard on Montmorency cherries, following the addition of a nitrogen-bearing fertilizer alone and the addition of manure. Yield increases followed the addition of phosphorus and potassium, and of nitrogen and phosphorus, but they were much smaller than those from either nitrogen alone or from manure.

Unsatisfactory stands with fall-sown cover crops continue. Moisture deficiencies in the orchards are enough to make satisfactory growth impossible.

STRAWBERRIES.—At Fort Collins raised beds of strawberries compared with ordinary level planting present some difficulty in irrigation, but they appear to give at least as good a stand the first season. Stand counts to be made this spring will give the first indication as to the possible value of this system as a control for black root.

At Avon the varieties Gem and Beauty were highest yielding of the 14 varieties fruited in 1937. The new 1-acre variety test will bear its first crop in 1938.

RASPBERRIES.—In the comparison of the hill and hedge-row training systems for raspberries, no significant yield difference was shown, but it is evident from the data that the largest and most productive canes are produced in and near the crowns in either training system. This leads to an assumption that yields may be increased by setting plants closer in the row.

GRAPES.—A 6-percent replacement of grapes was necessary in the variety test this spring. Late frosts destroyed most of last year's crop, and only a few scattered berries were produced on a part of the varieties.

Floriculture

The results under the floriculture project, while preliminary in nature, are showing definite trends. The incorporation of manure into sterilized and unsterilized virgin prairie sod soil has resulted in significantly greater yields of the Patrician variety of carnations when compared with virgin soil and sterilized virgin soil. No significant differences in the size of flower or length of stem were obtained.

Steam sterilization of old greenhouse soil has shown that it can be re-used without reduction in yield or quality of carnation flowers. Steam sterilization produced an initial increase in nitrogen, followed by a decrease, and an increase in potassium and a decrease in phosphate content of the soil.

Onion Tests

SWEET SPANISH ONION BREEDING.—In 1936 the first onion strain was released by the Station and called Sweet Spanish No. 6. The type is apparently meeting the needs of growers of the Eastern Slope districts, and requests for about 1,500 pounds of seed were received this spring. The present plan is to keep foundation seed stock supplies for growers and seedsmen for increase. Probably by next year there will be sufficient seed available in the seed trade. There is a pressing need for an early maturing Sweet Spanish for the Western Slope and an improved White Sweet Spanish line.

Since thrip insects are probably the most serious pest of onions, and a type which cannot be controlled satisfactorily by sprays, work is under way to develop a thrip-resistant line. The White Persian is a thrip-resistant variety, and it will be crossed with Sweet Spanish inbreds this year. A series of inbred lines have been maintained for further breeding work, and studies are being initiated on the sterility of the Sweet Spanish variety.

COMMERCIAL FERTILIZER TESTS ON ONIONS.—The results of commercial fertilizer tests on onions this past year were similar to those of the previous season. On the soil types to which the commercial

fertilizers were applied, no significant differences in yields were secured from the various treatments. The application of straight phosphate fertilizer hastened maturity and improved the color of the bulbs.

DATES OF PLANTING ONIONS.—Work on dates of planting onions has been carried on at Rocky Ford and will be concluded this year. In 3 out of 4 years, the first three dates of planting in March produced significantly higher yields.

Head Lettuce Breeding

Breeding of head lettuce has been slow. However, there are very many good lines that show resistance to tipburn. These are still being carried, and as soon as seed increase problems are better handled, it is believed that some new varieties can be introduced. Samples of seed have been sent to California for seed increase. Four years ago a sample of seed from a tipburn-resistant hybrid was sent to the Canada Station for trial, and after continued selection it is ready for certification by the Dominion of Canada for commercial planting. This indicates that the lines are nearly acceptable as soon as the seed-increase problem can be properly handled here. In addition, there are several very promising lines suitable for the home gardeners and local markets.

Pyrethrum Investigations

The work on the pyrethrum project is being carried on, but there are practically no plantings at the stations. It is now all carried on in the San Luis Valley, and the test strains developed at the Station are all planted there. The selected strains are showing a higher pyrethrin content, improved resistance to root rots, and a greater degree of winter hardiness. The area to be planted this year for commercial production will cover about 25 acres. The possibilities of the crop commercially will be given a thorough test, although it is still in the experimental stages.

Work Other Than Projects

Miscellaneous Vegetable Crops

The work on crops not under projects is here reported upon for record purposes:

TOMATOES.—In 1931 crosses were made between a mosaic-resistant forcing variety, a self-pollinating type, and Globe. The progeny from this cross shows promise of being desirable for greenhouse forcing and as a non-blossom drop type for field planting.

CANTALOUPES.—Cantaloupe work here has been mostly inbreeding of Hales Best No. 45 to develop more uniform lines. The same is being done with standard Hales Best and several of our own lines.

CELERY.—Inbreeding to fix uniform lines of both the tall and dwarf Giant Pascal varieties has been carried on for a number of years. One line of the tall type was released 3 years ago, and seed supplies are available from commercial growers. It is being well received.

BEANS.—Crosses made in 1930 between English and American market types of beans are still being carried on. Some of the progeny are still showing segregation.

POD PEAS.—A considerable number of crosses are being carried between early and late market varieties to develop an early, large-pod type for mountain districts and a large-podded Perfection canning type.

Budget

The section budget, while small for operating expenses, should be balanced at the end of the fiscal year. Sales have been fairly good, and this income plus the use of 14 National Youth Administration students has made it possible to carry the work. As our work increases, expenses also increase, and management problems develop.

Personnel

Prof. George A. Beach has been granted a leave of absence next year for advanced study, and Mr. William E. Gunesch is to take his classes and a part of his work at the Station. This change is being taken care of without increase in costs. The work is to be shifted next fall, and the necessary adjustments are to be taken care of within the Station.

Greenhouse

The management of the greenhouse has been well taken care of, but the place is far too small to satisfactorily handle all the work of the Station. The experimental work on carnations takes additional space, potato breeding work is demanding more space, and the chlorosis project will require still more room. This situation has developed into a serious problem of adjustment for space, and it will be impossible to maintain sales with this loss in space.

Additional space should be provided in a new greenhouse. A greenhouse about 50 by 100 feet can be constructed at low cost now. This would relieve the present crowded condition and provide an adequate experimental section. Additional sash houses are needed for spring plant growing.

Seed Certification

More certified seed will be planted in Colorado in the spring of 1938 than ever before. In addition to the 414,365 bushels produced in

Colorado in 1937, certified seed has been shipped in from Nebraska, Wyoming, Idaho, Michigan, Wisconsin, Minnesota, North Dakota, and New York. The program in the San Luis Valley, especially in Rio Grande and Saguache Counties, is almost ideal. The program in northern Colorado is rapidly nearing ideal. Here, growers in the mountains and in the dry lands supply foundation seed each year to irrigated growers who increase it for the northern Colorado district. The program on the Western Slope, while showing some improvement, still leaves much to be desired.

From present indications, an increase in seed certification may be expected in practically all parts of the State, with the possible exception of the San Luis Valley. This means that more help will be required, and this situation presents a serious problem. With the increasing number of diseases and complications experienced, inspectors are necessary. The use of students is undesirable, because of their youth and inexperience. It must be admitted that the work is valuable experience and training for the student, if not so desirable for the seed industry. At least one experienced man should be available to use year after year, even if he were obtained from the 9-months' teaching staff, the two field inspections being the most important.

The development of foundation seed makes experienced inspectors more important. Inspectors should also take time to personally assist foundation-seed growers. More than 5,000 tubers were indexed in the college greenhouses during the winter, and all lots of foundation seed have now been indexed at least once, while some have been indexed twice. To maintain a good program, 10,000 tubers should be indexed each winter. More greenhouse space is also needed for growing seedlings and making crosses.

Rural seed in the State is in deplorable condition, and many lots shipped in have been unsatisfactory. The college has obtained four strains from New York and two local strains for release to foundation-stock growers for test.

