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THE STATE AGRICULTURAL COLLEGE
OF COLORADO

The Thirty-Second Annual Report

OF

The Agricultural Experiment
Station

1919



University of Colorado at Boulder



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OF COLORADO

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The Colorado Agricultural College

FORT COLLINS, COLORADO

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LETTER OF TRANSMITTAL

To His Excellency, Oliver H. Shoup, Governor of Colorado:

In accordance with the law of Congress, I have the honor to transmit to you herewith the Thirty-second Annual Report of the Colorado Agricultural Experiment Station.

The financial statement is for the government fiscal year ending June 30, 1919. The other portions are reported substantially for the state fiscal year of 1918-19.

C. P. GILLETTE,
Director.

Agricultural Experiment Station,
Fort Collins, Colorado,
December, 1919.

REPORT OF THE DIRECTOR

To the President:

I am presenting herewith the Thirty-second Annual Report of the Colorado Experiment Station for the state fiscal year closing November 30, 1919. The financial statement is for the government fiscal year of 1918-19. The sections or divisions of the work at the time of this writing, number thirteen aside from the station editor, all of which are represented below by their reports.

The number of projects receiving more or less attention during the year is 59, distributed among the experiment station sections and funds as follows:

PROJECTS IN FORCE DURING THE YEAR

Chemical Section

Niter Studies, Adams Fund.

Bacteriological Section

Bacteriological Studies of Alkali Soils in Relation to Nitrogen Fixation. Adams Fund.

Nitrogen Fixation as a Function of Associative Action. Adams Fund.

Active Principle of Whorled Milkweed. Adams Fund.

Natural Inoculation of Colorado Soils with Legume Bacteria. Hatch and State Funds.

A Bacterial Disease of the Wragg Cherry. Hatch and State Funds.

Miscellaneous Vinegar Studies. Hatch and State Funds.

Pathology Section

Necrotic Stomatitis. State and Hatch Funds.

Contagious Abortion. State and Hatch Funds.

Chicken Diseases. State Fund.

Sheep Losses in Feed Lots. Hatch Fund.

Entomological Section

Plant Louse Investigations. Adams Fund.

Ants of Colorado in Their Relation to Plant Lice. Hatch and State Funds.

Life Habits of the Syrphus Flies. Hatch Fund.

Control of Insects by Egg Treatment. Hatch and State Funds.

Codling Moth Studies. Hatch and State Funds.

Grasshopper Control. State Fund.

General Insect Investigations. State Fund.

Irrigation Investigations Section

Drainage of Farm Crops and Drainage Factors. Adams Fund.
Evaporation Experiment. Hatch Fund.
Meteorology. Hatch and State Funds.
Current Meters. Adams Fund.
The Venturi Flume. Adams Fund.
South Platte Investigations, Seepage and Return Waters.
State Fund.

Agronomy Section

Relation of Soil Moisture, Structural Development and Acre
Yields in Small Grains. Adams Fund.
Correlation of Characters in Grain. Hatch Fund.
Alfalfa Breeding. Hatch Fund.
Methods in Selection Breeding. State Fund.
High Altitude Crops. State Fund.
Seed Crop Improvement. State Fund.
Rotation of Crops for Colorado. State Fund.
Plains Crops and Management. State Fund.
Methods of Handling Hay. (In co-operation with Engineer-
ing Section, Mechanical Division).

Horticultural Section

Hardy Stock for Apples. Hatch and State Funds.
Pear Growing in Eastern Colorado. Hatch and State Funds.
Potato Investigations. Hatch and State Funds.
Fruits and Vegetables for High Altitudes. State Fund.
Hardy Tree Fruits for High Altitudes. State Fund.
Seed Potato Growing in High Altitudes. State Fund.
Effect of Diseased and Ill Shapen Seed Potatoes on Succeed-
ing Crop. Hatch and State Funds.
Dehydration of Fruits and Vegetables. State Fund.
Fruit Surveys. State Fund.

Animal Husbandry Section

Advanced Registry Tests. State Fund.
Acre Value of Pasture for Dairy Cows. State Fund.
Steer Feeding Experiment. State Fund.

Botanical Section

Native Vegetation as an Indicator of Crop Possibilities.
Hatch Fund.
Microscopy of Stock Poisoning Plants. Hatch Fund.
Irrigation Water as a Disseminator of Weed Seeds. Hatch
Fund.
Hard Seed of Alfalfa. State Fund.
Colorado Forage Grasses. State Fund.

Fungous Disease Investigations. State Fund.
Proso Millet Smut. State Fund.
Whorled Milkweed Control. State Fund.
Reseeding of Tall Larkspur. Hatch and State Funds.

Forestry Section

Studies in the Decay of Wood. Hatch Fund.

Home Economics Section

Utilization of Raspberry and Plum Juices. State Fund.
Cooking Quality of Colorado Potatoes. State Fund.

Engineering Division

Road Materials of Colorado. (Civil Engineering Section)
State Fund.

Methods of Handling Hay. (Mechanical Engineering Section). In co-operation with Agronomy Section. State Fund.

Veterinary Section

Animal Diseases. State Fund.
Whorled Milkweed. State Fund.

The number of workers giving full time to the experiment station projects at the close of the year is thirteen; those giving part time number twenty-two.

The friendly relations and spirit of co-operation among those carrying on different lines of investigation has been very gratifying. A good majority of the sections are carrying on one or more lines of work in co-operation with some other section in this station and a considerable number of the sections are carrying on co-operative work with some branch of the Federal Department of Agriculture or departments of the State of Colorado. The progress of the work and the number of bulletin manuscripts that have been handed in for publication are all that could be reasonably expected.

I am especially glad to report the completion of the work carried on by the section of Irrigation Investigations in their study of the "Duty of Water in the Poudre Valley". Much important information has been gathered and the results of the investigation are now written in bulletin form and will be ready for publication as soon as we can get the approval of the Office of Public Roads. I believe the report upon this work will do much to improve the irrigation systems in this and surrounding states where irrigation is extensively practiced for the growing of crops.

The experiment station withdrew from the co-operative horse-breeding work on July 1. The horses remaining with the station as a result of this work have all been sold and the investigation has been transferred by the Bureau of Animal Industry to the State of Wyoming. Our withdrawal from the work was not be-

cause of any dissatisfaction in our relations with the Bureau of Animal Industry, nor was it because reasonable progress in the work had not been made, but on account of a general feeling among the members of the State Board of Agriculture and the officers in charge of the college and station work that it no longer seemed advisable to divert so large a portion of the Experiment Station funds to this line of investigation.

Our bulletins have been rather seriously delayed in their publication during the year, not from any fault of the college editor, but because of the overload he is obliged to carry for other departments of the institution. May I not urge that the Experiment Station be allowed the portion of the time of the editor for which it pays? Otherwise, it will probably be necessary to make some other arrangement for the editing of the publications of the station.

With the land indebtedness all taken care of and a somewhat increased valuation of state property for taxation, the Experiment Station should be able to keep its work fully up to the present standard during the coming year, in spite of the higher costs of expenses in every department.

Respectfully submitted,
C. P. GILLETTE,
Director.

REPORT OF THE AGRONOMIST

To the Director:

I am submitting herewith my annual report of the Agronomy Section of the Colorado Experiment Station for the period ending November 30th, 1919.

The work of the Agronomy Section of the Experiment Station has been carried on at the Fort Collins plant, at Cheyenne Wells, at Rocky Ford, and at Fort Lewis.

