

**THE STATE AGRICULTURAL COLLEGE
OF COLORADO**

The Twenty-Ninth Annual Report

OF

**The Agricultural Experiment
Station**

For 1916



The Agricultural Experiment Station

FORT COLLINS, COLORADO

THE STATE BOARD OF AGRICULTURE

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LETTER OF TRANSMITTAL

To His Excellency, Geo. A. Carlson, Governor of Colorado:

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

The financial statement is for the Government fiscal year ending June 30, 1916. The other portions are reported substantially for the state fiscal year of 1915-16.

C. P. GILLETTE,
Director.

Agricultural Experiment Station,
Fort Collins, Colorado,
December, 1916.

**FINANCIAL REPORT OF THE COLORADO AGRICULTURAL EXPERIMENT
STATION FOR THE FISCAL YEAR ENDING JUNE 30, 1916**

DR.		Receipts						Total	
From the Treasurer of the United States as per appropriations for the fiscal year ended June 30, 1915, under acts of Congress approved March 2, 1887 (Hatch Fund) and March 16, 1906 (Adams Fund).....		Hatch Fund	Adams Fund	State Appropriation Fund	Sales Fund	Horse Cash Fund	Special Fund	State Mill Levy Fund	Fund
		\$15,000.00	\$15,000.00		\$647.92	\$ 116.03	\$4,821.98	.....	\$ 5,585.93
	Balance on hand July 1, 1915.....			\$19,868.00	9.00	2,340.70	143.03	9,143.87	31,504.60
	Other sources than U. S.....								
	Total Receipts								\$67,090.53
Disbursements									
By	Salaries	\$11,081.40	\$13,269.98	\$ 3,876.21	.....	\$ 300.00	\$ 582.50	\$1,190.82	\$30,300.91
	Labor	1,175.92	315.57	1,189.59	.....	65.77	233.13	574.11	3,554.09
	Publications	1,175.75	.....	1,337.72	.....	.....	22.95	358.99	2,894.42
	Postage and stationery.....	360.36	16.75	310.63	.....	16.81	44.38	49.92	798.85
	Freight and express.....	59.02	42.24	68.81	.....	.....	.....	213.39	383.46
	Heat, light, water and power.....	63.14	128.38	5.25	.....	.....	.....	.....	196.77
	Chemical and laboratory supplies..	28.40	58.83	129.68	.....	.....	10.85	.....	227.76
	Seeds, plants and sundry supplies..	94.29	129.13	189.15	.....	44.10	4.61	545.67	1,006.95
	Fertilizers .....	.....	19.00	.....	.....	.....	.....	.....	19.00
	Feeding stuffs	19.41	.....	1,479.37	.....	819.71	5.65	1,524.81	3,848.95
	Library	103.83	9.09	42.00	.....	2.50	7.15	68.63	233.20
	Tools, machinery and appliances..	64.86	200.49	548.86	.....	17.90	1,463.35	1,477.15	3,772.61
	Furniture and fixtures.....	99.95	49.85	157.85	.....	.....	.....	44.35	352.00
	Scientific apparatus and specimens.	100.84	373.23	50.21	.....	.....	.....	30.00	554.23
	Live stock .....	.....	375.00	.....	.....	.....	.....	.....	375.00
	Traveling expenses	520.08	283.46	756.65	.....	41.20	24.35	1,064.58	2,690.32
	Contingent expenses	20.00	.....	.....	.....	38.20	2.50	105.00	165.70
	Buildings and land.....	32.75	104.00	2,705.84	.....	5.00	.....	418.85	3,266.44
	Total expenditures	\$15,000.00	\$15,000.00	\$13,222.82	.....	\$1,351.19	\$2,401.42	\$7,665.28	\$54,640.71
	Balance			6,645.18	656.92	1,105.54	2,563.59	1,478.59	12,449.82
				\$19,868.00	656.92	\$2,456.73	\$5,965.01	\$9,143.87	\$67,090.53

REPORT OF THE DIRECTOR

To the President:

I beg to present the following brief report upon the work of the Experiment Station for the State fiscal year of 1915-16, and am appending a financial statement upon all funds for the Government fiscal year ending June 30, 1916.

At the outset I wish to express my appreciation of the free hand that has been given me in the conduct of the Station work for the year, and also for the liberal support and kindly council from yourself and the executive committee of the State Board of Agriculture. This, with the State appropriation in the form of a mill levy, that could be depended upon for the support of the work, and a good *esprit de corps* among the workers, has made the labors of the year extremely pleasant.

We have co-operated with the various bureaus of the United States Department of Agriculture in the expenditure of approximately \$20,000 on a dollar for dollar basis. In addition to this, during the State biennial period closing November 30, 1916, we have co-operated with the Bureau of Plant Industry to the extent of spending the \$5,000 appropriated by the Twentieth General Assembly, to assist in carrying on the investigations of the Government Potato Station located in the Greeley district. The relation of this station to the work of the Potato Station has been entirely financial and advisory. All of our co-operative relations with the bureaus of the Department of Agriculture have been most congenial and the progress of the work has been very satisfactory.

The appropriation of \$5,000 made by the Twentieth General Assembly for the drainage of the lands of the Teller School of Agriculture, Mechanic and Household Arts has all been expended in an effort to install an outlet sufficiently large to carry the seepage from the entire area and at the same time drain the campus about the buildings. Because of extremely bad soil conditions and heavy rains while the work was in progress, the money gave out before this was accomplished. If the entire tract is to be drained, it will likely take double the amount that has already been used to put in an efficient drainage system.

The total amount expended by the Station during the fiscal year is \$54,640.71, or nearly \$2,000.00 less than in the preceding year. The progress of the experimental work seems to me, on the whole, to have been good. The number of bulletins (3) that have been published is much smaller than usual, though they have not averaged small in size, and bound together with the annual report would make a volume of 254 pages. For several years the Station has been held back in its publications because of a lack of funds and at the present time, there are manuscripts awaiting funds for publication and several others would soon be forthcoming if we had money with which to print them. It is quite a common fault with men in experimental work, that they become so absorbed in their investigations that they would rather continue on and on in the hopes of making farther interesting discoveries than to stop and publish the results already obtained. I believe that one of the most important needs of the Experiment Station at the present time is a fund of at least \$5,000.00 annually, appropriated especially for the publication of bulletins.

The Chemical Section is continuing with the wheat studies as the major line of work, which will doubtless require a full year yet before it can be completed. Two other minor projects will be worked during the coming year; these are a resumption of work on the "Rio Grande River Waters", which can soon be completed for publication, and a resumption of the "Soil Niter Studies" for the purpose of going more fully into a study of the sources of the nitrates that are doing so much injury to large areas of otherwise excellent soil in certain sections of this and surrounding states, lying in the arid region of the West.

In the Bacteriological Section the work has been somewhat interfered with because of our inability to obtain some of the technical apparatus that is indispensable in carrying on one of the important lines of investigation. This has necessitated our throwing the work more strongly upon other projects.

The Agronomy Section is continuing along about the same lines as last year, but is accentuating the dry farming and high altitude studies, without neglecting the important investigations in grain and alfalfa improvement. I regret that Prof. Kezer cannot give more of his time personally to the investigational work.

The work being carried under Irrigation Investigations has been switched rather largely from the hydraulic laboratory to field studies, a project having been approved which

undertakes a very thorough study of the Poudre River irrigation system for the purpose of collecting data that can be used to improve the irrigating systems of the country. The study is to be a very thorough one and will require two years or more for its completion.

The Animal Husbandry Section has not been carrying on any investigations the past year, but is planning a steer-feeding experiment for the coming winter and spring and has a project on the "Value of Pasture Grasses for Dairy Cows".

Brief statements concerning the work that has been in progress during the year will be found in the reports of the heads of the sections, which I am including with this.

PROJECTS IN FORCE DURING THE YEAR

Chemical Section

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

Rio Grande River Waters. Adams Fund.

Niter Studies. Adams Fund.

Bacteriological Section

A Bacteriological Study of Alkali Soils. Adams Fund.

Spur Blight of the Red Raspberry. Hatch and State Funds.

