COLORADO STATE COLLEGE FORT COLLINS

Fifty-Third Annual Report Experiment Colorado 1939-1940 Station

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*Deceased **†**Resigned

†On leave

Letter of Transmittal

Fifty-Third Annual Report Colorado Experiment Station

Hon. Ralph L. Carr Governor of Colorado Denver, Colorado

Sir:

In compliance with the law, I herewith present the Fifty-Third Annual Report of the Colorado Agricultural Experiment Station for the fiscal year of July 1, 1939 to June 30, 1940, inclusive.

U.E. Seewson

Acting Director

Fort Collins, Colo. July 1, 1940

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Director's Annual Report Fifty-Third Fiscal Year, 1939-40 Colorado Experiment Station

To the President and State Board of Agriculture:

On July 1, 1939, Dr. E. P. Sandsten retired as Station Director after 7 years of service. He was succeeded by Dr. C. H. Kick, who passed away on August 27. Thus was a young man of promise carried away in the flower of his youth. Since that time the undersigned has been acting as Director of the Station.

One of the most serious problems that had to be faced was the question of the budget. Owing to the usual practice of spending a considerable portion of the budget in the first 6 months, and the fact that the Station tax money comes in largely in the latter half of the year, there is always a lean period beginning in January and becoming particularly acute in March and April. This is intensified by the need of purchasing in the fall for feeding tests numbers of animals which are sold in the spring. In order to carry over this lean period, a sizable reserve fund is necessary. Unfortunately the carry-over at the end of the budget year was not sufficient to make up for this deficiency, and the Station was actually dependent upon Extension and Resident Instruction funds for its continuance during 2 months of the year. It is believed that by holding a larger reserve this difficulty can be overcome in the future.

The Station farm at Avon, which was purchased in 1921, was ordered sold in March of this year. This farm was acquired for the purpose of studying high-altitude crops, particularly head lettuce, peas, and potatoes. Also a considerable herd of beef cattle had been built up in order to make it more nearly self-supporting. For a number of years past the only experimental work carried was on potatoes. Since problems concerning tubers could be more efficiently studied in the San Luis Valley, it seemed better to transfer the work there. The potato growers in the Valley assisted in a commendable spirit by offering 160 acres of land, rent free, for our purpose. Unfortunately our financial condition did not allow us to carry that amount of land in experimental crops, and the Extension Service came to our rescue by offering to conduct the extra portion as a demonstrational farm. The Station will carry its experimental work on 20 acres of the land and is assured of a different plot each year for this purpose. Thus we find ourselves in cooperation with the Extension Service under conditions which clearly outline the distinction between demonstrational and investigational work. We are agreed that the Experiment Station is concerned with investigation and research, and that purely demonstrational activities are better conducted by the Extension Service. This will allow us an opportunity to give practical effect to this conception.

It may also be well to state the new policy on establishment of substations. Already, enterprising groups in various localities have offered us land for investigational work under conditions similar to those in the San Luis Valley, but we have found it necessary to refuse these generous offers because investigational work is necessarily quite expensive and our funds are limited. When it is decided to take up a problem in a given community, it is believed wise to acquire land by lease, sufficiently long to solve the problem, but not to tie up funds by purchase. When the problem is solved, the Station will move on to other fields.

Much attention has been given to the relationship of the work of this Station to the large regional laboratories which have been established by the Federal Department of Agriculture. There are nine of these regional laboratories carried under Bankhead-Jones funds and four under the Agricultural Adjustment Administration. These laboratories are much better supported than our own and will deal with problems of regional or national interest. Since Colorado is replete with local problems which may not extend beyond our borders, it is the feeling of our group that Colorado agriculture will be better served if our activities are confined to those problems which have local significance. Problems will always arise more rapidly than they can be solved, and some limitation must be exercised in order to get the most effective results.

There has always been discussion of the old question of fundamental versus applied research. The Station is continually being pressed to attack immediate problems of great economic significance, and while it is the desire of the staff to take full cognizance of all such questions, it must be remembered that many of these can be solved only after basic and fundamental questions have been settled. This is not only a wise course but is mandatory under several of the Federal acts. For example, Adams and Purnell funds are restricted almost entirely to fundamental problems on the assumption that only by giving attention to these matters can applied research be made effective.

There is also the problem of cooperation with Federal agencies. When these groups were first established on the campus they were heartily welcomed in the belief that they would render great assistance in the solution of our difficulties. It must be added that this assumption has proved true. The only question that now arises is whether, with so many of them, their activities do not become an increasing burden on our funds, since nearly all of them are furnished housing, heat, and telephone service free of charge.

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During the year we have called monthly Council meetings, attended by the section heads. These have given the Director a better understanding of the activities of the various sections, and the staff members say they have made for harmony among the sections. In addition to this a joint meeting between the Extension and Station groups has been held once each month for discussion of our common problems. These also have seemed to be helpful in ironing out differences of opinion that too often arise between these agencies. Both the Extension and Station men have developed a better understanding of each others' difficulties.

Through the Station Council meetings a publications committee has been provided so that every paper or bulletin now prepared by a staff member is referred to a committee for criticism. This has been helpful in preventing publication of some statements which might have been objectionable to other staff members and in promoting better cooperation between the various sections. It has also resulted in the establishment of a journal series, so that from now on all technical publications from the Station will be given a number and will be kept on file in consecutive order. It is believed that in the development of projects, committees can also be helpful in determining those which are most worth while and which should be submitted for approval.

We have been fortunate in that only three resignations have been presented, thus keeping our staff well intact. It must be expected that some of our young men will be lost to us through better offers from other organizations. We are fortunate that the inroads are not more severe. Four of our men have gone on leave to better themselves by doing graduate work in other institutions. The sabbatical leave system will be encouraged in the Station as well as in the College, although it may be a little more difficult to work out.

Substations

The original purposes of establishing substations were (1) to use them as field stations to test practical application of results developed in the Station laboratories and greenhouses, (2) to run field plot experiments on crops that cannot be grown at Fort Collins, (3) to study and evaluate the adaptability of new crops to Colorado, (4) to study the problems of crop variety adaptation and disease resistance in a particular district, and (5) to grow registered and certified seed as a local source for growers.

The substations serve as a direct contact agency between growers and the Experiment Station. With a state like Colorado where soils, climate, and water supplies vary there will probably always be a demand for field stations. In order to receive full value from field stations, however, it is necessary to have a strong main station program under way.

Station projects which are carried on the substations are made out by the different sections of the Experiment Station at Fort Collins.

AUSTIN.—The fruit substation at Austin, Colo., is operated cooperatively by the Colorado Experiment Station and the Office of the State Horticulturist. It is serving a very worth-while purpose on the Western Slope.

The fruit industry is passing through a transition period, with liquidation and some removal of old orchards past their period of profitable production. It is going through a period of rehabilitation. New plantings are going into old and new districts, and the present tendency is to distribute acreage on a sounder basis. Changes in ownership and management, establishment of new orchards, and rehabilitation of old orchards have increased the demands for Station work.

The Station project work is covered briefly in this annual report under the Horticulture Section. The work covers tree variety testing, commercial fertilizer tests, orchard cover crop practices, information tests on spray materials, spray schedules, control of diseases and insects, sanitation measures, rootstocks, and fruit washing.

Last year a total of 760 fruit frowers were contacted. Many pruning demonstrations were carried on in different districts, and many growers visited the substation. Interest in the work is clearly indicated by continual demands for information and assistance, indicating that the substation is well supported and of importance to fruit growers.

ROCKY FORD.—The substation at Rocky Ford is owned and operated entirely by the Experiment Station. Last year projects were carried on this substation by the Horticulture, Agronomy, Animal Investigations, Entomology, and Botany Sections of the Station. The activities covered a wide field of production problems on crops grown in the Arkansas Valley.

Projects carried were:

- 1. Sheep feeding tests.
- 2. Hybrid field-corn testing and breeding.
- 3. Corn-ear worm control on canning tomatoes.
- 4. Alfalfa variety tests for adaptation and resistance to wilt.
- 5. Onion breeding, fertilizer and strain tests on onions.
- 6. Cantaloupes, disease and insect control tests.
- 7. New crops (perilla culture).

There has been a soil building program practiced by turning under green manure crops. This program is being used now by many growers. Some of the soils on the substation are fairly representative of the Valley, the crops grown are similar, and the results are applicable to most farms.

Results obtained under the projects listed are reported by the different sections of the Station, with the exception of perilla culture. This project disclosed that yields over a 3-year period were too light and the price offered too low to make the crop commercially profitable.

During the year 361 growers were contacted by calls or visits to the substation, while about 125 persons were present during the feeders' day program.

Avon.—The mountain substation at Avon, Colo., was sold on April 1, 1940, and most of the Station project work on potatoes was transferred to the new San Luis Valley substation. A report of the results of the work there is briefly given under Station projects on potatoes.

Agricultural Division

Agronomy Section

Corn Improvement

Work has been continued on the study of hybrid corn brought in from other states. Tests have been made at Fort Collins, Akron, and Rocky Ford in attempts to ascertain the adaptability of outside hybrids in order to advise corn growers intelligently. Work has been continued on inbred lines and hybrids of our own production. Mimeographed reports have been sent out to farmers and growers showing the state of these tests. Wisconsin and Minnesota hybrids and one or two Iowa and Illinois hybrids do well in northern Colorado. Certain of the Illinois and Iowa hybrids are adapted to the longer growing season of the Arkansas Valley. Up to the present time no hybrid has been as successful in the dry land as the best open-pollinated varieties. Under irrigation the best hybrids have exceeded the openpollinated varieties in yield. A great many of the hybrids are not adapted.

Hydrocyanic Acid in Sudan Grass

The Adams Fund project on hydrocyanic acid in Sudan grass is continued, self-fertilized lines being used in the attempt to produce strains of Sudan grass with a low ability to produce hydrocyanic acid. The indication is that the tendency of Sudan grass to produce hydrocyanic acid is in part inherited. The most serious handicap in the strain production work is the inability to carry a sufficient number of strains. The chances of success would be increased with increased numbers.

Optimum Nutrient Balance in Soils

In the light of the practice of certain fertilizer companies, the project on optimum nutrient balance in soils needs to receive increased emphasis. In this project the attempt is being made to learn the effect of the nitrogen-phosphorus relationship on crop yields. Many fertilizer companies are making recommendations, sometimes not in accord with Experiment Station findings, and work should be done in this field which would bring out relationships of the three principal plant food constituents which occasionally become deficient.

Availability of Mineral Nutrients in Soils

It is known that some soils with relatively large total phosphorus content have low availability. Investigations in this field are being made to see whether field methods may be employed to increase field availability.

Chlorosis of Stone Fruits

The study of chlorosis of stone fruits, jointly carried on by the Soils Agronomy, Herticulture, and Botany Sections, is in the stage where the effect of different nutrients and nutrient combinations are under study. No final results have been obtained but interesting leads are developing.

Bacterial Wilt and Winter-Killing in Alfalfa

Work on bacterial wilt and winter-killing in alfalfa, Colorado's most valuable crop, is continuing. The present work indicates that disease-resistant lines of alfalfa will have to be created. Certain strains of Turkestan show considerable resistance. Grimm and Baltic, Colorado's highest yielding hardy sorts, have very little resistance. It is hoped that resistance can be produced in inbred strains. This type of work, followed by crossing and backcrossing, gives promise of furnishing resistant strains of high yield. It takes several years, however, for inbred strains and the backcrossing program to yield definite results.

Work associated with the Federal Government and the states of Wisconsin, Nebraska, and Kansas is continuing. These and some other states have organized an alfalfa breeding association of which Colorado is a member. Information and promising stocks are freely exchanged in this work.

As reported last year, suitable greenhouse and freezing equipment would shorten the time required because it would enable more than one generation to be grown in a year at certain stages in the work.

Linkage Relationships in Barley

The Adams Fund project on linkage relationships in barley is continued in its technical aspects of mapping genes and chromosomes into linkage groups. In 1938-39 this Section reported that Lico, a new barley, coming out as a by-product of this research, was being distributed to farmers. It can be reported at the present time that there are three new barley varieties in prospect which promise superior performance. Thus the purely technical and fundamental studies are beginning to yield a by-product of improved barley varieties.

Soil Resources and Land Use Survey

Semidetailed land use surveys have been continued. Cooperative work is under way with the Soil Conservation Service in most of the territory. New detailed surveys have been carried out in the Grand Junction section, extending the surveys started in 1938 and carried on during 1939. Under the cooperative arrangement all soil and land use maps made by the Agronomy Section, by the Soil Conservation Service, and by the Bureau of Plant Industry Soils Section are available to us. This cooperation considerably enlarges the territory which can be covered. It now appears that it would be wise to cooperate on finishing up some of the maps already produced to make them available for county extension agents, Soil Conservation Service, Farm Security, Bureau of Agricultural Economics, and other workers. Such maps are an improvement over many of those now in existence or which can be made by farmer cooperation and would constitute a sounder basis for planned programs.