The projects carried at the Fort Collins plant were carried under three funds—the Adams, the Hatch, and the Station Tax.

Under the Adams Act, we have carried the project on Critical Period for Moisture Requirements on Certain Crops. Owing to the fact that we have not been able to get normal growth in our field potometers, we have been obliged to use a small plat. Just why the potometer does not give a normal growth, we are unable to say. Whether it is size of container, a difference in soil physics or chemistry or biology, engendered by enclosing the soil in potometers, or whether it is the presence of some injurious substance, such as zinc from the galvanized potometers, we are unable as yet to state. The fact remained that we were unable with our present

potometers to get normal growth. Accordingly, tests were run in the field to find how far laterally the water movement took place and how much border protection we would have to give small plats to eliminate side movement of water. After this was worked out, wheat and barley were used in small plats protected by dikes. This year it was necessary to change the crop on the lands. It was only physically feasible to use a limited area of land in reach of our water supply. Accordingly, the plats which had been in grain were put in corn for silo. Beans were put in the potometers and another portion of our land reachable by our water supply was put in beans under tentage and beans outside tentage so that both methods could be compared. The corn was not under tentage. The tentage was so arranged that the cover was completely removed and kept removed in pleasant weather, but it was quickly put over in case of threatened rain. It so happened that the season of 1919 was an extremely dry one. No water fell at any one time sufficient to wet the surface soil one-half inch deep from March until after the first of September. In fact, the corn on spring plowed land on adjoining plats which were not watered did not germinate or come up until after the first of September, when a perfect stand came up from spring planting. It is desirable that this work be conducted, not only from the standpoint of irrigation, but from the standpoint of dry land. In the dry lands, it is not possible to apply water in critical periods, but it may be possible to so plant that water will arrive in a majority of seasons during the critical period. This phase of the problem is being studied in connection with our controlled work on the Fort Collins plant.

Under the Hatch funds on the home plant we have carried the work on Correlation. We accumulated an immense amount of data on this project, some of which apparently brings up some new points of view. We have deemed it wise on that account to get additional year's data to see if the earlier findings were substantiated and to collect enough evidence so that there would be no doubt in regard to the correctness of any published stand that we may take as the result of this piece of work.

Under the Station Tax fund we have had active a project on Pure Seed Improvement. Under this project we are doing in reality two things. We are conducting improvement work upon certain crops. We are taking improvements arising out of other pieces of work, increasing them under this project, and are finding means of getting this increased seed put to use in the State, making the attempt to establish seed centers for adapted sorts of the best improved kinds. We have done more work this year on corn under this project than we have ever undertaken in pre-

vious years. Our first problem has been to find the best adapted types to different Colorado localities. When these have been determined, we expect to do ear-to-row improvement work and spend time in the study of cultural methods. We had corn tests under this project going in eight counties this season. Owing to the dry weather, some of these were absolute failures, but much information of use the coming year was obtained. We have also done some work on our Farm Management cost surveys. This work was hampered somewhat by the fact that Professor L. F. Garey left us June 30 to take up work under the Smith-Hughes Act. Professor R. T. Burdick, who succeeded Professor Garey, did not arrive until about the first of August and even then he was obliged to spend some time in orienting himself with the work. The work was set back, but did not stop. Our work with high altitude crops and crop rotations was given some attention, but did not occupy any considerable amount of time.

The work at Cheyenne Wells has heretofore been largely demonstrations in successful methods of dry-land farming, taking into consideration the production of crops and the utilization of that production thru livestock. In addition to these demonstrations, we carried some minor experimental work in time and methods of preparing the seed bed for grain crops.

At Rocky Ford the main line of work heretofore has been the alfalfa project carried on under the Hatch Act. Under this project we have succeeded in producing a number of superior alfalfa strains from the types which have proved best for our agricultural and climatic conditions. The most serious problem confronting us now is the question of seed production. In the older alfalfa regions it seems difficult to get consistent seed production. At one time we thot this was due solely to an excessive water supply, due to the filling of the subsoil by irrigation. This factor undoubtedly affects seed production, but we have gone far enough in our work to know that it is not the sole controlling factor. It remains now to try out the possibilities of cultural and fertility treatments to see if these factors, singly or in combination, have any control of seed production. It is of little benefit for us to produce superior strains of alfalfa if we cannot at the same time put forward methods which will enable seed producers to obtain a fairly certain crop. The superior strains must be propagated to increase the wealth of the community. Trying these cultural and fertility treatments seems to be the next step in the alfalfa project. Mr. Blinn has also carried on the Rocky Ford land a project of our corn work, especially representing the tests for the Arkansas Valley.

At Fort Lewis the high altitude work in crop adaptation has been conducted. This year's work virtually eliminated some twenty-odd varieties of peas so that we now have the test down to five or six of the better sorts. Work with corn is still to be conducted and tests of sunflowers as a high altitude silage crop need to be conducted. We matured a crop this year that looks well, but we haven't yet received a report on tonnages.

All the lines of work carried this year should be continued. Among the new lines of work for which there is unusual inquiry is the use of surfur as a fertilizer on alfalfa. The call is so insistent that it would seem necessary to make a few tests representing different soil conditions so that we can authoritatively answer questions for our State.

During the year just closed we published Bulletin No. 248, "Mendelian Inheritance in Wheat and Barley". Bulletins are projected on technical and general data now in our hands.

Respectfully submitted,
ALVIN KEZER,
Chief Agronomist.

REPORT ON ANIMAL INVESTIGATIONS

To the Director:

I herewith submit annual report for the Animal Investigation Section for the fiscal year 1918-1919.

PROJECTS UPON WHICH WORK WAS DONE

Ration Experiments with Steers.
Acre Value of Pasture for Dairy Cows.
Advanced Registry Tests.

GENERAL FEATURES

One year's work on the Ration Experiments with Steers completed one group of experiments, and is being prepared for publication.

The irrigated pasture for the second project was established in 1917-1918, but because of extremely abnormal rainfall, this being the driest year in something like 30 years in this section, the actual pasturage experiment was not started this year.

Advanced Registry work is carried on from year to year without publication.

PROPOSED WORK

We would like to continue the following projects for the year 1919 and 1920:

Ration Experiments with Steers.

Acure Value of Irrigated Pasture for Dairy Cows.

Advanced Registry Tests.

Feeding Value of Sunflower Silage.

PUBLICATIONS

No bulletins have been issued during the past fiscal year.

Respectfully yours,

GEO. E. MORTON,

Animal Husbandman

REPORT OF THE BACTERIOLOGIST

To the Director:

I have the honor to submit herewith the annual report of the work of the Bacteriological Section of the Experiment Station for the year 1919.

Four lines of investigation have been carried on during the past year; three of these have been classified as Adams projects and one as Hatch. Two of these have been completed.

ADAMS FUND PROJECTS

1. *Bacteriological Studies of Alkali Soils*, (Continued).—We have given our attention here to the isolation of bacteria possessing low nitrogen requirements, from country rocks, whereby we might possibly account for the nitrates said to be found there and which might have resulted from the fixation of atmospheric nitrogen, followed by ammonification and nitrification. Certain symbiotic relations between lichens and these bacteria have also been studied.

2. *Ammonification in Soil as a Function of Associative Action*, (Completed).—We have endeavored to determine whether ammonia formation in peptone broth was hastened or retarded by combining pure cultures of different ammonifying organisms, isolated from soil. The results of the present work, which includes over 500 combinations of 17 different organisms, indicate that ammonia formation from peptone proceeds at practically the same rate with pure cultures alone as when two or more are associated with one another. For the present, this work has been discontinued.