Value of Certain Carbon Compounds as a Source of Energy for Azotobacter. Adams Fund.

Bacterial Disease of Field Peas. Adams Fund.

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

Entomological Section

Plant Lice Investigations. Adams Fund.

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

Drainage of Farm Crops and Drainage Factors. Adams Fund.

Water Requirements of Crops. Adams Fund.

Tank Experiment. Hatch Fund.

Weir Construction. Adams Fund.

Current Meters. Adams Fund.

Evaporation Experiment. Hatch Fund.

Pump Irrigation. Hatch Fund.

Seepage. Hatch Fund.

Experiments with Flow of Water. Adams Fund. (In abeyance.)

Concrete. Hatch Fund. (In abeyance.)

Grand Junction Indian School Drainage. State Fund.

Duty of Water in the Poudre Valley. State Fund.

Agronomy Section

Correlation of Characters in Grain. Hatch Fund.

Alfalfa Breeding. Hatch Fund.

Methods in Selection Breeding. State Fund.

High Altitude Crops. State Fund.

Feed Crop Improvement. State Fund.

Rotation of Crops for Colorado. State Fund.

Plains Crops and Management. State Fund.

Horticultural Section

Hardy Stock for Apples. Hatch and State Funds.

Pear Growing in Eastern Colorado. Hatch and State Funds.

Management of Niter Soils. Hatch and State Funds.

Potato Investigations. Hatch and State Funds.

Small Fruits for High Altitudes. State Fund.

Hardy Tree Fruits for High Altitudes. State Fund.

Seed Potato Growing in High Altitudes. State Fund.

Veterinary Section

Brisket Disease. Hatch and State Funds.

Sore Mouth Disease. State Fund.

Infectious Anemia. Hatch and State Funds.

Sheep Losses on Winter Feed. Hatch and State Funds.

Animal Disease Investigation. State Funds.

Contagious Abortion. State Fund.

Horse Investigations

To Establish an American Breed of Carriage Horse. State Appropriation Fund, in co-operation with Bureau of Animal Industry.

Animal Husbandry Section

Acre Value of Pasture for Dairy Cows. State Fund.

Irrigation Engineering Section

Duty of Water Upon the College Farm. State Fund.

Sub-Irrigation Investigations. Special Fund.

Forestry Section

Studies in the Decay of Wood. Hatch Fund.
Dandelion Studies. State Fund.

Botanical Section

Proso Millet Smut. State Fund.
Native Vegetation as an Indicator of Crop Possibilities in
the Colorado Transition Area. Hatch Fund.

BULLETINS

The only bulletins printed the past year are:

217.—A Study of Colorado Wheat, Part II, by Wm. P. Headden.

218.—A Bacterial Stem Blight of Field and Garden Peas, by Walter G. Sackett.

219.—A Study of Colorado Wheat, Part III, by Wm. P. Headden.

Very respectfully submitted,

C. P. GILLETTE,
Director.

REPORT OF THE AGRONOMIST

To the Director:

I am submitting herewith my annual report of the work of the Agronomy Section of the Experiment Station. Geographically the work of this section is distributed as follows:

I.

The work carried on at Fort Collins on the Fort Collins farms.

II.

The work directed from Fort Collins, but carried on at various points in the State.

This class of work includes the dry land farm management surveys and a small amount of co-operative work with different individuals scattered throughout the State.

III.

The Rocky Ford plant. This work is under the immediate direction of Alfalfa Specialist P. K. Blinn, and is almost entirely investigational work on alfalfa problems.

IV.

Cheyenne Wells. The work at Cheyenne Wells is carried on on our Cheyenne Wells dry-land farm. It is under the immediate supervision of the dry-land specialist, Mr. J. W. Adams.

V.

Fort Lewis. The resident work at Fort Lewis has been conducted by Mr. J. T. Copeland, and consists of crop adaptation and high altitude work for the immediate present.

VI.

Akron. At Akron we possess 160 acres of land adjoining 60 acres of land upon which is located the Akron Dry Land Station of the office of Dry Land Agriculture, United States Department of Agriculture, Washington, D. C. Through cooperative arrangement, dry land investigations are being conducted on this tract by the office of Dry Land Agriculture. We are consulted with respect to this work and publications concerning the Akron work have been submitted to us for comment and suggestions.

OUR FORT COLLINS WORK

The lines of work under way at the Fort Collins plant are at present largely confined to variations of the correlation problem. A great mass of data has been accumulated on morphological correlations with wheat, oats and barley. Careful study of these data has shown us that the trend of the correlation is often the result of the type of arrangement adopted with the data. Many interesting correlations and many interesting facts have been discovered, but owing to the fact that most of the morphological characters studied cannot be connected up with yield per acre, we are led to the conclusion that our results at present are two-fold in nature:

1. They are negative with respect to acre yield, relationships, or acre values, although they are quite positive with respect to individual plant relationships or values;
2. We have acquired very valuable tools for the working out of other plant problems.

This development of our work has led us to begin studies in physiological correlations, with an attempt to tie certain physiological factors up with acre performance. Such performance will be measured in yield, quality and other desirable attainments. A portion of this work has been outlined for special study.

Early in the development of this work, crosses were made taking into consideration certain morphological characters. Data were obtained with respect to correlations within the original pure lines. The purpose of the crosses was primarily to determine if the same correlations persisted in the hybrid progeny, and also to determine their relationships and what correlations would appear in the fixed types which would result from such crosses. This line of work is still under way, because it takes a considerable amount of time to fix some of the types because of the working of combinations and re-combinations of dominant and recessive characters. As a side line of this work, a very valuable amount of data has been accumulated which is essentially genetic in its nature. This will give rise to two publications. These are under way and are largely awaiting the printers of the colored plates and cuts.

Some of the other data mentioned above are in excellent shape for publication, but since some of them controvert existing opinions with respect to correlation, we have thought it advisable to withhold the publication until further information was at hand, in order to absolutely establish our present outline. We are convinced ourselves, but we want the data to be complete enough to be conclusive to others.

There are a number of lines of work which we should be carrying on at the Station and at various points in the State. These can be defined under the general heading of type adaptation work. We should be making a search of every prospective variety of wheat, barley, oats, and other agronomic crops, try these out first in rows, and the prospective good things in plats, on our Station farm, working out in connection therewith methods of distribution and continuance of the worthy sorts. For this kind of a purpose, State money should be used, as neither Hatch nor Adams funds lend themselves readily to this type of work. It is something the State needs from the standpoint of practical development.

In addition to such work on the Fort Collins farm, we should be doing similar work in many sections of the State. Such similar work should usually be preceded by regional surveys. There is absolutely no necessity of the Experiment Station experimenting on the things which have been worked out by farming communities. A survey will discover the practices and crops which have been stabilized by the farming community. It should start finding practices, crops and methods which have not yet been worked out by the farming communities, or at least, it should know what the methods are and make careful tests as to their value. Such a method will

not only conserve the time of the Experiment Station, but will make its usefulness much greater to our farming communities.

The dry land work directed immediately from the home plant has been in the nature of farm management surveys. The object of these surveys in dry land sections is two-fold:

1. To obtain facts and relationships with respect to the farming business as it exists upon the farms and dry land communities; to be able to suggest from an analysis of these records better practices immediately, and

2. To get information as to the need of specific kinds of experimental work in order that such experimental work may be taken up later when means are available.

These surveys have already resulted in much valuable material. Some of it could be published if it were thought wise to do so with two years' data. Some of it is quite significant and points absolutely in one direction. It is also putting us very closely in touch with the problems to be met upon the dry lands.

In addition to the lines of work already mentioned, and new lines suggested, we need to devote especial attention to the corn crop and the sorghum crop and their adaptation, culture and breeding. Corn has never been considered an important crop in Colorado, yet the number of bushels produced in the State is now almost as great as the combined bushels produced with winter and spring wheat, which crops have always been considered very important.

Following are the reports of the alfalfa specialist, Mr. P. K. Blinn, and of the dry land specialist, Mr. J. W. Adams:

REPORT OF THE ALFALFA SPECIALIST

To the Agronomist:

I herewith submit the following report of the alfalfa work in my charge for the period from July 1, 1916, to date.

