THE STATE AGRICULTURAL COLLEGE
OF COLORADO

The Twenty-Seventh Annual Report

OF

The Agricultural Experiment Station

For 1914

THE STATE BOARD OF AGRICULTURE

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V. M. CONE, B.S ..... Irrigation Investigations
W. P. LITTLE, B.S., U. S. Expert-in-charge ..... Horse Breeding
R. E. TRIMBLE, B.S ..... Assistant Irrigation Investigations
P. K. BLINN, B.S., Rocky Ford ..... Alfalfa Investigations
EARL DOUGLASS, M.S ..... Assistant Chemist
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H. E. DVORACHEK, B.S.A ..... Assistant Animal Husbandman
MIRIAM A. PALMER, M.A ..... Delineator
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BREEZE BOYACK, B.A., M.S ..... Assistant in Agronomy

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LETTER OF TRANSMITTAL

To His Excellency, E. M. Ammons, Governor of Colorado:

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

The financial statement is for the Government fiscal year ending June 30, 1914. The other portions are reported substantially for the state fiscal year of 1913-14.

C. P. GILLETTE,
Director.

Agricultural Experiment Station,
Fort Collins, Colorado,
December, 1914.

FINANCIAL REPORT OF THE COLORADO AGRICULTURAL EXPERIMENT STATION FOR THE FISCAL YEAR ENDING JUNE 30, 1914

Dr. **RECEIPTS**

From the Treasurer of the United States as per appropriation for the fiscal year ended June 30, 1914, under acts of Congress approved March 2, 1887 (Hatch Fund) and and March 16, 1906 (Adams Fund)	Hatch Fund	Adams Fund	State Fund	Special Fund	Sales Fund	Total Fund
	$15,000.00	$15,000.00	.....	.....	.....	.....
Balance on hand July 1, 1913	.....	.....	3,325.26*	3,584.59	284.00	543.33
Other sources than U. S.	.....	.....	10,301.87	3,823.87	4.60	14,130.14
Total receipts	.....	.....	.....	.....	.....	$44,673.47

DISBURSEMENTS

By	Hatch Fund	Adams Fund	State Fund	Special Fund	Sales Fund	Total Fund
Salaries	9,969.26	11,568.04	923.72	137.49	.....	22,598.51
Labor	996.37	322.21	1,155.00	241.65	10.68	2,725.91
Publications	975.45	.....	411.74	38.50	.....	1,425.69
Postage and stationery	542.16	36.98	51.78	48.78	.40	680.10
Freight and express	28.78	112.50	70.83	18.30	.....	230.14
Heat, light, water and power	215.57	.....	.....	.....	.....	215.57
Chemicals and laboratory supplies	.....	811.65	8.70	3.15	6.50	830.00
Seeds, plants and sundry supplies	181.70	87.02	295.63	127.16	8.45	699.96
Fertilizers	.....	19.50	.....	.....	.....	19.50
Feeding stuffs	.....	.....	3,189.44	84.42	.....	3,273.86
Library	53.07	88.39	.....	.....	.....	141.46
Tools, machinery and appliances	565.90	72.57	448.32	72.95	.....	1,159.74
Furniture and fixtures	248.30	10.20	7.50	.....	.....	266.00
Scientific apparatus and specimens	107.04	678.40	.....	.....	.....	785.44
Live stock	.....	.....	17.00	.....	.....	17.00
Traveling expenses	433.93	472.70	191.15	30.05	1.80	1,129.63
Contingent expenses	20.00	.....	4.00	1,000.00	.....	1,024.00
Buildings and land	662.47	719.84	201.80	34.84	2.10	1,621.05
Total expenditures	$15,000.00	$15,000.00	$6,976.61	$1,837.29	$ 29.93	$38,843.83
Balance				5,570.97	258.67	5,829.64
				$7,408.26	$288.60	$44,673.47

*Overdraft.

REPORT OF THE DIRECTOR.

To the President:

I am presenting herewith a brief annual report of the work of the Agricultural Experiment Station for the year just closing. The financial statement is prepared for the Government fiscal year closing June 30, 1914, but the balance of the report covers the work of the station during the State fiscal year closing November 30, 1914.

While the funds available for experimental work during the year have been meager, I feel that the results are all that could be reasonably expected. The appropriations made by the Nineteenth General Assembly have been paid in larger proportion (80%) than those for the previous biennial period, but no money was received until after the close of the first fiscal year, in fact, we have had only eleven months in which to spend the State Appropriation, and have not known how much of the appropriation would become available until the last month of the year.

I have called attention in my former reports to the great need of something being done to enable the Station to plan more definitely the experimental work that is to be carried on from year to year. A condition of uncertainty makes it impossible to use the money to the best advantage. We could get along with less money and do better work, if we could know a year or two in advance what funds we are to have for the support of our experiments. I very much hope that a bill may be passed by the next General Assembly, that will give the Station a continuing appropriation, or make the appropriation available until one year, at least, after the biennial period for which the appropriation is made. This would enable the Station to plan its work economically and save money to carry the work from one biennial period until money is made available in the next period.

I am glad to report that there has been very few important changes in the station staff during the year. This is a matter of much importance in Station work. Every change in the head of a section means a heavy loss in the progress of the work. We lose a year or more of the work of the man who goes, and it takes a year or more for a new man to become adjusted in his new relations. The co-oper-

ative work that has been carried on in our Irrigation Investigations with the Office of Experiment Stations, and in the Horse Breeding work with the Bureau of Animal Industry, have progressed very satisfactorily, and I hope both lines of co-operation may be continued. There have been other offers of co-operation on the part of men connected with the Department of Agriculture, and I hope that we may be able, during the next year, to take up at least two or three additional lines.

I am also pleased with the progress made by the Chemical Section in the work undertaken by Dr. Headden to determine the factors that effect the qualities of wheat, and especially that part of his work which bears upon the cancer of "yellow-berry."