3. *The Active Principle of Whorled Milkweed*, (Continued).—We have succeeded in isolating an active principle, in impure form, from whorled milkweed which is soluble in the ordinary organic solvents. It gives no visible reaction with the usual alkaloidal reagents, but does reduce Fehling's Solution, which fact suggests that it may possibly have a glucoside nature. Further studies are in progress upon the purification and identification of the poisonous constituent.

HATCH FUND PROJECT

1. *Honey as a Carrier of Intestinal Diseases*, (Completed).—This project has been completed and the work is being published as Bulletin No. 252 of the Experiment Station.

The results of the study indicate that no member of the typhoid-colon group can live in pure honey longer than five days, and, therefore, mature honey is probably seldom, if ever, to be considered as a carrier of intestinal diseases.

PROJECTS FOR 1919-1920**Adams Fund**

1. Bacteriological Studies of Alkali Soils. Nitrogen-fixing bacteria from country rocks.
2. Nitrogen fixation as a function of Associative Action.
3. The Active Principle of Whorled Milkweed.

Hatch and State Fund

1. The Natural Inoculation of Colorado Soils with Legume Bacteria.
2. A Bacterial Disease of the Wragg Cherry.
3. Miscellaneous Vinegar Studies: Vinegar Bees; Watermelon Vinegar, etc.

BULLETINS

Bulletin No. 252, "Honey as a Carrier of Intestinal Diseases".

Pure cultures for vinegar-making are still being supplied, and during the past year numerous requests have been received from persons outside of the State.

In conclusion, I wish to express my sincere appreciation of the support accorded to my work and of the personal courtesies extended to me by the Director.

Very respectfully submitted,
WALTER G. SACKETT,
Bacteriologist.

REPORT OF THE BOTANIST

To the Director:

I am submitting herewith the annual report of the Botanical Section of the Experiment Station for the fiscal year 1918-1919.

During the past year the section has worked upon the following projects:

1. *Microscopy of Stock-poisoning Plants*.—Considerable work was done on this project although it is yet far from completed. Through a careful histological study of the most important poisonous plants, a basis is being formed for the diagnosis

of deaths occurring among the animals on the ranges. A large number of microscopic slides are being prepared showing the characteristic anatomical structures of each plant. Microphotographs of these slides will be made. These photographs, with the necessary explanatory notations will be published. The resulting bulletin should serve as a very valuable aid in diagnosing cases of stock-poisoning. Since this project has been under way, several such determinations have been made in our laboratory, demonstrating the practicability of the work. This project is being pushed as rapidly as possible and we hope to have it completed during the coming year.

2. *Hard Seed of Alfalfa*.—Considerable work has also been done on this project but it is not expected to be completed for some time yet. The object of the investigation is to find out if possible the part hereditary features play in the development of hard seed. Investigations to date have shown considerable variation in the hard seed content of seed produced from individual plants of different alfalfa strains grown under comparatively uniform conditions and threshed in a uniform manner.

3. *Irrigation Water as a Factor in the Dissemination of Weed Seeds*.—The first part of this project has been completed and a bulletin, setting forth the results obtained, is now in the hands of the editor. The second phase of the work is being continued and the results will be published in a later bulletin. This investigation has shown irrigation water an extremely important factor in the dissemination of weed seeds and the results obtained promise to be of much practical value to the farmer.

4. *Whorled Milkweed*.—The Veterinary, Pathology, Bacteriological, and Botany Sections are all co-operating on this project. The Botany Section is concerned chiefly with methods of eradicating the weed. Mr. May spent last summer on the ranges in Western and Southwestern Colorado working on this problem. A thorough investigation of the efficiency of the following methods of eradication were made:

- (1) Clean cultivation by means of deep plowing and discing.
- (2) Grubbing followed by harrowing.
- (3) Spraying with various chemicals.
- (4) Smothering.
- (5) Several cropping methods.

This work is being continued this summer and the results obtained during the past two years' investigation will be published in the form of a bulletin as soon as possible.

In view of the serious losses resulting from poisoning due to milkweed it seemed advisable to issue a preliminary bulletin, stating the general principles underlying the prevention of stock

poisoning on the range. A brief bulletin setting forth these principles is now in the hands of the editor. The publicity work carried on by Mr. May while in the field has resulted in a remarkable decrease in the amount of poisoning from this source.

5. *Forage Grasses of Colorado*.—This project has been conducted in co-operation with the state forester, W. J. Morrill. A bulletin giving the results of the project is now in preparation.

6. *Fungous Disease Investigations*.—This project is designed in such a way as to include miscellaneous minor problems that may arise during the season. Co-operative seed-treatment experiments were carried on with the United States Department of Agriculture and a number of state experiment stations, under the direction of the advisory board of American Plant Pathologists. The experiments carried on at this station demonstrated conclusively the efficiency of the standard formaldehyde treatments for the control of cereal smuts. The copper sulphate treatments were decidedly unsatisfactory, both from the standpoint of control and seed injury. Consequently the use of copper sulphate is being discouraged. The dry, or spray, method of applying formaldehyde, which has been recommended in a few places, was found to be ineffective. I have recently been informed by the chairman of the committee that these results coincide with results obtained at a number of other stations. A summary of the results obtained at all of the stations is to be issued soon. As soon as this is received the information will be made available in some suitable way.

One or two other problems of minor importance are being investigated.

7. *Native Vegetation of Colorado and its Relation to Crop Possibilities*.—Work on this project was suspended during the past two seasons and due to rush of work and lack of assistance this project will probably be discontinued.

8. *Reseeding of Tall Larkspur*.—Some work was done on this problem during the past season but final results have not yet been obtained.

In addition to the above projects the Botanical Section has collaborated in the following activities:

(1) *Plant-Disease Survey* in collaboration with the Office of Plant-Disease Survey, Bureau of Plant Industry, United States Department of Agriculture. By this arrangement one member of the section was enabled to spend the entire month of June making observations and collections of plant pathological specimens throughout the State. This collaboration has been extremely

valuable to the section in determining the importance of problems for investigation and for obtaining a knowledge of the prevalence and distribution of plant diseases in the State.

(2) *Barberry Eradication Campaign*, in co-operation with the office of Cereal Investigations, Bureau of Plant Industry, United States Department of Agriculture, and with the office of the State Entomologist. A complete and thorough survey of the State for the occurrence of the common barberry is now under way. Every possible agency is being used in order to insure that every common barberry bush in the State will be removed. It is expected that this work will be carried on throughout this year and the next. By that time it is hoped that the entire State will be free of the common barberry.

(3) *Co-operative Seed Treatment and smut control experiments* carried on under the direction of a committee of the advisory board of American Plant Pathologists.

Relation of Section to Extension Service.—The close relation between this section and the Extension Service has been maintained. The state-wide project "Better Seed for Colorado", which was presented to and adopted by the county agents as an emergency measure has been pushed with vigor throughout the year. All members of the section have had an active part in this work. The following Extension publications were issued during the year:

No. 153-A, "Seed Testing in the Home and School", by W. W. Robbins and G. E. Egginton.

No. 155-A, "Destroy the Common Barberry", by W. W. Robbins and H. E. Vasey.

No. 159-A, "Prevention of Cereal Smut by Seed Disinfection", by Julian G. Leach.

STATION PUBLICATIONS

No. 248, "Alfalfa Dodder in Colorado", by W. W. Robbins.

No. 251, "The Identification and Control of Colorado Weeds", by W. W. Robbins and Breeze Boyack.