The work outlined under five topics in my report of June 1, 1916, has progressed as follows:

I.

Testing out different strains of alfalfa:

Under this head there are three experiments or tests.

(a) *Seeding of New Varieties or Strains of Alfalfa in Nursery Rows.*—We had only a few new lots of seed to sow this season. They were sown in 20-inch rows west of the station barn at Rocky Ford, beginning to count from the north side.

Rows 26 and 27 were sown from seed from one Baltic plant that produced 9.6 ounces of seed in one season on dry land in eastern Oregon in 1915. The seed was furnished to us by Mr. L. R. Brethaupt, Burns, Oregon. This made an extra good growth. For the first season it seemed to show a strong tendency to set seed.

Rows 28 and 29 were sown with Mongolian alfalfa, said to be one of the strongest, most vigorous growing types of alfalfa. Seed was furnished us by Mr. Samuel Garver, Redfield, South Dakota. Good growth, but not extra good.

Rows 30, 31, 32 and 33 were sown to Falcata alfalfa, two upright varieties said to be the best of this type of Falcatas. Seed was furnished us by Mr. Samuel Garver, Redfield, South Dakota. Good growth, but nothing very different than many of the Sativa and Falcata hybrids.

Row 34, about 200 feet of the east end of the row, was sown to alfalfa seed from one plant furnished by Alvin Kezer, from E. H. Thomas, seed produced at Moffat, Colorado. This made exceptionally large forage growth.

Row 34, one hundred feet at west end of row, was sown to Proliferating alfalfa, Falcata variety. Seed was furnished by Mr. Samuel Garver, Redfield, South Dakota. No evidence of the proliferating roots yet.

Row 17, in 1915 seeding, deserves to be mentioned for the wonderful results in seed production. This row was sown with seed from R. A. Okley, S. P. I. No. 38464, China, and was the earliest blooming strain of alfalfa in all our tests by at least a week. It set very uniformly with seed, in fact the whole row had a very uniform type of plants—uniform in color of the flowers, which were dark purple. Over twenty pounds of clean seed were secured from 270 feet of a single row with rows 20 inches on either side of it. Besides this, a very large amount of seed shattered off and sprouted in the pods, owing to a 3-inch rain with three or four wet days just after the seed had been cut and in the shock. Commercial Baltic rows in the same nursery only produced 2½ pounds to the row; a selected Grimm strain only produced 4 pounds per row. Hence the China row seemed to make a phenomenal seed yield.

(b) *Propagating Select Plants From Crown Cutting.*—For several years we have been attempting to increase the seed production of extra good types of alfalfa in order to secure a little pure seed, with known tendencies, to test out in a comprehensive way hay- and seed-yielding tests, rather than to try mixed commercial strains. We now have one hundred

or more plats of four to eight plants each, all started from crown cuttings.

This season we have secured seed from about 25 plats. The seed is not all cleaned. But one or two plats have been exceptionally good. One plat of eight plants has produced 3½ pounds of very fine seed of a select Grimm plant that the writer originally made in 1910, in Carver County, Minnesota. We plan to plant these lots of seed in a new testing experiment similar to the one outlined in the next topic.

(c) *Testing Selections and Strains Under Field Conditions.*—The general plan is to seed the different varieties to be tested in strips 5 feet wide including a 12-inch border or space between them. This will permit the plats being cut with a 5-foot mower. The plats are sown crosswise of the field in triplicate. The plats are spaced 50 feet long; a border of several widths of a mower surrounds the series of plats. The entire field is irrigated and treated as an ordinary field of alfalfa. When the hay is ready to cut, the border swaths are cut, cured and removed. The plats are then cut and weighed green. The plats are cut all in one direction. The past season three crop tests have been made on a test of 21 different lots of alfalfa, and the tests have been very free from many of the variable factors that have often entered the comparative test we have made with other plans.

II.

Selecting and Propagating Plants of Superior Traits.—During the past season we have added to our nursery propagations from cuttings of nineteen new plats of plants selected for early spring growth and late fall growth, heavy forage development and good seed production. One hundred and eighty-four cuttings were made with 100% growing. Owing to a very heavy rain in August, no seed was formed on this year's nursery cuttings.

III.

Cultural Methods for Alfalfa Seed Production.—Under this head three experimental tests were conducted during the season just closed.

(a) Clipping off the first and second growth from an old field of Grimm alfalfa, part of the field was left unclipped. There was no perceptible difference in the seed setting. Very little seed set on any part of the field. The forage growth seemed too heavy for seed yield.

(b) Five different commercial strains were seeded in 40-inch rows to test seed production. One-half of each plat

was seeded to spring wheat in rows on each side of the alfalfa row. The alfalfa was two years old, but the growth here was also too rank for seed production. Very little seed formed; not enough to pay to thresh. The varieties were Baltic, Grimm, Canadian Variegated, Black Hills and Kansas Crown. The Baltic showed the best tendency toward seed production. The wheat in the alfalfa necessitated several irrigations to furnish moisture for the wheat. The wheat did not make much of a growth on account of the alfalfa being too rank, and the influence of the wheat toward alfalfa seed production was negative on this two-year-old alfalfa test.

(c) Eight acres of new seeding of a select strain of Baltic alfalfa was sown in 40-inch rows alternating with rows of spring wheat. The spring wheat was sown in rows on each side of the alfalfa row at a distance of 10 inches. This experiment had two objects in view. First, to test the cultural method of growing grain in the alfalfa to influence seed production in the alfalfa; and, second, to increase the stock of seed for distribution or commercial planting. This strain has been selected for seed yields for several years. There were two portions of this seed. Three and one-fourth acres were sown with seed from 150 heavy seeded plants, four and three-quarter acres were sown with seed from the remaining plants in the plat.

The results in seed yield were as follows: Three and one-fourth acres from select seed, 60 pounds of seed; four and three-quarters acres of poorer seed-yielding plants, 75 pounds. These are light yields, but when considered as yields from seedling growth the first summer, the yield is good. They also show a little advantage in the selection of heavily seeded plants for seed. The effect of the grain was of no evident advantage to the alfalfa except that it supported the alfalfa so that it harvested better, but the portion in each field without grain made a better growth in forage and equally as much seed. So the grain experiment is not conclusive.

IV.

Comparative Rates of Seeding in Hay Yield and Cultural Tests.—Tests of hay yields have been made on ten different rates of seeding with two varieties of alfalfa, Baltic and common Colorado-grown seed. There has been very little difference in the yield in tons per acre, but the last season's records show that the common alfalfa out-yielded the Baltic by about 400 pounds per acre.

The test seeded last year for the Bureau of Plant Industry, on space effect on seed production, gave little results during the past season. The variation in individual plants was greater than the variation between the different spacing.

V.

Co-operative Field Observations With the Bureau of Plant Industry.—Owing to the lateness of the authorization of expense, I was unable to make any trips outside of the State on the alfalfa seed investigation.

We have about 150 pounds of the select strain of Baltic alfalfa, so far designated as C-6. This strain has been selected and increased on account of its very good seed-producing tendencies. It is not exceptional in hay production, but is as good as the average of the tests we have made. I would recommend that this seed be furnished to some reliable man who is in a position to grow it for commercial seed production. Mr. R. A. Oakley made an oral offer to make a contract to any such grower as the Colorado Experiment Station would select, and furnish with seed. Mr. Oakley's department would make a satisfactory contract with the grower to take the seed, and would then agree to turn over to the Colorado Station such part of the seed as we might agree was a fair proportion.

Respectfully submitted,

PHILO K. BLINN,
Alfalfa Specialist.

REPORT OF THE DRY LAND SPECIALIST

To the Agronomist:

I am submitting herewith my report of the activities of the Cheyenne Wells Station.

The season of 1915 was a very wet one; 1916, on the contrary, has been one of our driest.

Small Grain.—In May it looked as if it could not possibly make a crop unless rains came. The rains did not come. Accordingly, I cut my oats and spring rye for hay when in the dough. I left a patch of each to see if they would ripen grain. It did not look as if it would be possible, but these patches did mature in a small amount of very good grain. I had two acres of Durum wheat for chicken feed which yielded about ten bushels per acre.