It will undoubtedly require one or two years yet to complete the main line of work undertaken in this project.

The work of the Bacteriological Section on Raspberry Spur Blight, and Bacteriological Studies of Alkali Soils, also of the Agronomy Section on the Correlation of Characters in Grain, have made excellent progress during the year. The work carried on in the Veterinary Section to determine the real cause of the new malady known as "Brisket Disease," will no doubt be of much interest to the stockmen of the high altitudes and enable them to save much of the loss they would otherwise sustain.

The co-operative work with the Costilla Estates Development Company came to a close with the gathering of the crops this year. A bulletin has been prepared covering this work and is ready for publication as soon as funds become available. I believe the results obtained warranted the co-operation, as the Station has been to no expense outside of the time required to direct the work on the part of Professor Keyser and Mr. Cone.

We have received some financial assistance this year in conducting the Brisket Disease investigation, from the Commissioners of Jefferson County, for which we are very thankful. Without this assistance we would hardly have been able to undertake the investigation at all. A preliminary report upon the work has been prepared and will be issued at once as a Station bulletin.

A considerable number of important new projects have been presented for consideration by different members of the Station staff, which I have not thought it advisable to approve, because we do not have sufficient funds or equip-

ment to carry more work than we have already undertaken. It has been my policy to try to support fairly well the lines of work that we attempt to carry on, so that results may be reached in a reasonable length of time. This necessitates the rejection of many projects that I would otherwise like to see undertaken.

While we have been able to publish a larger number of bulletins this year than a year ago, we are still unable to print as many popular bulletins as we should have for the information of the farmers. At the present time there are four or five bulletin manuscripts ready for the printer which we are unable to publish because there is no money available for the purpose. Any one of these bulletins would be of great value to the farming community if it could be published and distributed.

The publications for the year are as follows:

BULLETINS

193—Nitrifying Efficiency of Certain Colorado Soils, by Walter G. Sackett.

194—Frictional Resistence in Artificial Waterways, by V. M. Cone, R. E. Trimble and P. S. Jones.

195—Small Fruits for Colorado, by E. P. Sandsten.

196—Some Soil Changes Produced by Micro-organisms, by Walter G. Sackett.

197—Hog Cholera Control, by Geo. H. Glover.
Necrotic Stomatitis, by I. E. Newsom.

198—The Onion in Colorado, by E. R. Bennett.

199—Vegetable Growing in Colorado. Hot Beds and Cold Frames, by R. A. McGinty.
Common Insects of the Garden, by C. P. Gillette.

200—Silos and Silage in Colorado, by H. E. Dvorachek.

201—Some Colorado Mushrooms, by B. O. Longyear.

202—Handling and Testing of Milk and Cream, by R. McCann.

The Station projects for the most part are the same as one year ago; a few old projects have been completed and a number of new ones added. I am giving below a list of Station projects that have received some attention at the hands of the station force during the past year. Those that are marked with an asterisk were completed during the year.

STATION PROJECTS IN FORCE DURING THE YEAR

Entomological Section

Plant Louse Investigation, Adams Fund.
Codling Moth Investigations, Hatch and Special Funds.
Syrphus Flies in Relation to Plant Lice, Hatch Fund.
Control of Insects by Egg Treatment, Hatch and Special.
*Life Habits of Lady Beetles, Hatch and Special.

Chemical Section

A Study to Determine the Factors Causing the Softening of Wheat, Adams Fund.

Veterinary Section

Brisket Disease, Hatch and Special Funds.
Sore Mouth Disease, Hatch and Special.
Infectious Anemia, Hatch and Special.
Disease Investigations, General and Special Funds.

Bacteriological Section

A Bacteriological Study of Alkali Soils, Adams Fund.
*Nitrifying Efficiency of Some Colorado Soils, Adams.
*Spur Blight of the Raspberry, Hatch and Adams.
Value of Certain Carbon Compounds as a Source of Energy for Azotobacter, Adams.
Soil Algae, Hatch Fund.

*Completed.

Agronomy Section

Correlation of Characters in Grain, Hatch Fund.
Alfalfa Breeding, Hatch.
Methods in Selection Breeding, Special Fund.
High Altitude Crops, Special Fund.
Feed Crop Improvement, Special Fund.
Rotation of Crops for Colorado, Special Fund.

Horse Investigations

To establish an American Breed of Carriage Horse State Appropriation, in co-operation with Bureau of Animal Husbandry.

Animal Husbandry

Ration Experiments with Steers, Special Fund.

Irrigation Engineering Section

Duty of Water Upon the College Farm, Special Fund.
Sub-irrigation Investigations, Special Fund.

Horticultural Section

Hardy Stock of Apples, Hatch and Special Funds.

Pear Growing in Eastern Colorado, Hatch and Special Funds.

Management of Nitre Soils, Hatch and Special Funds.

Irrigation Investigations Section

Experiments with Flow of Water, Adams Fund.

Drainage of Farm Crops and Drainage Factors, Adams.

Water Requirements of Crops, Adams.

*Co-efficient of Friction, Adams.

Weir Construction, Adams.

Current Meters, Adams.

Evaporation Experiment, Hatch.

Concrete, Hatch.

Tank Experiments, Hatch.

General Meteorology, Hatch.

Pump Irrigation, Hatch.

Seepage, Hatch.

Following are brief reports of the work of the year from the Experiment Station Sections.

Very respectfully submitted,

C. P. GILLETTE, Director.

REPORT OF THE ENTOMOLOGIST.

To the Director:

In the main, the Entomological Section has been working along the same lines as last year. The major part of the work has been devoted to our studies of the life habits of the plant lice belonging to the family Aphididae. I believe that very good progress has been made. Important new information has been secured concerning the habits of a considerable number of our Colorado species.

