THE STATE AGRICULTURAL COLLEGE
OF COLORADO

The Thirty-Fifth Annual Report

OF

The Colorado Experiment Station

1922

The Colorado Agricultural College

FORT COLLINS COLORADO

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LETTER OF TRANSMITTAL

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

In accordance with the law of Congress establishing Agricultural Experiment Stations, I have the honor to transmit to you herewith the Thirty-fifth Annual Report of the Colorado Agricultural Experiment Station for the government fiscal year, July 1, 1921, to June 30, 1922.

The report covers a full financial statement of all receipts and disbursements, and brief summaries or outlines of the work done by those in charge of the different sections or departments of the Experiment Station.

C. P. GILLETTE,
Director.

Agricultural Experiment Station
Fort Collins, Colorado
December 1, 1922.

FINANCIAL REPORT OF THE COLORADO AGRICULTURAL EXPERIMENT STATION
FOR THE FISCAL YEAR ENDING JUNE 30, 1922

	Hatch Fund	Adams Fund	State Mill Levy Fund	Special Fund	Pure Seed Fund App'n	Total Funds
DR.						
Balance July 1, 1921	.....	.....	$ 9,724.71**	$10,489.66	$8,713.36	$ 9,478.31
From the Treasurer of the United States as per appropriation for the fiscal year ending June 30, 1922, under acts of Congress approved March 2, 1887 (Hatch Fund) and March 16, 1906, (Adams Fund)	$15,000.00	$15,000.00				30,000.00
Other sources than the United States			84,178.27	25,507.95	.....	109,686.22
Total Receipts	$15,000.00	$15,000.00	$74,453.56	$35,997.61	$8,713.36	$149,164.54
CR.						
To Salary	$11,711.91	$13,019.23	$28,833.00	$21,163.13	$4,251.61	$ 78,978.88
Labor	1,704.56	196.85	6,887.87	229.15	148.79	9,167.22
Publications	497.00	.....	2,301.19	218.91	18.50	3,035.60
Postage and stationery	33.87	9.27	1,127.52	86.69	183.82	1,441.17
Freight and express	57.92	17.25	675.42	4.07	2.48	757.14
Heat, light, water and power	.....	.....	16.95	31.26	.....	48.21
Chemicals and laboratory supplies	30.19	987.70	612.17	5,703.26	2.32	7,335.64
Seeds, plants and sundry supplies	96.46	82.81	1,300.84	761.37	111.75	2,353.23
Fertilizers	.....	.....	.....	.....	.....	.....
Feeding stuffs	276.95	4.70	4,661.34	408.87	.....	5,351.86
Library	36.67	10.00	478.60	38.10	11.45	574.82
Tools, machinery and appliances	38.15	12.05	497.24	37.95	1.25	586.64
Furniture and fixtures	134.05	4.25	1,161.71	60.49	175.21	1,535.71
Scientific apparatus and specimens	14.47	312.59	2,880.91	206.28	252.10	3,666.35
Live stock	120.00	.....	4,405.31	.....	.....	4,525.31
Traveling expenses	211.61	337.70	3,725.25	399.45	886.83	5,560.84
Contingent expenses	.....	.....	946.50	269.62	.....	1,216.12
Buildings and lands	36.19	5.60	7,436.50	5.45	23.91	7,507.65
Total Expenditures	$15,000.00	$15,000.00	$67,948.32	$29,624.05	$6,070.02	$133,642.39
Balance on Hand June 30, 1922	.....	.....	6,505.24	6,373.56	2,643.34	15,522.14
Grand Total	$15,000.00	$15,000.00	$74,453.56	$35,997.61	$8,713.36	$149,164.54

REPORT OF THE DIRECTOR

To the President:

I have the honor to present the following brief report of the work of the Experiment Station during the fiscal year closing June 30, 1922:

It is a pleasure to call attention to the fact that there have been but four workers who have left the official staff during the past year. The regular staff now numbers forty-five, of whom eighteen are employed by the Station full time, the balance devoting a portion of their time to teaching or other institutional duties. The income from the State mill levies for the support of the Experiment Station work has materially increased, amounting to $84,178.27, the past year. This amount will doubtless be increased by a few thousand dollars during the coming fiscal year.

The number of projects carried during the past year is fifty-eight. The number of sections now engaged in Station work is fifteen, and nine bulletins and one annual report have been published during the year, totaling 400 pages.

The fire of December 22nd, that burned the chemical building, caused a severe loss to the Experiment Station in equipment and in the loss of the records of chemical work done during the previous year. The fire also prevented the institution from carrying out its building program for the construction of an experimental chemical laboratory upon the campus. However, I am glad to note that the Station is likely to be very well cared for the coming year by the reconstruction of the old building and giving the whole of the first floor and much of the basement to the investigational work of the Chemistry section.