Cultivated Crops.—These did very well on the moisture carried over from 1915 until about the middle of July. There

was no rain from April 6 until August 13th, when we received one-half an inch, followed by several cloudy days with light showers. On August 20th we had 1.48 inches of rain, and on the 22nd we had .85. Corn, which in July I believed to be past resurrection, revived and made a fair crop. All but three acres were cut and put into the silos, yielding at the rate of about 2½ tons per acre. Corn which was not cut was saved for seed, returning about 10 bushels per acre.

All of the sorghums revived with the August rains and made a heavy yield (the season considered) of excellent fodder, but did not mature seed in many instances.

Sod Crops.—Ten acres of corn or sod broken in the spring of 1916 was an absolute failure, owing to the lack of moisture.

Burbank Thornless Cactus.—Half an acre of cuttings of Burbank Thornless Cactus were put out in the spring. They did not make sufficient growth to be of any value whatever. The first hard freeze killed them.

Contour System.—The contour system of farming which has been practiced on the Cheyenne Wells farm had no opportunity to function this year, as there was not rain enough to make surface run-off. However, it was very evident that the use of the contour system in 1915 stored a greater amount of moisture in the soil and enabled cultivated crops to withstand the drouth better than land which had not been so treated.

Garden.—In spite of the drouth a fine garden was raised. Watermelons, cantaloupes and tomatoes were extra good, although a little late.

Beans.—About an acre of beans were put out, consisting of Navy, Pinto, Marrowfat and Tepary. The Navies were practically a failure; the Marrowfats ripened before the rain of August 13th, making a fair crop. The Teparies and Pintos did not set pods until after August 13th. As a consequence, the season for development of bean seed was short. Much of the crop did not mature before frost. In spite of this the crop was thrashed and has returned a fair yield.

Potatoes.—One-third of an acre of early Ohio potatoes were planted April 13th. These lived until the rain of August 13th, when they commenced to develop. From this one-third acre, we dug 1,000 pounds of extra nice quality potatoes. Owing to their lateness in starting, they barely matured before frost.

The Dairy.—The cows this season gave very excellent returns in milk production as long as the silage held out. Silage feeding was stopped June 5th. It was thought that the num-

ber of animals was not great enough to justify opening the 12-foot silo, as it was thought that in hot weather the silage would spoil because it would not be fed off to prevent spoilage. After the silage feeding was stopped the milk flow fell off very rapidly until August when the herd was practically dry.

The milking machine has proved a decided success. We quit using it after the cows were mostly dry. Our cows will begin to freshen soon, when we expect to again resume the use of the milker.

I have had rather bad luck with my cattle this year. We lost two young calves. One was killed by the aged bull, being gored to death, and one died of what the local veterinarian called mechanical pneumonia. One died of scours. Early in October I lost three cows from poisoning. I had about three acres of corn which I left standing, from which to select seed. After frost, I snapped the corn and then turned my cows in to pasture it. After they had run in the field about ten days, I found two dead one morning. They were well the night before. The local veterinarian was called in. While he was there another cow was noticed standing braced, with glassy eyes. We tried to make her move. She simply fell over stiff and died in a few minutes in spite of anything the veterinarian could do. The local veterinarian wired for Dr. Lamb, state veterinarian, who came in and dissected the last cow to die. He decided that the cows were poisoned from something they had eaten. I have not turned cattle in the corn field since, and have had no further loss.

I am submitting herewith a summary of the cattle account for the summer.

Cattle

Nov. 1, 1915, had 33 head valued at \$55 per head..	\$1,815.00	
Sold during the year, 8 head for.....		\$ 426.00
Sold during the year, dairy products.....		625.00
Sold during the year, hides from cattle that died....		24.00
On hand Nov. 1, 1916, 38 head valued at \$62.....		2,356.00
Bought during the year, 4 head.....	225.00	
Cost of water, salt, pasture and feed not raised.....	120.00	
	\$2,360.00	\$3,432.30
Balance		1,172.30

I have on hand about the same value in feed as a year ago.

Poultry

Nov. 1, 1915, had 6½ dozen hens.....	\$ 40.00	
Sold during the year, poultry and eggs.....		\$ 172.23
Have on hand 6½ dozen hens.....		40.00
Feed purchased.....	20.00	
	\$ 60.00	\$ 212.23
Balance		172.23

Have made no account of feed raised on the place, neither have I made account of poultry and eggs consumed. These would probably balance pretty closely.

Swine

I have not begun breeding swine yet, but in March			
I bought 7 pigs at \$3 per head.....	\$	21.00	
In July I bought 11 at \$3.....		33.00	
(Three of the first lot died from over-feeding of sour skimmed milk. One of the second lot got killed.)			
In August I sold three head of the first lot for.....			\$ 37.74
I have on hand 11 head worth.....			90.00
Corn fed.....		40 00	
		<hr/>	
	\$	94.00	\$ 127.74
Balance			33.74

I have good hog quarters now. I shall endeavor to get some pure bred stock and have pigs to sell in the future.

Respectfully submitted,

J. W. ADAMS,
Dry-Land Specialist.

The above report of Mr. Adams outlines the development under way at the Cheyenne Wells plant. The present year we have compensated Mr. Adams for time spent on improvement work by employing a man, paying him regularly.

Mr. Adams keeps a record of the performance of his live stock and of the land. Since he must get his living out of the land, under our present arrangement, it is necessary to plan the work on the farm so as to be capable of as cheap execution as possible. The general plan of work, therefore, is rather simple.

The farm, as has been previously reported, is laid out in contours, in order to prevent surface run-off and also in order to collect water falling upon higher lying lands, which water flows onto our tract. The crop plan is simple yet. It includes alfalfa, some of the small grains, some of the sorghums and corn. Some tillage systems are being tried, but these necessarily must be simple. It is hoped that we can add to the means of the place to increase work on some of these things, and likewise to take up a little more accurate work on the feeding of the herd.

It is our plan to keep the work simple and insofar as possible to work upon problems which are pertinent to that immediate section of the State. We have accomplished something along this line. We built the first pit silos in Cheyenne

County. From the small beginning there are now probably 100 in the county, which have been built because of the success of our experiment with this type of silo. It will be necessary to provide for this work as well as last year. It would be advisable to expand expenditures a little bit, making a few further improvements and putting in money which will enable some of the above suggested records to be accurately kept.

REPORT OF THE WORK AT FORT LEWIS

The arrangement at Fort Lewis was a co-operative one, in that the Fort Lewis School of Agriculture, Mechanic and Household Arts furnished the land and was to have furnished the labor necessary for the conduct of experimental work. Mr. J. T. Copeland, who carried on the resident end of this project was paid half his salary from the Station funds, and half from Fort Lewis funds.

Mr. Copeland reported in detail from month to month the condition of the work, the condition of the weather, and working relationships and conditions.