The requirements for certification were met by 169 lots of seed. A summary by varieties is as follows:

Varieties	*Acres*	*Bushels*
Bliss Triumph	620	74,300
Perfect Peachblow	565	169,155
Red McClure	243	72,075
Irish Cobbler	215	38,205
Brown Beauty	98	32,200
Katahdin	51	13,980
Russet Burbank	31	8,750
Rural New Yorker	17	2,800
Chippewa	11	2,200
Russet Rural	5	700
Totals	1,856	414,365

Irrigation Investigations Section

The work of the Irrigation Investigations Section is in cooperation with the Division of Irrigation, Bureau of Agricultural Engineering, United States Department of Agriculture. Over the past year, active work has been done on the following projects: Design, invention, and testing of irrigation apparatus; snow survey and irrigation water supply forecasts; pumping for irrigation and drainage in Colorado; and meteorology.

Apparatus Design and Invention

ADJUSTABLE TUBE ORIFICE METER.—Further study of the adjustable tube orifice meter has been made at the Bellvue laboratory. Two different schemes of observing the square roots of the difference in pressure heads have been investigated with some degree of success. The practical operation of this type of measuring device is the observing of the square root of the difference in head and the multiplying of this value by a known constant which gives the rate of discharge in second-feet.

Resulting from these studies, there has been evolved another departure wherein the actual pressure heads are not observed and, in lieu thereof, a small rotating index operated by the effect of cavitation will serve as the velocity factor where the rate of rotation will bear a direct relation to the discharge through the meter. Preliminary apparatus has been prepared and actual laboratory tests made which indicate the possibilities of this new feature in connection with the adjustable tube meter. This measuring device is intended for use in determining the rate of flow in high farm laterals or ditches of flat grade.

NEW INSTRUMENT.—A new and interesting integrating instrument is now under construction. This instrument will totalize or sum up the discharge in acre-feet over any period of time and indicate the stage in feet and the corresponding discharge in second-feet when operated in connection with a free-flow weir, a Parshall measuring flume, or a stable rating flume. This meter would be especially useful in summing up the extent of the discharge in acre-feet from storage reservoirs, and would also serve as a means of immediately determining the extent of applying water in the irrigation of individual fields. This instrument is simple in design, and at this time it is believed it can be made at a very reasonable cost.

VORTEX TUBE SAND TRAP.—Further studies have been made on the vortex tube sand trap at the Bellvue laboratory. Formerly, our investigations have been confined to straight constant diameter or

tapering sections, whereas the recent investigations were for a tube which in both plan and elevation is composed of parabolic curves, the tube itself being molded of concrete cast around a specially prepared form. No material advantage of this tube has been noted. This special tube has a diameter of 6 inches at the outlet end and 4 inches at the other end, and is about 11 feet long. Under favorable conditions of operation, a cobblestone weighing 12 pounds has been moved through the entire length of the tube.

NEW SAND TRAP.—Some years ago experiments were made on the riffle deflector type of sand trap, where it was found that it was possible to move the bedload directly across the channel at an angle of 90 degrees to the direction of the stream flow. This device is highly efficient but is objectionable because of the fouling of the riffles with debris. Fairly high velocities are necessary for the best operation of both the vortex tube and the riffle deflector types of traps.

Recently a new scheme has been investigated at the Bellvue laboratory in which an entirely different type of riffle is used. Preliminary observations on this new set-up, in an experimental channel 8 feet wide, show that it is possible to move the bedload laterally across the channel at moderate velocities such as would approximate the ordinary canal or ditch conditions of flow. Plans are being made to try out this new sand trap in the Arkansas Valley by an installation in one of the C. F. and I. canals near Pueblo. If this method proves successful, it will serve a useful purpose not only in the Arkansas Valley but elsewhere where sand deposits in irrigation channels are a menace to efficient operation of canal and ditch systems.

Flume Use Increasing

Information has been received which points out the increasing use of the Parshall measuring flume in connection with irrigation, as well as the adaptation to sanitation engineering in the measurement of sewage. Two large measuring flumes are to be built in the immediate future at Hastings, Nebr., by the Central Nebraska Public Power and Irrigation District.

Farm Lateral Lining

Plans are now under way for investigating the possibilities of lining small farm laterals with a cotton fabric and asphalt to prevent seepage loss.

Snow Survey and Irrigation Forecasts

The work carried on under this project is in cooperation with the Forest Service, the National Park Service, the Bureau of Reclamation, and the Weather Bureau, Federal agencies, and with the State Engineer, Denver Municipal Water Board, and irrigation interests.

There are being reported in Colorado 65 snow courses scattered through the mountain areas from the Wyoming to the New Mexico state lines, these courses ranging in elevation from 8,000 to nearly 11,000 feet. In addition to the Colorado snow courses, there are reported to our office each month 43 courses in Wyoming; 12 in New Mexico; 3 in Arizona; and 27 for the Colorado River drainage in Utah.

For the past 3 years, reports on the snow cover and water content have been issued showing the conditions as of February 1, March 1, April 1, and May 1. The February report is of a general nature, while for the other monthly issues separate reports are made for the Colorado, the Rio Grande, and the Missouri-Arkansas watersheds. For the spring months of 1938, the total issue covering the three drainage basins approximated 2,000 copies for each month. These reports are promptly mailed to various organizations and individuals interested in the prospective water supply. The April report indicates favorable run-off for all the drainage areas in Colorado, except that for the Rio Grande, which, it is believed, will be slightly below normal. The snow cover records are not as yet sufficiently extensive to make possible reliable forecasting. It is expected that this feature of our reports will be attempted in a limited way next year.

Pumping for Irrigation

The work under this project has been active during the past year, but the field work has been restricted. Comparative tests of different methods of measuring the discharge from pumps, field installation, were made last fall in the vicinity of Greeley. This work was undertaken to establish a standard practice in connection with testing pumps for acceptance efficiency ratings.

Work has continued on water-table investigations in various parts of the State during the past year.

Further studies have been made in the investigation of the effect of cool ground water pumped from wells and used for the irrigation of potatoes, as compared with surface supplies of higher temperature. No marked effect upon the crop has been noted.

Meteorology

The twice-daily weather observations have been continued without interruption throughout the year. A summary of the 50-year Station weather records has been prepared, primarily with the viewpoint of ascertaining trends of precipitation, temperatures, barometric pressure, and other factors. This study does not reveal any marked consistency of the elements of weather; however, it shows a number of interesting correlations.

Miscellaneous Activities

Supplemental Irrigation

During the period from May to September 1937, Mr. Carl Rohwer was assigned to work on the supplemental irrigation project in the drought areas of South Dakota. The work was carried on by the Bureau of Agricultural Engineering, in cooperation with the Farm Security Administration. The general scope of the work consisted in giving assistance to farmers interested in providing supplemental irrigation water supplies.

Pathology and Bacteriology Section

Animal Pathology

Poisonous Plants

OAT-HAY POISONING. — No new outbreaks of oat-hay poisoning have been reported during the past year. Six head of cattle donated for experimental purposes by Mr. E. H. Grant of Denver were destroyed by feeding them poisonous oat hay from an outbreak west of Fort Collins. The ruminal contents of four of these cattle, when tested by the sodium picrate method, showed the presence of hydrocyanic acid. Since the reactions were not marked, however, it is still felt that the cause of this condition is uncertain. Two technical papers have appeared as a result of this work and will be found in the list of publications. It seems that both sheep and horses may eat the poisonous oat hay with impunity.

SUCKLEYA SUCKLEYANA.—This plant, which grows around water holes rather late in the summer, was found to be heavily impregnated with hydrocyanic acid. Cattle, sheep, guinea pigs, and rabbits were destroyed by feeding. In one instance a cow, after being poisoned by feeding the plant, was saved by the administration of sodium nitrite.

SILKY SOPHORA.—For a number of years suspicion has been cast upon silky sophora, a plant which is widely distributed over eastern Colorado. Six sheep were fed the plant for 8 days without any evidence that it was toxic.

ONION POISONING.—Seven horses out of nine pastured on an onion field near Greeley died with pronounced symptoms of anemia and hemoglobinuria. This calls to mind a similar instance in which 14 head of purebred Shorthorn cattle died in the same area some years ago. From these and other reports, it must be believed that frozen onions are toxic to both horses and cattle.

Work With Sheep

Death Losses of Lambs

The work with intestinal filtrates, previously mentioned, was continued during the past winter. Sixty-eight filtrates from 100 lambs dead of overeating proved to be toxic for rabbits. From 51 lambs dead of other diseases, three filtrates were slightly toxic, and all of the rest proved harmless. Of six lambs injected with toxic filtrates, five died showing blotchy hemorrhages and the presence of pericardial exudate, which are considered typical of overeating. All showed albumin in the urine, but none showed the presence of sugar. The record of the work with intestinal filtrates since 1932 has been prepared and accepted for publication by the Journal of the American Veterinary Medical Association.