High-Altitude Crops

The major portion of the work on high-altitude crops is conducted at the Fort Lewis branch of the institution. It covers work with grains, peas, high-altitude, dry-land, and irrigated grasses, alfalfa, and a minor list of forage crops. Breeding work on peas is continued. Preliminary work for grass breeding studies is under way.

Improved Seed

New varieties of crops are being created on this Experiment Station and on other stations to supply Colorado farmers with information and the best adapted varieties. These varieties are commonly tested under the general project of improved seed to ascertain their value in our system. Varieties are often purified and foundation stock seed started which, as soon as possible, is put into the hands of farm seed growers in order to get a supply of seed of the best adapted sorts for general farm distribution. This project is the means of converting the more technical research projects supported on Federal funds into practical use.

Plains Crops and Management

The Agronomy Section is cooperating with the Division of Dry Land Agriculture at the field station at Akron. This cooperation includes investigation of cultural methods for all common farm crops, rate and date of planting, best sequence of crops in the rotation, and other similar types of work. A successful though minor work has been the improvement of sorghums. Two new varieties have already been created which have sufficient merit to move safe grain sorghum production 200 miles farther north than was possible before this work commenced. Sorghums are much more drought-resistant than corn and respond much better after summer fallow than does corn. These new sorghum types are capable of materially increasing feed and grain certainty for the dry-land agriculture of the Plains. The Akron substation is also used as a place to eliminate strains of all crops which are not well adapted to our general agriculture. Many sorts which do well at Fort Collins will not survive at Akron. Thus Akron is the final testing ground for the adaptability of many of the new strains.

Personnel

The Agronomy Section staff may be divided into two groups those entirely on Station work and those part time on Station work and part time on teaching. In the group entirely on Station work are Dr. D. W. Robertson, professor; Mr. Dwight Koonce, Mr. Robert Gardner, and Dr. Lindsey A. Brown, associate professors; Dr. Ralph M. Weihing, assistant professor; and Mr. Otto Coleman, instructor. Those having part time teaching and part time other duties are Dr. Warren H. Leonard, associate professor, on corn research; Mr. Robert S. Whitney, assistant professor, on soils research; Prof. Alvin Kezer, professor in charge, part time teaching, administration, and research.

The Division of Cereal Crops and Diseases has maintained a cooperative arrangement during the year, as for the year 1938-39, with Mr. J. J. Curtis in charge, assisted by Mr. Horace S. Smith, who is supported on a fellowship basis. Mr. Curtis' problem has been wheat breeding research.

Animal Investigations Section

Cattle Experiments

Protein Supplements and Iodine for Fattening Steers

Eighty head of yearling steers have been divided into eight uniform lots and are fed the following rations:

Lot. 1. Six pounds corn, 6 pounds barley, 1 pound cottonseed cake, 30 pounds wet pulp, alfalfa.

Lot 2. Six pounds corn, 6 pounds barley, 1 pound soybean oil meal, 30 pounds wet pulp, alfalfa.

Lot 3. Six pounds corn, 6 pounds harley, 1 pound tankage, 30 pounds wet pulp, alfalfa.

Lot 4. Six and one-half pounds corn, 6 pounds barley, one-half pound mixture*, 30 pounds wet pulp, alfalfa.

Lot 5. Six and one-fourth pounds corn, 6 pounds barley, three-fourths pound mixture*, 30 pounds wet pulp, alfalfa.

Lot 6. Six pounds corn, 6 pounds barley, 1 pound mixture*, 30 pounds wet pulp, alfalfa.

Lot 7. Five and three-fourths pounds corn, 6 pounds barley, 1¼ pounds mixture*, 30 pounds wet pulp, alfalfa.

Lot 8. Six pounds corn, 6 pounds barley, 1 pound cottonseed cake, iodine, 30 pounds wet pulp, alfalfa.

*Mixture composed of one-third cottonseed meal, one-third tankage, one-third soybean oil meal.

The objects of the test are as follows:

1. To compare the feeding value of various protein supplements, cottonseed cake, soybean oil meal, tankage, and a protein mixture (composed of one-third cottonseed meal, one-third tankage, and one-third soybean oil meal) in a beet by-product ration composed of grain, protein supplement, wet beet pulp, and alfalfa hay for fattening steers.

2. To ascertain the optimum amount of a protein mixture (composed of one-third cottonseed meal, one-third soybean oil meal, and one-third tankage) necessary to balance a standard beet by-product ration.

3. To ascertain the value of adding iodine to a standard beet by-product ration composed of corn, barley, cottonseed cake, wet pulp, and alfalfa for fattening steers.

These cattle are still on feed. The experiment will be closed the latter part of May. All the lots will be followed through the packing

plant at killing time to ascertain dressing percent and carcass grade, and to obtain the thyroids of the steers in the various lots for the iodine study which is conducted in connection with the experiment. This latter phase is conducted in cooperation with the Pathology and Bacteriology Section.

Supplementary Feeds for Breeding Cows on Winter Pasture

Thirty grade and purebrod Hereford cows are being run on the foothill range and are divided into two lots fed as follows:

Lot 1. Winter pasture, cottonseed cake, alfalfa, minerals, salt.

Lot 2. Winter pasture, alfalfa, minerals, salt.

This test, still in progress, is designed to show the value of cottonseed cake as a partial substitute for hay, and also the effect on calf crop and milk production.

Conservative Versus Deferred and Rotated Grazing for Breeding Cows

The grazing experiment is run in cooperation with the Range Management Section to ascertain the relative values of conservative and deferred-rotated grazing; to record seasonal gains of the cattle; and to ascertain the effect of varying rates of stocking on range capacity, the effect of seasonal growth of the important forage species, and the degree of use that may be made of each important forage species and each major forage type without permanent injury to the range.

Thirty head of grade and purebred Hereford cows are again to be divided into two lots. Lot 1, composed of 10 head, will be run on the conservatively grazed pasture, and Lot 2, composed of 20 head, will be run on the deferred and rotated pasture.

This is the fourth year of this 10-year experiment, and detailed data is as yet not available.

Sheep Experiments

Urinary Calculi With Lambs

The cooperative test between the Pathology and Bacteriology Section, the Chemistry Section, and the Animal Investigations Section on urinary calculi with lambs was completed on April 9, 1940. Only two typical cases of calculi were produced, although there were several other lambs that showed partial obstruction. The last of the lambs are being marketed and a bladder examination is made of each lamb to find the number of calculi present in the lambs of the various lots. Results of these findings are not yet available.

Twenty lots of 25 wether lambs each were fed 140 days. The rations used were as follows:

Lot 1. Yellow corn, alfalfa, salt.

Lot 2. Barley, alfalfa, salt.

Lot 3. Wheat, alfalfa, salt.

Lot 4. Milo, alfalfa, salt.

Lot 5. Millet, alfalfa, salt.

Lot 6. White corn, bran, cane fodder, salt.

Lot 7. Barley, bran, cane fodder, salt.

Lot 8. Wheat, bran, cane fodder, salt,

Lot 9. Milo, bran, cane fodder, salt.

Lot 10. Millet, bran, cane fodder, salt.

Lot 11. White corn, bran, cane fodder, bone meal self-fed, salt.

Lot 12. White corn, bran, cane fodder, bone meal low level,

salt.

Lot 13. White corn, bran, cane fodder, bone meal high level, salt.

Lot 14. White corn, bran, cane fodder, lime self-fed, salt.

Lot 15. White corn, bran, cane fodder, lime low level, salt.

Lot 16. White corn, bran, cane fodder, lime high level, salt.

Lot 17. White corn, "C" molasses, bran, cane fodder, salt.

Lot 18. White corn, cane molasses, bran, cane fodder, salt.

Lot 19. White corn, corn molasses, bran, cane fodder, salt.

Lot 20. White corn, "C" molasses, beet tops, lime, salt.

Feeding results found in this test were as follows:

1. When fed with alfalfa hay, the relative value of the various grains used ranked as follows: Yellow corn, wheat, barley, millet, and milo.

2. When fed with cane fodder, the grains ranked as follows: Millet, wheat, white corn, barley, and milo.

3. Molasses added nothing to a ration of white corn, wheat bran, and cane fodder.

4. Beet molasses proved superior to both cane and corn molasses. In a feed combination of white corn, wheat bran, and cane fodder, corn molasses was least efficient.

5. In a ration of white corn, wheat bran, and cane fodder, the feeding of either bonemeal or lime in small amounts rather than self-feeding or feeding in large quantities seemed to prove most economical.

6. A peculiar combination of white corn, beet molasses, and beet tops proved to be the cheapest and most efficient ration of the test.

Breeding Study with Hampshire Ewes

Unfortunate circumstances through the purchase of a ram a year ago gave us 33 percent "parrot-mouthed" lambs in all the lambs

dropped by our flock of ewes. Since the "parrot-mouth" condition is becoming more and more prevalent among the animals of our purebred breeders, an experiment was designed to make as complete a study as possible of the inheritance of "parrot-mouths" in sheep.

We are using 25 sheep in this study. We are also retaining the ram, whose genetic make-up apparently tended to induce this condition, and are breeding back to him a certain number of the "parrot-mouthed" ewes. The balance are being bred to a ram which has never been known to produce a "parrot-mouthed" lamb. This study will necessitate quite a number of years' work before any definite conclusions can be drawn.

Wintering Rations for Pregnant Ewes

Two hundred grade range ewes are used for the study of wintering rations for pregnant ewes. These ewes were allotted into two groups of 100 each and are being fed the following rations to compare the feeding values of cottonseed cake and oats when fed as a supplement to alfalfa, and to study the effects of these two supplements on the condition, lamb crop, and wool production of these ewes:

- Lot 1. One-half pound oats, 4 pounds alfalfa, minerals, salt.
- Lot 2. One-fourth pound cottonseed cake, 4 pounds alfalfa. minerals, salt.

This experiment is still in progress. The lambs from the two lots will be fattened out next fall on the same rations to ascertain the influence of breeding on economy and rate of gain.

Iodine Study with Growing Ewe Lambs

Twenty-four grade ewe lambs are used in the study of iodine with growing ewe lambs and are divided into three lots which are fed as follows:

- Lot 1. One-half pound oats, alfalfa, salt.
- Lot 2. One-half pound oats, alfalfa, salt, iodine.
- Lot 3. One and one-half pounds corn, alfalfa, salt, iodine.

Three similar ewe lambs were killed at the beginning of the test to ascertain the condition of the thyroids. Others will be killed periodically throughout the experiment and at the end of the test to find the effects which iodine had when fed in these rations.

If definite advantages are shown in feeding iodine, it probably will be necessary to continue this study on a larger scale next year.

Cut Milo Fodder Versus Cut Corn Fodder for Fattening Lambs

Two hundred and forty-six range lambs were fed for 118 days at Rocky Ford on the following rations:

- Lot 1. Ground barley, cottonseed cake, ground corn fodder, ground alfalfa hay.
- Lot 2. Ground barley, cottonseed cake, ground milo fodder, ground alfalfa hay.

Results of the experiment showed that cut milo fodder and cut corn fodder were equal in feeding value, pound for pound.

Miscellaneous Experiments

Nutritional Control of Mastitis

Work on nutritional control of mastitis is designed to study the reaction of animals to fasting at different stages of the lactation cycle, to study the change of milk constituents during the fast, and to study the behavior of phagocytic blood cells, antibody-protein fraction, and organisms associated with mastitis condition in mammary tissue during fast. Also it is to ascertain the type of bacteria present in the animals studied.

Up to the present time it has been possible to carry out two complete checks for mastitis on the College dairy herd. Chloride, pH, and other analyses were made on the milk from each quarter of every milking cow in the herd. Unfortunately but one cow showed clearly a mastitis infection. This case was a very mild type, and although the cow was nearly at the end of her lactation period, favorable results were obtained during a fasting experiment. The pertinent observation that proteolytic activity in incubated milk samples was decreased because of fasting was made during this work.

Sperm Longevity Study

The sperm longevity study includes a preliminary study of metabolism of sperm. It includes also a critical review of the present status of storage methods and longevity of sperm life, motility, and fertilization potentialities; of nutrition of both male and female as it affects life of sperm in storage, motility, and impregnation potential; of nutrition of sperm in storage; and of temperature effects.

Official Testing

The following herds are those being tested as of March 1, 1940. In the herd improvement test all purebred cows in the herd are tested.

Holstein Herds

HERD IMPROVEMENT TEST:-C. W. Henry, Greeley; George T. Sinton, Colorado Springs; the Denver Farm, Henderson; J. K. Mullen Home, Fort Logan; and Modern Woodmen Sanatorium, Woodmen.

Guernsey Herds

ADVANCED REGISTRY:-F. C. Kay, Pueblo; Robert Roemer, Fort Collins; J. W. Loving, Pueblo; George T. Konishi, Platteville; Loyd Robertson, Rocky Ford; Velma G. Shanks, Rocky Ford; Charles Ewing, Fort Lupton; Wallace Ewing, Fort Lupton; and H. L. Thomas, Las Animas.