Several papers have been published or placed in the hands of technical magazines for publication covering features of this work during the year. Miss M. A. Palmer has completed her paper on "The Life Histories of Colorado Lady Beetles," (Family Coccinellidae), which is being published by the Annals of the American Entomological Society. This paper reports upon the life histories and food habits of the more important lady beetles, having the habit of feeding upon plant lice in Colorado. Two full page color plates accompany this paper.

Mr. C. R. Jones has made good progress in his work upon the Colorado Syrphidae, but does not contemplate publishing the results of his studies for a year or more yet. We have also gathered considerable additional data upon the effect of various insecticide materials upon insect eggs, and hope to be able to publish upon this work in the near future.

On account of the failure of a large proportion of the apple growers in Colorado to properly control the codling moth, this section undertook to gather additional data upon the life history of this insect in the Grand Valley the past summer and also gathered data upon the effects of the different methods of spraying for the control of this pest. Two orchards were sprayed experimentally in this work, and I believe we have gathered a mass of data that is going to be very valuable in enabling us to point out some of the weak points in the methods of control that are at present in vogue.

In connection with our work with the plant lice, we have gotten together a very fine collection of this group of insects.

Respectfully submitted,

C. P. GILLETTE.

REPORT OF THE CHEMIST.

To the Director:

The chemical section has been engaged in prosecuting its study of the composition of Colorado wheats, and no other subject, since its last semi-annual report.

The real subject which we have in view and which has been repeatedly stated, is to find out if possible the factors in our conditions which determine the character of our wheat. In gathering the data already acquired pertaining to our wheat, I found that there had been no work done on the subject since that recorded by Clifford Richardson in 1883 and 1884. Mr. Richardson evidently worked on samples furnished by Professor Blount, then Professor of Agriculture in this institution. It was therefore advisable, almost essential, that I should go over the whole ground of study which has extended considerably since the time of this earlier work, to find out if possible, just what the character of our wheat is. This is somewhat of a task, as we have no standard by which to be guided.

When we entered upon this work, we deemed it advisable to prosecute our study for three years on field crops,

so arranging our work as to accompish as many objects as possible with the least expenditure of time. One of the objects had in view was to establish the composition and character of Colorado wheat. We thought to attain to this by the study of grain grown on our check plots, and by the study of general samples secured from different sections of the state. We have found the study of general samples so good as useless, because we cannot obtain competent information concerning the conditions under which the grain was grown, and this information is absolutely indispensible. I have tried writing to millers, but as is easily recognized, they cannot, even if they are interested in the general questions involved, give such information as is required, besides there is the greatest uncertainty about the information that they do give. Another difficulty was encountered in the multiplicity of varieties obtained in this way, both of spring and winter wheats. I have abandoned this feature of the work and am confining myself to samples grown or collected by myself from sections under conditions with which I am familiar.

A second object had in view, and even more important for my purposes than the former, was to establish what the effects of two versus one irrigation may be. We recognized the fact that irrigating is not simply a question of applying water to the land. It involves questions of plant physiology or nutrition, but these questions do not form a distinct part of our proposed work, though they are directly involved and in an important sense. Up to the present time, we have applied one irrigation when the wheat was in boot, and, to certain sections, a second irrigation four weeks later. At this period the wheat is in full head and the grain set, and an ordinary irrigation exposes us to the danger of a mishap should there chance to come a little wind, or, if a shower, accompanied by wind, should happen to visit us, the crop on these sections would probably be ruined. We have so far escaped this danger.

A further and still more important object in connection with our specific purpose, is to establish, by direct experiment, the effect of the application of nitrogen, phosphorus and potassium upon the growth, maturation and character of the crop. These substances have been applied to different plots in different quantities, the same quantity, however, to the same plot each year. There have been nine experiments with each of these substances annually,

together with nine checks. Of these substances, the nitrogen is by far the most important to us.

We have now prosecuted this work for two seasons, so far as the cultural results go, we have no reason to be disappointed. The season of 1914, unfortunately, introduced factors which complicate our results to a very undesirable extent, but so far as we can now see, it did not vitiate them. The questions introduced by these untoward events are interesting, but it was no part of our purpose to consider them till they were, in this manner, forced upon us.

Our maximum yield in 1913 was 41.5 bushels of 60 pounds each. The variety reaching this yield was the Defiance. The minimum yield for 1913 was obtained with the Red Fife and was 26.2 bushels per acre. The maximum yield in 1914 was 55.5 bushels. This yield was reached by the Red Fife, and was followed closely by the Kubanka. The minimum yield in 1914 was 25.8 bushels from the Defiance plots. There is even a more marked difference in the quality of the different varieties as indicated by the weight per bushel in the two years. The Defiance in 1913 ranged from 61 to 63 pounds per bushel; in 1914 this variety ranged from 52 to 60 pounds, but for the most part weighed from 55 to 58 pounds. The Red Fife in 1913 weighed from 62¾ to 64¼ pounds per bushel, and in 1914 from 63 to 64½ pounds. The Kubanka in 1913 weighed from 62¼ to 64¾ pounds and in 1914 from 64½ to 65 pounds per bushel.

We have already done a great deal of analytical work on these crops, but are far behind with it. We were so far behind when the season of 1914 opened, that we have been unable to do any of the soil work which we carried on during the season of 1913. This is regretable, but was an unavoidable fact. We hope to be able to carry this soil work during the season of 1915, but if we cannot, we will have to depend upon subsequent observations to cover the subject.

All of this work is really preliminary to the real question proposed in this project. If at all possible, I should start pot cultures during the coming season, but I do not see how I can possibly do this with my present help. If we carry out our field experiments with the observations on the moisture and nitrogen content of the soil, I am sure that we will be farther behind in twelve months from now

that at the present time. I am satisfied, however, that we shall not be able to reach the real pith of our project till we can grow our wheat under thoroughly controlled conditions. This means control of moisture, amount of plant food, and bacterial flora, in particular the nitrogen fixing and nitrifying bacteria. To this end we need some additional facilities, not necessarily very elaborate ones, but such as may suffice.