The Seed Laboratory.—The work of the laboratory is embodied in a special Annual Report, being issued as "Colorado Seed Laboratory Bulletin Vol. 1, No. 6".

The number of seed samples tested by the Seed Laboratory is increasing very rapidly and it is very probable that additional funds will be needed in the near future to meet the increased expenses.

Mention should be made here of the work of our delineator, Miss Caroline M. Preston. Her work has been of the highest

quality and has been indispensable in the publication of the various bulletins of the section.

Respectfully submitted,
J. G. LEACH,
Acting Botanist.

REPORT OF THE CHEMICAL SECTION

To the Director:

I have the honor to herewith submit an account of the activities of the Chemical Section of the station for the fiscal year 1918-19.

We have but one project which is active, with one held in abeyance. The active project at the present time is entitled, "The Occurrence of Nitrates in Sandstones and Shales and its General Occurrence and Effect Upon Vegetation". This subject has really developed into four lines, namely:

1.—*The occurrence of these salts on the surface of rocks*, which we have found do not penetrate to any considerable depth. The question of interest to us in regard to the occurrence of nitrates in rocks, is their source. In regard to the soil, we advanced the theory that the atmosphere, through a medium of biological agencies, was the source of the nitrates. We held the same to be true with the occurrence of these salts on the face of the rocks. We have endeavored to prove this and are now at work on this subject. The data so far obtained seem to affirm this question. We do not know at the present time what the organisms are which effect this fixation, or to what class of plants they belong.

2.—*The development of nitrates in a section near Wellington, Colorado*. This section, up to the present time, has not been mentioned, as it is practically a new development. Considerable work has been done in this particular section in the study of the occurrence of the nitrates in the soil and in the surface waters. By surface waters, we here mean such as occur in shallow wells. Our studies of the deeper wells, so far as we have been able to obtain water of this character, show that while they are rich in ordinary salts, they are exceedingly poor and entirely wanting in nitrates. We have taken a line of samples from near Nunn, westward through Wellington, to beyond Waverly. In this line we find no nitrates between Nunn and a point about three miles east of Wellington. After passing Wellington, going westward, we find no nitrates until we reach the neighborhood of Waverly. This latter district has not been studied at all. The north and south line running east of Wellington, shows that the nitrates do not exist more than three miles, or less, north of Wellington, but

south they are continuous, or nearly so, to a point south of the Ault road. We have sampled in this district some twenty odd sections of land, taking twelve samples from each section. We find the nitrates varying exceedingly in the surface 3 inches, from nothing up to very large quantities, indeed, 2,000 parts per million.

3.—*This development of the subject relates to the dying of cherry trees in the Arkansas Valley.* We have not been able to address ourselves to this phase of the subject since July 1, 1918, though previous to that we had done considerable work in an endeavor to find a definite cause for the death of the trees. So far, we have not succeeded with any degree of satisfaction. In connection with this work we incidentally found, south of Lake Minnequa near Pueblo, the occurrence of nitrates in a small area, the origin of which seemingly cannot be attributed to any other cause than to the one heretofore advanced to account for such. We are at the present time studying a series of samples taken from this particular locality.

4.—*In the San Luis Valley we have been unable to do any work this year.* In this section we are studying the association of the nitrates with the salts of the valley, which seems to be very analogous. In certain places it is sodic carbonate; ordinary alkalis. being a mixture of sodic and calcic sulfate and still in other sections it is associated with calcic chlorid.

The only subject completed during the year was "The Study of Colorado Wheat", on which we published our last bulletin in July, 1918, which was a resumé of the bulletins previously published and intended to be a popular presentation of the subject. The section has also presented an extension bulletin on the "Properties and Use of Emmer Flour".

The personnel of the section remains the same as heretofore. We are still one man short.

In regard to new work, I do not deem it advisable to branch out any further than we have already gone. The four divisions of the nitrate subject will occupy us for several years. So far as prospective bulletins are concerned, the advancement of the work does not justify us in making any prophecy as to when we shall be able to present any bulletins.

Respectfully submitted,
WM. P. HEADDEN,
Chemist.

REPORT OF THE EDITOR OF PUBLICATIONS

To the Director:

Five bulletins and two annual reports were published during the fiscal year ending June 30, 1919. There were 277 pages in these bulletins and reports, with a combined edition of 44,500. My previous reports have been for the year ending November 30, and in bringing this report in time with our fiscal year, four of the bulletins previously reported upon have been included herein.

The bulletin not previously reported on was "Orchard Management", an unusually effective, practical bulletin carrying information regarding the whole problem of the management of an orchard in Colorado, including pruning, maintaining fertility, cover crops, cultivation, irrigation, renovation of old orchards, and thinning.

The two reports were the Thirty-first Annual Report of the Agricultural Experiment Station and the Second Annual Report of the Colorado Seed Laboratory. The Experiment Station report contains the usual information regarding the period closing November 30, 1918. The Second Annual Report of the Colorado Seed Laboratory gives the results of the activities of the laboratory during a period from December 1, 1917, to November 30, 1918. Besides giving a complete detailed record of the activities of the laboratory, the report carried considerable information of interest and value to the farmers of the state, which had been gathered at the laboratory during the year.

The publications of the Experiment Station for the period herein reported are grouped under three heads, popular bulletins, technical bulletins, and reports, as follows:

POPULAR BULLETINS

Bulletin No.	Title and Author	No. Pages	Number Published
246	"A New Poisonous Plant; The Whorled Milkweed" By Geo. H. Glover, I. E. Newsom and W. W. Robbins	16	7,000
248	"Alfalfa Dodder in Colorado" By W. W. Robbins and G. E. Eggin- ton	15	9,000
250	"Orchard Management" By E. P. Sandsten	20	10,000
Totals		51	26,000

TECHNICAL BULLETINS

247	"A Study of Colorado Wheat" By W. P. Headden	15	10,000
259	"Mendelian Inheritance in Wheat and Barley Crosses" By Alvin Kezer and Breeze Boyack	139	5,000
Totals		154	15,000

REPORTS

Thirty-first Annual Report of the Agricultural Experiment Station By C. P. Gillette	48	15,000
Second Annual Report of the Colorado Seed Laboratory By W. W. Robbins	24	2,000
Totals	72	17,000
Grand Total	277	58,000

Respectfully submitted,
RALPH L. CROSMAN,
Editor of Publications.

REPORT OF THE ENGINEERING DIVISION

To the Director:

Herewith I present the report for the Engineering Division of the Experiment Station.

DEPARTMENT OF MECHANICAL ENGINEERING

Up to the present time the experiment station work of the Department of Mechanical Engineering has not been commenced. There are two projects that have been outlined and ready for work as soon as it can be begun. The instructional requirements in the department have been so acute that all members of the department have been heavily loaded with classes so that it has been impossible to start the experimental work. After the first of April the first project will be gotten under way. The arrangement has been made whereby this department will have half the time of Mr. Cummings, the other half of his time being given to the Department of Agronomy in the teaching of Farm Motors and Machinery. After the first of April all of his time for the remainder of the college year will be devoted to carrying forth the project of putting up hay. This project was turned over to the Department of Mechanical Engineering to push forward and Mr. Cummings has been employed to actually do the work.

It is hoped that the spring semester will offer us enough relief in the matter of teaching so that the work of the Experiment Station may go forward. At that time we hope to take up the matter of measuring the radiation constant of the ordinary wall board that is being used very extensively now in the place of plaster and ceiling. At the present time we have no data whatever on this radiation constant and it is hoped we will be able to work out the constant so that it may be used in heat calculations.