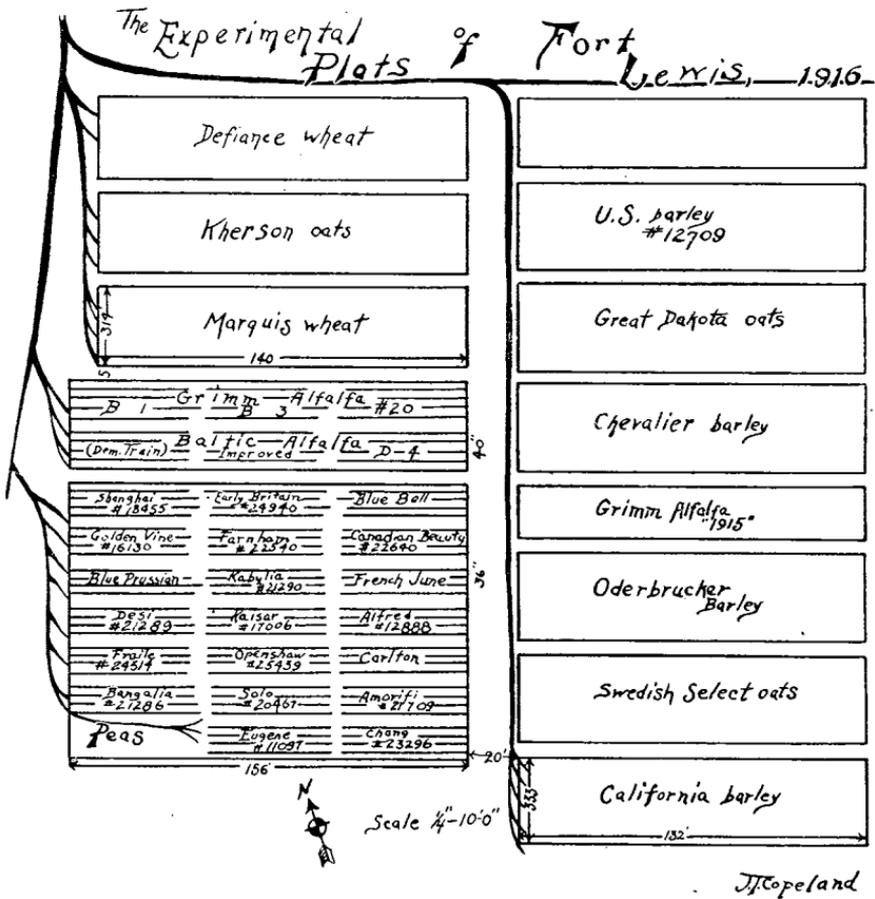
When Mr. Copeland left here, he was supplied with a plan of operation which gave him in detail the crops to plant and the work to be done. The following grains and crops were provided and planted according to instructions:

Barley—	Oats—	Wheat—	Alfalfa—
Oderbrucker	Swedish Select	Defiance	Baltic
California	Kherson	Marquis	Grimm
Chevalier	Great Dakota		
U. S. No. 12709			
Hanna			
		Peas	
Alfred No. 12888	Shanghai No. 18455	Kaisar No. 17006	
Blue Bell	Amorita No. 21709	Solo No. 20467	
Canadian Beauty No.	Blue Prussia	Bangalia No. 21288	
22640	Early Britain No.	Carlton	
Desi No. 21289	24940	Chang No. 23290	
Eugene No. 11097	Farnham No. 22540	Fraile No. 24314	
French June	Golden Vine No. 16130	Openshaw No. 25439	
Kabilya No. 21290			

The plans were purposely simple for this year.

1. Because of lack of means to do everything at once; and

2. Because we felt that Mr. Copeland should get in touch with the needs of his problem before attempting more serious work. Consequently, this year's plans were adaptation plans, attempting to find out adapted types from which the best adapted varieties might be chosen. The plan comprehends



later breeding work to get the greatest possible improvement with adapted types. We expect to try cultural methods, and these adapted types both under dry-farming and irrigated conditions. The range of altitude on the Fort Lewis reserve varies from about 7,500 feet to over 9,000 feet, which permits a considerable variation in altitude study.

The Fort Lewis reserve itself is a vast tract of land and some of our experimental work should be aimed at solving the agricultural problem for this tract. This need has helped us shape our work in cultural, dry and irrigated farming, and our adaptation work.

AKRON

There is very little to report on our Akron land. The arrangement with the Office of Dry Land Agriculture permits

them to operate our land. This office is entirely agreeable to, in fact desirous of, our co-operation, and would like to have our suggestions and help even if we could help no further than by occasional visits and suggestions as to work. So far we have had insufficient funds to do very much in caring for this possible source of information. The Office of Cereal Investigations and the Office of Dry Land Agriculture have both been very cordial and have submitted manuscripts for bulletins to the Agronomist for comment.

It is quite possible that we could be of some service by distributing some of the best lines of pure seed, possibly through our co-operative student association. It would be possible for us to get practically all data collected at the Akron Station if we were able to employ an assistant and place him at this point. It is worth while to consider some of these factors and possibly make use of them at some time in the future.

Respectfully submitted,

ALVIN KEZER,
Chief Agronomist.

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 1916.

During the year which is about to close, three lines of investigation have been pursued, two of which have been supported by the Adams fund and one by the Hatch and State funds. One of these has been completed and two are still in progress. No new projects have been initiated, although a new phase of one of the old ones has been taken up.

In addition to the above, a number of minor investigations, along miscellaneous lines, not covered by definite projects, have claimed no inconsiderable amount of my time.

The preparation and distribution of vinegar cultures has been continued, and the reports from those who have used them have been most gratifying.

PROJECT I. A Bacterial Disease of Field and Garden Peas

This study has shown that during certain years and under certain conditions, both field and garden peas in Colorado are subject to a stem and leaf blight which is caused by a previously undescribed micro-organism, *Pseudomonas pisi*, n. sp.

The casual germs enter the plants either through the stomata or through wounds produced by mechanical injury, and bring about the characteristic discoloration and blighting.

The work of this project has been completed, except for a further study of resistant varieties, and the results of the investigation have been published as Bulletin No. 218.

PROJECT II. Bacteriological Studies of Alkali Soils

During recent years the soil bacteriologist has had his attention called to a form of life in the soil, not bacterial, but animal in origin, the soil protozoa. This has come about through an apparent inter-relation between soil bacteria and the soil protozoa in questions of soil fertility. Our knowledge of the presence and activity of these forms in arid soils is very limited at present, and, accordingly, we have given some attention to their occurrence in our soils.

Mr. J. H. Newton, who has assisted me with this work, finds that the total number of protozoa, as well as the number of species, in the soils we have examined, is apparently less than that reported for soils from the more humid regions.

PROJECT III. A Bacterial Disease of the Wragg Cherry

Laboratory and field experiments have shown that the fruit, leaves and twigs of the Wragg cherry are attacked by a micro-organism which appears to be similar, if not identical with *Pseudomonas pruni*, resulting in a characteristic spotting of the cherries and leaves.

Spraying with self-boiled lime sulphur as soon as the blossoms have fallen, again when the cherries are the size of small peas, and again when they are half grown has reduced the injury to the fruit from 40 per cent to 10 per cent.

MISCELLANEOUS STUDIES

During the year there has been an increasing demand upon my time for the investigation of minor questions which are directly related to my field of activity, but which are not covered by any specific projects, and which are not of sufficient general interest or importance to warrant drafting a definite project.

There is no question but that these problems are deserving of consideration, and, personally, I am always glad to look into them, but whenever I do so, I must do it at the expense of my regular projects, which I feel I have no right to neglect. Practically all of this subordinate work, as well as much of my daily routine, could be taken care of by a competent assistant under my direction, and more of my time could be devoted to the more important phases of our investigations. With the

present organization, it is a physical impossibility for me to satisfy all the demands made upon my time by the numerous minor problems and at the same time to prosecute in a creditable manner my regular research work.

Some of the minor questions which have been referred to me for solution during this year follow:

1. Water analyses for farmers and stockmen.
2. Green milk in a dairy herd.
3. Fishy flavor in ham and bacon.
4. Internal black rot of tomatoes.
5. Streak disease of beans.
6. Chemical soil analyses for potato experiments.
7. Dwarfing of begonias.
8. Dwarfing of lettuce.
9. Co-operative work on methods in soil bacteriology.

Five lectures have been given at Farmers' Institutes and seven lectures before college classes.

Very respectfully submitted,
W. G. SACKETT,
Bacteriologist.

November 20, 1916.

REPORT OF THE BOTANIST

To the Director:

I have the honor to present the following report covering the work of the Botanical Section of the Experiment Station for the year ending June 30, 1916.

The following projects have been worked on during the period covered by this report:

- (1) Native Vegetation as an Indicator of Crop Possibilities in the Colorado Transition Area.
- (2) Fungous Disease Investigations. (a) Sub-project: Millet Smut Investigation.

Work upon the first mentioned project has consisted of a study of the climatological data available from localities in the area involved and a reconnaissance field trip of close to 3,500 miles throughout Colorado, in which trip the limits of the chief native plant associations that occur within the transition area were determined, and their broader relations to climatic factors and to agriculture ascertained. Further detailed study is in progress.