I may state that I am in no way discouraged or inclined to desist from the prosecution of the specific problem as first proposed. This is not to be interpreted as a prediction of a positive and definite answer to the implied question, but simply that I am sanguine that we shall be able to contribute something to our knowledge of this problem, at least as it presents itself in our State.

I again present my request that, if in any way possible, this section of the station work be provided with more room. I have in my report to the President as Professor of Chemistry and Geology, presented the case of both the college and station and suggested that I believe that, for the sum of $15,000, we can erect and equip with the stationary fixtures which are necessary, a building adequate to our needs. I do not think it necessary to repeat in this place the reasons set forth in the other report. We are quite badly crowded and have been for several years. A fact of which I know that both you and the President have had cognizance.

We have had to make one change in our working staff since my last report. The misfortune of Mr. Rood made it necessary to obtain the services of someone else in his stead. We obtained Mr. J. W. Tobisca for this place.

Respectfully submitted,

WM. P. HEADDEN.

REPORT OF THE VETERINARIAN

To the Director:

In the Veterinary Section, investigations have been directed largely to three projects, viz: "Brisket Disease," "Necrobacillosis," and "Animal Diseases." Aside from the three projects mentioned, which have been subjects of special consideration, the station staff have examined and made laboratory diagnoses on one hundred and two path-

ologic specimens sent to the College from various sections of Colorado, and a few from adjoining states. In September of this year, Dr. H. S. Eakins was employed by the College as Professor of Materia Medica (relieving Dr. C. L. Barnes) and as assistant to Dr. I. E. Newsom in the Pathology laboratory. It was hoped that this arrangement would relieve Dr. Newsom, who was overworked, and permit of more time in the interest of animal disease investigation. Dr. Eakins, however, is employed by the City of Fort Collins in the capacity of Deputy Food Inspector for one-third of his time, and this combined with the fact that the funds for this work have been inadequate, inopportune and uncertain, have handicapped us in doing the work that we might have done, and prevented us from doing the work that the Veterinary Section could do to promote the live stock interests of the State. Three bulletins have been issued during the present fiscal year: "Hog Cholera Control" (popular) by Geo. H. Glover; "Necrotic Stomatitis" (popular) by I. E. Newsom, and "Brisket Disease" (popular) by I. E. Newsom and Geo. H. Glover.

"BRISKET DISEASE"

Dropsy of High Altitudes

The Experiment Station, not having the funds available to finance this project, prominent cattle men of Park County, advanced two hundred dollars, a fund which was later enhanced in a small way by receipts from sales on experiment animals that had recovered and were sold for feeders. One condition exacted in connection with the donation of this money was to the effect that it was to be limited to the support of this project in Park County. There has been a small amount of money available from special state appropriations, however, and this has enabled us to extend our observations to other high altitude regions of the State where the disease prevailed.

A preliminary report on "Brisket Disease" is now ready for publication. Our work thus far has led to the following conclusions: A disease occurs in cattle in the high altitudes of Colorado; the principal symptoms of which are swelling of the brisket and of the loose tissue under the jaw, diarrhoea, and a moist cough, with gradual emaciation and death. It is chronic in character, but fatal in practically all cases. On autopsy the most marked features are general dropsy, enlarged and hard liver, and dilated heart.

Six cases shipped to a lower altitude (about five thousand feet) all recovered without other treatment, although it seems reasonable to believe that they would have died had they not been shipped. It appears to be caused by an exhaustion of the heart muscle associated with varying degree of dilatation and hypertrophy and this being brought about by exertion before acclimatization at high altitudes, or in the case of calves, inherited cardiac weakness.

Necrotic Stomatitis

Necrotic Stomatitis is a sore mouth condition found mostly in pigs and calves and caused by the necrosis germ, *Bacillus necrophorus*. This same micro-organism is known to be the etiologic factor in the so-called Diptheria of calves, and in the "Lip and Leg" disease of sheep, as well as in the sore mouth condition of hogs. This condition is known collectively as *Necrobacillosis*, and, being widely distributed over the State among several species of animals, causes an aggregate loss that is quite a factor in the live stock business.

This organism is found associated with hog cholera in most instances in Colorado and the relation of these two diseases to the serious losses in hogs, warrants a careful investigation. While no systematic work has been done in this connection, a few casual observations have been made and noted for future reference. In two instances where herds of hogs had been all but wiped out by what was presumed to be hog cholera, inoculation of virulent blood from these hogs failed to produce cholera. The heavy loss in hogs from disease has become an important economic factor in the State and the State would do well to appropriate money for the investigation of animal diseases. The loss is not confined alone to the animals that die from disease, for the risk has become so great that one naturally hesitates to invest in such a precarious business. Another considerable loss in this connection is the indiscriminate use of anti-hog cholera serum, which is expensive, in all cases where hogs are dying, under the assumption that they have cholera.

Animal Diseases

This project is self supporting in that the expenses are paid by the petitioner, and was made to cover in a general way, outbreaks of animals diseases that we might be called

upon to investigate in the field and render at least temporary assistance in matters of control. In many of these cases by combining field observations with our laboratory facilities for diagnosis we are enabled to render valuable assistance to farmers and stockmen.

During last fall and winter over 200,000 sheep were visited in the feed lots, where the losses were considered excessive. In all of these cases infection was thought to be present, but in no instance was this found to be true. Bad judgment in handling, especially in feeding, is found to be the chief cause of loss in lambs in the feed lots, ranging from two to ten per cent. Lambs are taken from the range where they have subsisted upon native grasses and have had many miles exercise every day, and are placed in the feed lots where they are wont to pile-up and become over heated; the feed is changed suddenly to alfalfa (often a poor quality), straw and molasses, pea vine ensilage and heavy rations of barley, corn, or other concentrates. The lower animals, unlike man, cannot endure a sudden and heavy change of food ration.