Sheep Losses in the Feedlot

SORE MOUTH.—The vaccination of lambs within a few days after arrival in the feedlots seemed quite effective in prevention not only of the disease itself but in the development of complications. Even when symptoms of the disease were already apparent, vaccination seemed to prevent the development of complications. Since there were some very heavy losses during the past year as a result of secondary infection to sore mouth, it appears justifiable to recommend the practice of vaccination during the first few days after arrival.

COCCIDIOSIS.—Coccidiosis was quite prevalent during the past feeding season, losses running up to 6 percent. Remedial agents were used in several lots but did not show sufficient value to justify their general use.

INTESTINAL PARASITES.—Weekly fecal examinations made by the sugar flotation method on more than 2,000 lambs showed that coccidia increased to a peak about 30 days after arrival in the lots, after which they materially decreased throughout the feeding period, although in only a very few instances were they completely absent.

Of the other intestinal parasites, stomach-worm eggs were usually present, but the number did not markedly change during the feeding season. Occasional eggs of the slender-necked intestinal worm, the whipworm, and the broad tapeworm were found, but in general they were absent.

The sugar flotation method was also applied to the feces of all lambs brought to the laboratory for autopsy. The total number examined was 141. Only 16 of these showed no eggs of intestinal parasites. One hundred twenty-six showed coccidia, 50 stomach-worm eggs, 17 slender-necked intestinal worms, three the whipworm, 16 the broad tapeworm and 1 the lungworm. Ten out of the entire number showed the presence of the fringed tapeworm in the ducts of the liver and seven in the intestines.

Sore Head

Attention has been called to a disease of the name of "sore head" in the southwestern corner of the State, and also in New Mexico. Lesions occur not only on the head but at times around the feet and on the abdomen. They consist of loss of wool and, due to scratching, the development of a raw, ulcerating surface that frequently bleeds. In one ewe shipped to the Station from Breen, Colo., it was possible to demonstrate microfilariae in the lesions on the head and the presence of several mature worms in the blood stream, thus confirming the work of Dr. H. E. Kemper of Albuquerque, N. Mex., who has reported similar findings during the past 2 or 3 years.

Encephalomyelitis

Again the state was visited with a serious outbreak of encephalomyelitis which has developed during 5 of the last 6 years. More than 2,000 cases were reported by the veterinary practitioners. Vaccination was more extensively used this year than at any previous time, with what appeared to be favorable results. A total of 2,350 horses were vaccinated, 1,390 of which received two doses 30 days before the appearance of the disease. Of this number, seven developed encephalomyelitis. The disease became pandemic throughout the Mississippi Valley, affecting many thousands of horses, with a high mortality rate.

Bang's Disease

Cooperation with the Federal government in the Bang's disease control program continued, resulting in the testing of 22,317 animals between July 1, 1937 and April 1, 1938.

Disease Problem Increasing

The disease problem in Colorado seems to be increasing in seriousness. For this reason, it is of the utmost importance that research into animal disease be better supported. Colorado is essentially a livestock state and could well afford to spend much more money on research than she is now spending. At least one man should be added to the staff during the next year.

Soil Microbiology

Tests for Available Phosphorus

In microbiological tests for available phosphorus, there was assembled a collection of about 90 Colorado soils for which approximate yield data, and in some cases data concerning reaction to phosphate fertilization, were available. The Cunninghamella plaque test was applied to these soils untreated, and with the addition of varying

amounts of mono-calcium phosphate. The response of the Cunninghamella colony to various types of phosphorus compounds was also determined.

Activities in Slick-Spot Soils

Studies connected with microbiological activities in slick-spot soils have included determination of total nitrogen, nitrate nitrogen, organic carbon, and pH of slick-spot and corresponding normal soils. Studies of microbiological activities have been made by determining rate of nitrification; carbon dioxide evolution from untreated soils and soils to which organic matter had been added; and total numbers of bacteria, fungi, actinomyces, and Azotobacter cells present. Work on this project has been concluded during the past year.

Decomposition of Organic Matter

Work on the project of decomposition of organic matter has dealt with the inorganic nutrition of cellulose-decomposing bacteria and with the development of techniques for the quantitative measurement of their activity. Attempts at the latter have met with considerable difficulty, since activity of the organisms often is influenced by the physical condition of the cellulose and nutrient medium to a greater extent than to changes in other factors which it is desired to study. It is necessary, therefore, to keep constant the physical conditions in the culture being studied. One or two methods of doing this have shown promise but require further development.

Miscellaneous Activities

Previous studies in this laboratory have indicated that the abundance of Azotobacter in soils could be greatly modified by the addition of certain organic substances. During the past year, an investigation was made concerning the effect of benzoic acid compounds upon the Azotobacter population of a soil. The results have been of such interest that a more extensive investigation is being planned.

Investigations were begun seeking to determine the factors associated with variations in hydrocyanic-acid content of *Suckleya suckleyana*. These have included determinations of the moisture, and of total nitrogen and nitrate nitrogen content of soils on which the plant was found.

Personnel

On September 1, 1937 Mr. R. W. Monk assumed the duties of a fellowship in soil bacteriology.

Poultry Section

Growth of Plant

The main building program on the experimental poultry plant is completed, and this section is now well equipped to pursue intensive research on its projects.

The Poultry Section now has a breeding flock of 50 Bronze turkeys, in addition to 100 on experiment. The breeding flock of White Plymouth Rock chickens was nearly exterminated this spring by a spontaneous and untraceable outbreak of laryngotracheitis. Fortunately, sufficient eggs were in the incubator to continue the breeding program, with the supplementation of some outside breeding stock which was necessary anyway. However, this has seriously interfered with experimental work.

Some practical home-made equipment has been successfully constructed and used, among this being waste-proof, sanitary feed-hoppers, cheap electric hovers, and an egg cooler. A semi-automatic system of poultry-house ventilation is also proving satisfactory. In the chemical laboratory, a home-made vacuum drying-oven is in daily use.

Projects in Progress

Vitamin G Requirements

In the 1937 hatching season, preliminary evidence indicated that a practical laying ration would not suffice for good hatchability of turkey eggs, but that a breeder ration, containing about 250 chick units of vitamin G per 100 grams by calculation, gave as good results as one containing about 325 units. This work is being repeated in duplicate lots in the 1938 season. Results to date show that 250 units per 100 grams of ration is insufficient for maximum hatchability under unfavorable incubation conditions. Poults hatched from the higher vitamin G diets are heaviest at 6 weeks of age when raised on a practical ration.

Observations have been made with duplicate lots on the 250-unit ration, under strict confinement, and similar lots in shelters open on the south and with bare range. The birds were mated and put under lights to make a 14-hour day on January 1. Egg production started in the third week indoors and in the fifth week outdoors. Fertility and hatchability have been insignificantly better outdoors.

Sources of Green Feed

Early in the year, vitamin G assays with chicks were inconclusive, as a result of too rapid growth on the negative-control diet and

poor gains on the positive-control diet. One possible explanation is that the basal diet was at fault, in that the casein may have carried too much flavin, and in that the diet was also inadequate in some other respect. Another explanation is that the strain of White Leghorn chicks used may have had a low requirement for vitamin G.

It was found that the Argentine casein originally used carried a moderate amount of flavin. A domestic casein could be rendered very low in flavin by simply soaking overnight, washing with water 10 times, and drying either in the sun or indoors. Exposure to sun alone had little effect.

The basal diet, composed essentially of corn meal, gray shorts, purified casein, fish oil, and minerals, was inadequate to support an acceptable rate of growth when supplemented with a whey adsorbate rich in flavin. The substitution of bran, wheat germ, oatmeal, or bran and oatmeal for the shorts improved the diet slightly, but that of hempseed meal or soybean oil meal was best. A supplementation of 5 percent molasses, presumably to supply the filtrate factor, was necessary for maximum growth and was as satisfactory as a special rice-bran concentrate. However, such a supplementation was unnecessary when dried whey was used as a source of flavin. Preliminary results indicate that a basal diet composed of corn meal, purified casein, soybean oil meal (15 percent), oatmeal (20 percent), fish oil, minerals and molasses (5 percent) is satisfactory, and that it gives maximum growth when supplemented with crystalline riboflavin. Lactoflavin adsorbed on fuller's earth appears not to be as effectively used as crystalline riboflavin.