Jersey Herd

REGISTER OF MERIT :--- E. L. Eden, Pueblo.

Summary of Testing

Following is a summary of the testing work done since April 1, 1939:

Month	Number of cows on yearly test in advanced registry division	Number of cows on yearly test in herd improvement division	Number of herds	Fees
April	88	84	17	\$34.40
May	76	85	15	27.50
June	74	71	13	25.60
July	69	74	13	24.65
August	73	76	15	25.85
September	65	69	14	23.15
October	68	70	14	24.60
November	67	85	14	20.15
December	65	77	14	20,95
January	66	75	15	20.65
February	68	90	15	19.80
March	68	65	15	20,80
	847	921	174	\$288,10

Botany Section

Diseases of Ornamental and Greenhouse Plants

Further tests are being made of strains of *Fusarium* causing carnation root rot. Cultural reactions and the relation of soil temperatures to infection are being studied, using controlled thermal units in the greenhouse beds. Identified cultures of *Fusarium* from England, Germany, and localities in the United States have been obtained for comparison. Graded concentrations of aniline have been used in distinguishing different strains of the fungi. Eighteen different kinds of carnation are being tested for possible resistance.

Virus Diseases of Stone Fruits

Budding and inoculation work with peach mosaic has been continued. The following technical paper is prepared for publication: "Studies on the Host Range of the Peach Mosaic Virus in Western Colorado," by E. W. Bodine and L. W. Durrell.

Physiology of Poisonous Plants

A very toxic substance has been isolated from the range plant, Oxytenia accrosa. This plant has been responsible for sudden death of cattle in western Colorado.

Analyses of *Suckleya suckleyana* are being continued in a study of the nitrogen metabolism of that actively cyanogenic plant.

Studies are being continued on Anabaena flosaquae, an alga poisonous to livestock.

Chlorosis of Stone Fruits

Analyses of leaf tissue of chlorotic peach trees from the Palisade area are being continued; also analyses are being made of tissues from peaches grown in the greenhouse under controlled soil conditions. Application of sulphur was made to soil of chlorotic areas.

Corn Smut

All data of the 2 years' work on the testing of inbred lines of corn for smut resistance has been compiled.

Miscellaneous Studies

Extensive studies were conducted on the respiration of sugar beets in storage October to November 1939, and significant data were assembled showing the effect of mechanical handling and high temperature on sugar loss.

Field plantings were made of potatoes inoculated with strains of *P. sepedonica* from various regions, and tests were made of the reaction of different varieties of potatoes to ring rot. Studies are also being made of the interrelation of various rot organisms associated with the ring rot.

Artificial freezing and dessication and histological studies have been carried out relative to winter-killing of Latham raspberry. Experiments were also continued on the anatomy of weeds, extending the study to *Hymenophysa pubescens*, the white weed, and *Centaurea picris*, the Russian knapweed. Some microchemical tests and histological studies have also been started on peach tissues.

Chemistry Section

During the present fiscal year the Chemistry Section has carried on with continuing projects from the previous year with one exception. Of four major projects, the collecting of field and laboratory data on our potato investigations (cooperative with the Horticulture Section) and the investigation of the exchange capacity of some Colorado soil profiles should be completed with the termination of the present year.

The initiation of one new major project is under advisement and an outline has been submitted for approval. The proposed project has to do with the tolerance limits of alkali drinking waters in livestock fattening operations. Other projects are in abeyance pending the approval of the one just mentioned. A brief resume of current projects is as follows:

PROJECT 1. The Yield, Starch, and Mineral Content of Tubers Grown in the Principal Potato-Growing Sections of Colorado as Affected by the Available Nutrients of the Soil and by Moisture Conditions (cooperative with Horticulture Section).—This project was continued for several years and in the main the work is written for publication in bulletin form.

On the basis of our work with six varieties, it would appear that virus and bacterial diseases and insect pests are the more prominent causes of fluctuation in production in different sections of the State, although soil conditions and moisture applied are also important.

Starch content appears to be influenced by both genetic and environmental factors, since we were able to align our tubers in this respect, both as to variety and location of plots. Significant differences in starch content from year to year, depending on moisture, maturity, and size of tuber, were noted. Over a 4-year period it was consistently found that oversized, mature tubers in excess of one-half pound in weight contained more moisture and less starch than smaller tubers.

With the use of a coefficient for variety, it appears that a satisfactory factor for starch content for commercial tubers could be based upon dry matter content.

Good yields of good quality potatoes can be grown in soils of pH ranging from 5.5 to 8.5. The soil pH did not materially affect the pH of the tuber within this range (the tuber pH ranging from 5.6 to 5.8). Phosphate, nitrogen, and potassium fertilizers in different soils not only increased yields but imparted other qualities. Phosphate application consistently tended to produce thicker, well-rus-

seted skin, while potash produced light-colored, starchy, and thinskinned tubers. The specific gravity of the tuber juices gave no consistent indication of either the mineral ash content or starch.

The ash content of mature tubers ranged between .4 percent and 1.2 percent, with an average (250 samples) of .9 percent. From Colorado soils which are usually well supplied with soluble minerals the total mineral content of tubers appeared to bear a rather complex relation to the moisture supplied during the growing season.

Dry-land tubers were significantly higher in nitrogen content and lower in starch content, with the possible exception of Irish Cobblers and Bliss Triumphs which are early varieties and appear to do equally well under irrigated and dry-land conditions.

The foregoing were among our most important findings. The laboratory and field work on this project has been completed.

PROJECT 2. A study of the Base Exchange Capacity of Typical Native Sods and Cultivated Soil Profiles of Colorado, Together with the Effects of Saline Irrigation Waters upon Adsorptive Soil Complex.—Some 40 soil profiles in 4-inch sections down to a depth of 3 feet have been subjected to chemical investigation. These soils were from the dry-land and irrigated sections of the eastern half of the State. Rather voluminous data have been accumulated, and these will require intensive study before final deductions are attempted.

Based on ready observations during the course of sampling, it was apparent that Colorado has many distinctive types of soil, mostly young in stage of evolution. Many of the native sods are neutral or acid in the surface few inches, while irrigated soils range from neutral to rather alkaline reactions at the surface. From the profiles sampled it would appear that there is a greater tendency to the formation of "hard pan" in dry-land soils than is the case with irrigated ones.

The laboratory work dealing with these profiles will be completed this year, but a systematic tabulation and study of the data will remain.

PROJECT 3. Inorganic Constituents of the Alfalfa Plant in Relation to the Available Soil Nutrients.—This project was undertaken (1939) to study the variation in mineral composition of Colorado alfalfas which could be attributed to their growth in soils of varying fertility—such as long-cropped soils, irrigated soils, new-irrigated soils, and mountain-valley soils.

Samples of soil and plant have been collected for 1 year and are in process of study. This work has not progressed far enough to warrant any comments. The project is being continued. PROJECT 4. A Study of the Causes of Urinary Calculi in Feeder Lambs (cooperative with the Pathology and Bacteriology Section and Animal Investigations Section).—Owing to the feeding of concentrated rations in the feed lots, some systems of stock feeding have caused losses of wether lambs and steers, especially toward the end of a feeding season. These losses have caused some concern among livestock feeders of northeastern Colorado and have been diagnosed as due to the formation of precipitates in the urinary tract.

This is a continuing project and is of rather large scope. In 1938-39 the study was based on seven lots of feeder lambs (source, New Mexico) which were maintained for 120 days on seven distinct feeding regimes. The mineral composition of the urine of 49 lambs was followed throughout the feeding period. Seventy lambs (10 from each lot) were bled at the beginning and at the end of the feeding period to find any changes in their blood content of calcium, phosphorus, and magnesium.

Many interesting facts were observed, and the work has been repeated this year (1939-40) on 20 lots of lambs (source, Wyoming). During this season 20 feeding regimes were followed in a similar manner. The mineral composition of urines from 40 lambs (2 from each lot) was followed, and 100 lambs (5 from each lot) were bled at the beginning, in the middle, and again at the end of the feeding period to find any changes in the content of essential minerals. The chemical investigations of blood and urines are still in progress.

It is desirable to continue this project for another year in a more intensive study with a smaller number of lambs, taking a course which will be indicated by the findings of the past two feeding seasons.

Urinary calculi in livestock have been studied by other experiment stations and in foreign lands. Among the conclusions reached by other workers, lack of vitamins (A in particular), deficiencies or excess in certain minerals, and the volume of water consumption occupy prominent place. Our own work thus far is not contradictory to any of these findings but does indicate that the cause in a given case is not due to a single factor but probably to a combination of factors.

Our laboratory has had occasion to test "bladder stones" from several species of animals. In a very general way the components have been 35 to 55 percent volatile and organic matter, with the balance of inorganic constituents. Among the latter have been found magnesium, calcium, alumina, and some iron among the basic ions, and phosphates, sulphates, carbonates, and silicates among the acid ions.

Fodder from corn, cane, mountain meadow rushes and sedges, and similar species is inordinately high in silica content, and in the present study there are some indications that silica is at least a factor in the cause of urinary precipitates.

Interdepartmental and Miscellaneous Service

As in the past, numerous chemical services have been rendered to other sections of the Station, as well as to citizens of the State. The latter were largely of the nature of livestock-poisoning cases and poison weeds and livestock drinking waters.

As by agreement in past years, in cooperation with the Colorado Director of Markets and Food Inspection, this Section tested between September and November 1939 some 300 samples of fruit for arsenical spray residues.

Entomology Section

General Insect Problems

The largest general insect problem of last year was the grasshopper plague. The infested areas did not change materially from those of the previous year. Financial aid was obtained from the Federal Government, and the control work was again under the direction of Mr. Sam C. McCampbell, Extension Entomologist, with the Station Entomologist cooperating.

General insect problems, outside a few severe outbreaks, were about the same as last season, and in most cases were handled by correspondence through the Entomology office. Only in emergent cases were Station men detailed to the site of infestation.

The new household pest for Colorado reported last season from Wray, Colo., appeared again this season in Pueblo. No work has been attempted to control it.

A Harlequin cabbage bug occurred in vast numbers in the southern part of the State. A preliminary field test, made by Mr. John L. Hoerner, of 15 percent dry pyrocide and 85 percent talc, applied to two infested fields and one cage experiment, gave a very satisfactory control. Field tests of the same materials and the same strength made on Say's plant bug, which occurred in vast numbers in various parts of the State, were also satisfactory.

Tomato Pests

It is very questionable whether sulphur compounds should be used for psyllid control on canning tomatoes late in the season. In early June it appeared that psyllids might be abundant on tomatoes. Several nonsulphur compounds were tested with satisfactory results. Dust applications were made on June 12 and June 22. All insecticides used killed some of the psyllid nymphs. The untreated plants did not have enough psyllids on them to develop the "purple-top." No differences in yields were obtained.

With the cooperation of Mr. McCampbell, insecticides were furnished to Mr. Breiding of a canning company at Brighton for experimental use on the tomato psyllid and striped cucumber beetle. The failure of these insects to develop in injurious numbers this season has resulted in almost total failure to obtain control results.

Work on the tomato fruit worm in the Arkansas Valley was continued this season. Worms appeared on the tomatoes at a much later date than last year and were not nearly as numerous. This year at the first picking of tomatoes on August 30 the untreated tomatoes averaged 0.5 percent wormy as compared to 6.5 percent in 1938. The last picking was 5.9 percent wormy as compared with 31.5 percent in 1938. Two liquid sprays, and commeal mixed with cryolite, were included in the tests this year.

Plant Bug on Potatoes

Late in July, calls from Hillrose, Brush, and Fort Morgan, and sections of Weld County, brought to our attention a serious potato crop injury by Say's plant bug, Chlorochroa saui, Mr. L. B. Daniels went to Hillrose where detailed studies were made on the condition. It was found that some fields were injured 85 percent, a single plant having as many as 27 of the adult insects feeding upon it, producing a condition very similar to psyllid vellows. This is a new potato disease and is apparently carried and transmitted by the feeding of the pentatomid, Chlorochroa savi Stal. In the field where the disease was first noted, no psyllids could be found, but 13 percent of the plants were showing symptoms closely resembling vellows. This field had been spraved five times with lime-sulphur and zinc arsenite. Detailed examination showed in every case a definite relationship between plant bug feeding and the disease. Cage experiments at the Colorado Potato Experiment Station of the United States Department of Agriculture at Greeley confirmed the observations made at Hillrose. The disease was found to be widespread in Weld and Morgan Counties. The term, "big bug blight", has been applied to the condition. Detailed descriptions were made, and further studies on this disease were carried on during the later summer and fall. Some of the findings have already been published.

Aphids of Colorado

The project on aphids has been continued by Miss Miriam A. Palmer in connection with another Station project. Several aphid determinations were made by her for various entomologists. Ten additional species from Morocco have been added to the collection here, together with 30 Colorado slides containing 14 species, 2 of which are new to the aphid key Miss Palmer is compiling.