The heaviest losses in animals from disease, as they have been reported to this office, or investigated in the field, have been as follows, in the order named: Hog cholera, necrobacillosis, contagious abortion and forage poisoning from moldy hay, beet tops, ensilage, etc., poisonous plants, blackleg, anthrax, granular vaginitis, and infectious anemia. These losses, combined with hundreds of others that might be easily prevented, total an aggregate that would compare favorably with the expenses of the State government for a year.

Respectfully submitted,

GEO. H. GLOVER,
Veterinarian.

REPORT OF BACTERIOLOGIST

To the Director:

Sir—I have the honor to submit herewith the annual report of the Bacteriological Section of the Experiment Station for the year 1914.

Under the provisions of the Adams Fund, five lines of investigation have been carried on during the year which is about to close. This work is covered by three projects, two

of which were carried over from the previous year, while the third one is new.

In addition to the research conducted by this section, we have continued the preparation and distribution of pure cultures for vinegar making and have engaged in a very limited amount of extension work.

Project I. Bacteriological Studies of Alkali Soils

As the research man pursues any line of investigation and learns more and more of the different factors involved in his problem, the more hopeless becomes the prospect of the early completion of the project. While he may direct his efforts in the beginning along lines that seem at the time paramount, it not infrequently happens that, as the problem begins to unfold, and as new light is shed in the progress of the investigation, there are suggested to him closely related questions of fundamental importance, and in reality of equal or greater importance than the topics of the main project. This, of necessity, is often the case since the larger problems reveal themselves only as the investigation proceeds, and cannot be anticipated at the start.

Our experience in the study of Colorado soils has been much of this nature. Thus far, we have taken up the nitrogen-fixing, ammonifying and nitrifying efficiencies of certain soils, and have published the results of these investigations as Experiment Sation Bulletin Nos. 179, 184 and 193. In the course of these studies, several related questions, which do not appear in the original project, have arisen to which we have given some attention. Among these may be mentioned the production and solubility of the brown pigment made by *Azotobacter chroococcum*, the Azotobacter flora of Colorado soils, and certain phases of the nitrification question which called for further experimentation. Progress has been made with all of these, and some of the results are ready for publication. In this work, I have been assisted by Mr. Artschwager and Mr. Newton.

In co-operation with the Departments of Chemistry and Horticulture, we are carrying on a bacteriological study of niter soils where certain remedial measures are being tried out.

Recognizing the technical nature of our publications, which deal with the bacteriology of Colorado soils, and their unfitness for the lay mind, and realizing moreover, that much of this information would be of value to the farmer

could it be presented in a popular form, we have attempted to embody the most important results of our studies, as well as a discussion of the various biological possesses that go on in the soil, in a popular bulletin, No. 196, entitled, "Soil Changes Produced by Micro-organisms."

Project II. Spur-blight of the Red Raspberry

Spraying experiments were conducted during the season of 1914 upon the same area as in 1913, our purpose being to secure confirmatory evidence of the benefit from the use of Bordeau Mixture in the control of the spur-blight. One and one-half acres of sprayed canes showed a gain of over 300% berries as compared with last year, while the increase on unsprayed canes due to the favorable season was considerably less than 30%. Although the causal organism has been described previously by Peck, a careful study of its life history and the pathology of the disease are being carried on.

Project III. Energy Studies

During the course of our soil investigations, we have been confronted, from time to time, with the problem of providing energy for certain bacteriological functions. In this project we are endeavoring to gain some definite knowledge of the role which certain soil constituents play in the biological activities of the soil.

I am being very ably assisted in the carrying on of this work by Mr. Douglas of the Chemical Department.

Miscellaneous Work

The demand for vinegar cultures has kept up throughout the year and is increasing at the present time. In view of this, it seems desirable that we continue this commercial enterprise. Since we began distributing cultures two years ago, eighty-two sets have been sent out.

The first edition of Bulletin 192, "Home-made Cider Vinegar," published in November of last year, was exhausted early in September, and the continued demand for the bulletin has made necessary the issuing of a second revised edition.

At the request of President Lory, I visited the Fort Lewis School in August, for the purpose of making a sanitary examination of the domestic water supply, and for formulating plans for the installation of a filter plant, should the supply, upon examination, be found to be unsafe. At the time the examination was made, the supply was reasonably

safe, but was open to pollution from the town of Hesperus some distance above. In view of the fact that the supply was not in dangerous condition, and that there was some question about the future of the school, no steps were taken toward a filtration plant.

Seven lectures have been given during the year before college classes and organizations, and one farmers' institute was attended at Loveland. Short articles have been prepared from time to time for News Notes.

Very respectfully submitted,

WALTER G. SACKETT.

REPORT OF AGRONOMIST

To the Director:

I am submitting herewith my annual report of the experiment station work of the Department of Agronomy.

On the Hatch Fund, two projects have been active the past year, the Alfalfa Project, which is being handled primarily by Mr. P. K. Blinn, and the Correlation Project. In addition to these Hatch Fund Projects some little work was done on the State Appropriation at the Plains Substation, and on high altitude crops. At the present time the funds are only sufficient to warrant a certainty of continuance in the Alfalfa and Correlation Projects.

Bulletins have been prepared on High Altitude cropping in the San Luis Valley, in co-operation with the Department of Irrigation Investigations, and bulletins were prepared on Forage Crops for the Plains.

Later in this report are included reports from the Superintendent of the Dry Land Sub-station and of the Alfalfa Specialist.

The Correlation Project has given rise to a large amount of material in the past year. Data are on hand sufficient for several publications when worked into manuscript form.

Respectfully submitted,

ALVIN KEYSER.

To the Agronomist:

Sir—I am submitting herewith a report of my work as Alfalfa Specialist for the past year. The alfalfa investigations included practically the same lines of work carried the year previous. These include the selection and testing of

alfalfa; investigation of factors influencing seed production: testing cultural methods to determine their influence on forage and seed production; testing methods of seeding and culture for seed and hay production on the dry lands.