In the study of millet smut, pot and field studies were made during the summer to determine (1) the extent of cross-inoculations when using two species of millet smut (*Ustilago panicumiliacei* and *Ustilago crameri*) upon the common economic types of millet (*Echinochloa frumentacea*, *Panicum miliaceum*, *Chas-tochloa italica* and *Pennisetum spicatum*); (2) degrees of resistance to the smuts; (3) manner of infection; (4) methods of control. The results of the first season's work, while very gratifying, will be checked by further laboratory and field studies.

Mr. H. E. Vasey is carrying on the Fungous Disease Investigations.

Respectfully submitted,
W. W. ROBBINS,
Botanist.

November 15, 1916.

REPORT OF THE CHEMIST

To the Director:

I herewith present my annual report of the activities of the Chemical Section of the Experiment Station.

The progress made has been satisfactory to us in some ways and disappointing in others. The disappointments grow out of the very great prevalence of wild oats in our wheat plots which necessitated our sacrificing the crop, as it would have been next to impossible to have cleaned the grain and there would have been a question regarding the normality of the crop grown under such conditions of crowding by the oats. I feel, however, that it is necessary for us to try again, as we need fresh grain grown under the same conditions as nearly as we may be able to reproduce them for the study of the effects of these conditions on the baking qualities of the flour.

The work on this phase of our project had to be postponed, as you know, because we were fully engaged in carrying on the analytical work connected with the other features of the investigations. We are now about ready to begin this work, but we are confronted with the fact that some of our flour samples are too old to be relied upon. We intend to go through with the series as though no question concerning the fitness of the sample existed, but I feel that we should have a series of entirely fresh and unquestionable samples for comparison. It was for this purpose, more than for any other, that we wanted this year's crop, but it is evident that we cannot avoid a whole year's delay in this feature of the work. We have now pre-

sented Bulletins 205, 208, 217 and 219, embodying the results of our work on this subject; you and the investigators of the country will judge the results presented.

While we have as yet been unable to do the things that I wanted to do, and would still like to do, I feel that the main objects of the project have already been attained in so decisive a fashion that we should feel satisfied if we get no further good or definite results. This is no intimation that I do not expect interesting and decisive results from the remaining portion of the work.

The developments in the San Luis Valley during the past years—the last two years especially—have been of very considerable interest in connection with our niter question, and we have made some observation and taken some samples in connection with this work. There seems to be a more general interest in this subject than I was aware of.

The work done on the development of nitrates and the fixation of nitrogen in the soil on which our wheat experiments have been made have an important bearing on this question. While I am as firmly convinced as ever that the source of an important part of the soil nitrogen in certain sections is the atmosphere and that bacterial activity both fixes it and transforms it into nitrates, certain occurrences have come to my knowledge which justify further investigation of other possible sources. I am not clear that it is possible in any case to so satisfactorily remove the possible agency of bacteria in relatively modern times that one could assert that another source had been established. Still we wish to investigate certain shales and waters to see whether we can establish any other source with facts of conclusive nature to support it.

In connection with one study of the waters of the San Luis Valley, which we undertook under the subject of "The Rio Grande Waters", the question of the agricultural importance of the soda waters of the Hooper-Mosca section has taken on a decided importance. We have had the question of their part in the barren condition of this section thrust upon us by results of investigations carried on this summer in an endeavor to get the results of work done some years ago into shape for publication. While this matter is of big importance, possibly we can at this time only do enough to point out the reality and seriousness of this problem which is intimately connected with the water question and the non-productive condition of some 500,000 acres of land in the valley.

Respectfully submitted,
WM. P. HEADDEN,
Chemist in Charge.

REPORT OF THE ENTOMOLOGIST

To the Director:

The major portion of the investigational work for the year in this section has been upon three projects: Plant Louse Investigations, Codling Moth Investigations, and Insect Control by Egg Treatment. Some time also has been given to the study of the food habits and life histories of lady beetles by Miss M. A. Palmer, and the study of Grasshopper Control and the habits of Syrphus Flies by Mr. C. R. Jones. Mr. L. C. Bragg has accumulated a large amount of data upon the life histories of the aphides, and Mr. Geo. M. List, Mr. O. G. Babcock and Mr. Chas. Fluke have carried on the Codling Moth work in Mesa County.

This Section is greatly in need of an insectary and a natural temperature room since the removal of the old insectary to make room for the central heating plant.

The more technical papers resulting from the investigational work are being published in technical journals, and the more practical results are prepared for Station bulletins.

Respectfully submitted,

C. P. GILLETTE,
Entomologist.

REPORT OF THE FORESTER

To the Director:

I herewith submit the annual report of the Experiment Station work done in the Forestry Section from July 1, 1915, to June 30, 1916.

Two projects have been carried on during the year, the first, dealing with the control of the dandelion, having been started while the Sections of Botany and Forestry were still combined.

This project was undertaken with the purpose of determining the most practicable and economical means of controlling dandelions in lawns and fields, and includes the various methods commonly in use, such as digging, spraying, and using gasoline. Studies of the dandelion have been made in order to learn the full life history of the plant from seed to the mature blooming stage. Seed germination studies were carried on to determine the length of time required for the

heads to mature seeds after the first day of blooming. Photographs were taken to illustrate the life history of the plant and these will be used in a bulletin now in preparation.

While it is desirable that one more season of work in spraying and further observations be given to this project, it is, however, possible, with the data on hand, to recommend the most economical and effective methods of control among those employed.

The second project, Studies in the Decay of Wood, has for its purpose (a) the development of a relatively rapid and accurate method of testing the durability of different species of wood in the laboratory, and (b) the application of this method to determine the relative durability of the commonly used species of timber.

The essential features of the method employed consist in using a large number of wood specimens of each species to be studied, the specimens being as uniform in size and quality as possible. After being dried to a uniform degree and weighed, these are planted in a large iron box of soil and kept under conditions of moisture and temperature suited to rapid decay. At regular intervals several pieces of each species are extracted, dried to the same degree as before, and weighed. Loss of weight is interpreted as indicating the extent of decay. Each piece of wood is then subjected to a breaking test and this is compared with similar tests upon sound wood, the data thus secured being correlated with that obtained from loss of weight. Comparisons are also being made between the sap and heartwood of each species where it is possible to secure suitable material. The first test was begun April 1, 1915, with nineteen species and a total of 1,079 specimens. Specimens of one species have been planted out-of-doors for comparison with those kept inside. This project is now being carried on as planned, and, while results to the extent of 5 per cent. have been secured in the case of the less durable species, it is still too early to publish results.

Respectfully submitted,
B. O. LONGYEAR,
Forester.

November 15, 1916.

HORSE-BREEDING INVESTIGATIONS

To the Director:

I beg to submit the following annual report of the horse-breeding work which is being conducted in co-operation with

the United States Department of Agriculture for the purpose of evolving a type of horse suitable for carriage and general work purposes.

Animals in the Stud

Some promising individuals are included among the past season's colt crop of fifteen foals. The mating of the stallions, Albion and Carnagie, to certain mares that are half-sisters, stallions and mares being sired by Carmon, is proving highly beneficial. The total number of animals to be retained in the stud for the coming year are included in the following table, those individuals recently condemned by the board of survey not being listed:

	Stallions	Mares	Total
Five year old or over.....	5	20	25
Four year old.....	..	1	1
Three year old.....	2	4	6
Two year old.....	..	5	5
Yearlings	3	7	10
Weanlings	5	7	12
Total	15	44	59

General

During the past year the seven-year-old stallion Defender and the three-year-old stallion Highball stood for public service at Carbondale and Montrose, Colorado, respectively. Both stallions took well in their respective communities and made big seasons, the stallion Highball receiving the maximum number of mares allowed him for the season. For next year arrangements have been made to retain Highball at Montrose, Colorado; Defender will stand at Shell Postoffice, Wyoming; and the coming four-year-old stallion Hichman will make the season in the southern part of the State. Stallions of the type being sent out from the Station are in great demand, many inquiries being received throughout the year.

Diligent efforts are still being made to procure a suitable stallion of outside blood to mate with the Carmon mares. Not a few stallions have been inspected for this purpose in numerous sections of the country, but so far none have been found that possess the combination of qualities desired for this work.