Syrphidae in Relation to Plant Lice Control

The project on Syrphidae in relation to plant lice control has received minor attention by Miss Palmer and Dr. C. R. Jones. Several new records were made on feeding habits and life history, and seven parasites were reared from five species of Syrphidae. Miscellaneous breeding cage work was conducted along with this project.

Cucurbit Insects

With the limited funds available Mr. Hoerner continued the project on cucurbit insects. Insecticides tested for the control of the squash bug were made on a randomized Latin square consisting of 25 plots. Fourteen applications of dust were made at about 3-day intervals from June 14 to August 11. The insecticides tested were applied on the squash variety, Buttercup, and resulting yields were as follows:

- 1. Dry pyrocide 15 percent, talc 85 percent; 7.11 tons an acre.
- 2. Dry pyrocide 10 percent, talc 90 percent; 8.83 tons an acre.
- 3. Dry pyrocide 10 percent, gypsum 90 percent; 5.86 tons an acre.
- 4. Calcium cyanide around plant killed all plants; replanted June 16 and dusted as in test 1, using dry pyrocide 15 percent and talc.
- 5. Untreated check; 0.08 ton an acre.

Psyllid Resistance

The psyllid resistance project formally drawn up in 1938 has been carried on by Mr. Daniels in cooperation with Mr. W. C. Edmondson, Bureau of Plant Industry, at the Colorado Potato Experiment Station at Greeley. Mr. Daniels has propagated a disease-free population of psyllids at Fort Collins and has made releases on the various strains and hybrid potatoes grown in the greenhouse at Greeley to ascertain their resistance to psyllid yellows. Propagation of psyllids was begun in September, test plots were started in March, psyllid releases were made early in April, and the first symptoms appeared in late April. Several potato strains have shown resistance. The most promising ones are being tested under field conditions at

Estes Park, Fort Collins, and Greeley. The experiments, although preliminary in many respects, yielded important data on variation in plant reaction to psyllid feeding, additional evidence on the time required to produce symptoms, and information on the effects of extreme psyllid population under controlled conditions. Thirty-four family lines of potatoes were grown, with Bliss Triumph used as the check. Perfect symptoms of psyllid yellows were obtained in the greenhouse experiments. Four strains showed resistance to psyllid feeding.

Peach Mosaic

Mr. Daniels continued the peach mosaic project on the Western Slope. This work was carried through the summer until late October.

The work consisted of continuing the case studies begun in 1938. Fifteen trees previously diagnosed as positive cases were removed by the eradication crews on the first survey. Studies on alternate hosts of the green peach aphis, *Myzus persicae*, were undertaken. The common morning glory, which is extremely abundant in the Palisade area, serves as an important late summer and fall host for this aphid. Detailed charting and close study of this perennial weed as a possible reservoir for peach mosaic were carried out through the summer and fall. Transmission experiments were started. Aphids and plant bugs were used in a variety of tests to ascertain whether the virus could be transmitted from diseased to healthy peaches; data is expected to be obtained from these tests next year. Other experiments were carried on with groundcherry and morning glory, both of which carry a mosaic condition in the seriously diseased orchards.

In October fall readings were again made from the case studies previously charted. Tabulated data indicate that nearly 50 new cases will be removed next spring. A number of study areas were photographed and carefully charted. Three rows of peach pits were planted at Whitewater for additional work in 1940.

Sprayer Efficiency

Work on the sprayer efficiency project has been carried on at the Colorado Potato Experiment Station at Greeley on a limited scale this season. The fact that there were no psyllids on the late plantings made work on this project of little value. However, data on flea beetle control are being taken on the basis of experiments in which tractor speeds were varied. Pressure, concentration, and number of applications were constant. The harvest samples are now being checked and tabulated.

Home Economics Section

Baking of Flour Mixtures at High Altitudes

Directions for preparing and baking yellow sponge cakes at different altitudes have appeared in bulletin form (Tech. Bul. 27). It has been possible to maintain the sugar requirement of these sponge cake formulas constant over the altitude range from sea level to 12,000 feet. This was accomplished because of the more complete understanding of the relative contributions of the various ingredients to the strength and texture of the resulting cake structure gained in this study. The balanced formulas for each altitude given were adapted for use with hand equipment, small mechanical mixing equipment, and larger equipment of the commercial type. Improved methods of mixing were given.

The most common cause for failure of this type of cake at high altitudes has been the failure to control the quantity of leavening air introduced into the batter. Directions for the measurement of this ingredient were given.

Air pressure conditions prevailing from 5,000 to 7,500 feet altitude are the most favorable for the development of qualities most desirable in yellow sponge cakes from the ingredients in this batter.

Studies on the stability of egg foams and meringues containing egg yolk were reported in part. These studies are being continued.

Foundation Butter-Type Cakes

A preliminary report of the work on whole-egg cake containing shortening has appeared. In this and a more extensive report now in press formulas for whole-egg cakes of normal and high-sugar ratio are given for different altitudes.

Difficulties arising from the use of ordinary hydrogenated shortening in the preparation of whole-egg butter-type cakes high in sugar, liquid, and eggs may be overcome by a suitable modification of the single-stage method of mixing. This method of mixing was found to be superior to the conventional methods used.

The water requirement for a particular cake batter is determined to a large extent by its sugar content. This correct water-sugar ratio must be varied with altitude. The proper water-sugar ratio and the right amount of leavening are two outstanding factors which must be controlled for cake formula balancing at any altitude.

The basic whole-egg cake formula, lean in sugar, eggs, liquid, and shortening, was rebalanced stepwise with added increments of sugar, egg solids, shortening, and liquid. A nomograph based on these findings has been prepared which permits the formulation of an indefinite number of whole-egg butter-type cake formulas for any altitude up to 10,000 feet.

Cost data per unit of cake volume produced indicate that as sugar and liquid are increased in a cake formula egg solids and shortening should also be increased. When a proper balance is maintained between these different ingredients of the cake batter, cakes high in sugar, milk, and eggs can be produced as economically, volume for volume, as cakes lean in these ingredients.

Cooking Quality of Eggs

The project on cooking quality of eggs is being conducted in cooperation with the Poultry Section. In preliminary studies a year ago it was established that a high coefficient of correlation existed between certain physical measurements used in estimating egg quality and the volume and quality of cakes prepared therefrom.

Present studies confirm the observations of others that great differences exist in the quality of newly laid eggs. Moreover our observations show that rates of deterioration of eggs from different individual hens vary tremendously. Physical measurements used to estimate the egg quality and follow their deterioration rates could be used to predict the relative volume and tensile strength of cake produced therefrom with remarkable accuracy, as long as eggs from a single individual were used. This close agreement holds for approximately 90 percent of the birds. The eggs of the other 10 percent are equally outstanding in their disagreement.

By selection of low-quality eggs on the basis of these physical measurements and the use of these selected eggs in preparation of whole-egg sponge cakes, it has been found that such eggs yield cakes at 5,000 feet altitude that are comparable in all physical measurements to cakes baked with high-quality eggs at 9,000 feet altitude. This means that the strength of the cake structure yielded by these low-quality eggs is only 52 percent of that obtained when high-quality eggs are used. These observations should find application in the frozen egg industry.

A study of the relation of egg quality to the characteristics of custards prepared and baked therefrom is being conducted through the cooperation of Dr. Elfriede F. Brown of the Division of Home Economics and Miss Hannah Yanke. They report that when the same weight of whole-egg substance is used in the preparation of cus-

tards, those prepared from eggs stored at room temperature for 10 and 30 days were comparable in palatability, firmness, and smoothness of curd to custards made from newly laid eggs. However, custards prepared from eggs stored at room temperature for 20 days were not as palatable and with the same baking period did not undergo the same degree of coagulation as custards made from fresh eggs.

Culinary Quality of Potatoes

A study of the effect of fertilizer treatments upon the culinary characteristics of Russet Burbank potatoes has proceeded far enough so that certain conclusions may be drawn. The field treatments involved the addition of the following elements and combinations: Nitrogen, phosphorus, potassium, nitrogen plus phosphorus, phosphorus plus potassium, and nitrogen plus phosphorus plus potassium. Penetrometer studies show that nitrogen fertilization alone produced potatoes which were significantly firmer when cooked than did the other fertilizer treatments. Moreover these potatoes held their firmness in storage over a longer period of time than did those receiving the other growing treatments. Potatoes receiving the potassium and phosphorus supplements alone cooked the most unevenly when boiled and gave the greatest mean penetration. The untreated check plots produced potatoes which when boiled were comparable in their firmness to potatoes from the nitrogen-treated plots, but these potatoes did not hold their crispness in storage as did those from the nitrogen-treated plots.

The sloughing of pared boiled potatoes was shown to be related to the rate of solution in hot water of the pectinous material in the tissue. Sloughing in potatoes with high sloughing tendencies can be controlled by the addition of sufficient calcium ion to the water in which the potatoes are boiled to keep the pectins in an insoluble form. If one-eighth of the 1-percent salinity required in the cooking water to impart the proper flavor to the boiled potatoes is due to the presence of a suitable calcium salt, sloughing is no longer troublesome.

In deep fat frying tests Colorado-grown Triumphs and Chippewas proved very unsatisfactory. Cobblers were intermediate. Russet Burbank, Katahdin, and R-10 potatoes were satisfactory. The Chippewa proved to be a potato of poor quality by every cooking method tried. Over a period of years the Katahdin potato grown in Colorado has been of much higher quality from the culinary standpoint than the experience of workers in other states would lead one to expect. When boiled it is only moderately mealy, but it is a good baker and has good deep-fat frying qualities. R-10 was comparable in quality to the Russet Burbank.

The potatoes for this project are provided through the cooperation of the Horticulture Section and are grown under its supervision.

Pome and Stone Fruits

A new project on pome and stone fruits has been undertaken because of widespread demand upon the Horticulture and Home Economics Sections for information regarding the culinary and processing qualities of new and standard varieties of Colorado-grown fruits. The project is a cooperative one with the Horticulture Section.

An investigation of the canning qualities of freestone varieties of peaches which were considered promising from the production standpoint gave the following noteworthy results for the 1939 crop. Of all varieties tested, the Station strain of the Canadian Queen showed the smallest shrink during processing. This difference was highly significant when the standard Elberta was used as the basis of comparison and was also highly significant when the mean of all varieties was used. Canadian Queen, Vivid Globe, and J. H. Hale gave smooth pack peaches. The packs from standard Elberta, July Elberta, and Jewel were distinctly ragged. Consumer preference scores and other data indicate that Jewel and Z-peach have little to recommend them and possess characteristics that are distinctly undesirable.

In a study of cherry juice preparations and blends it was found that the consumer preferred a fresh juice flavor to a cooked flavor. Juice from cannery pitters was too dilute to make a palatable beverage but could be used satisfactorily in blends with cold-pressed juice. This juice after clarification did make excellent jelly. Two juice blends were considered very attractive and palatable in consumer preference tests: (1) a cocktail made of two parts clarified coldpressed Montmorency juice and 1 part 15-percent sugar syrup and (2) a cocktail containing 50 percent clarified cold-pressed Montmorency juice, 16.7 percent clarified hot-pressed Montmorency juice, and 33.3 percent of 18-percent sugar syrup. Clarified cold-pressed Montmorency juice and blends of clarified cold-pressed and hot-pressed Montmorency juices made excellent jellies.

Horticulture Section

The results reported on projects of the Horticulture Section should not be considered final, but more as information developed during progress of the work.

Colorado's annual income from the sale of horticultural crops amounts to more than 25 million dollars. These crops are produced under intensive cultural methods and are highly perishable, so that

problems arise rapidly and cause heavy losses in a short time. While fairly good progress has been made on projects, the staff and budget are too small to take care of the problems of the field adequately.

Vegetable Crops Projects

POTATO BREEDING AND IMPROVEMENT (in collaboration with the U. S. Department of Agriculture).—This project consists of crossing potato varieties and inbred lines and testing of the hybrids for yield, quality, disease resistance, and adaptation to Colorado conditions. Three varieties have been released during the past few years: Red McClure, Katahdin, and Chippewa. Resistance to scab is also being studied on many hybrid seedlings.

COMMERCIAL FERTILIZERS FOR POTATOES.—This project includes the study of the effect of nitrogen, phosphate, and potash in combination and in single element applications on the yield and quality of potatoes. The results in the various districts vary widely, and until the project is summarized over the 5-year period, final conclusions cannot be given. Present indications point to favorable increases in yield from the use of commercial fertilizers on extremely light sandy loam soils, from supplementary applications of animal manures, and from turning under green manure crops. So far, phosphate applied alone has hastened maturity, thickened the skin, and reduced bruising and handling injury.

BACTERIAL RING ROT OF POTATOES (in cooperation with Botany and Pathology and Bacteriology Sections).—Results to date indicate that losses from bacterial ring rot can be reduced by (1) planting disease-free seed; (2) disinfecting cutting knives; (3) warming up seed potatoes before planting and discarding all slow-sprouting or dormant tubers; and (4) treating the seed after cutting. Special methods have been developed to identify the disease in tubers and in plants. Cleaning up seed stocks is the chief method of preventing transmission, and every effort is being made to do that as rapidly as possible by developing new foundation seed stocks.