Weather conditions have been very unfavorable for our alfalfa experiments. Two hail storms and several excessive rains made seed production a failure throughout the Arkansas Valley where our work is largely centered. This has seriously delayed our results.

Selection to Improve Alfalfa

For a number of years we have been planting alfalfa in nursery rows. Each row was planted with the seed from an individual plant selection. The rows were given as uniform care and conditions as possible. The general results show the Baltic, Grimm and Hardy Turkestan strains to be the best foundation stocks for selection work. The results of the different selections in different seasons have not always been consistent. These facts have made it necessary to carry our testing through a greater number of years so as to be able to pick out those strains which are best in a majority of the different conditions to be met.

Determining Factors Influencing Seed Production

In 1913 exceedingly good results in seed production were produced under two conditions. First, crown cuttings set out in the spring developed plants with a very large branching surface root system. These surface-root feeders were very heavily set with seed. Second, a portion of one of the fields was not irrigated for three years. This test revealed the fact that the root system was largely in the upper two feet of soil. Soil tests revealed the fact that soil moisture did not penetrate deeper than this. Thus, this alfalfa was artificially made a surface feeder. It set very heavily with seed.

In 1913 all of our work seemed to indicate that surface feeding or limiting the water supply assisted seed production. In 1914 all efforts to test this point further were of no avail, because the ground was made too wet by excessive rains. No seed was produced in 1914. In the spring of 1914 we set out 25,000 crown cuttings from the progeny of three of our best selections. Owing to exceedingly dry early conditions, the stand was poor, because there was not sufficient water in the soil to permit the cuttings to root and get a start. Ditch water could not be obtained early enough to help out.

Later in the summer, rains were so heavy that those that survived made an enormous hay growth, but no seed growth.

A five-acre field of Grimm and Baltic alfalfa in rows, 20 inches apart, not irrigated for three years, was sub-soiled to a depth of 10 inches, with the exception of a check where the land was left undisturbed. During the rainy season of 1914 no difference could be detected between the sub-soiled and un-sub-soiled crop.

Culture Methods to Improve Hay Yields

Rates of seeding and different methods of seeding have been tried for the past two seasons to determine the influence or rate and method of seeding on hay yields. So far the results indicate that the rate of seeding has very little influence upon hay yield provided the rate of seeding is heavy enough to give a uniform stand over the ground. This work has not been carried far enough for final conclusions.

Alfalfa on Dry Land

The present year, 1914, has been exceedingly wet in some dry land sections. On the Keen Ranch at Eastonville, 40 acres of Grimm and Baltic alfalfa made two good crops of over a ton each, per acre. Conditions were too wet at this point for a good seed yield. On the ranch of M. D. Healy at Grover, 90 acres of Grimm were harvested for seed. This promised well. The crop was harvested and is in the stack, but has not yet been thrashed.

Respectfully submitted,

PHILO K. BLINN.

To the Agronomist:

Sir—I am submitting herewith a brief report of the work at the Plains Sub-station for the year ending November 30, 1914.

One field last year was laid off in contours for each foot of elevation. The rows of plants were made parallel to these contours so as to make each row as nearly level as possible. The purpose of this work was to hold the rainfall, especially the dashing rains, in contact with the field as long as possible so that the runoff would be slow. It was hoped that this would give a greater "soak in." Only one dashing rain occurred this year and that was early in May. The rainfall was not great enough to run off on plowed

land, but did run off the unbroken prairie on to the plowed land at the upper end of one field. The yield at this upper end was two to five times as great as on the rest of the field. I have laid off the rest of the fields in contours for next year's work.

This has been a very unfavorable season. I succeeded in growing enough feed to fill three silos. I have enough dry cured feed to go with the ensilage when weather will not permit ranging the cattle on pasture. I will not have to purchase feed this winter unless I should decide to buy oil cake to balance up the ration.

I put seven loads of Russian Thistles in one silo. The thistles were mature but still green. The silo was then filled with corn. I began feeding this silo August 15th. I have fed down to the thistles. The cows eat the thistle silage, but not as well as the corn silage. In five days after starting the thistle silage, the milk cows fell off one-third in production. I then opened another corn silo and the cows have regained the lost milk flow. I shall feed the balance of the thistles to "stock" cattle.

Dairy

I sold most of my older cows last spring. During the summer I have milked 11 cows—one aged Holstein; three aged common cows; one 3-year-old Holstein; two 3-year-old Holsteins; four 2-year-old half-breed Holsteins. One of the half-breed Holsteins gave bloody milk so she was dried up and sold to the butcher. This is the first year that I have milked cows, progeny of my Holstein bull purchased four years ago. The result is quite satisfactory. Another year I can do still further culling.

November 1, 1913, I had 43 head of cattle, counting all ages, which we valued at $45 per head all around, or	$1,935.00	
During the year we have sold 21 head of males and culls for		$ 811.00
One cow died of milk fever		
I have raised 12 calves this season; this leaves 31 head valued at $55		1,705.00
I have sold dairy products		519.78
Feed, water and pasture cost me	500.00	
Profit	600.78	
	$3,035.78	$3,035.78

An individual record has been kept of each cow. This will enable me to dispose of less profitable cows as I have a surplus.

Poultry

We kept three dozen Rhode Island Red hens last fall. We have ten dozen now. We paid out $20.00 cash for feed. We did not keep account of feed of our own raising, but think that eggs and poultry used in the family will more than offset this.

The proceeds of the hens were as follows:

Nov. 1, 1913, 3 dozen hens	$ 12.00	
Sale of eggs		$ 44.21
Sale of poultry		32.91
10 dozen hens on hand Nov. 1, 1914		40.00
Feed purchased	20.00	
Profit	85.12	
	$117.12	$117.12

Garden

One-half acre devoted to garden gave an income of $30.00 besides furnishing vegetables used by the family. A half acre of potatoes was practically a failure as only a little more than the seed was harvested. A half acre of beans yielded 200 pounds, and half an acre of pop corn yielded 300 pounds of marketable corn.