Difficulties were also encountered with hatchability studies in 1937, in that the hatchability on the negative-control diet was practically as high as on the supplemented diets. Such studies are temporarily discontinued until a satisfactory diet has been evolved for chicks. Adaptation of such a diet was interrupted by laryngotracheitis.

Some evidence has been obtained on the experimental grass range in cooperation with the Range and Pasture Management Section that bluegrass and crested wheatgrass are better adapted for a heavily grazed poultry range than blue grama, mountain brome, or smooth brome. Data on buffalo grass is inconclusive as yet.

Role of Trace Elements in Poultry Nutrition

Additional studies have been made on the sample of phosphoric acid which had been found to possess a perosis-preventing property. Spectographic tests gave no clues as to the cause. In a repetition of the original experiment, this acid failed to prevent perosis, but it did result in less severe symptoms than did the basal diet or a diet with an equivalent amount of phosphorus from steamed bone meal. A

sample of calcium carbonate caused as severe perosis as did steamed bone meal, when fed on a calcium-equivalent basis. The combination of the acid and the carbonate salt nullified any preventive effect of the acid. The preventive action of an acidified watery extract of wheat germ was confirmed, and the residue and ether-alcohol extract were inactive. However, the degree of severity of perosis on the basal diet used in this series was extraordinarily great.

Another experiment was run to evolve a more satisfactory diet through the substitutions of soybean oil meal for part of the fish meal, dried whey for dried buttermilk, or molasses for alfalfa; but no significant amount of perosis occurred on any of the diets, even on negative control.

Owing to unavoidable suspected fluctuations in the composition of such ingredients as fish meal and alfalfa-leaf meal, an attempt was made to simplify the diet and to use less variable ingredients. This work is combined with the similar simplifications and standardization of the vitamin G diet. The tentative corn-oatmeal-soybean oil meal-casein diet evolved in that work is now under test for adaptability to this work.

New Project

The project on control of mortality through survival of the fittest is being replaced by a new one on iodine requirements of poultry, which is financed by the Iodine Educational Bureau Investigatorship. A graduate biochemist, Dr. A. R. Patton, formerly assistant professor of animal nutrition at the University of Arkansas, has been engaged as assistant, effective July 1, 1938. This investigatorship has made it possible to appoint such a well-trained and capable man through a 3-year grant of funds.

Range and Pasture Management Section

The range-research program of the section during the past year followed rather closely the outlined projects. Because of inexperienced personnel on the mountain meadow study, it was necessary to curtail one or two minor phases of the work. This did not seriously interfere with the broader phases of the project. Since our projects are on a long-time program basis, only tentative results are available on the 2-years' accumulated field data.

The field work in range research during the past year was carried on at three main centers: at and near Fort Collins; near Spicer in North Park; and in Washington County, located in the eastern

plains area of Colorado. At Fort Collins, studies were continued on native-range lands and artificial revegetation of native and introduced grasses. In the North Park area, field data were obtained on mountain-meadow lands and sagebrush lands; and in Washington County the range-resource surveys were completed.

Improvement of Native Range

Palatable range grasses made a rather marked recovery in our experimental range pastures during the past year by reduction of stocking to the actual grazing capacity of each pasture and due to better rainfall conditions, especially in the early part of the growing season. Although the rainfall for the period April 1 to September 30 was considerably below the long-time mean, the native forage crop was better than for several years. Range surveys of the various pastures in the late summer showed some increase in density and vigor of the better range grasses. The stand of palatable grasses as a result of drought and over-stocking the past few years had declined in density 50 to 60 percent. A very marked increase in unpalatable weeds was apparent in all pastures from previous heavy stocking and drought.

For the present, a conservative plan of stocking is to be followed to allow rapid recovery of the better grasses. Studies are to be started to obtain field data on rate of recovery of the palatable vegetation under various systems of grazing. The recovery of the range pastures should be augmented somewhat by the plan of delayed grazing in the spring. None of the pastures are to be grazed before May 15, or at least until the better range grasses are considered ready to be grazed. The section is cooperating with the Animal Investigations Section on this project.

Artificial Revegetation

It is becoming more apparent that comprehensive field data are needed on methods of sowing introduced and native range grasses, the rate of their establishment under different soil and climatic conditions, and their relative grazing values under range and pasture conditions. Results obtained in the experimental grass nursery indicate that preference should be given our native grasses over most of the introduced grasses. Sowings of the native grasses, blue grama *(Bouteloua gracilis)*, sideoats grama *(Bouteloua curtipendula)*, western wheatgrass *(Agropyron smithii)*, and blue bunch wheatgrass *(Agropyron spicatum)*, were successfully established during the past year under dry-land conditions.

Successful stands of blue grama were obtained by sowing in early spring at the rate of 4 pounds per acre in 36-inch drill rows. The seed stalks of the blue grama were clipped before seed dissemination

and scattered between the 36-inch rows. A heavy straw mulch was spread over the scattered seed stalks, to prevent wind blowing and possibly to aid natural reseeding of blue grama between the rows.

The source of native grass seed is of importance in artificial reseeding. Sideoats grama seed, secured from Oklahoma and sown in our grass nursery, produced vigorous plants; but seed maturity was uncertain. The blue grama seed from Amarillo, Tex., gave the same results. Blue grama seed from near the northern limits of its range (west central Montana) produced smaller plants and matured its seed from 4 to 6 weeks earlier than our Colorado seed. It is possible that the plants grown from seed from these different sources may eventually adapt themselves to Colorado conditions. The results seem to indicate that the better plan is to secure grass seed for artificial reseeding from local sources whenever possible.

The problem of transplanting sod pieces of native range plants, particularly those that spread by surface and underground runners, needs more consideration. Because of the difficulty in obtaining seed of buffalo grass, it appears that sod transplanting is a likely procedure. Successful sod transplanting of this grass was done in the nursery for the past 2 years. Its ability to spread after establishment justifies the use of this method in rehabilitation of abandoned lands in the short-grass region.

The artificial revegetation studies are gradually progressing to a point where some work on a cooperative basis with various livestock men and farmers over the State is necessary. The work is essential in order to test out both introduced and native species under different range conditions. It is not proposed to carry out a very extensive program, because of limited funds. Field tests were started last fall, in cooperation with Charles W. Lilley at Virginia Dale. An old, abandoned field of about 5 acres was seeded to a mixture of various native and introduced grasses. Additional reseeding is to be done this spring on Mr. Lilley's ranch, as soon as weather permits.

Native Hay Meadows and Sagebrush Lands

An important land resource in the mountainous areas of Colorado from an economic standpoint is the land that is used primarily for production of native hay and the sagebrush land that is used for the grazing of livestock. Studies on these various types of land were started in 1932, in the North Park area near Spicer. Precipitation records obtained near Spicer show an annual mean precipitation of 11.42 inches over an 18-year period. The ranchers of the area are primarily dependent upon irrigation water for hay production, because of inadequate precipitation during the growing season. They use the flow for irrigation out of the North Platte River and its tributaries.

Because of the controversy that is pending in regard to the use of the North Platte River water between the states of Colorado, Wyoming, and Nebraska, and lately the Federal Government, studies were started in 1937 to determine the role of water in production of hay. Partial records were secured on State Senator Charles P. Murphy's meadows of the inflow of water over the meadows and the return flow to the streams. The mown hay areas were accurately mapped and all hay stacks measured and tonnage computed. Measurements of consumptive water and hay yields on the meadow areas should aid in determining the amount of water needed to produce a ton of native hay in the North Park region. It is planned to carry on these studies over a period of years, in cooperation with other State agencies.

Five years' records are available on yield of native hay and species densities on experimental plots irrigated by three different methods. A comparison of hay production for the 5-year period 1933-37, inclusive, shows an average yield of 1.63 tons per acre under continuous irrigation (May 15 to July 15); 1.43 tons per acre under early intermittent irrigation, or 12.3 percent less than under irrigation; and 1.14 tons under late intermittent, or 30.0 percent less than under the continuous irrigation. Since 1934, the continuously irrigated plots show a greater yield than the plots irrigated under the other practices. It can readily be seen that, from the standpoint of hay production, continuous irrigation is necessary during the main growing period.