Sale of Rejected Animals

At the annual meeting of the board of survey held November 14, 1916, twenty-two animals were recommended for disposal. Included among this number are: One eight-year-old mare, one seven-year-old mare, one five-year-old mare, three three-year-old mares, one three-year-old stallion, five two-year-old fillies, two two-year-old stallions, one yearling

filly, four yearling stallions, and three weanling colts. Twenty of the above animals are the property of the Experiment Station and two the property of the Department of Agriculture. These will be offered for sale at public auction during the coming winter. In addition, the two geldings held over from last year's sale will be disposed of.

Respectfully submitted,
WM. P. LITTLE,
Expert in Charge.

November 28, 1916.

REPORT OF THE HORTICULTURIST

To the Director:

I beg to submit the following brief report on the status of the experimental work in horticulture for the year 1916.

In this report I shall briefly state the progress on the different projects as they are at the present time.

MANAGEMENT OF NITER SOIL

This project was started in June, 1914, and has been carried on during the last three seasons on the farm of Mr. B. F. Bain in the Grand Valley. The results of the work show conclusively that niter soil can be reclaimed by flooding, and that excessive accumulation of niter may be checked by proper soil management.

The field on which this experiment was conducted was divided into two portions; one portion was enclosed by an embankment thrown up to the height of about 12 inches. Into this enclosure water was conveyed until the entire surface was covered to the depth of six or more inches. The water was maintained at this height for a period of two weeks, at the end of which time the plot was drained of the surplus water and the embankment leveled down. When the ground was sufficiently dry it was disked, harrowed and seeded to oats.

The effect of this flooding was very marked, as the grain germinated readily and a fine stand was obtained. Crops have been grown continuously on this piece for the last three years, and there is no indication of the soil returning to its former condition. In other words, when thorough flooding, with the resultant washing out of the soluble niter salts, is practiced, normal crops can be raised.

The balance of the field was plowed, harrowed, seeded to oats and corrugated. Water was then conveyed into the corrugations and kept running for six days. The effect of this

extensive watering was apparent, as the oats that happened to be just at and below the water level in the corrugations came up and made considerable growth, but no seed germinated on the top of the ridges, being apparently killed by the niter present. The oats, however, failed to make more than a temporary growth, except in isolated spots where the growth continued for several weeks.

This method of washing the soil has been repeated for the last three years, and the ultimate results show that this method of reclamation is not wholly satisfactory.

From our work it is apparent that the most effective way of dealing with niter land that has passed the stage of sustaining plant life is by means of flooding. While the initial cost of this method is considerably greater than the cost of washing the lands by means of corrugation, it is much more rapid and certain of results, and, in the end, more economical.

This project has been carried far enough to demonstrate the possibilities of reclaiming our niter lands, and there is no reason for continuing the work any further.

The result is now being written up and will be presented in bulletin form within a very short time.

The second part of this project, relating to the checking of the initial stages of nitrification, particularly in the orchards in the Grand Valley, has been carried out with varying degrees of success for the last three seasons. The great difficulty in obtaining satisfactory results, or even data on which to base results, is due to the heavily shaded soil and the difficulty of obtaining a satisfactory stand of cover crops. The work, however, would indicate that soil in the first stages of niter trouble can be restored and the excessive accumulation of niter prevented by the plowing under of green crops.

The Department has constantly preached the use of cover crops in connection with fruit growing on our irrigated land, especially on the Western Slope. The fruit growers have been slow to use cover crops, mostly because the clean culture method has been practiced for so long a time that the growers have come to look upon it as a fundamental necessity in profitable production of fruit. However, considerable progress is being made in this direction, due mainly to the excellent results obtained by a number of growers who have adopted a system of cover crops in connection with clean culture. There is still a great need for missionary work along this line.

PEAR GROWING IN NORTHEASTERN COLORADO

This project was also started three years ago. The object was to discover some means whereby the growing of pears

in this section of the State could be made a success, at least to make it possible for the farmer to grow this fruit for home consumption.

A small orchard of 75 pear trees grafted on quince roots was planted. Several varieties were used in this experiment. These trees have been given the ordinary cultivation and irrigation during the last three years, and the result thus far has proven very encouraging. Pear blight is the greatest drawback to successful pear growing in Northeastern Colorado, but, up to date, we have not had a single case of blight. The loss in the dying of the pear trees has been less than 5 per cent. The outlook is very promising, but no final conclusion should be drawn for many years to come.

GROWING HARDY STOCK AND HARDY VARIETIES OF APPLES FOR EASTERN COLORADO

This project was also started three years ago, and a large number of varieties of apple trees were planted. The question of hardiness in fruit trees is a complex one, in so far as it relates to Colorado conditions. There is some misapprehension among our growers as to what constitutes hardiness in apples. From our work thus far, it would indicate that it is not a question of hardiness in relation to low temperature. On the contrary, the low temperature experienced in this section of the State does not offer any serious obstacles against the successful growing of most commercial varieties of fruit. Hardiness should be translated in terms of ability of different varieties of apples to resist dry atmosphere or drought occurring during the winter months, or during the dormant period of the trees.

We hope to further study this problem in connection with laboratory work to ascertain what morphological characters of the trees militate for or against their ability to resist the dry weather during the winter.

A large number of varieties are under control; many of these are making rather poor progress, while others are making a very satisfactory growth.

GROWING VEGETABLES AND SMALL FRUIT IN HIGH ALTITUDE

This project was started last year in connection with the project of seed potato growing in high altitude at Fort Lewis. The first year's work has been mostly of a preliminary nature, as necessary preparations had to be made before the plan of the work could be put into execution. However, a start was made, and the work will be in full swing this year. The preliminary work of last season is of great interest, as it points

to great possibilities in the growing of many of the hardy fruits and vegetables in this altitude. The altitude at Fort Lewis is about 7,700 feet.

SEED POTATO GROWING IN HIGH ALTITUDE

This work was started in connection with the foregoing project. Only preliminary work was done during last season, but plans have been provided for extending this work by the introduction of pure seed and new varieties.

GROWING POTATOES IN THE VICINITY OF FORT COLLINS

It is a common experience that potatoes do not succeed on our heavy soil in Northeastern Colorado. Repeated trials of many years' duration have, without exception, proven failures. In order to study the probable causes for this failure, some experiments were started last year. Two sets of experiments were inaugurated, one to test the adaptability of different types of soil in the production of tubers, and the other to grow potatoes normally in the field on soil previously heavily manured with well-rotted stable manure.

Considerable preparation was made for this work, both in providing for control experiments and for field experiments under normal conditions. The control experiments were conducted in five pits constructed of cement, 12 feet long, 3 feet deep and 3 feet wide. One pit was filled with soil from a Greeley potato field, one with soil obtained in the mountains, one with soil obtained in the garden, one with sand taken from the river which had been washed by the river so that it contained practically no vegetable matter; another was filled with a made-up soil consisting of one-third sand, one-third leaf mold, and one-third mountain soil. In all the five pits we had no evidence of disease. The potatoes matured in all instances and a fairly good yield was obtained. The soil obtained from the garden gave the highest yield, and also the highest quality. The tubers were smooth and marketable.

In the case of the field experiments it is evident that potatoes can be grown successfully on our heavy soil if previous preparations have been made. This is the third year that we have endeavored to grow potatoes in our experimental ground, and it is the first year that we have succeeded.

In studying the various factors that may be responsible for our success, it appears that the question of soil preparation is paramount. Without the presence of vegetable matter, success cannot be obtained. In soil that has been cropped, and to which no vegetable matter has been added, either in the form of stable manure or in the form of green manure, pota-

atoes will not succeed. A soil devoid of vegetable matter will, under the influence of irrigation, puddle to the extent of making it almost impervious to air, and, under such conditions, the tubers are not able to develop.

It further appears that the question of irrigation is also important. The practice in the Greeley district of withholding the water for the greater portion of the summer and applying it about August 1st, and then in frequent intervals thereafter until the potatoes have reached their full development, is not, according to our interpretation of our results, a good one. We endeavor to keep the plants supplied with sufficient moisture from the beginning to the close of the growing period.