CIVIL AND IRRIGATION ENGINEERING

In the Department of Civil and Irrigation Engineering work on road material testing has been in progress since early in the summer.

I am attaching herewith the report of Professor E. B. House on the work of this department.

ELECTRICAL ENGINEERING

Up to the present time no project has been outlined, no work undertaken, and no appropriation made for the Department of Electrical Engineering. This has been caused by the fact that the department was manned with only Professor Foltz and his time was completely occupied with instructional work. However, it is hoped next year that he will have relief so that a project can be carried forward in this department.

Respectfully submitted,

LD CRAIN,

Vice-Director.

To the Vice-Director:

Following is the annual report of the Civil and Irrigation Engineering Section of the Experiment Station, Colorado Agricultural College, for the year 1919.

All the experimental work carried on by this section was done by Mr. O. V. Adams, who gave half of his time to the station, and half to the college from January to June, and full time to the station from June to December.

The project upon which he is working is Road Materials of Colorado. The scope of the project is four-fold:

First: To assist the various state, county, and municipal officials in the selection of the best road materials available for them.

Second: Determination of the best materials, or combination of materials for road purposes in different sections of the State.

Third: The publication of bulletins, giving the results obtained.

Fourth: The publication of a final report, showing the location, quality, and approximate quantity of the various deposits of road materials within the State.

Progress Made.—A publicity campaign among the state, county, and municipal highway officials has been carried on. The results on the whole have been disappointing. In only a few sections of the State is there much interest manifest in highway construction, and the most serious phase of it is that it is at present handled as a political problem, rather than a construction problem.

From December until June, Mr. Adams' time was taken by the installation of the machinery in the road-testing laboratory. The laboratory is now fully equipped, all the apparatus is installed, and work is proceeding satisfactorily.

During the summer a number of trips were made to different parts of the State, the road materials available examined, samples were taken and the same have been carefully tested out in the laboratory.

Within the next fiscal year, it is hoped that our laboratory will receive the official recognition of the State Highway Commission, also that greater co-operation may be secured from the state and county officials.

As millions of dollars are to be spent in Colorado during the next two years for the construction of roads, there is an urgent need for suitable financial arrangements whereby a complete survey of road building materials may be made, especially in counties where surfaced roads are to be constructed.

Respectfully submitted,

E. B. HOUSE,

Civil and Irrigation Engineer.

REPORT OF THE ENTOMOLOGIST

To the Director:

The projects that have received some attention in this section the past year are given below.

Plant Louse Investigations (Adams fund).—Work on this project has been in progress thruout the year, Mr. L. C. Bragg giving his full time to the work, Miss M. A. Palmer doing the work of a delineator, besides helping in other ways, and the writer has also given such time as he has been able to get from his other duties. We now have a very large collection of Colorado species, nearly all of which are drawn in color in the different stages thru which the plant lice pass in their round of development. While no paper has been published on this project during

the year, there are papers in progress which we hope to have completed at no distant date.

Codling Moth Investigations (Hatch and State funds).—Our life history and control work on this insect has been continued during the past season. In the Grand Valley, in the vicinity of Grand Junction, we have been co-operating in this work with the Bureau of Entomology, of the U. S. Department of Agriculture, with Mr. Leo Antlers in immediate charge of the work during the early part of the summer and Mr. Win. Yetter after July 1, Mr. Geo. M. List being in general oversight of the work for the station. The main purpose of the work this year was to demonstrate the methods of control that had been worked out thru the investigations of former years. The year has been an exceedingly unfavorable one for normal results in this work and the data have not been worked over sufficiently to enable us to draw any definite conclusions at the present writing. The ravages of this insect have been extremely severe, however, in most of the apple-growing sections of the State this year, probably because of the unusually warm summer, the temperature averaging considerably above the normal. The injuries were especially bad where the crop was very light.

At Paonia, in Delta County, Mr. J. H. Newton was in immediate charge of the life history investigations and codling moth control. The statements already made concerning the unfavorable conditions for normal results apply also to that section. Considerable complaint has come to this office during the late summer and fall by fruit growers who suspected they had used a poison of poor quality for spraying purposes, but it is probably that the seasonal conditions above mentioned are the chief factors in causing the increased number of wormy apples.

The Western Bean-beetle (State funds).—Our work upon the life history and control of the western bean beetle, *Epilachna corrupta*, was continued during the summer, the work being carried on principally by Mr. Floyd Brinley, under the direction of Mr. Geo. M. List. Good results were obtained in the control of this pest by using either arsenite of zinc or arsenate of lead, and the number of broods in this locality have been determined as one and a very small fraction of a second. A fuller report on this work will appear in bulletin form later.

Syrphus Flies and Their Relation to the Plant Lice (Hatch fund).—The work on this project is in charge of Mr. C. R. Jones, who is able to give only a small portion of his time because of a heavy teaching schedule. However, he is able to report progress.

Grasshopper Control (State funds).—This project was in charge of Mr. C. R. Jones. Fortunately the grasshopper outbreaks

have not been numerous or very serious in Colorado during the year and no experimental work has been carried on for their control.

Ants of Colorado in Their Relation to the Plant Lice (Hatch and State funds).—This project was started late in the season and, so far, the principal work done has been to collect material and notes to be worked up at a later date.

Miscellaneous Insect Pests (State fund).—This project was planned to cover needs that might arise for the investigation of unsuspected insect outbreaks during the year.

(1) *The Beet Web-worm, Loxostege sticticalis*, appeared in very unusual numbers in northern Colorado in what might be called the Fort Collins-Greeley district during the past summer. Thousands of acres of sugar beets were eaten to the ground after the tops had grown to the height of 10 or 12 inches. In many of the fields, nothing but a few of the stronger mid-ribs of the leaves were left standing. The recovery of the beets was quite remarkable, however, so that many of these fields seemed to make almost a full growth of tops, but the effect upon the beet itself must have been to greatly lessen the tonnage per acre. We tested Paris green, calcium arsenate, magnesium arsenate, and arsenate of lead in varying strengths to determine their efficiency in the control of these worms and found that any of these poisons were very satisfactory when used in double the ordinary strengths used for control of ordinary leaf-eating caterpillars.

(2) *Cut-worms*, and more especially the variegated cut-worm, *Peridroma saucia*, were injurious to crops in certain sections. The crop suffering most was alfalfa. In the vicinity of Rocky Ford, following the first cutting of alfalfa, the worms in some cases, completely prevented the growth of the alfalfa for fully two weeks before the fields began to look green again.

(3) *The Western Corn root-worm, Diabrotica virgifera*, continues to be a serious pest, especially to sweet corn growing in gardens where the same area is planted to corn year after year. Occasionally field corn suffers also where planted year after year on the same ground.

(4) *The Alfalfa Weevil, Phytonomus posticus*, has continued to spread in Delta County, from the region about Paonia where it was first discovered. Mr. Claude C. Wakeland has been in charge of our alfalfa weevil investigations and has carried on extensive life history work as well as testing out methods of control. The past season he has traced the spread of the weevil several miles to the south and west beyond the area that was found to be infested last year. In fact one small area of slight infestation was discovered on the mesa two miles west of Montrose. A

rather full account of the work that has been done in this State with this insect will be found in the reports of the State Entomologist for the years 1917 and 1918.

Respectfully submitted,
C. P. GILLETTE,
Entomologist.

REPORT OF THE FORESTER

To the Director:

I have the following annual report to make of work done in the Section of Forestry of the Experiment Station.