Aftermath growth clippings were made in 1937 on the mowed plots previously irrigated by the three different practices. It is rather significant that only slight differences occurred in total yield of aftermath growth, under the three conditions of irrigation. The aftermath growth in 1937 averaged 17 percent of the total seasonal growth. In some years the aftermath growth on the meadows furnishes considerable feed for livestock in the fall.

A greater and more uniform vegetative cover was maintained under continuous irrigation. Under this system of irrigation, however, the so-called water grasses—sedges and rushes—are on the increase, while the tame hay species—timothy and tufted hair grass—are on the decline.

Extensive areas of sagebrush lands are present in North Park. A large percentage of these sagebrush lands are of low grazing value, because of too heavy use by livestock. Studies show that they may be improved naturally by greatly reducing the number of livestock and by employing some means of eradicating the dense stands of sagebrush. The best results were obtained by heavy railing of the sagebrush, followed by exclusion of livestock. Field data indicate that the above-mentioned practice is much better than removing the sagebrush and artificially reseeding the area.

Studies are to be continued during the coming field season on irrigated meadow and sagebrush lands.

Range Resource Surveys

Basic information concerning the native vegetation and soil are necessary to develop future agricultural programs in the Great Plains area of the State. Bankhead-Jones funds were made available the past 2 years for range-resource and soil surveys in Washington County. The range-resource surveys were conducted by this section and the soil surveys by the Agronomy Section. The range-resource surveys of the county were completed in September of last year.

A total land area of about 1,636,000 acres was covered by the field crews in the 2 years. The location and extent of crop land, various types of native vegetation, and abandoned cropped land were mapped. The densities and composition of the native vegetation were determined in order to obtain the grazing capacities of the various pasture units throughout the county. The compilation and analysis of field data and the drafting of maps have progressed very satisfactorily during the past fall and winter. The drafting of the base map of the county, on a 1-inch scale, is in progress for publication.

The type of land use in the southern half of the county is somewhat different from that in the northern half. Slightly more than half the land area on the hardland soils remains in native sod, chiefly because of a terrain too rough for the plow. More than 25 percent of the land that was plowed up is abandoned at the present time. In some hardland areas, the extent of abandonment is as much as from 35 to 42 percent. About 91 percent of the sandhill area in the southeastern part of the county is still in native range land.

The total density of native range species is generally low, on both hardland and sandy soils. Blue grama grass furnishes from one-third to one-half the palatable feed on the range areas, irrespective of type of soil. Buffalo grass and blue grama occur as the two dominant species on the hardland soils, but buffalo grass is not found on sandhill soils. Western wheatgrass occurs to some extent in the swales in the hardlands and makes up a slightly higher percentage of the vegetation on the rough hilly soils.

A depleted range vegetation, especially of the palatable species, has naturally resulted in a greatly reduced grazing capacity. Mistreatment has encouraged annual weed growth, which now comprises a large percentage of the total vegetation in many areas. Because the inferior vegetation has replaced more palatable species, the average acreage per animal-unit-month for the short-grass type is 5.56. Some range areas in the county, however, have higher grazing capacities. Better handling of the range areas, as a whole, will be necessary to restore them to a higher grazing capacity.

The results of the Washington County range resource surveys are to be published during the year.

Cooperative Project

The section is cooperating with Dr. H. S. Wilgus of the Poultry Section on a project to determine sources of green feed for poultry. Seed of five species of introduced and native grasses were sown, and sod pieces of buffalo grass planted, in the spring of 1937. The results indicate that crested wheatgrass and Kentucky bluegrass are the most desirable grasses for green feed. These grasses withstood close utilization by chickens throughout 1937 and recovered rapidly after grazing ceased. They also furnished green feed late in the fall.

Personnel

The appointment of Clinton H. Wasser as assistant in the section was made on March 1. Mr. Wasser is a graduate of the University of Arizona and comes highly recommended. He is assuming the research and instructional activities in a commendable manner.

Seven National Youth Administration students were assigned to the section at the beginning of the fall semester. Because of this additional assistance, the experimental work has progressed more satisfactorily during the fall and winter months. The work of these students has been of high order and very commendable.

Rural Economics and Sociology Section

Type-of-Farming Areas in Colorado

Complete records for the 1937 year's business were obtained from 23 farmers in northeastern Colorado, all of whom operate under dry-farming conditions. These men and others in the same community are continuing this work during the current year. The variations in returns shown for 1937 provide convincing evidence of the hazards in dry-land farming. This project will aid in furnishing economic information to supplement previous studies and should give the section and the Station basic data that will serve as a guide toward a more enduring plains agriculture. It may be of interest to observe that 15 of these men have purchased inexpensive rain gauges and will report rainfall for their districts during the growing season.

Twelve farmers in the Greeley area completed their records for the 1937 year's business. All these men operate under irrigated conditions. They constitute a part of the group which cooperated on the

former Station project relating to an economic study of farm organization and management in this particular region. The inclusion of these few records in this project has made it possible to keep a continuous file on a few farms since the year 1922. This has proved to be extremely valuable, in that we have been able to check on economic changes under irrigation.

Progress has been made in an anlysis of the accumulated data in this irrigated area looking toward the preparation of a manuscript which will deal with the economic relationships between landlord and tenant and the effect of differences in lease terms upon the net income of each. The statistical work has also been completed in anticipation of a revised and up-to-date analysis of the cost of producing crops under irrigated conditions. The supply of the original publication, Colorado Station Bulletin 353, has been exhausted for some time.

Range Livestock Industry

Efforts on the project studying the range livestock industry during 1937-38 were confined chiefly to a field trip during the summer months, at which time 50 ranchers in the Yampa River Valley were interviewed and data collected with respect to the organization and operation of these units. Some of the men are keeping records of their ranch business during the current year. Our studies have shown that cattle ranching has been on the decrease in some areas of western Colorado, but it has maintained its relative importance in others. Preliminary reports in the past have thrown some light on the general situation, but more work will be required in order to permit us to draw final conclusions.

Cooperative Work in Southeastern Colorado

This department has cooperated during the year with the Research Section of the Soil Conservation Service, U. S. Department of Agriculture. A few comments from a preliminary summary may be of interest at this time.

Severe drought conditions since 1932 have allowed only a spotted and meager production of crops, a condition hindering the introduction and lessening the benefits of new tillage methods and practices. Since a large proportion of the land in the county is owned by nonresidents and usually operated by tenants, desirable cooperation with the Service has been difficult to obtain. The control of wind erosion requires the serious attention of land owners and land operators, in order that soil blowing may be held to a minimum and eventually curbed. Only 54 percent of land owners of the 67 farms surveyed lived in Baca County; 43 percent of the owners of these farms lived

outside the State; and 3 percent lived in the State, but not in Baca County. These 67 farms were owned by 123 individuals.

The tenure status of the farm operators also influenced the fulfillment of a conservation program in the wind-erosion area. Owner-operators are able to make definite plans toward a conservation program, while tenant operators must consider the wishes of their landlords and are obliged to contend with short-term rental agreements. Data from the whole of the economic survey showed that the proportion of owner-operators and owners-additional operators was 74 percent of the total number of farmers in the survey; whereas this type of farm operator constituted only 61 percent of all farm operators in Baca County. Therefore, although owner operators are the more reliable type of farmers to cooperate in a sound farm program, and while they constituted one-third of all farm operators, they handle only one-fourth the farm land in Baca County. More permanency in the agricultural communities results when tenant and owners-additional operators cultivate approximately the same land year after year.

Rural Sociology

From the standpoint of our research work in rural sociology, at least five observations may be made with respect to progress during the year:

Cooperative relationships have been continued with the WPA Division of Social Research, Rural Section. During the fiscal year, WPA will have supplied approximately $2,901.21 to pay the salary and expense of an assistant supervisor and for the purchase of specified supplies and services. The assistant supervisor has been employed in the service of the Experiment Station when not needed for WPA duties. Two minor projects have been conducted under this cooperative arrangement: First, a survey of current changes in types of relief needs was made in two sample counties to enable federal WPA administrators to submit a report to the Senate Committee on Unemployment relative to the extent of need for additional work-relief funds until June 30, 1938; and second, a study was undertaken of the comparative intelligence and grade attainments of the children of rural relief and non-relief families in one sample county.