ONION BREEDING (in collaboration with U. S. Department of Agriculture).—The first-generation crosses in the development of a thrip-resistant variety of onion will be back-crossed to Sweet Spanish and Mountain Danvers this year. Lines are also available that are resistant to purple-blotch disease, and these are being used to develop varieties resistant to both the disease and the thrip insect pest. Inbred lines are being maintained for breeding purposes.

VEGETABLE VARIETY TESTING.—Introductions released by experiment stations, seed companies, the Department of Agriculture, and other agencies are tested on a trial ground basis every year. The in-

formation obtained is useful in breeding work and in supplying growers with information on types and yield performance of main crop varieties. Lack of space prevents a detailed report of results.

Fruit Crops Projects

TREE FRUIT VARIETY TESTING.—Tree fruit variety tests at Fort Collins and on the fruit substation at Austin, Colo., are being continued. Lack of space prevents a detailed report.

ORCHARD MANAGEMENT.—In fertilizer trials with sour cherries (cooperative with Agronomy Section) applications of a nitrogen-bearing fertilizer alone, and manure alone, continue to show significant yield increases over all other treatments being used. Yields obtained with nitrogen and phosphorus, and with phosphorus and potassium, also continue above check plot yields, but the differences are steadily decreasing. In contrast, yields where nitrogen, phosphorus, and potassium all have been applied are continuing to increase. All differences in yield obtained so far have been from an increase in the number of fruits set, and not from an increase in size of individual fruits.

In the study of fruit tree rootstocks, mahaleb rootstocks have shown superiority over mazzard rootstocks for the Montmorency sour cherry in northern Colorado in three respects: Tree survival, rate of tree growth, and incidence of chlorosis.

In tests of the use of straw mulch, at the end of 2 years Montmorency sour cherry trees on mahaleb roots which have been heavily mulched with straw showed no trees seriously chlorotic, while more than 12 percent of the trees on the same rootstock grown under continuous clean cultivation were severely chlorotic.

The effect of commercial fertilizers on the yield and quality of peaches is being studied on the fruit substation on the Western Slope. A comparison of cover crops turned under for green manure is also being made there.

CHLOROSIS OF STONE FRUITS (cooperative with Agronomy and Botany Sections).—Nutritional tests with Elberta peach trees grown in quartz with nutrient solutions are being continued. The present tests seem more positive than those of last year. Some relationships between the calcium and the potassium content of the nutrient solutions are indicated.

WINTER INJURY ON RASPBERRIES.—The first readings on the effect of fertilizer applications, late irrigation, and winter protection treatments on winter injury of raspberries were taken this spring. No difference in survival of canes is noticeable to date on any of the treatments.

Flower Crops Project

FERTILIZER TREATMENTS ON CARNATIONS.—Tests are under way to ascertain the best medium, such as gravel, quartz, and other materials, for use in the growing of carnations in liquid nutrient solutions. A comparison of nutrient solutions of different nitrogen, phosphorus, and potash levels is under study. The results should discover practices that will remove some of the hazards of production in soil.

Requests for Additional Work

Requests are received for answers to problems on (1) lower-cost cultural methods; (2) plant nutrition; (3) better and more disease resistant varieties; (4) better methods of handling fruits and vege-tables during harvest, storage, and marketing; (5) better protection from diseases and insect pests; and (6) methods of utilizing unmarketable surplus fruit and vegetables.

Budget

The operating budget is far too small to cover the field of work. Sales income is used to cover the cost of maintaining the physical plant, since no funds are available to maintain greenhouses and the orchard and gardens, other than from sales of products.

Personnel

There are now about 1.5 technical men in Horticulture, which is not sufficient personnel to take care of present projects to the best advantage.

Seed Potato Certification

This year marks the first time that mature field inspectors have been used in seed potato certification. Grower confidence has shown a decided change for the better, and the quality of the product is much better. This year there has been more active participation by the Extension Service and more support from the Experiment Station in maintaining foundation seed stocks. This change was badly needed, especially since the state-wide occurrence and serious losses now caused by bacterial ring rot of potatoes. The first recommendation on the control and prevention of transmission is through the use of disease-free seed stocks.

The certification program is divided into five steps:

1. Maintenance of disease-free foundation seed stock by the Experiment Station.

2. Increase of foundation seed by foundation seed growers for sale to certified seed growers, who in turn sell to table-stock growers.

3. Test-plot plantings of all certified seed growers' samples in Colorado, and in Alabama and Louisiana.

4. Two field inspections and one bin inspection after harvest are required, and all seed must meet set standards on freedom from disease, varietal mixtures, and other requirements.

5. Station work on problems which develop in maintaining foundation stock, and on how diseases or other troubles are transmitted. The potato breeding and variety testing work of the Station is directly tied into the certification program.

The program of potato seed certification is maintained by a special biennial legislative appropriation and by application and tag fees collected by the Colorado Certified Seed Growers' Association. The following tabulation gives data on potato seed certified in 1939:

Number of growers	Acreage	Total bushels	Counties
156	3,015	705,600	21

No fields of potatoes were certified where plants showed any external symptoms of bacterial ring rot.

The new greenhouse lean-to was completed this winter by funds cooperatively furnished by the Colorado Certified Seed Potato Growers' Association and the Public Works Administration. Over 20,000 tubers were indexed and returned to foundation growers for increase. This work is necessary and is the basis of a sound potato seed program in the State.

The cooperation of the Extension Service through the specialists and county agents, and the added support of the Experiment Station on the bacterial ring rot disease problem, are greatly appreciated by potato growers' organizations as well as by this Section.

Pathology and Bacteriology Section

Animal Pathology

Poisonous Plants

Oxytenia acerosa.—Further experimental work with oxytenia has shown the dried stems (stored more than 1 year), devoid of leaves, to be toxic when force-fed to a lamb. The dried ground plant when mixed with tannic acid was toxic when administered to a lamb, indicating that the poisonous principle is probably not an alkaloid. LARGE BUTTERCUP AND SMALL BUTTERCUP.—Both plants were nontoxic in the amounts force-fed to a lamb.

GUM WEED.—Gum weed was found to be nontoxic when forcefed to a lamb.

BLUE-GREEN ALGAE (Anabacna flos-aquae).—These microplants were found in a small pond in northern Colorado where many wild birds and a few domestic ducks had died. The water on the windward side of the pond was blue green in color because of concentration of the algae by the wind. Experimentally, the pond water was found to be toxic to rabbits, guinea pigs, and chickens. The water was still toxic when boiled (30 minutes) or filtered through a Seitz disc. Botulinus antitoxin failed to neutralize the toxic principle.

Suckleya suckleyana.—Studies on the variation in the hydrocyanic acid content of Suckleya suckleyana have been continued. A part of these are mentioned under soil microbiology in this report. The titrations with rabbits checked very closely with the chemical analyses when the amount of hydrocyanic acid was not lower than 0.75 milligram per 10.0 cc of aqueous extract.

NITRATE CONTENT OF PLANTS.—Preliminary work has been done on nitrate content of plants in cooperation with the Agronomy Section.

In oat hay the nitrate is changed to nitrite in the rumen and is absorbed as such. Nitrite is toxic and combines with the blood to produce methemoglobin. In vitro the rumen contents of cattle will reduce nitrate to nitrite in from 4 to 6 hours at 37° C. Water extracts prepared from oat hay, which was toxic to cattle, killed a lamb following oral administration. The lesions were not typical of oat hay poisoning found in cattle.

Water extracts prepared from beet tops (18 kilograms) known to contain nitrate were toxic when given to a lamb. Here again the lesions were not typical of nitrite poisoning. It seems apparent either that sheep react differently than cattle to forage containing potassium nitrate or that sheep die from the effects of the salt (potassium nitrate) before reduction to the nitrite has taken place.

Lambs

Sore MOUTH VACCINATION.—In one lot of 3,000 lambs which had approximately 15 percent infection of sore mouth upon arrival, vaccination stopped the progress of the disease in the infected animals and immunized the remainder against the disease.

PARASITES.—Three field outbreaks of coccidiosis have been investigated. The losses varied from 1 to 3.4 percent. This disease broke

out among the lambs on the calculi experiment. The lambs were turned out during the day on dry bluegrass pasture and at night were fed cane hay. A death loss of 1.2 percent occurred with 0.8 percent culls.

A critical parasite study was made on fecal samples from 170 lambs submitted for autopsy. Coccidia were found in 160 (94.1 percent) of the samples. The parasite distribution was as follows:

Name	Number	Percent	
Eimeria arloingi	151	88.8	
Eimeria parva	98	57.6	
Eimeria nina-kohl-yakimovi	- 70	41.1	
Eimeria faurei	31	18.2	
Eimeria intricata	16	9.4	
Hemonchus contortus	83	48.8	
Ostertagia spp.	11	6.4	
Nematodirus filicollis	74	43.5	
Trichuris ovis	34	20.0	

In connection with the study of the fringed tapeworm, methods have been developed which have made it possible to recover the eggs and egg cases in cast-off segments and in lamb feces. The finding of the egg cases represents a distinct contribution to the study of the life cycle of this worm. The contents of 125 intestines have been examined and 443 gravid segments recovered. *Moniezia* spp. were present in 51 (21.8 percent).

In a total of 233 lambs autopsied, 88 (37.7 percent) showed fringed tapeworms in the liver, 74 (31.7 percent) in the intestines, and 48 (20.6 percent) in both intestines and liver.

Among the 117 lambs dead of overeating, 51 (43.5 percent) showed fringed tapeworms in the liver, 49 (41.8 percent) in the intestines, and 31 (26.4 percent) in both intestines and liver.

In the 116 lambs dying from other causes, 31 (26.7 percent) showed fringed tapeworms in the liver, 25 (21.5 percent) in the intestines, and 17 (14.6 percent) in both liver and intestines.

OVEREATING.—Cultures of *Cl. welchii* isolated from lambs dead in the feedlots are being studied for toxin production. Difficulty is being encountered in getting the micro-organisms to produce a potent toxin which is necessary for typing purposes.

The pH of the intestinal contents of lambs recently dead is being run in order to ascertain the effect of the hydrogen-ion concentration upon diseases of the digestive tract, particularly overeating:

Cause of death	Number	Duodenum	Jejunum	Heum
overeating	s	5,43	6.46	6.49
Pneumonia	3	6.61	6.87	6.78
Coccidiosis	4	6.7	6.52	7.25
Slaughter	3	5.21	7.2	7.8

THYROID GLANDS.—The majority of thyroid glands from lambs which have received no iodine in the ration are enlarged about three times as compared with the glands from lambs on iodine supplement.

URINARY CALCULI.—The urinary calculi project is being continued in cooperation with the Sections of Animal Investigations and Chemistry. Two cases (8.0 percent) of calculi occurred in the lot fed milo, bran, cane fodder, and salt.

Cattle

A condition in cattle has been investigated in which the principal lesion is a large hemorrhage located in the thalamus of the brain. The first cases were observed in cattle in the Eads area, while more recent ones have appeared in the vicinity of Fort Collins. Information on feeding practices and the water supply is being collected. No results have thus far been obtained to indicate that this is an infectious disease.

A herd of range cattle on the Western Slope was found to be heavily parasitized with stomach worms (Ostertagia spp.), Nematodirus filicollis, and tapeworms (Moniczia planissima). Fecal samples of cattle from other areas have been examined. Stomach worms (Ostertagia spp.) were found in three separate mountain areas. No significant infestations other than coccidia have been found in the Plains area. Tapeworm eggs were found in three of six herds on the Western Slope.

Bimonthly fecal examinations have been made on 80 feedlot steers belonging to the Animal Investigations Section. Four different coccidial species were found, namely: *Eimeria smithi* (predominate), *Eimeria zurnii, Eimeria cylindrica*, and *Eimeria clipsoidalis*. Stomach worm eggs (Ostertagia spp.) were also found.

Bang's Disease

The incidence of Bang's disease in the Station herd at Avon has been reduced from 24 reactors in 1936 to no reactors and no suspects in the last 2 blood tests.

After each blood test the reactors were sold and the suspects were quarantined. The feeding of hay from bunks and the frequent removal of manure has also been helpful in controlling the infection.

Routine testing of blood samples in cooperation with the Federal Bureau of Animal Industry has continued. Since the last report 46,644 blood samples have been tested, 852 of which were positive.

Canine Coccidiosis

Critical fecal studies showed sulfanilamide to be effective in eliminating *Isospora bigemina* from six of seven acute cases of mixed infections. *Isospora rivolta* and *Isospora felis* apparently passed into the chronic stage. All dogs recovered.

Poultry

IODINE REQUIREMENTS OF CHICKENS.—Study of iodine requirements of chickens, in cooperation with the Poultry Section, has been continued.

PULLORUM DISEASE AND PARATYPHOID INFECTION.—These account for the major portion of the death losses in turkey poults during the first month of life. During the spring of 1939, 28 cases of pullorum disease were reported, which represents only a portion of the total number of outbreaks. In 13 outbreaks involving 18,700 birds, 3,363 (18 percent) of the poults died during the first 3 weeks. There were six outbreaks of paratyphoid infection. In one outbreak involving 500 birds, 70 (14 percent) poults died during the first 3 weeks.