I do not wish to make a positive statement in regard to our results at this time, as it is necessary to verify them by continuing the work for at least one or two years longer. I believe that we are on the right track, and that it is only a question of verification and extended work.

ORCHARD SURVEY OF MESA COUNTY

This project was finished a year ago this fall, so far as the field work is concerned. The notes have been worked up and the results are now ready for publication in the form of a bulletin.

These are the main lines of our work, though we always have some minor work in the forcing of vegetables in progress in the greenhouses.

During the past season, no publications have been issued. A small bulletin was written by Miss Kinnison, under the direction of the Department, giving an account of forcing strawberries in the greenhouses.

One bulletin on "Potato Growing in Colorado" is in the hands of the printer.

We also have a bulletin ready for publication on the "Orchard Survey of Mesa County", and one on "Hotbeds and Coldframes", by Mr. Limbocker; also a bulletin on "Fruit Growing in Colorado", which has been delayed on account of lack of funds to pay for the colored plates.

Respectfully submitted,

E. P. SANDSTEN,
Horticulturist.

IRRIGATION INVESTIGATIONS

To the Director:

The following is a brief report of the work done by the co-operative Irrigation Investigations during the year 1916.

Of a total of approximately 4,300 experiments made in the hydraulic laboratory since it was started in 1913, only about 400 experiments were made during this season. In addition to this, about 150 current meter ratings were made on both the rotary and tangent rating stations. The work in the hydraulic laboratory this season has been on the following subjects: Discharge Through Reservoir Outlet Tubes, Submerged Orifices, The Woodman Meter, Proportional Divisors, A New Type of Venturi Flume, Calibrations of the Standard Types of Venturi Flumes and Current Meter Experiments.

The project requiring the most work during this season has been the investigation of the "Use of Water in the Cache la Poudre Valley". Six men with automobile transportation have been constantly employed in this work and additional survey parties assisted them for about two months. This project will continue at least another season.

The only publications which appeared from this Section during the past year were two articles in the Journal of Agricultural Research of the U. S. Department of Agriculture on "Flow Through Weir Notches With Thin Edges and Full Contractions", and "A New Irrigation Weir". Other manuscripts on measuring devices are ready for publication and probably will appear in the near future. A preliminary report on the Venturi Flume and a bulletin on divisors for dividing the flow of water in a ditch among two or more users are in course of preparation.

Some time has also been spent in connection with experimental drainage work on the former Indian School grounds at Grand Junction, and in an advisory capacity for other drainage work in different parts of the State.

Respectfully submitted,

V. M. CONE,

U. S. Engineer in Charge Irrigation Investigations.

REPORT OF THE IRRIGATION ENGINEER

To the Director:

I submit herewith the annual report of the experimental work done by the Department of Civil and Irrigation Engi-

neering. This Department is in a peculiar position, due to the fact that most of the irrigation experimental work is done in co-operation with the United States Department of Agriculture. The report of this work will be by Mr. V. M. Cone.

There are two projects in charge of this Department; one is concerning the Duty of Water on the College Farm, and this was carried on last summer in the usual way, making the fifth consecutive year of records. The second project is on Sub-Irrigation by Means of Underground Pipes, and the same line of work previously done and reported was carried on for another year and records kept of the results.

This constitutes all the experimental work done by the Department of Civil and Irrigation Engineering during the current year.

Respectfully submitted,

E. B. HOUSE,
Irrigation Engineer.

REPORT OF THE VETERINARIAN

To the Director:

BRISKET DISEASE

The larger portion of the experimental work done by this section has been directed toward the study of the condition in cattle known as Brisket Disease. A preliminary report of this disease was published in January, 1915. Since the publication of that report, two lines of work have been followed; one to determine whether normal animals living at high altitudes had heavier hearts than those living near sea level, and the other to determine the importance of food as a factor in the disease. On the first subject, heart weights were taken at Denver, San Francisco and Fort Worth, Texas, with the result that the weights of hearts per one thousand pounds of carcass is nearly a pound heavier for high altitude animals than for low. On the second phase of the work, a few animals were shipped to a low altitude and fed upon hay grown in the districts where cattle are susceptible to the disease. It appears from this work that the food is not a factor in the production of the disease. Complete reports on these two phases of the work and on some other matters that were not included in the previous report are now practically ready for publication.

LAMB LOSSES IN THE FEED LOTS

Lamb feeding is an important industry in Colorado and the heavy losses in the death of lambs in the feed lots has rendered the business somewhat precarious. The profits in lamb feeding depend chiefly upon four important factors:

- (a) The purchase price of range lambs.
- (b) The price of feed and other necessary expenses in handling.
- (c) The percentage of lamb losses in the feed lots.
- (d) The selling price of the finished lambs.

Under average conditions a loss of less than 1 per cent. in the feed lots is considered nominal and does not destroy the possibility of a satisfactory profit on the feeding investment, but a loss ranging from 3 to 10 per cent. of lambs cuts heavily on the profits and may mean a disastrous financial loss for the season.

Some work has been done in the San Luis Valley and on the Eastern Slope to determine, if possible, the reason for such heavy losses of lambs in the feed lots. More than 2,000,000 lambs have been seen in the feeding operations where heavy losses were reported. The methods of feeding and handling have been studied and many autopsies have been held. There has been no widespread infection among sheep in Colorado. A few lambs have died from tapeworms (*Taenia fimbriata*) that have inhabited the gall ducts in large numbers. There is in most cases a small loss from pneumonia, caused by crowding and over-heating, and from a variety of diseases and accidents.

Much of this loss, it seems, is caused by trying to get the greatest possible gains in the least possible time, without taking into consideration the fact that a lamb is not a machine, but a very sensitive animal that is easily killed by careless feeding.

While over-feeding, change of feed, and improper feeding are apparently responsible for the greater part of this loss, there are some things in this connection that are not easily accounted for in this way. The oldest feeders in the San Luis Valley testify that while formerly their losses of lambs on the pea fields were nominal, during the last three seasons, with the same methods of handling, their losses have grown heavier each year. Again, in the San Luis Valley, on the newer lands to the east, lambs are turned into the fields and within a few days are getting all of the peas that they want and the losses

are not heavy. With the hope of determining some of the unknown factors in this connection, we are now arranging a feeding experiment at the college in conjunction with a continuance of the field observations.

ANIMAL DISEASE PROJECT

Under this project are grouped those diseases on which no special investigation has been planned and for which no appropriation of funds has been made.

NECROBACILLOSIS

One outbreak of necrobacillosis in hogs was studied rather closely with a view to determining appropriate therapeutic measures for handling diseased pigs. Various local treatments have been tried and several antiseptics used to determine their value, but the work has not progressed sufficiently to warrant definite conclusions for publication at this time.

POISONOUS PLANTS

A great many plants have been sent to the Experiment Station for identification, and accompanying these specimens have been statements of heavy losses, presumably from poisonous plants. Many reports of fall and winter poisoning of cattle and sheep by the Whorled Milkweed (*Asclepias verticillata*) have been reported from the Western Slope and Southwestern Colorado.

Out of a band of 1,400 sheep that were driven across the open range to Cortez, 577 died with symptoms of poisoning. The seeds of the Whorled Milkweed were found in large numbers in the stomach contents. While it is not definitely proven, yet there is sufficient reason to strongly suspect that this milkweed is a dangerous plant for cattle and sheep.

Several visits have been made to different parts of the State to investigate poison-weed conditions. Losses this year have been quite heavy from larkspur. There is a difference of opinion as to whether sheep are immune to larkspur poisoning. United States Department of Agriculture Bulletin No. 365 reports an inability to poison sheep with two species of larkspur, and suggests the feasibility of grazing sheep on larkspur ranges in advance of cattle grazing as a partial solution of the problem. Many testimonials have come from experienced sheepmen to the effect that they have lost heavily from pasturing on larkspur ranges. This is an important matter and further investigation is needed.

About 125 pathological specimens for diagnosis of disease have been received at the laboratories.

About the close of the present fiscal year we began distributing Government blackleg vaccine free to farmers and stockmen of the State.

Respectfully submitted,

GEO. H. GLOVER,
Veterinarian.