Progress has been made in the project comprising a type-study of selected social aspects of land utilization. Data have been secured to show country or state of origin of all household heads by precincts and farm-to-farm mobility by tenure status of all farm operators, by precincts. A land settlement map for the entire county has also been practically completed.

A memorandum of agreement was signed with the Federal Bureau of Agricultural Economics for a cooperative study during the

period January 1 to June 30, 1938. The project on an estimate of the farm population and farm population movements seeks to determine changes in the farm population in all counties of the state during 1937. This first study is to be the basis for making similar estimates during subsequent years. The results will be made available to all persons and groups concerned with rural affairs; such data are considered basic to any planning for the farm population.

Additional work has been done for the project of an exploratory study of farm family living. A schedule has been devised and field-tested for its adaptability to Colorado conditions. Family living data have been secured from more than 40 farm and ranch families. Representatives of the Colorado Extension Service wish to use these data as soon as a report can be completed.

Services rendered include the supplying of preliminary information for the confidential use of the Governor's Advisory Committee on Relief Problems, at the request of the committee chairman. Representatives of the Secretary of Agriculture appointed to designate "fair and reasonable" wages for sugar-beet field laborers report they have made extensive use of the Station study of beet workers and of supplementary information provided them.

Seed Laboratory

The Seed Laboratory serves all agencies in Colorado concerned with crops. Seeds have been submitted by investigators, the Farm Security Administration, the Soil Conservation Service, those in charge of the weed control program, the Seed Registration Service, and seed dealers and farmers. The larger number of samples have come from farmers.

There has been a demand for greater service and for more prompt service than the laboratory has been able to render with the limited staff.

Seed Testing

The Seed Laboratory has had a reduction of more than 40 percent in the annual income received from legislative appropriations in the last 5 years. As a result, no inspection was undertaken during the spring of 1938. Northern-grown alfalfa adapted to Colorado has been high in price. The result has been that low-grade seed, without labels, and southern seed labeled as Colorado-grown have been sold in Colorado. The Seed Laboratory has been aware of the general

facts with respect to this matter and of specific instances of such practices, but because of lack of funds it has been unable to institute proceedings to prevent repetitions.

Farmers could enforce the seed law by purchasing only seeds guaranteed as to quality. Since no money was available for inspection, a survey of seed actually being used in one county, Weld, was made, in cooperation with the county extension agent and the extension agronomist, the purpose being to acquaint farmers with the need for labels indicating guaranteed quality.

Tests made during July, August, and September 1937 of survey seeds collected in the one Colorado county during the spring of 1937 furnish the following data which indicate the need for guarantee as to quality of seed:

58% of alfalfa samples contained dodder.
80% of barley samples contained wild oats.
75% of oats samples contained wild oats.
76% of wheat samples contained wild oats.
14.5% of wheat samples contained wild morning glory, bindweed.
8.5% of oats samples contained wild morning glory, bindweed.

Since weed control is one of the big problems of agriculture, and since the Colorado seed law requires that the number of noxious weeds per pound be stated on the label, the need of law enforcement is evident from the foregoing.

Seed samples have been tested as follows: Current samples, field and lawn seeds, 2,034; current samples, vegetable seeds, 682; survey samples, 816; total, 3,532.

Work on longevity of stored seeds has been continued. A study of the germination of certain weed seeds found in crops is in progress.

A study of frost injury to oats at various stages of immaturity has been carried on in cooperation with Dr. D. W. Robertson of the Agronomy Section.

Publications

The following papers have been prepared:

"Germination of Stored Seeds," presented before the Colorado-Wyoming Academy of Science, No. 26, 1937.

"Quality of Seeds Sold and Offered for Sale in Colorado During the Spring of 1937," presented before the Colorado State Seed Dealers Association, Dec. 3, 1937.

"Summary of Survey Samples."

Editorial Service

The Station Editorial Service during the year 1937-38 has issued 24 publications, totaling 810 pages, as follows:

Popular Bulletins

No.

434—"Improving the Farm Wagon," by William P. Kintzley and Dudley P. Craig; 8 pages.

435—"North Park Cattle Production—An Economic Study," by R. T. Burdick and Martin Reinholt; 88 pages.

436—"Fitting Sheep Into Plains Farming Practices," by George E. Morton, E. J. Maynard, and J. F. Brandon; 80 pages.

437—"Controlling Colorado Potato Pests," by Leslie B. Daniels; 36 pages.

438—"Proso or Hog Millet," by J. J. Curtis, J. F. Brandon, and D. W. Robertson; 16 pages.

439—"High-Altitude Studies on Dry-Land Grasses and Clovers," by Dwight Koonce; 16 pages.

440—"Seal Coats for Bituminous Surfaces," by Adrian R. Legault; 24 pages.

441—"Plant Propagation," by L. R. Bryant; 32 pages.

442—"Planting and Maintaining Colorado Lawns," by George Beach; 16 pages.

443—"Home-Made Farm Equipment," by William P. Kintzley; 24 pages.

444—"Rural Households and Dependency," by Olaf F. Larson; 48 pages.

445—"Improving Colorado Home Grounds," by George A. Beach; 52 pages.

446—"Growing Better Potatoes in Colorado," by C. H. Metzger; 130 pages.

366—"Baking Quick Breads and Cakes at High Altitudes," by Marjorie W. Peterson (revised); 50 pages.

Technical Bulletins

No.

20—"Slick Spots in Western Colorado Soils," by Robert Gardner, Robert S. Whitney, and Alvin Kezer; 16 pages.

21—"Nutritional Characteristics of Some Mountain Meadow Hay Plants of Colorado," by J. W. Tobiska, Earl Douglass, C. E. Vail, and Melvin Morris; 24 pages.

22—"Suckleya Suckleyana, A Poisonous Plant," by Frank Thorp, Jr., A. W. Deem, H. D. Harrington, and J. W. Tobiska; 20 pages.

23—"Survival of Several Alfalfa Varieties Seeded on Irrigated Land Infested With Bacterial Wilt," by Ralph M. Weihing, D. W. Robertson, and O. H. Coleman; 12 pages.

24—"Preliminary Report on Inheritance of Differential Ability of Inbred Lines of Sudan Grass to Produce HCN," by O. H. Coleman and D. W. Robertson; 8 pages.

13—"Baking Angel Food Cake at Any Altitude," by Mark A. Barmore (reprint); 16 pages.

Press Bulletins

No.

91—"Western Slope Lamb Feeding," by George E. Morton, H. B. Osland, and R. C. Tom; 8 pages.

92—"Beet Tops for Fattening Steers II," by George E. Morton and H. B. Osland; 12 pages.

93—"Controlling the Squash Bug," by John L. Hoerner; 8 pages.

Miscellaneous Publications

Fiftieth Annual Report, Colorado Experiment Station, 66 pages.

In observance of the Golden Anniversary of the Station, this Annual Report included a special historical sketch.

For the first time, an effort was made by the Editorial Service to compile in the Annual Report a list of publications, other than official Station bulletins, issued by Station staff members for the year of the report; these lists were printed in the report, and a similar list is included in this year's report, with others to be included in each annual report hereafter.

National Award

In national competition with Station and Extension Service bulletins from other institutions, one of this year's bulletins from this Station was awarded second honors by the American Association of College Editors. This distinction was given to Bulletin 443, "Home-Made Farm Equpment," by William P. Kintzley. This is the second such award received by this Station in the past 3 years.

Miscellaneous Activities

Following notice to section heads by the Director that the services of the Station Editorial Service are available upon request to all Station staff members in preparation of manuscripts for publications other than the regular bulletin service, 13 such manuscripts were received and edited. In addition, the office has edited, upon request of section heads and other staff members, three bulletin-size reports for publication elsewhere, and one thesis. Assistance has also been given to a limited extent to the author of a technical book.

This year the editor is providing the author of every manuscript, whether for Station bulletins or for publication elsewhere, a typewritten report giving detailed corrections and suggestions. Usually

this report, after study by the author, is followed by conferences between the author and the editor. This procedure has been found to improve the standard of publications emanating from the Station, and also to improve relationships between the Editorial Service and the members of the various research sections.

The manuscript of "Timely Poultry Tips," a mimeographed poultry-news publication issued monthly by the Poultry Section, in cooperation with the Extension Service, has been edited by the Station editor each month this year, by request of the Director.

A newspaper article regarding the work of the Station was prepared, upon request of the Director.