The original set of test specimens employed in carrying on the timber decay project has been used up and the data from same recorded in graphic form. At the present time the only species under test is a set of California redwood specimens furnished by the California Redwood Association. This is one of the very durable timbers of the Pacific Coast forest region and a comparison of it with some of our more eastern species seems desirable.

It is desired that this project be considered in force for the coming year, as it is found that it cannot be hastened greatly with present facilities.

My absence during a part of the past year for surgical treatment and consequent period of convalescence, together with increasing demands from the teaching work in the College, has necessitated limiting my attention to the above project.

The part of this project involving co-operation with the Mechanical Engineering Department, which was begun last year, was dropped on account of the lack of time from members of that department. This co-operative work, it is hoped, may yet be done when less strenuous times in teaching lines are experienced by those with whom this work was undertaken.

No bulletins have been published during the year, although a detailed report on the above project is in preparation and may be considered suitable for publication.

Very truly yours,
B. O. LONGYEAR,
Forester.

REPORT OF HOME ECONOMICS SECTION

To the Director:

I am presenting herewith a report of the work of the Home Economics Section for the fiscal year closing June 30, 1919.

RESULTS

The one project occupying the time of the worker, Miss Evelyn G. Halliday, from July 1, 1918, to January 1, 1919, was that approved the previous year, "Utilization of Raspberry and Plum Juices". Experiments were made to determine satisfactory methods of clarifying cherry, plum, and raspberry juices. Following is a summary of methods used and results obtained:

In the work with the juice of Montmorency cherries the experiments indicated that clarifying agents are not necessary in order to secure a clear, well flavored juice and that sulfurous acid does not improve the color. Both color and flavor seem to be considerably impaired by high temperature.

With red raspberries, in experiments similar to those with cherries, in all cases juice was slightly cloudy when first extracted and did not materially change in appearance when allowed to stand for a period up to one month. A number of portions of this cloudy juice were filtered through asbestos. These filtered very rapidly and the cloudiness all disappeared. Such a large number of the portions containing clarifying agents were stolen that no conclusion regarding their effect could be drawn.

The varieties of plums used were Sunset, Forest Garden, Wyant, and Lombard. Judging from the experiments, plum juices that are cloudy and viscous when extracted do not become clear upon standing, either with or without the addition of clarifying agents.

The precipitation of pectin and the determination of pectin acid and reducing substances constitute a part of the work done but results to date do not permit of conclusions.

FORECAST FOR 1919-1920

The two projects to be considered in force for 1919-1920 are:

Utilization of Raspberry and Plum Juices

The Cooking Quality of the Colorado Potato

The first named project is that on which Miss Halliday is at present working toward her master's thesis at the University of Chicago. Miss Halliday will then report results and conclusions to this department, that they may be in turn incorporated in a publication from the Station. Doctor N. E. Golthwaite, successor to Miss Halliday, will, it is contemplated, another year take up the work on fruit juices at the point at which Miss Halliday will discontinue her work. It is anticipated then that another year the work of Doctor Goldthwaite will be devoted to the two projects

named, which means that we do not anticipate the completion of any project this year.

PUBLICATIONS

No publications have been issued from this section.

Respectfully submitted,

INGA M. K. ALLISON,

Head of Department.

REPORT OF THE HORTICULTURIST

To the Director:

I beg to submit the following report on the work in progress in the Horticultural Section during the past year:

PEAR GROWING IN NORTHERN COLORADO

This project is still in force, tho the original trees planted have been reduced to a dozen. Two varieties seem to stand the climatic conditions well and one of these fruited last season. The trees are now five years from planting and those still living are making good progress. This project will not be further extended, tho notes will be kept on the progress of the surviving trees.

GROWING HARDY STOCK AND HARDY APPLES FOR NORTHERN COLORADO

This project will continue in force indefinitely. The two severe freezes that we had three years ago and two years ago demonstrated the fact that many varieties planted are unsuited for the existing conditions. Replants were made and the orchard is now in very good shape for the future.

GROWING VEGETABLES AND SMALL FRUITS IN HIGH ALTITUDES

This project is carried on at the Fort Lewis School of Agriculture under the direction of Professor McGinty. The work has progressed far enough to warrant Professor McGinty to write a brief bulletin for the information of farmers and others living in this section of the State. Apparently, there is little occasion for continuing this work on a large scale, except testing new varieties that appear from time to time in the market. The common vegetables grown in other sections of Colorado seem to do well and to mature perfectly. We are in hopes that Professor McGinty will write up the results during the winter.

SEED POTATO GROWING IN HIGH ALTITUDES

This work has also been carried on at Fort Lewis. The early maturing varieties mature well in this section. Seed selection has been carried on and there now is on hand a good supply of selected seed for future work. This project should be continued for several

years more. The selection has been from typical hills, and the results obtained are promising.

FRUIT GROWING IN HIGH ALTITUDES

The work on this project is carried on at Fort Lewis in connection with the other two. The small fruits, such as strawberries, raspberries, currants, and gooseberries, do well at Fort Lewis. There is need of winter protection for both strawberries and raspberries. Considerable trouble is encountered from the injury caused by rabbits and mice. Strawberries and raspberries and other hardy bush fruits can be grown successfully if the grower is willing to give the plants the needed protection in the fall. The larger fruits, such as plums, cherries, and apples, have not done as well as had been expected. The late spring frosts kill not only the blossoms but also the young, tender shoots, thus setting the trees back in their growth and causing the loss of the fruit crop. It is only in exceptional seasons when the fruit is not killed by frost.

Fruit trees should be grown not only for the sake of obtaining a possible crop of fruit, but they may be used as shade trees on the lawn and in other places. In this way, there would not be the expense in connection with caring for an orchard planted for fruit production.

POTATO GROWING AT FORT COLLINS

This project is completed in so far as the work on potato growing at Fort Collins is concerned. I believe that we have demonstrated conclusively that potatoes can be grown on our heavier soils if proper methods are pursued. This work will be written up in connection with the work now carried on at Del Norte in the San Luis Valley. At this place work is being done to determine the effect of rough or gnarly or knotty seed on yield and on quality. The work has now been in progress for two years and valuable data has been collected. The difficulty in carrying on work of this kind away from immediate control is noticeable. One is never absolutely sure of results, as the work is often interfered with by the owner of the land. The interference, while not intentional, is often done thoughtlessly and without proper regard for experimental data. This is especially true if the owner of the land has some fixed idea in his mind as to the value of different kinds of seed. So far, there are strong indications that gnarly or knotty seed are the effect of secondary growth, or uncongenial soil, are not hereditary and only affect the crop raised from them in the way of vigor and possible productiveness, but so far as the shape is concerned, there seems to be little or no difference.

The results seem to bear out our conception that the cultural side of potato growing is too often neglected, and possibly too

much emphasis is placed on the seed. This, of course, does not mean that we should let down the bar and use all kinds of seed, but simply that we should pay closer attention to the cultural side to enable the plants to grow normally.

TOMATO PROJECT

This project was started two years ago, the idea being to determine the varieties of tomatoes best adapted to the truck-growing sections of Northern Colorado. Over 70 varieties have been planted in our trial ground. This year's work on tomatoes was entirely lost, due to the belated frost, and the work will have to be repeated for at least one year more before we can feel warranted in giving the data to the truckers.

DEHYDRATION OF FRUIT AND VEGETABLES

This project is in abeyance for the present. There seems to be no demand for dehydrated products, especially from the standpoint of the immediate producer and consumer. The commercial aspect, or the commercial drier, will undoubtedly remain with us, but the community drier will undoubtedly disappear.