Three breeding turkey flocks were blood tested for pullorum disease, and the reactors and suspicious birds were removed. No pullorum disease occurred in poults hatched from eggs coming from these flocks.

The ovaries of 31 suspicious birds from 1 flock were cultured, and *Salmonella pullorum* was isolated from 19 percent of these organs.

A group of 8 reacting turkey hens and 11 suspicious birds were kept, and the incidence of pullorum infection in the eggs and poults was observed. *S. pullorum* was isolated from four eggs and one poult.

THYROID STUDIES.—In cooperation with the Poultry Section, histological studies are being made on thyroid tissues from rats and fowls which are on various experimental diets.

1. Dinotrophenol seems capable of restoring a goitrous thyroid to a normal gland.

2. Soybean oil meal contains a factor which is goitrogenic.

3. Chicks hatched from eggs laid by hens on a goitrogenic diet have thyroids which are goitrous to the same extent as that of the mother.

4. It appears that the thyroid gland under certain circum-

stances is capable of using certain thymus cells in the formation of follicles.

5. In work which was in cooperation with the Chemistry Department, University of Colorado, diethyl-stilbestrol appeared to be carcinogenic for 4 of 20 rats injected. Metastasis occurred in the animals.

A staining technique has been developed which can be used as a basis for studying the activity of the thyroid gland.

Diagnostic Services

A summary of the diagnostic service is given :

Number	of Bang's disease tests run	6,443	(813 reactors)
Examina	ations:		1.0
	Chickens	734	
	Turkeys	435	
	Cattle	107	
	Hogs	33	
	Sheep	26	
	Dogs	19	
	Horses	20	
	Water samples	98	
	Miscellaneous	34	
	Total	7,949	

Soil Microbiology

Decomposition of Organic Matter

Work on the project on decomposition of organic matter has continued to deal with the bacterial decomposition of cellulose. Studies have been continued on methods for ascertaining the amount of cellulose decomposed and on the mineral nutrition of the organism concerned.

Studies on Azotobacter

Previous ecological and physiological studies showed that upon incubating a soil with sodium benzoate it was possible to demonstrate the presence of *Azotobacter vinelandii* which had not before been found in Colorado soils. This work has been repeated with the same result, and by using a modified method the organism has also been demonstrated to be present in another soil. A more extensive study is now under way, including a larger number of soils. Studies have been made on factors influencing pigment formation by *Azotobacter* vinelandii. The utilization of various benzoic acid compounds by different species and strains of *Azotobacter* have been investigated.

Miscellaneous

In cooperation with the Botany Section, investigations were continued on factors influencing the hydrocyanic acid content of *Suckleya suckleyana*. During the summer of 1939 it was possible to obtain for the first time a complete series of samples over the entire season at a single location. Analyses show that the plant contains the most hydrocyanic acid and therefore is most toxic at about the time of flowering or the beginning of seed formation. The toxicity varies greatly with location, but the factors causing this have not yet been definitely shown.

Personnel

Dr. F. X. Gassner was transferred to this Section September 1, 1939.

Poultry Section

Sources of Green Feed for Poultry

The chick assay for vitamin G was found to be more accurate when the chicks were depleted the first 2 weeks of life than when they were put on various levels of riboflavin at hatching time. White Leghorn chicks were preferable to White Rock chicks. The White Rocks evidenced a considerably lower requirement for riboflavin.

Samples of alfalfa hay, cut at various stages of maturity, have been supplied for vitamin G assay through the cooperation of the Agronomy Section. Riboflavin assays by both the chick and the microbiological method *(Lactobacillus casei)* are in progress to determine the most economical yield per acre of this vitamin in this plant. The results of this first year are not clear-cut, owing to grasshopper damage in various lots.

Chick assays of dried buttermilk produced in Colorado confirm earlier results showing that it contains at least 30 micrograms of riboflavin per gram.

Inorganic Elements in Poultry Nutrition

Finely divided bonemeal as such or as it occurs in meat scraps appeared to cause slightly less perosis than the coarsely ground bone. Meat scrap caused slightly more perosis than fish meal. Manganese adsorbed on bonemeal was no more readily utilized than that added separately. Manganese phosphate was as effective as the sulphate.

Alkaline water from northeast Colorado had no effect on the incidence of perosis.

Vitamin G Requirements of Turkey Breeders

Results of the first 3 years of study of the vitamin G requirements of turkey breeders indicate that turkey breeding rations should contain at least as much if not slightly more vitamin G than chicken breeding rations. The critical point approximates 225 units of vitamin G per 100 grams of ration or slightly more than this amount. The percentage hatch of fertile eggs declined in direct proportion to smaller amounts and increased only slightly on larger amounts. Breeders confined to indoor pens allowing about 4 square feet of floor space per bird produced a few more eggs per bird than those allowed sheds opening on the south into outdoor yards. However, fertility was slightly better in the outdoor pens so that the total number of poults produced per bird under the two conditions was about the same.

The fourth year on this project is under way.

Iodine Requirements of Poultry

Thirteen experiments on iodine requirements of poultry have been completed to date, involving from 6 to 22 pens each. Histological studies of thyroids from more than 1,000 birds have been completed. The following results have been observed in cooperation with the Pathology and Bacteriology Section:

1. Goiter, accompanied by slightly inferior growth, has been produced in both sexes on rations containing as little as 13 parts per billion of iodine.

2. One thousand parts of iodine per billion parts of the experimental goitrogenic ration (containing liberal amounts of soybean oil meal) were required to produce a normal, active gland as measured by histological appearance.

3. Five thousand and ten thousand parts of iodine per billion parts of this ration produced normal resting glands.

4. Mild goiter has been observed in chicks and hens on practical all-mash rations recommended by this Station.

5. Feeds produced in Colorado and Iowa have been found to be very low in iodine. Local water has been found to contain only minute traces of this element.

6. Soybean oil meal contains a goitrogenic factor which is insoluble in chloroform, hexane, ether, acetone, or alcohol. It is slightly heat labile. The goitrogenic effect is partially alleviated by casein and totally so by iodine. Cystine and tyrosine have no marked effect

when added to the soybean oil meal ration. Subjecting the birds to light appears to enhance the goitrogenicity of this ration, indicating pituitary involvement.

7. Production and reproduction on the high soybean oil meal ration have never been normal even when supplemented with iodine, although growth has been excellent. The occurrence of small yolks on this ration indicates ovary involvement. Meat scrap in the place of casein in this ration appears to overcome this difficulty.

Further studies on the goitrogenic factor are under way.

Further experiments are in progress to ascertain whether there are any economic effects of iodine on growth, egg production, and hatchability on a practical type of ration. Studies on the identity of the goitrogenic factor and of the factor required for normal reproduction on the experimental ration are in progress.

Personnel

On August 20, 1939, Dr. A. R. Patton resigned to become head of the Chemistry Department at the Montana Agricultural Experiment Station, Bozeman, Mont.

Mr. Livingston P. Ferris, H, B.S. '36, Dartmouth, and M.S. '39, Colorado, was appointed research assistant, and Mr. Earl R. Reeves of Chicago was appointed two-thirds time research assistant, both appointments effective September 1, 1939.

Dr. Frank X. Gassner, formerly of the Department of Physiology, was appointed full-time research assistant professor in the Station on June 1, 1939. All of his time was devoted to poultry research until September when he was transferred to the Pathology and Bacteriology Section. He is continuing to devote a large proportion of his time to poultry problems.

Range and Pasture Management

Substantial progress was made during the past fiscal year on the various range research projects. The information obtained in the 1939 field season shows the effects of climate upon the results of the experimental work. The year 1939 was the driest in Fort Collins since 1893. In the past 10 years, 4 drought years, 1931, 1934, 1936, and 1939, have been experienced in Colorado. Because of the lack of wet years between the drought years, the better range forage plants have had little chance to recover and as a consequence many annual weeds and perennial grasses of low forage value have replaced the better forage plants. Several wet years, not one, will be required to bring the ranges back to their former productivity.

Management of the Native Range Resource

Studies on the management of the native range resource show that range livestockmen should be more conservative users of native range forage. This becomes necessary because of the uncertainty of range forage crops year after year. In the 1939 growing season, March to August, inclusive, the precipitation at Fort Collins was 6.02 inches as compared to the long-time mean of 10.46 inches. An analysis showed that only one-fourth of the precipitation occurred in the summer period from June to August, inclusive. Furthermore, the precipitation in that period was poorly distributed, with the result that there was very little growth of the two short grasses, blue grama and buffalo grass. In most years sufficient precipitation occurs in the spring months to make substantial growth of the two tall grasses, western wheatgrass and green needlegrass. Good gains were made by the livestock from the growth of these earlier grasses. However, with the advent of the extremely dry weather, these grasses dried up earlier than usual and became very unpalatable. The good gains the cattle made earlier in the season could not be maintained on the poorer feed. It was therefore necessary to remove them from the pastures about a month before the regular time despite a conservative plan of grazing.

Plant area measurements since 1937 of the more prominent grasses in the experimental pastures show a downward trend as the result of drought and grazing. On an area where no livestock have grazed for about 18 years, the spring-growing grasses, western wheatgrass and green needlegrass, showed a slight gain since 1937. Buffalo grass, a summer-growing plant, showed a loss in plant area of 30 percent.

In the deferred pastures for the same period the stands of western wheatgrass and buffalo grass were reduced about one-third, and blue grama was reduced one-half. The loss in plant area in the conservatively grazed pasture was even greater, except for western wheatgrass. Buffalo grass was reduced in stand to where it was only 38 percent, and blue grama to only 25 percent, of the 1937 stand. The grasses which sustained such great losses in plant area had never fully recovered from previous droughts, even though they have been grazed either on a conservative or deferred basis the past 3 years.

A study of nutritive values of range forage in cooperation with a livestock operator near Virginia Dale and with the Chemistry Section confirms the belief that blue grama forage cures better than that of the tall or more rank-growing grasses, western wheatgrass and western needlegrass. The three grasses rank high in protein content in the early stages of plant growth. Blue grama forage, however, maintains a high protein level until late fall. In the case of the two tall grasses the protein content is greatly reduced by late fall. Chemical analyses of blue grama forage that had remained ungrazed on the range for a period of a year showed a decline in protein of 60.0 percent from the high of the preceding June. The loss of protein in the foliage of western wheatgrass and western needlegrass in the same period was even greater. These analyses indicate that considerable loss of plant nutrients may be expected throughout the winter months.

Artificial Revegetation of Depleted Range and Abandoned Croplands

There are two important phases of the project on artificial revegetation, namely, (1) to test native and introduced species under controlled nursery conditions and (2) to test out under field conditions the promising species and methods developed under controlled conditions in the nursery.

Unfavorable climatic conditions in the forepart of the 1939 growing season seriously interfered with the successful establishment of new stands of grass seedlings. Drying winds and low temperatures prevented satisfactory germination of grass seed.

Better yields of grass forage and seed were obtained on row plantings spaced 2 feet or more apart than on rows 1 foot apart or on broadcast seedings. The effect of drought on seed production of blue grama was brought out rather strikingly. A close correlation was found to exist between the width of drill rows and seed production. Seed production was highest in the 36-inch spaced rows and almost nil in the 12-inch rows. It is recommended in reseeding abandoned croplands that the seed be drilled in with a grain drill where practicable.

Seed of western wheatgrass was obtained in 1936 from north central Montana, Nebraska, and Oklahoma as well as locally and was sown in the nursery. In 1939 the plants that were produced from Oklahoma seed were superior in vigor, quality of forage, density of stand, and volume of growth.

Soil moisture samples obtained throughout the 1939 season at depths to 6 inches, from 6 to 12 inches, and from 12 to 24 inches, showed a very desiccated condition of the soil. Because of closer spacing of plants throughout the broadcast grass plot the soil moisture content at the 6- to 12-inch depth during the height of the growing period in June and July averaged about 41.0 percent less than in the plot of drilled rows.

Improvement of Mountain Hay Meadows

A decreased yield of native hay on the higher mountain meadows was noted on the North Park experimental plots because of inadequate irrigation water. In the winter of 1938-39 the snowfall on the nearby watersheds was considerably below average. In addition to the reduced amount of irrigation water, rainfall conditions were extremely bad.

Over a period of 7 years, continuous summer irrigation of mountain meadows in North Park decreased the stand of timothy and other prominent hay grasses, while the same practice increased the stand of sedges and other water grasses. On a meadow where irrigation was started on June first of each year, continued for a period of 3 days and then discontinued 3 days and the practice repeated throughout the remainder of the season, a prominent sedge (*Carex lanuginosa*) decreased 67.0 percent in stand in the 7-year period.

The average annual yield of hay is much greater where the meadows are continuously irrigated in the summer. Because of the average higher protein content of the sedges, the hay produced on the continuously irrigated meadow exceeded the hay on the early intermittent irrigated meadow in total protein content by 9.6 percent and that of the late intermittent irrigated meadow by 40.0 percent.