The editor has given one radio address, substituting for an Extension Service speaker, and six addresses before college classes on the campus on the subject of editorial work.

Staff Contributions

For the period from July 1, 1937 to June 30, 1938, the following articles by Station staff members have been published other than as Station bulletins, section heads and members of the College library staff having assisted in compilation of the list:

Barber, Clifford W. Pulmonary Cavitation and Herniated Recticulum as Sequellae to a Probable Traumatic Gastritis. Cornell Veterinarian 28:78. 1938

Barmore, M. A. The Effect of the Temperature of Coagulation on the Physical Properties of Coagulated Egg White (abstract). Jour. Colo.-Wyo. Acad. Sci. 2(2):16. June 1937

Barmore, M. A. Potato Mealiness and Changes in Softness on Cooking. Food Research 2:377-83. Sept. 1937

Barmore, M. A. The Sloughing of Potatoes. Amer. Potato Jour. 15:170-71. June 1938

Barr, C. Guinn. Carbohydrate Fluctuations in the Root of Wild Morning Glory (abstract). Jour. Colo.-Wyo. Acad. Sci. 2:65. June 1937

Barr, C. Guinn. The Carbohydrates of the Corn Plant—Polysaccharides (abstract). Jour. Colo.-Wyo. Acad. Sci. 2(2-3):69. June 1937

Barr, C. Guinn. Some Chemical and Physical Properties of Reserve Carbohydrates in the Roots of Certain Perennial Weeds (abstract). Jour. Colo.-Wyo. Acad. Sci. 2:66-67. June 1937

Beach, G. Latham, Cuthbert, and June Raspberries Under Hillrow and Hedgerow Training. Amer. Soc. Hort. Sci. Proc., 1937 35:497-500. 1938

Binkley, A. M. Mountain Vegetable Production in Colorado. Market Growers Jour. 62(1):20-21, 30. Jan. 1, 1938

Binkley, A. M. and Lorenz, O. A. The Effect of Fertilizer Treatments on Onion Bulb Characteristics. Amer. Soc. Hort. Sci. Proc., 1937 35:717-19. 1938

Bodine, E. W. and Durrell, L. W. The Maynard Plum—A Carrier of the Peach Mosaic Virus. Science n. s. 86(2221):81. July 23, 1937

Bodine, E. W. Control of Peach Mosaic in Colorado (abstract). Phytopathology 27:954. Sept. 1937

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Brandon, J. F. The Spacing of Corn in the West Central Great Plains. Amer. Soc. Agron. Jour. 29(7):584-99. July 1937

Bryant, L. R., Gardner, Robert, and Goodwin, J. B. Fertilizer Trials with Sour Cherries Under Semi-Arid Conditions; Yields and Fruit Size. Amer. Soc. Hort. Sci. Proc., 1937 35:347-51. 1938

Burdick, R. T. Colorado Farm Leases. Colo. Exp. Sta. mimeo. Oct. 1937

Burdick, R. T. Farm Business Problems for High School Students. State Bd. Voc. Ed. mimeo. Feb. 1938

Burdick, R. T. Fur Farm Cost Accounting. Amer. Fur Breeder 10(10):8, 10. April 1938

Code, W. E. Some Observations on Well Characteristics (transcript). Amer. Geophys. Union 18, pt. 2:557-63. 1937

Coleman, O. H. Studies in the Sudan Grass (abstract). Jour. Colo.-Wyo. Acad. Sci. 2(4):23. April 1938

Daniels, L. B. Potato Insect Years. Nebraska Potato Improvement Assoc. Ann. Rept., 1936-37. 18:24-25. 1937

Donaldson, D. N. Gold Movements. Bul. 242, Gold Symposium. Mining and Metallurgical Soc. Amer. 30:180-86. Oct.-Nov. 1937

Forsberg, J. L. Results of Investigations on Carnation Root Rot in Colorado. Colorado's Third Annual Florists' Short Course. Hort. Circ. 18. 1938

Gunesch, W. E. The Effect of Pasteurization and Manure Treatment on Virgin Carnation Soil. Amer. Soc. Hort. Sci. Proc., 1937 35:807-09. 1938

Gunesch, W. E. Tests for Deficiency of Phosphorus in Colorado Soils. Florists' Review 81(2100):19. Feb. 24, 1938

Hoerner, J. L. A New Gooseberry Pest, *Stretchia plusiaeformia* Hy. Jour. Ec. Ent. 30(6):900. Dec. 1937

Hoerner, J. L. Control of Squash Bug. Mimeo. circ. 3 pages.

Jones, C. R. The Life History and Control of One of the Nymphalid Butterflies, *Phyciodes variota* (abstract). Jour. Colo.-Wyo. Acad. Sci. 2:79. June 1937.

Jones, C. R. The Use of Pyrocide in the Control of the Blister Beetle, *Epicauda maculata*, and Others (abstract). Jour. Colo.-Wyo. Acad. Sci. 2:81. June 1937

Kreutzer, W. A. A Phytophthora Rot of Cucumber Fruit (abstract). Phytopathology 27:955. Sept. 1937

Kreutzer, W. A. A Vascular Rhizoctonosis of Sugar Beet (abstract) Phytopathology 27:955. Sept. 1937

Kreutzer, W. A. Invasion of Onion Roots by *Phoma Terrestris* Hansen (abstract). Jour. Colo.-Wyo. Acad. Sci. 2(4):26. April 1938

Kreutzer, W. A. Vascular Rhizoctonosis of Sugar Beets (abstract). Jour. Colo.-Wyo. Acad. Sci. 2(4):26. April 1938

Kreutzer, W. A. and Durrell, L. W. Rot of Mature Tap Root of Sugar Beet Caused by *Pythium Butleri*. Phytopathology 28(7):512-15. July 1938

Larson, Olaf F. Beet Workers on Relief in Weld County, Colorado. Res. Bul. 4, Cooperative Plan of Rural Research. May 1937

Larson, Olaf F. Economic Trends and Sociological Problems in the Rural Areas of the Rocky Mountain Region. Proc. Regional Conf. of State W. P. A. Coordinators of Research, Survey, and Statistical Projects, June 1937 pp. 42-46.

Larson, Olaf F. Discovery by Census. Western Farm Life 39:12. Aug. 1, 1937

Larson, Olaf F. and Wilson, John E. The Relief Situation in Colorado Rural and Town Areas. Res. Bul. 5, Cooperative Plan of Rural Research. Aug. 1937

Larson, Olaf F. Rural Youth on Relief in Colorado. Rural Sociology 2:465-68. Dec. 1937

Larson, Olaf F. Rural Community Patterns of Social Participation. Social Forces 16:385-88. March 1938

Lute, A. M. A Method for Testing Chaffy Native Grasses (abstract). Jour. Colo.-Wyo. Acad. Sci. 2:37. June 1937

Lute, A. M. Germination Characteristics of Wild Oats. Assoc. Off. Seed. Anal. North Amer. Proc. 23-26(1930-33):70-73. 1938

Lute, A. M., Thornton, B., and Dixon, K. Study of the Effect of Altitude on Germination of Seeds. Assoc. Off. Seed Anal. North Amer. Proc. 23-26(1930-33):83-86. 1938

Lute, A. M. and Robertson, D. W. Longevity Studies—Wheat, Barley, Oats (abstract). Jour. Colo.-Wyo. Acad. Sci. 2(4):24. April 1938

Metzger, C. H. A Preliminary Report on the Effects of Commercial Fertilizers on Potatoes in Colorado. Amer. Potato Jour. 14:383-94. 1937

Metzger, C. H., Tobiska, J. W., Douglass, Earl, and Vail, C. E. Some Factors Influencing the Composition of Colorado Potatoes. Amer. Soc. Hort. Sci. Proc., 1937 35:635-43. 1938

Nelson, E. W. Natural Rehabilitation of Abandoned Crop Lands (abstract). Jour. Colo.-Wyo. Acad. Sci. 2(4):23. April 1938

Newsom, I. E. Urinary Calculi with Special Reference to Cattle and Sheep. Jour. Amer. Vet. Med. Assoc. 92:495. April 1938

Palmer, M. A. Some Aphid Puzzles (abstract). Jour. Colo.-Wyo. Acad. Sci. 2:80. June 1937