FRUIT SURVEYS

The fruit survey of Fremont County has been tabulated and the result is now in the hands of the station editor. This makes the second county that has been surveyed and the data tabulated. Last season the survey was completed in Delta, Montrose, Montezuma, and La Plata Counties, and a start was made in Otero County. It is the intention to complete the remainder of the State early next summer and then publish a bulletin covering the status of fruit growing in the State.

The work of the State Horticulturist has been correlated very closely with that of the Experiment Station, and Mr. Locklin is now carrying on some experimental work on the storing of apples at different periods of maturity. The experience of Colorado fruit growers with certain varieties in storage prompted the experiments. It has been the experience of growers and of buyers that the Jonathan apples often keep very poorly in cold storage, and in addition, develop spots which make the fruit unsalable. To test out whether the stage of ripening of the fruit has an influence upon their storage qualities, the fruit was picked at different dates and immediately placed in cold storage, where it will be examined from time to time.

In addition to this work, co-operative experiments in the use of cover crops in Delta County were started, the seed being fur-

nished by the State department. Work has also been done on the hill selection of potatoes to encourage the grower to use better seed.

PUBLICATIONS

Only one publication has been issued from the section, namely, "Orchard Management", and the one now in press, "Orchard Survey of Fremont County".

If time permits, a bulletin on cherry growing, and also a bulletin by Professor McGinty on vegetables for high altitudes will be written. In addition to these, we hope to be able to re-write the bulletin on "Small Fruits", and possibly one general bulletin on vegetables. There is an urgent demand for information bulletins that should be supplied.

Respectfully submitted,
E. P. SANDSTEN,
Horticulturist.

REPORT OF IRRIGATION INVESTIGATIONS SECTION

To the Director:

The following constitutes the report covering the work of the co-operative irrigation investigations for the year 1919. The work covered by the fiscal year ending July 1, 1919, has, in part, been touched upon by the last annual report from this section for the year 1918.

Water Requirements of Crops, an Adams project, has been abandoned, that is, no more field data are being secured. This work was started in the spring of 1911 and continued each season until 1918. Various crops were raised in buried concrete basins such that the water table could be maintained at a constant depth during the growing season. The principal crops grown were alfalfa, sugar beets, and grain. The concrete tanks were in duplicate and so arranged that the water table would be maintained at 2, 3, 4, 5, and 6 feet below the ground surface. The study of yields according to depth of water brought out some interesting facts, especially on the sugar beet production. It was observed that the weight and size of beets increased with the depth of the water table. It was also evident in one set of tanks that the percentage of sugar increased with the depth. There was a tendency for the coefficient of purity to also increase with the depth of water. The results of the investigation with barley and wheat were of little account. The area upon which the tests were made was necessarily small, leaving but a few normal plants to each basin. The loss due to broken stems, birds, and rodents was sufficient to obliterate the

trend of the effect of the water table. However, it was apparent that the increase in production was proportional to the increase in depth of the water. The alfalfa was not susceptible and little difference was noted for the 3-, 4-, 5-, and 6-foot tanks. The growth maintained almost a uniform height for these tanks, but there was a noticeable difference for the 2-foot tank where the growth was more thinly distributed over the area of the tank. The last couple of seasons show a very erratic regulation of the water table which no doubt resulted from ruptured partition walls due to frost action. It was deemed inadvisable to attempt the repair of this equipment in view of the data already secured from the experiment when the tanks were known to have been in good condition.

The Poudre Valley Project has been virtually completed. This study was made to determine the facts underlying the good use of water in this valley. The field work was done in the years of 1916 and 1917, but it was necessary to secure additional data during the summer of 1918. The vast amount of data secured resulted in a very extensive piece of work in the compilation and coordination of these data. The credit for completing and writing the report on this work is due Mr. Robert G. Hemphill, who has been connected with this investigation since its inception. This work was carried out as a special project and required a number of field men, together with a considerable amount of equipment.

The work in Meteorology has been carried on with little or no change. This project has been carried for a number of years as a Hatch project, but only in its most general application can it be said that it directly approaches an investigation. The data secured at this station, in our meteorological work, have been very widely used, not only throughout the State but have formed a part of various studies made by other workers of the station in agricultural lines.

The Venturi Flume Project, on the Adams fund, has been active and some work done in the office to correlate the results obtained by investigations at Cornell University with those derived here at our laboratory. In compiling these data, it was found that the two sets could not be well worked out as a unit. This was due to the fact that our own equipment was insufficient to make observations on discharges of high heads. In order to establish the relation between the discharges for various widths of throat, it seemed necessary to secure additional data for high heads on the smaller flumes. Plans were drawn up for the installation of a field laboratory to be located near Bellvue, at the headworks of the Jackson Ditch, where it is possible, with little effort, to carry on this investigation. A report by V. M. Cone on the Venturi flume

has been published by the U. S. Department of Agriculture, but since its publication there has come to light a number of interesting points which have caused us to feel that more investigation is necessary before this device is thoroughly understood. It is hoped that the additional data secured will enable us to establish the law of flow and to further our knowledge concerning some of the eccentricities of this measuring device.

The Current Meters Project, Adams, and the *Evaporation Project*, Hatch, have been held in abeyance. Some work has been done with the current meter study but nothing with the evaporation.

South Platte Project.—A new project of considerable magnitude has been launched in the investigation of the seepage and return waters to the South Platte River in Colorado. This project is being carried out under an agreement involving the Irrigation Division of the Bureau of Public Roads, U. S. Department of Agriculture, the State Engineer's office of Colorado and the Colorado Experiment Station. It is proposed that this study be confined to that stretch of the river between Kersey and the Nebraska State line at Julesburg. Under an agreement with the county commissioners of the various counties interested, it is understood that the deputy water commissioner of Districts Nos. 1 and 64 are to be appointed in the interests of our investigation. However, it is not to be inferred that the appointment of these deputies is wholly for our purpose, but, being duly appointed by the law, they are subject to the demands of the water commissioner of their respective districts. These deputies, Mr. Thos. L. Doyle at Sterling, in charge of our work in District No. 64, and Mr. H. E. Grosback in charge of the investigation in District No. 1 at Fort Morgan, have carried on the field work in our interests, in addition to their regular work as deputy commissioners. Mr. R. G. Hemphill has been assigned to Fort Morgan to direct the field work. The greater part of the summer season is crowded with work requiring immediate attention, while during the winter the computation and tabulation of data will consume the time of the entire field force. The State Engineer's office is to be supplied with duplicate records of our data which adds considerably to the office work of the investigation. We have installed nearly fifty water stage registers of which seven are located on the river and the remainder on canals and seepage streams. The registers are of various types and approximately one-half of these instruments were designed by the writer and built here at our laboratory. The design is somewhat of a departure from the standard type, but the performance of these instruments in the field has been very satisfactory, which is gratifying in view of the fact that their cost was about one-third

that of standard instruments purchased in the open market. More registers will be installed next season to enable a closer check on the conditions of flow. The travel in the field is by Ford automobiles, furnished by the station. At this time we are not able to draw any conclusions, but it is evident that we have an extremely fertile field for carrying on our investigation. It was originally proposed that this investigation should continue until approximately January, 1921, in order that sufficient time could be given the study to fully establish the various factors underlying this problem. It is perhaps not out of place to mention that the co-operation and interest of the people of these communities has been highly satisfactory and it is expected that our organization will establish a condition of justice and fair dealing among the water users of these two districts.