The results are significant in that any change in irrigation practice from the continuous system will reduce the productivity of hay both in tonnage and protein yield.

Range Resource Surveys

The major part of the field work on the range resource survey project in Elbert County was completed in September 1939. During the field seasons of 1938 and 1939, 1,186,560 acres were mapped to show the location and extent of the various types of native range lands, agricultural lands, timber lands, and abandoned croplands. The compilation and analysis of field data and drafting of maps have progressed very satisfactorily during the past fall and winter. It was definitely shown that the range stockmen who graze their ranges in a conservative manner year after year are able to go through a drought year without much difficulty.

Native range land comprises 65.0 percent of the land area on 35 townships in the County; timber lands (Black Forest), 1.4 percent; cropland, 21.6 percent; abandoned cropland, 8.4 percent; and miscellaneous (towns, highways, railroad right of way, etc.), 3.6 percent. Abandoned cropland is an important problem in the County since 28.0 percent of the sod land that was turned up-side-down is now abandoned. The return of this land to grass by natural means is an extremely slow process. If cropland that is idle 1 to 5 years is used for grazing purposes, it will be necessary to have 17.8 acres to supply enough feed for one cow for a month, as contrasted to 3.9 acres of native range.

Another phase of the survey was to obtain factual data on grazing capacity of the range and abandoned croplands. The purpose of this study was to obtain more concrete data on the volume of forage produced by individual range plants. From clipped plots, western wheatgrass yielded 5.4 times more forage than blue grama of the same density. At the end of the grazing season both species had been utilized about the same (45 percent) by livestock. On this basis, using the product of percent of forage used and the volume produced. the calculated volume utilization rating ("palatability"), would be 100 for western wheatgrass and 20 for blue grama. The present palatability ratings of our forage grasses are based upon how a grass is relished by livestock, and the respective ratings for blue grama and western wheatgrass are 80 and 70 percent. These palatability ratings are not accurate for range species in the Plains region of the State. Therefore it appears that the volume utilization plan is a more accurate method of measuring grazing capacity. Additional studies of this method are to be carried on in the coming field season.

Personnel

Mr. Weldon Shepherd resigned on February 18 to accept a temporary position in the Department of Agronomy at the University of Wisconsin at a considerable increase in salary. Mr. Frank Kapel, a graduate of the University of Idaho, School of Forestry, and with a Master of Science degree in 1939 from Iowa State College was appointed on February 20 to fill the position vacated by Mr. Shepherd.

Rural Economics and Sociology

Type-of-Farming Studies

A comparative statement relating to a limited number of winter feedlots in the northern Colorado area shows that the net return per head of lambs sold represented a gain of \$1.13 for the 1938-39 season in contrast with a loss of \$2.43 per head during the 1937-38 season. Taking the records that have been assembled during a period of 17 years, it is found that these operators have reported a gain of 32 cents per head. From the standpoint of the farm as a whole, the 1938 calendar year was one of the poorest in this area because of a poor feeding season in 1937-38 and low crop prices in 1938. The record

for these same units during the past year indicated considerable improvement. The limited group of farms under study showed a net cash income which was back to 88 percent of the net return in 1937 and was much higher than the 1938 average. The number of farms studied happens to be rather small and will not justify using the average as an indication of what farmers did in general. However, the relative changes in cash incomes do reflect what is going on in one of the most important irrigated areas in the State. Farm records were assembled as usual in northeastern Colorado, but the summaries of these have not been completed and it is not possible to indicate trends for this area.

Range Cattle and Sheep

During the early part of the current fiscal year approximately 70 cattle and sheep ranches were visited in northwest Colorado. The operators of these ranches furnished data relating to the production and organization of the respective units. This is a continuation study, the first records in this area having been taken in 1926. A recent analysis relating to the possibilities of obtaining income from the cattle business shows a wide range of variation due to such factors as calf crop, death loss, cow replacement, sale weights, sale prices, and age at which heifers were bred. Two reports, one dealing with the factors involved in producing cattle on the range and the other relatmg to the business of producing lambs and wool on the range, have been prepared and will be offered for publication shortly. To clarify these statistical presentations and to permit a ready comparison for any size of cow herd and for different sizes of flocks, the calculations for cattle are based upon 100 breeding cows in the herd while the calculations for range sheep are based upon 1,000 breeding ewes in the flock. These two reports when made available should prove helpful to operators who desire to measure the results from different methods of range management and who require direct calculations showing the probable returns for units of various sizes.

Rehabilitation Records

For approximately 2 years this Section has cooperated with the Work Projects Administration in sponsoring and supervising a study of farm records obtained from Farm Security Administration clients. Our first analysis, including the 1937 year's business, was based upon 261 records, many of which were for part of a year only. From this group, 155 records from 28 counties were analyzed and were used as the basis for a special report. The second report, covering the records for the year 1938, included 294 year-long accounts and 283 short records where data were available for an average of 9.2 months. Receipts and expenses on these farms are on a comparatively small

scale in comparison to the experience and records from farms with better credit ratings. In 1937 the average cash farm receipts on 155 rehabilitation units throughout Colorado were \$807, while for the succeeding year the average farm receipts on 294 units amounted to \$933.

Tax Study

The tax study project is being developed in cooperation with the Work Projects Administration, but it has not been carried for a sufficient length of time to permit a summarization of results. Information relating to the sale of farm tax certificates has been assembled in 20 agricultural counties, and 15 additional counties are being solicited at the present time. The data for the first group are being tabulated and mapped in two sets, the first of these showing the length of time certificates have been outstanding, the second indicating the land subject to tax title by county and private parties. Information pertaining to farm land assessments has also been assembled in this cooperative enterprise. Since the Bureau of Agricultural Economics has available actual land use data in these same counties, it will be possible to make a comparison of the two lists of records and to ascertain the degree of overassessment or underassessment.

Land Utilization

Beginning in September 1939, this Section entered into a cooperative agreement with the Bureau of Agricultural Economics and the Extension Service for the purpose of instituting research work in land use planning. Studies in this field will include such items as land ownership, land use, crop yields, the place of livestock production in the respective types of farming, the sale of tax certificates, the study of farm land assessments, and the status of rural life in the areas studied. The following counties have been selected for consideration in this project: Boulder, Delta, Kiowa, Kit Carson, Phillips, and Rio Grande. These county units are distributed in such a way that the major type-of-farming areas in the State will have adequate representation in the analysis. In this connection a study of agricultural history in Kit Carson County has been made. The results in this field indicate that the dry years of the early nineties forced an adjustment to the semiarid environment quite similar to the present adjustment which may be described as a transition from grain farming to dairying and cattle raising.

Rural Social Research

Since the rural social research projects have not been completed but are in process of development, the following is a progress report.

1. Population trends in Colorado between 1860 and 1930.— Approximately 100 tables which show the major population trends

have been worked out and an equal number of graphs have been set up to show pictorially the changes that have been made. In this study special attention has been given to the relationship of population trends to such factors as agriculture, industry, mining, and major social institutions and social problems. The Work Projects Administration has cooperated and assisted in this work.

2. Problems of youth in some selected areas in Colorado.—Approximately 1,000 schedules dealing with youth problems have been analyzed. Tables have also been constructed and graphs have been drawn to illustrate the material. The study shows the relationship of youth problems to the service problems of such agencies as the Extension Service, schools, and churches, as well as various organizations and service clubs. In this also the Work Projects Administration has given assistance.

3. Changes which have occurred in Colorado's farm and ranch population during the past year.—This is a cooperative enterprise with the Division of Farm Population and Rural Life of the United States Department of Agriculture and the Extension Service. At least two annual preliminary reports have been made on this project and a third report will be available shortly. Most of the field work has been done and a large portion of the data has been collected.

4. Housing conditions, work patterns, and related problems of sugar beet laborers in Colorado.—Personal interviews were conducted with 467 families working in sugar beet areas of the Arkansas River Valley and the northern Colorado irrigated section. The information relates to housing conditions, work patterns, and related problems. Some 35 tables have been constructed to date, and several graphs have been prepared in the analysis of the statistical data in question. In this field the National Youth Administration has cooperated.

Seed Laboratory

Control of weeds is one of the most important problems on every farm. Eradication is of little value if new infestations are started by planting weed seeds.

The Seed Laboratory is set up to furnish to farmers information as to the quality of seed they plant. It is charged with the duty of enforcing the State seed law which requires accurate labeling of all seeds sold or offered for sale. It serves various groups interested in seeds, such as farmers, dealers, and investigators.

After being closed 3 months for lack of funds, the laboratory was opened on July 1 with a limited staff of one analyst and a part time secretary. On October 1 an assistant analyst was added. Since the appropriation made by the Legislature for the present biennium was \$1,000 less than for the previous one, it has been impossible to employ additional help for the busy season as has been the custom in previous years.

A total of 1,774 samples have been tested. Approximately onethird were submitted by dealers, one-third directly by farmers, and one-third by all other agencies combined. There are at the present time 273 samples on hand to be tested.

Since funds were insufficient to carry on a state-wide inspection in connection with enforcement of the pure seed law, a survey of one county has been made. In cooperation with the county extension agent samples were collected from lots which farmers were planting. These samples show that farmers are still planting seeds of noxious perennial weeds and low-germination crop seeds.

Miss Helen Kroeger, assistant seed analyst for the past 3 years at such times as there have been funds to pay her, resigned April 30 to accept a position with the United States Department of Agriculture at an increased salary and continuous employment, leaving the laboratory with a staff of one. It is possible, therefore, to offer assistance in the weed problem to only a limited number of citizens of Colorado.

Engineering Division

Civil Engineering Section

Division of Work

The work of the Civil Engineering Section has been divided among the staff members as follows: Mr. William E. Code has been placed in charge of investigations on the use of ground water for irrigation; Mr. Maxwell Parshall has charge of the work which relates to meteorology; Mr. Adrian R. Legault is in charge of materials research as related to rural housing and agriculture; Dr. Dwight Gunder is responsible for making investigations on a theory of hydraulic

model testing, particularly models in which sediment is moved by the flow; Mr. Ralph L. Parshall directs the work relative to snow surveys and irrigation structures; Mr. Carl Rohwer directs work relative to the design and operation of pumping plants.

The foregoing outline indicates the division of responsibility for planning and execution of the projects within this Section. Each of the men makes a monthly progress report on his particular projects and is responsible for bringing each one to its logical conclusion.

Projects

High-Strength Wire for Concrete Reinforcement

The feasibility of using high-strength wire for reinforcement in precast concrete beams is being investigated by Mr. Legault. If a practical method for making such beams is devised, they may become of importance in the construction of homes, especially rural homes and farm structures which have inadequate fire protection.

Preliminary tests indicate that by using a high-strength steel wire in place of the ordinary steel bars to reinforce precast concrete beams, a reduction of approximately 50 percent in the quantity of steel necessary may be possible. Several beams have already been cast and comparisons made between wire reinforcement and ordinary reinforcement bars. This project is about 15 percent complete.

Waterproofing of Adobe Construction

Mr. Legault is investigating and attempting to devise methods for waterproofing adobe construction. The importance of adobe construction in rural areas need not be stressed here.

Various adobe structures have been examined, test blocks have been prepared, and at present tests are in progress comparing the relative merits of three different means of waterproofing. The project is about 20 percent complete.

Experimental Check of Rohwer Evaporation Formula

By comparing computed values with the 50-year record of the Colorado Experiment Station, Mr. Maxwell Parshall and National Youth Administration student assistants are checking the reliability of the Rohwer formula for calculating evaporation. The work is approximately 65 percent complete.

Meteorological Observations

To keep a complete record of the climate at Fort Collins, daily observations on temperature, precipitation, wind direction and velocity, evaporation, relative humidity, terrestrial radiation, and ground temperatures at various levels are taken by Mr. Maxwell Parshall and assistants.

Apparatus for Measuring Fall Velocity of Particles in Water

Dr. Gunder and assistants, through analytical analysis and laboratory experiments, are attempting to develop apparatus for measuring the fall velocity of particles in water. This apparatus is necessary in order to make a more fundamental investigation of the action of sand in hydraulic models. The project has just been initiated.

Separation of Sand According to Fall Velocity in Water

A project for development of a hydraulic sand classifier for separation of sand according to fall velocity in water has just been initiated and is being carried on by Dr. Gunder and assistants through analytical analysis and laboratory experiments. This apparatus is also a preliminary step in a broader investigation of the movement of sands in hydraulic models.

Design and Invention of Irrigation Structures

Mr. Ralph Parshall is carrying out experiments in the laboratory and in the field for development of structures which will improve irrigation practice. Structures for the measurement of water, sand traps for removing sediment from irrigation channels, and erosion control structures for prevention of channel scour are being investigated.

During the last year several experiments have been made on sand traps and Parshall measuring flumes. A revised manuscript of Farmer's Bulletin 1685 of the United States Department of Agriculture, "Measuring Water in Irrigation Channels", has been prepared.