Alfalfa

Three acres of alfalfa seeded in 1912 gave one light cutting. One acre was seeded last spring. In spite of the dry weather a good stand was obtained.

Orchard

There were a few cherries. The apples set on well but mostly fell off on account of worms. We had a few strawberries, but the vines were nearly killed from the summer drought.

Respectfully submitted,

J. W. ADAMS,
Plains Sub-station.

REPORT OF HORSE BREEDING INVESTIGATIONS

To the Director:

I beg to submit the following annual report of the carriage horse breeding work which is being conducted in cooperation with the United States Department of Agriculture.

From the present time, the basis of the horse breeding work will differ slightly from that which has been followed since the experiment was inaugurated. A horse of larger size and more usefulness will be sought for. In order

to obtain this, action and finish must be sacrificed to a small degree, but instead of producing a horse useful for only driving and show purposes, an animal will be procured that will meet the needs of the farmer for both driving and general work purposes. The encouragement of the breeding by the farmer of such an all-purpose type of horse is well worth striving after. The station is well equipped with foundation stock for furthering such a project, the careful selection and the breeding for the type desired, being of paramount necessity.

Animals in Stud

The following table shows the number of animals in the stud at this date, exclusive of those condemned to be sold at auction during the coming winter:

Ages	Stallions	Mares	Total
5 year olds or over	5	27	32
4 year olds		1	1
3 year olds		4	4
2 year olds		4	4
Yearlings	4	5	9
Weanlings	5	13	18
Total	14	54	68

Of the above animals, two aged stallions, fifteen aged mares, two 2-year-old fillies, and two yearling colts are the property of the Department of Agriculture, and the remainder the property of the Experiment Station.

The stallion Wilmering, 48569 A.T.R. has been added to the stud and will take the place of Loyal D. 50088 that has been at this station since 1912.

Sale of Condemned Animals

The Board of Survey met November 24, 1914, and condemned twenty animals as unsuitable to be retained for breeding purposes. These include six brood mares, one five-year-old stallion, one two-year-old filly, eight yearling stallions, one yearling filly and three weanling foals. These animals will be sold at public auction at the earliest practicable date.

General

Of the six mature stallions in service during the past year, three were sent to stand for service at other points. The stallions Carnagie and Davenport were leased for the season and stood at Rock Springs, Wyoming, and Falcon, Colorado, respectively. The stallion Defender made the season at Akron, Colorado. It is hoped that within a few

years an additional number of stallions will be available so as in this way to assist in, and to encourage the breeding of a better class of horses.

Aside from the breeding work, the large number of animals in the stud make it possible to pursue experimental work along feeding lines. During the coming winter, work will be started in an effort to obtain information on the influence of feeding alfalfa to brood mares.

Respectfully submitted,

WM. P. LITTLE.

REPORT OF ANIMAL HUSBANDMAN

To the Director:

The following is an outline of the work of the year, as requested in your call for a report:

No experimental projects were carried out during the year, but considerable time has been given to the working up of data already on hand for publication.

We have one project under way at the present time—Ration Experiments with Steers—the chief comparison in which will be the value of Corn Silage with Beet Pulp for the fattening of range steers.

The following bulletins have been published during the year: Bulletin 202—The Testing and Handling of Milk and Cream; Bulletin 189—The Cost of Beef Production under Semi-Range Conditions, and Bulletin 200—Silos and Silage in Colorado. In addition, there are under preparation at the present time, a bulletin on Milk Production, and one on Poultry Raising. Respectfully,

G. E. MORTON.

REPORT OF THE IRRIGATION ENGINEER

To the Director:

I submit herewith the annual report for the experimental work done by the Department of Civil and Irrigation Engineering for the year 1914.

Two projects are in charge of this department and I can report progress on each of them.

Project I. "The Duty of Water on the College Farm."

Work began on this project four years ago. During the first year only a partial record of the water applied for irri-

gation was obtained. This was due to the inability of the farm department to install some of the weirs in time for the first irrigation of the alfalfa. Data on all other crops were obtained. Complete data have been secured for the entire farm for the last three years. Work was continued on this project during the irrigation season of 1914.

Project 2. "Sub-Irrigation With Porus Tile."

Last year was a very poor year for this experiment, due to the fact that the rainfall was sufficient to mature the crops planted without any irrigation whatever, and the effect of the irrigation system installed was not noticeable on the crops produced. In fact, the two years that this experiment has been running have not been a fair test for the system. The system was not completed until the middle of July, two years ago; the ground was very dry when the crop was seeded and a fair test of the system was impossible. During the coming winter I expect to try out winter irrigation with a wet subsoil at the beginning, and hope to get good results from the system.

This department is co-operating with the Irrigation Section of the U. S. Department of Agriculture, and a force of from four to six men has been maintained, giving their entire time to experimental work in irrigation. The progress of this work will be reported upon by Mr. V. M. Cone, who has charge of the work.

No new work other than the above could be attempted by the department during the last year on account of short funds and it has been a struggle to continue the old work for the same reason. The uncertainty of these funds is the worst feature. The legislative appropriation two years ago was sufficient to warrant some good work being attempted, but it has been impossible to ascertain how much would be available until long after the irrigation season began and hence the possibility of practical field work was lost entirely.

Respectfully submitted,

E. B. HOUSE.

REPORT OF IRRIGATION INVESTIGATIONS

To the Director:

The following is a brief report of the work done by Irrigation Investigations during the year 1914.

The principal part of the work has been done in the hydraulic laboratory. During the past two seasons we have made 2,736 experiments, about 1,500 of which were run during 1914. The data obtained are valuable and have some very practical application. Two manuscripts are now ready for publication by the Government on the flow of water over weirs with sharp crests and full contractions, which includes the discharge over rectangular, Cippoletti, circular and triangular notch weirs and submerged weirs, and weirs having incomplete contractions. It is the intention to publish this information in two bulletins, one of which will give the technical material and the other will have practical deductions for the use of farmers.