The Hydraulic Laboratory.—No work of a continuous nature has been undertaken at the Hydraulic Laboratory. Last November there was tested here an integrating water meter, known as the Reliance Meter, for the Hydrometric Company of Los Angeles, California. This type of meter has met with considerable success in California where accurate measurement and record is necessary on account of the value of water for irrigation purposes. A number of problems have been awaiting attention, but due to lack of assistance these have not been undertaken.

PROPOSED WORK

The following projects will be considered actively in force the coming fiscal year: Venturi Flume and Current Meters, on the Adams Fund; Meteorology and Evaporation, on the Hatch Fund, and the South Platte project, on the state funds.

No bulletins have been published from this section for the last fiscal year.

In planning the work for the fiscal year 1919-20 and in making up the estimate of expense, it became necessary to modify various items to accommodate an unexpected change in the apportionment of funds from the government. While the co-operative agreement between the station and the Irrigation Division of the Bureau of Public Board specifically states the amount of money available from the government fund for the Colorado work, it was not known at the time of the original estimate of certain increases of salary to be paid from this fund. Salaries and personal traveling expenses absorb this entire fund, so it was necessary to make readjustments and eliminations in our proposed schedule on the projects under investigation. The South Platte project had been started and certain estimates made to carry on this work. Later it became necessary to materially change these and shift the expenses either to the station or the State. It appears now that the present rearranged

schedule will carry on the work. In this connection it may not be out of place to mention the matter of salaries.

There seems to be some discontentment on the part of the workers as to the amount of salary received, but I am unable to recommend any solution for this ever-present problem. Cost of living has so greatly increased and those of us who are paid from government funds feel considerably at a disadvantage on account of the relatively low salaries received.

This section of the station is called upon frequently to assist with various problems about the State. Considerable travel has resulted from these activities, especially in connection with the South Platte project. This office has assisted with both irrigation and drainage problems and has also been called upon for considerable special work by the Berkeley office. In May a trip was made to Ogden, Utah, in the interests of a canal company relative to the calibration of a large-sized Venturi flume. Various reports on special problems have been made which have required some time in their preparation.

Respectfully submitted,
RALPH L. PARSHALL,
Irrigation Engineer.

REPORT OF THE VETERINARIAN

To the Director:

The workers in the veterinary section this year consist of a veterinarian, a pathologist, and two assistants. Of these, one assistant only is on full time with the Experiment Station.

The following approved projects have been under consideration: Necrotic Stomatitis, A Disease of Chickens, Contagious Abortion, Sheep Losses in the Feed Lots, Whorled Milkweed, and Animal Diseases. The pathologist, Dr. I. E. Newsom, will report on all save the last two mentioned.

No work has been done recently, in the veterinary laboratories, on the Whorled Milkweed project. A field man has been at work throughout the summer season under the immediate direction of the botanical department and Dr. W. G. Sackett is studying the toxic properties of the plant. It has been fully demonstrated that the whorled milkweed is one of the most deadly poisonous plants in the state and in economic importance must be rated with the loco weeds and larkspur. We shall hope to complete the work under this project and publish a bulletin on the same within the coming year.

The Animal Disease project is presumed to cover all animal diseases that are not otherwise designated under approved projects.

The Experiment Station is frequently asked to investigate outbreaks of contagious and infectious diseases, which may not be carried far at the time, but which means the rendering of a valuable service at the time of the outbreak and which serves to collect valuable information for future investigation.

The Kansas horse plague made its second appearance in epizootic proportions in July of this year. It started apparently at Hartman, Colorado, and spread as far west as the mountains and in other directions for several hundred miles. The cause has not been determined. Inoculation experiments have failed to transmit the disease. The consensus of opinion is that it is "forage poisoning" and this term does not represent a distinct entity in the causation of disease. Much has been learned respecting treatment of the disease and fully 50 per cent. of affected animals were saved.

There have been several outbreaks of hog cholera and other diseases which have received cursory attention from an investigational standpoint but which have, aside from the assistance rendered at the time, served at least to keep us in touch with the animal disease problems of the State.

Most of our time has been devoted to investigation of sheep losses in the feed lots. This project seems to be of overwhelming importance. In fact, because of the heavy losses which each year are becoming heavier, the lamb-feeding industry is seriously threatened. There are peas enough raised in the San Luis Valley to feed at least three times as many lambs as are being fed this year. The risk is too great and capital for this kind of an investment is becoming wary. Many thousands of sheep have been vaccinated experimentally and the loss to a certain extent has been curtailed. It has been definitely determined that much of the sheep losses can be attributed to hemorrhagic septicemia. A full report will be made later by the pathologist, who is in charge of the investigation.

Respectfully,
GEO. H. GLOVER,
Veterinarian.

REPORT OF THE VETERINARY PATHOLOGIST

To the Director:

The Pathology Section has given a large share of its attention to the sheep project during the year, as it has largely overshadowed the others in economic importance. The first report on this problem was given in a paper to the 1918 meeting of the American Veterinary Medical Association held at Philadelphia.

The paper was published in the journal of that association for April and May, 1919. A paper detailing further work was presented to the Missouri Valley Veterinary Association held at Kansas City in February, 1919, which was published in the American Journal of Veterinary Medicine for July. For the special benefit of the sheep men a bulletin was written for the Extension Service which appeared in January, 1919, Series 1 No. 154-A.

We may say that the general conclusion at which we have arrived is that a large proportion of our sheep loss in the State is due to hemorrhagic septicemia. The investigational work is now largely turned toward preventive measures. We already have record of some 35,464 sheep where the vaccine was applied in infected herds. We expect to continue this work for some time as the economic results are just now becoming apparent.

CHICKEN DISEASE

Some work was carried on during the year in a further attempt to reveal the cause of the chicken disease which causes such losses in eastern Colorado. The general result of the experimental work was to indicate that the disease does not occur when chickens are kept off of sod. Consequently, we have advised raising them on bare ground or in shade. The actual cause of the disease has not yet been determined.

CONTAGIOUS ABORTION

Routine serum tests have been conducted on this project but have as yet not led to any conclusion.

NECROTIC STOMATITIS

No work whatever was done on this project during the year, it being held in abeyance until such time as we were able to give it more attention.

MILKWEED PROJECT

Bulletin No. 246 on "The Whorled Milkweed" was published during July, 1918, giving the results of our work up to that time. We received shipments of the plant approximately every two weeks during the summer of that year and showed the plant was poisonous throughout its entire period of growth. This poisonous property was exhibited for both rabbits and sheep.

The work of this section is becoming so considerable that we find ourselves greatly cramped for room. The pathology laboratory is occupied during the school year practically every hour of the day, and since it is in this laboratory that the major portion of the experimental work must be carried on, we find ourselves very much crowded. I trust that the new building plans may provide an entirely separate laboratory for experimental purposes. We

also are very much in need of a small animal house where proper sanitation can be maintained.

During the year we have examined 210 pathological specimens sent in by farmers and veterinarians from different parts of the State. This work is requiring so much time that special provision should be made for it. In fact, one man's time would be required in order to handle all of these specimens properly. We recommend, therefore, that special funds be set aside from the experiment station budget or that a special request be made to the legislature for funds to handle this phase of the work.

List of projects in operation during the year: Sheep Losses, Contagious Abortion, Milkweed, and Chicken Disease. Projects in abeyance during the year: Necrotic Stomatitis.

Respectfully submitted,

I. E. NEWSOM,
Veterinary Pathologist.