Palmer, M. A. Aphid Taxonomy as Related to Economic Entomology and Plant Pathology. Jour. Ec. Ent. 30(6):910-14. Jan. 1938

Reuszer, H. W. The "Why" of Fall Manuring. Through the Leaves 25:151-54. 1937

Reuszer, H. W. and Gee, L. L. Studies on the Fixation of Nitrogen in Colorado Soils. Abstract of papers, Western Soc. Soil Sci. p. 11. 1937

Reuszer, H. W. The Role of Nitrogen Fixing Bacteria in Soil Fertility. Through the Leaves 26:58-62. March 1938

Robertson, D. W. Inheritance in Barley II. Genetics 22(4):443-51. July 1937

Robertson, D. W. and Gardner, Robert. Factors Affecting Chlorosis in Irrigated Wheat. Jour. Agr. Res. 55(7):511-20. Oct. 1, 1937

Robertson, D. W. and Lute A. M. Germination of Seed of Farm Crops in Colorado After Storage for Various Periods of Years. Jour. Amer. Soc. Agron. 29:822-34. Oct. 1937

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Simonds, A. O. The Cause of Hypocotyl Contraction in *Medicago sativa* L. Seedlings (abstract). Jour. Colo.-Wyo. Acad. Sci. 2:37. June 1937

Simonds, A. O. Root Anatomy of Three Species of Ranunculaceae (abstract). Jour. Colo.-Wyo. Acad. Sci. 2:64. June 1937

Thornton, B. J. A Bibliography of Literature on Weeds, Vol. I, Author Index, 228 pp; Vol. II, Subject Index, 240 pp.

Thorp, Frank Jr. Some Feedlot Diseases of Lambs. Sheep Practice. Selected discussions, Vet. Med. 32:22-24. 1937

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Weihing, R. M. The Survival of Seven Varieties of Alfalfa Seeded on Land Infested with Bacterial Wilt (*Aplanobacter insidiosum*) (abstract). Jour. Colo.-Wyo. Acad. Sci. 2(4):23. April 1938

Whitney, R. C. State Ownership of School Lands in Selected Areas in Colorado and Nebraska. Jour. Farm Econ. 19(4):935-43. Nov. 1937

Whitney, R. C. A Farm Business Report Relating to 23 Farms in Phillips, Washington, and Yuma Counties for the Year 1937. Colo. Exp. Sta. mimeo. March 1938

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Wilgus, H. S. Jr., Heuser, G. F., and Norris, L. C. The Quantitative Vitamin-G Requirement of Chicks. Poultry Sci. 17(2):105-108.

Wilgus, H. S. Jr. Feed for Hatchability. Western Farm Life 40(5):21. March 1, 1938

Wilgus, H. S. Jr. Alfalfa for Poultry. Western Farm Life 40(10):21. May 15, 1938

The foregoing pages, with the financial statement on the next page, constitute the Annual Report of the Station for the fifty-first fiscal year, 1937-38.

Respectfully submitted,

E. P. Sandsten

Director.

FINANCIAL REPORT, COLORADO EXPERIMENT STATION *For the Year Ending June 30, 1938*

DR.	Hatch fund	Adams fund	Purnell fund	Bankhead-Jones fund	State mill levy fund	Special fund	Pure-seed fund	Total funds
Balance, July 1, 1937	.....	.....	.....	.....	$ 9,782.40	$16,016.59	$5,000.00	$ 30,798.99
From the treasurer of the United States as per appropriations for the fiscal year ending June 30, 1938, under acts of Congress approved March 2, 1887, (Hatch fund), March 16, 1906, (Adams fund), February 24, 1925, (Purnell fund), and June 29, 1935, (Bankhead-Jones fund)	$15,000.00	$15,000.00	$60,000.00	$16,823.22	.....	.....	.....	106,823.22
Other sources than the United States					74,222.37	39,781.35	.....	114,003.72
	$15,000.00	$15,000.00	$60,000.00	$16,823.22	$84,004.77	$55,797.94	$5,000.00	$251,625.93
CR.								
To salaries	14,908.00	15,000.00	47,560.52	11,444.39	33,043.78	21,736.74	4,268.96	147,962.39
Labor			4,659.95	2,005.39	14,096.88	8,498.05	240.25	29,500 52
Stationery and office supplies			556.43	281.83	737.56	353.93	90.00	2,019.75
Scientific supplies, consumable			744.20	126.30	504.30	933.86	3.90	2,312.56
Feeding stuffs			581.85	.....	1,784.48	886.28	.....	3,252.61
Sundry supplies			384.64	16.26	1,142.88	2,080.20	.....	3,623.98
Fertilizers			133.29	.....	39.74	76.05	.....	249.08
Communication service			150.17	34.03	1,308.10	289.53	10.39	1,792.22
Travel expense	92.00		2,203.96	1,668.86	4,367.75	1,552.87	.....	9,885.44
Transportation of things			24.58	2.16	912.01	310.82	.....	1,249.57
Publications			37.09	.....	3,059.91	230.35	.....	3,327.35
Heat, light, water, power			28.12	.....	2,189.96	4,583.44	.....	6,801.52
Furniture, furnishings, and fixtures			164.57	82.15	124.15	83.76	.....	454.63
Library			158.97	.....	90.77	195.15	28.00	472.89
Scientific equipment			1,896.96	167.55	755.40	1,071.96	.....	3,891.87
Livestock			51.79	.....	1,714.50	1,872.67	.....	3,638.96
Tools, machinery, and appliances			385.02	979.87	2,903.71	2,829.65	.....	7,098.25
Buildings and land			274.56	14.43	2,835.49	7,951.74	.....	11,076.22
Contingent expenses			3.33	.....	21.05	221.65	.....	246.03
	$15,000.00	$15,000.00	$60,000.00	$16,823.22	$71,632.42	$55,758.70	$4,641.50	$238,855.84
Balance on hand, June 30, 1938					12,372.35	39.24	358.50	12,770.09
Grand total	$15,000.00	$15,000.00	$60,000.00	$16,823.22	$84,004.77	$55,797.94	$5,000.00	$251,625.93

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Warren H. Leonard, M.S. Associate
Dwight Koonce, M.S., Associate
L. A. Brown, Ph.D., Associate
Robert Whitney, B.S., Assistant (Soils)
Otto Coleman, M.S., Assistant
Ralph Weihing, Ph.D., Assistant

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George E. Morton, M.S., in Charge
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C. G. Barr, Ph.D., Associate
A. O. Simonds, Ph.D., Assistant
W. A. Kreutzer, M.S., Assistant
J. L. Forsberg, M.S., Assistant

Chemistry

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Earl Douglass, M.S., Associate
C. E. Vail, M.A., Associate
Earl Balis, B.S., Assistant (on leave)

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E. M. Mervine, M.E., Agr. Engineer, U. S. D. A.

Entomology

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Miriam A. Palmer, M.A., M.S., Associate
Leslie B. Daniels, M.S., Assistant (on leave)
John L. Hoerner, M.S., Associate

Home Economics

Inga M. K. Allison, M.S., in Charge

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E. P. Sandsten, Ph.D., Horticulturist
C. H. Metzger, M.S., Associate
George A. Beach, B.S., Assistant
Louis R. Bryant, Ph.D., Associate

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Carl Rohwer, B.S., C.E., Assoc. Irrig. Engr., U. S. D. A.
William E. Code, B.S., Assistant
Maxwell Parshall, B.S., Meteorologist

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I. E. Newsom, D.V.M., in Charge
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Frank Thorp, Jr., D.V.M., Ph.D., Assoc. Pathologist
A. W. Deem, D.V.M., M.S., Assistant
G. S. Harshfield, D.V.M., M.S., Assistant
Elizabeth Heiss, Ph.D., Assistant

Poultry

H. S. Wilgus, Jr., Ph.D., in Charge

Range and Pasture Management

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Clinton H. Wasser, B.S., Assistant

Rural Economics and Sociology

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R. T. Burdick, M.S., Associate
D. N. Donaldson, M.S., Associate
Olaf F. Larson, M.S., Associate
R. C. Whitney, M.S., Assistant

Seed Laboratory

Anna M. Lute, A.B., B.Sc., Seed Analyst

Horticultural Substations

Herman Fauber, M.S., Supt., Rocky Ford
Ralph Manuel, B.S., Supt., Avon
Ferris M. Green, B.S., in Charge, Austin

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