Irrigation Use of Ground Water in the South Platte Drainage Basin

To ascertain the amount of ground water used for irrigation purposes in the South Platte drainage area, a project has been initiated this year. Both drought and cheap power for pumping have tended to increase the number of irrigation pump wells used in Colorado. The present rate of development will produce approximately 300 new irrigation pumping plants in the South Platte drainage area alone during the present irrigation season.

In order to guide this development now and in the future, a body of facts should be accumulated. Ground water should be looked upon as a supplemental source of water to be used to bridge drought periods. Overdevelopment may result in great financial loss to farmers and power companies of the State. To get a body of facts relative to supply and use of ground water, it is important that a project such as this be supported. Mr. Code, assisted by members of the Colorado Water Conservation Board, will measure the flow of all wells in the South Platte drainage; the data will be summarized later in the office.

Fluctuation of Ground Water Levels

Mr. Code is making field observations and office analyses to ascertain if possible the effect of irrigation usage on ground water levels in the South Platte drainage basin.

Design and Operation of Pumping Plants

Under a project assigned to Mr. Rohwer by the United States Department of Agriculture, he and his assistants are investigating design, operation, efficiency, and economy of irrigation pumping plants by a combination of field observations, laboratory experiments, and office analysis. The work has been in progress for some time. During the year one bulletin has been published by the Department of Agriculture, Circular 546, "Putting Down and Developing Wells for Irrigation." Manuscripts for two other bulletins are in preparation.

Photographic Method of Making Snow Surveys

To investigate the feasibility of making snow surveys by photograph, Mr. Maxwell Parshall and assistants will take photographs of selected portions high up in the Poudre drainage area at monthly intervals. These photographs will be critically examined later to discover some key by which they may be correlated with the amount of stored moisture in the watershed. In the past these photographs have been taken from a particular location on the ground. In the future airplanes may be used to assist in taking the pictures.

From a given point monthly pictures have been taken of one section of the Cache la Poudre watershed during the season of snow cover for the past 2 years. These pictures indicate that the method has promise, but airplanes should be used to get closer to the section being photographed.

Snow Course Measurements

Snow course measurements made by Mr. Ralph Parshall and assistants to accurately measure moisture content in the snow cover for the purpose of predicting the spring and summer runoff are widely used by agricultural people, bankers, and engineers. They are necessary for intelligent planning of crops, regulation of storage reservoirs, and safe loaning of money for agricultural purposes.

Measurements by means of snow tubes on numerous snow courses in Colorado and neighboring states are made. This method actually

measures the moisture in the snow pack, and by taking averages fairly good estimates can be made of the total water stored in the snow cover.

For several years snow course measurements have been made in Colorado as well as in the rest of the Western States. The project as a whole is a Government project, but each of the states in the West is cooperating in one way or another with the Government in obtaining these data. Enough records are now on hand to permit preliminary studies showing the relation between snow surveys and water supply for the following summer.

Personnel

Mr. Code and Mr. Maxwell Parshall are full-time workers in the Civil Engineering Section, and Mr. Legault and Dr. Gunder are parttime workers. Mr. Ralph Parshall, Senior Irrigation Engineer, and Mr. Rohwer, Irrigation Engineer, United States Department of Agriculture, are government cooperators.

Mechanical Engineering Section

Activities of the Mechanical Engineering Section have been confined to work on sugar beet machinery. This project is in cooperation with the Bureau of Agricultural Chemistry and Engineering of the United States Department of Agriculture. Considerable help was received from the Botany Section through Dr. C. Guinn Barr, and financial support was received from the United States Sugar Beet Association.

Single Seed Ball Planting

More nearly complete mechanization of the growing of the beet crop has been attained. One contributing factor to this mechanization has been the single seed ball planter, the development of which started at this Station. This single seed ball planter places the seed at more regular intervals in the row than has been previously possible. This makes more single plants in the row and eliminates many of the bunches. As a result of this improved distribution of plants, the operation of thinning is much easier; in fact it makes mechanical thinning more nearly practical. Several commercial concerns are now building single seed ball planters. Commercial fields of beets were raised without the customary stoop labor, and the industry all over the United States is inclined to follow this practice.

Storage Losses in Beet Piles

With the advent of mechanical harvesting and the possibility of mechanically thinning beets, there is the probability that more of the beets will be bruised, or that there will be more small beets in the pile, or that there may be more dirty beets going to the storage piles. These probabilities made it desirable to make some preliminary studies on storage losses. It has been accepted as a fact that losses in piles amounted to half a pound of sugar per ton of beets stored per day of storage. This, in the entire country, would be equivalent to several million dollars per year.

This preliminary study was to ascertain the effect of temperature on the respiration rates of beets stored under the different conditions that might be obtained by beets under mechanical culture. This 1 year's study has yielded respiration rates for beets under a wide range of temperatures and has shown the desirability of good circulation of air through the piles to prevent the heat of respiration increasing the temperatures up to a danger point, that is, a point where anaerobic respiration increases and serious losses result.

Editorial Service

The Station Editorial Service during the year 1939-40 has issued the following publications:

Popular Bulletins

No.

- 454—"The Potato and Tomato Psyllid and Its Control on Tomatoes", by George M. List.
- 455-"Colorado's Poisonous and Injurious Plants", by L. W. Durrell and I. E. Newsom.
- 456—"Analysis of 50 Years' Record of Meteorological Data Taken at the Colorado Experiment Station, Fort Collins, Colorado", by Maxwell Parshall.
- 457---"Educational Foundations for Rural Rehabilitation", by R. W. Roskelley and Olaf F. Larson.
- 458—"Orchard Management in Colorado", by E. P. Sandsten, F. M. Green, and L. R. Bryant.
- 459—"Restoring Colorado's Range and Abandoned Croplands", by E. W. Nelson and W. O. Shepherd.

Technical Bulletins

- 27—"Preparing and Baking Yellow Sponge Cake at Different Altitudes", by W. E. Pyke and Gestur Johnson.

Quarterly Bulletins

Vol. I, No. 3, Colorado Farm Bulletin, July-September 1939.
Vol. I, No. 4, Colorado Farm Bulletin, October-December 1939.
Vol. II, No. 1, Colorado Farm Bulletin, January-March 1940.
Vol. II, No. 2, Colorado Farm Bulletin, April-June 1940.

Annual Report

Fifty-Second Annual Report, Colorado Experiment Station.

Other Publications

During the year 28 papers by Station staff members for publication in scientific journals and elsewhere have been edited, as have the following mimeographed bulletins:

- "Colorado Rehabilitation Farms, Income and Expense, 1937", by R. T. Burdick.
- "Farm Family Standards of Living in the Northern Colorado Irrigated Area", by Ralph W. Roberts and Olaf F. Larson.
- "Colorado's Farm and Ranch Population as of January 1, 1939", by R. W. Roskelley.
- "Symptoms of Nutritional Deficiencies", by H. S. Wilgus, Jr., and Frank Thorp, Jr.
- "Turkey Production in Colorado", by H. S. Wilgus, Jr., and O. C. Ufford.
- "Feeding Chickens", by H. S. Wilgus, Jr., and O. C. Ufford.
- "A Practical Poultry Improvement Program for Colorado", by H. S. Wilgus, Jr., and O. C. Ufford.
- "Selection of Feedstuffs for Poultry", by H. S. Wilgus, Jr., and O. C. Ufford.
- "Spray Program for Fruits in Colorado."

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No.

The office has on hand, awaiting publication when funds permit, the following manuscripts:

"Colorado Weeds", by B. J. Thornton and L. W. Durrell (revision).

"Possibilities for Cattle Income", by R. T. Burdick.

"Colorado Farm Bulletin"

The Colorado Farm Bulletin, devoted to "presenting in popular form and with seasonal timeliness the findings of scientific research, with resultant recommendations," has continued to meet with popular approval. Because requests for the Bulletin have been numerous, it has been necessary to increase the number printed from 4,000 to 4,200, even though "dead timber" was cut from the mailing list through cooperation of county extension agents. A lower bid from the printer on the second year's publication of the Bulletin has madeit possible to expand the mailing list without an increase in cost.

News Writing

Obtaining material for and writing news articles regarding work of the Station for publication in newspapers and other periodicals throughout the State is a new function this year of the Station Editorial Service. Forty-three articles have been written for distribution through "News Notes" of the College, and six special features and pictures have been prepared for publication in newspapers and farm magazines. Information was assembled on mechanical culture of sugar beets and this was used on a national farm broadcast.

Journal Series

In accordance with action by the Station Council two series of journal articles are being established, scientific and miscellaneous. Reprints or typewritten copies are being filed in duplicate in the Station editorial office where they are to form a permanent record. A third series for abstracts also is to be established.

Miscellaneous Activities

Other activities include :

Preparing bulletin displays for the meeting of the Colorado-Wyoming Academy of Science and for farmers' days at Avon and at Akron.

Editing of material for the Colorado Poultry Improvement Plan yearbook in which appeared 15 articles by members of the Station staff. Aiding in preparation of publicity for Colorado Lamb and Wool Week.

Speaking to technical writing and journalism classes of the College on work of the Station Editorial Service.

In addition to her other work in this office, Miss Josephine Lambe, a student assigned by the National Youth Administration, is indexing Station publications. This index is beginning with bulletins of 1919, the oldest which were not indexed in the previous compilation published in 1921. Mr. James G. Hodgson, College librarian, has given Miss Lambe advice in this work.

Personnel

The present editor began work of this office on July 27, 1939. His gratitude is due the former editor, Mr. James R. Miller, for help in becoming familiar with the work.

Staff Contributions

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Your acting Director wishes to express his appreciation to the whole Station staff who so freely cooperated in a trying situation, and to the President and the Board for helpful suggestions and excellent advice. No doubt mistakes have been made, but actions have been taken only after consultation with all interested parties.

Very truly yours,

U.E. Seever

Acting Director.

FINANCIAL REPORT, COLORADO EXPERIMENT STATION

For the Year Ending June 30, 1940

DR.	Hatch fund	Adams fund	Purnell fund	Bankhead- Jones fund	State mill levy fund	Special fund	Pure-Seed fund	Total funds
Balance July 1, 1939					\$15,061.00	\$ 1,010.94*	****	\$ 14,050.0
From the treasurer of the United States as per appropriations for the fiscal year ending June 30, 1940, under the Acts of Congress ap- proved March 2, 1887 (Hatch fund), March 16, 1906, (Adams fund), February 24, 1925 (Pur- nell fund), and June 29, 1935, (Bankhead-								
Jones fund)	\$15,000.00	\$15,000.00	\$60,000.00	\$22,430.96				112,430.96
Other sources than the United States			N 12		83,403.82**	66,533.98	\$ 4,500.00	154,437.80
CR.	\$15,000.00	\$15,000,00	\$60,000.00	\$22,430.96	\$98,464.82	\$65,523.04	\$4,500.00	\$280,918.82
To salaries	14,860.00	15,000.00	50,714.00	15,721.96	37,744.64	11,640.89	4,291.46	149,972.93
Labor		*****************	2,831.45	1,449.95	16,341.66	5,927.04	*************	26,550.10
Stationery and office supplies		······	208.10	121.68	836.18	50.03	12.65	1,228.6
Scientific supplies, consumable			1.620.55	428.80	1,931.16	1,015.12	116.47	5,112,19
Feeding stuffs	*****		670.46	1,646.05	7,145.41	987.11	eres and a second	10,449,03
Sundry supplies			91.65	15.66	1.886.36	1,524.41		3,517.4
Fertilizers		****	3.78		168.63	141.63		314.0
Communication service			124.23	16.48	1,247.01	226.47	23.27	1,637.4
Travel expenses	140.00		1,860.08	2.117.34	3,368.92	1,100.39	4.90	8,591.63
Transportation of things			11.29	1.75	1,329,30	286.57		1,628.9
Publications			55.54	*****	3,450.41	25.00	*********	3,530.93
Heat, light, water, and power			34.42		2,458.35	4.521.86		7.014.63
Furniture, furnishings, and fixtures			2000.00		127.13	214.65	5.25	347.03
Library			27.33		483,99	150,47	10.00	671.75
Scientific equipment			1,644.53	529,60	1,961.71	1,446,19	36.00	5,618.03
Livestock					7.618.45	3,490.03		11,108,43
Tools, machinery, and appliances	********		32.34		2.377.63	1.216.11		3,626.05
Buildings and land			68.50	382.20	4,777.52	1,382.86		6,611,02
Contingent expenses			1.75		137.77	148.32		287.8
	\$15,000.00	\$15,000.00	\$60,000.00	\$22,430.96	\$95,392,23	\$35,495.15	\$ 4,500.00	\$247,818.34
Balance on hand June 30, 1940					3,072.59	30,027.89		33,100.45
Grand total	\$15,000.00	\$15,000.00	\$60,000.00	\$22,430.96	\$98,464.52	\$65,523.04	\$ 4,500.00	\$280,918.82

*Overdraft. **Includes \$2,025 from special appropriation, H. B. 424.