Data are being put in shape for additional practical and technical bulletins, concerning a new type of weir which has been developed in the laboratory during the past year, and also a modified type of submerged orifice. There is also ample data on miner's inch measuring devices for a bulletin. It is expected that much of this material will be published this winter.

In connection with the hydraulic laboratory a reinforced concrete channel, 5 ft. wide by 3½ ft. deep, and 210 ft. long, has been constructed for additional work on the measurement of water and for experiments under conditions approximating a canal. This channel is also equipped as a current meter rating station and a new electric car has been provided. An Adams project has been drawn to cover a series of experiments on current meters and this will be supplemented by a rotary rating station, which will be built this winter. The rotary station will be placed in the storage reservoir connecting with the hydraulic laboratory.

The Adams project on the Coefficient of Friction in Artificial Waterways, has been completed and the results published in Station Bulletin 194.

The field investigations in the San Luis Valley and the Experiment Farms which were operated co-operatively by the Costilla Estates Development Company and the Experiment Station, have been drawn to a close and the essence of the results obtained have been put in manuscript form for a Station bulletin.

Mr. Hemphill is in the Arkansas Valley making a field study of economical factors concerning irrigation systems and their management.

A new project has been drawn for a laboratory and

field study of factors which affect seepage losses from canals.

The tank experiments on water requirements of crops, and also on drainage factors have been continued and we are able to report progress. The general meteorological work as well as the experiments concerning evaporation from a free water surface go on without interruption.

Some of the popular projects have not been worked on to any extent this year, due to the shortage of State Appropriation funds, but it is hoped that these can be taken up in earnest in the near future. However, sufficient co-operative funds have been available to permit considerable work to be carried on without interruption and good results have been obtained.

Respectfully submitted,

V. M. CONE.

REPORT OF BOTANIST

To the Director:

I herewith submit the semi-annual report of the Botanical Section.

The only investigation which has been carried on during the past year is that concerned with the study of Soil Algae. This has been continued from the work of the previous year and along the same lines and concerns itself now entirely with securing pure cultures of the blue-green forms. These are especially abundant in our soils and are the ones in which we are the most directly interested. All of this work is being done by Professor W. W. Robbins in close co-operation with the Bacteriologist, Professor W. G. Sackett. This project is to be continued during the coming year. No special results are yet available for publication.

One bulletin, No. 201, "Some Edible Mushrooms of Colorado," by B. O. Longyear, has been published during the past six months. Many of the illustrations for this bulletin have been gathered through a period covering at least nine years. It is popular in character and is intended purely for the novice who desires to become familiar with our most common edible species.

During the past five years some work has been carried on in the control of dandelions in lawns by means of chemical sprays. Should time permit during the coming season,

this work should be continued so as to secure further data for publication upon this subject. While some of the results in this line have been very pronounced, it is evident that under ordinary conditions such as those prevailing on most lawns and with unskilled manipulation, inferior results are apt to be obtained.

The relatively small amount of time devoted to Station work is due largely to the heavy teaching schedule which is carried by Prof. Robbins and the State Forester, in addition to teaching which has been required of myself. This has made it not only impossible to make much progress in any one line of work, but has detracted considerably from the enthusiasm which should accompany such work and which can be developed only through more continuous work along a given line. Most of the projects which a botanist can undertake and carry to a successful close at the present time demand concentrated attention such as can be secured only through continuous work in the same field. It has been thought best, therefore, not to plan any further projects for the coming year than those which have already been mentioned.

Respectfully submitted,

B. O. LONGYEAR.

REPORT OF HORTICULTURIST

To the Director:

Complying with your request, I herewith submit a brief report on the status of the experimental work in the Horticultural Department.

I report on the work in the order of the projects:

The Project on Hardy Stock for Apples

The work on this project was started last spring with the planting of a new orchard and the getting together of hardy stock. Of course, there is nothing in the way of results from this project thus far, and I can only report progress.

The Project on Pear Growing in Eastern Colorado

which was also started this spring, has for its aim to discover some pear stock that will be hardy in Eastern Colorado, and which will make the trees more resistent to blight. We have made a start in this project, and a small orchard

of dwarf pears was planted last spring. The trees in this orchard are doing well, but nothing definite can be reported at this time but progress.

The Niter Project on the Western Slope

which has for its object to neutralize or eliminate the excessive niter in the orchards, was started during the summer. Two places were selected for this work. The first place was located on Mr. Bain's farm west of Grand Junction, on land which had previously been in apple orchard, but due to the presence of niter, the entire orchard had been killed, and for the past several years no vegetation has been growing.

By the use of diking and heavy flooding, a portion of this land is now in a good stand of rye, while another portion has a poor stand.

From the work thus far done, it would seem that by heavy flooding for a considerable length of time, the niter, which is very soluble in water, can be washed out, to the extent at least of permitting crops to grow. The work on this land looks very promising.

The other field selected was in the orchard of Mr. Smith, also west of Grand Junction. The orchard is a mixture of Jonathans, Winesaps and Gano apples. The trees are but twelve years old, and show the first indication of niter-burn practically throughout the whole orchard, which comprises about five acres.

In this orchard, cover crop experiments were carried on, with the object in view of turning the cover crops under, thereby to some extent, at least, neutralizing the niter. The difficulty of obtaining a stand of cover crops was greater than we had anticipated, due in the main to the fact that the trees were planted closely together, and consequently shaded the ground to the extent of interfering with crops underneath them.

However, a fair crop on some portions was obtained, and those that were of annual nature were plowed under this fall, while perennial plants, like the hairy vetch, were left over to be plowed under early next season.

It is yet too early to tell what effect the plowing under of these crops will have, and I can only report progress on the work.

Respectfully submitted,

E. P. SANDSTEN.