The co-operative work undertaken by the Agronomy, Bacteriology, Chemistry and Irrigation sections for the purpose of discovering some means of controlling the nitre trouble in the Arkansas Valley was well planned and the work nicely started during the spring and early summer of 1921, but the investigation was suddenly brought to a close in June, 1921, by the Pueblo flood. However, plans have been completed to continue this investigation for the coming year.

The program of work for the year is indicated in the following list of projects carried by the several sections of the Station and the brief reports of the heads of sections that follow:

AGRICULTURAL DIVISION

Agronomy Section

Relation of Soil Moisture, Structural Development and Acre Yields in Small Grains. Adams Fund.
Correlation of Characters in Grain. Hatch Fund.
Alfalfa Breeding. Hatch Fund.
Methods of Selection Breeding. State Mill Levy.
High-Altitude Crops. State Mill Levy.
Seed-Crop Improvement. State Mill Levy.
Plains Crops and Management. State Mill Levy.
Arkansas Valley Nitre Investigation. State Mill Levy.

Methods of Handling Hay. (Co-operation with Mechanical Engineering Section.) State Mill Levy.

Animal Investigations Section

Acre Value of Pasture for Dairy Cows. State Mill Levy.
Ration Experiments with Steers. State Mill Levy.
Rations for Fattening Lambs. State Mill Levy.
Range Management. (Co-operation with Botany Section.) State Mill Levy.
Winter Maintenance of Breeding Ewes. State Mill Levy.
Summer-Fallow Experiment at Akron, Colo. State Mill Levy.
Supervision of Dairy Cow Records.

Bacteriology Section

Heat Resisting Bacteria in Fresh and Canned Vegetables. Adams Fund.
Value of Certain Carbon Compounds as a Source of Energy for Azotabacter. Adams Fund.
Active Principle of Whorled Milkweed. Adams Fund.
Natural Inoculation of Colorado Soils with Legume Bacteria. Hatch Fund.
Arkansas Valley Nitre Investigation. State Mill Levy.
A Bacterial Disease of the Wragg Cherry. Hatch Fund.

Botany Section

Microscopy of Stock-Poisoning Plants. Hatch Fund.
Hard Seed of Alfalfa. State Mill Levy.
Biologic Specialization of Parasitic Fungi in Relation to Disease Resistance. Adams Fund.
Range Improvement. (Co-operation with Animal Investigations.) State Mill Levy.
Plant Disease Survey. State Mill Levy.

Chemistry Section

Nitre in Colorado Soils, its Occurence, Formation and Effects upon Vegetation. Adams Fund.

(a) Relation of Nitrates to Potato Diseases in the Greeley District, Colorado.

Entomology Section

Plant-Louse Investigations. Adams Fund.
Ants of Colorado in their Relation to Plant Lice. Hatch and State Mill Levy.
Codling Moth Studies. Hatch and State Mill Levy.
Grasshopper Control. State Mill Levy.
General Insect Investigations. State Mill Levy.

Forestry Section

Studies in the Decay of Wood. Hatch Fund.

Home Economics Section

Cooking Quality of Colorado Potatoes. State Mill Levy.
A Study of the Bread-making Qualities of Colorado Flours. State Mill Levy.

Horticulture Section

Hardy Stock for Apples. Hatch and State Mill Levy.
Potato Investigations. Hatch and State Mill Levy.
Seed Potato Growing in High Altitudes. State Mill Levy.
Hardy Tree-Fruits for High Altitudes. State Mill Levy.
Tomato Variety Tests. State Mill Levy.
Head Lettuce in High Altitudes. State Mill Levy.

Irrigation Investigations Sections

Current Meters. Adams Fund.
Evaporation Experiment. Hatch Fund.
Meteorology. State Mill Levy.
Measurement of Water as Applied to Irrigation. Hatch Fund.
Arkansas Valley Nitre Investigations. State Mill Levy.

Marketing Section

Survey of Marketing Practices. State Mill Levy.

Pathology Section

Contagious Abortion. State Mill Levy and Hatch Funds.
Sheep Losses in Feedlots. Hatch Fund.

Veterinary Section

Animal Diseases. State Mill Levy.

ENGINEERING DIVISION
Civil Engineering Section

Road Materials of Colorado. State Mill Levy.

Mechanical Engineering Section

Coefficient of Heat Transmission in Commercial Wallboards. State Mill Levy.
Methods of Handling Hay. (Co-operation with Agronomy Section.) State Mill Levy.

Respectfully submitted,
C. P. GILLETTE,
Director.

REPORT OF THE AGRONOMY SECTION

To the Director:

The work of the Agronomy Section for the fiscal year ending June 30, 1922, has been a continuation of the work for the previous fiscal year.

The following projects have been active:

Relation of Soil Moisture, Structural Development and Acre Yields in Small Grains. Adams Fund and State Funds.
Correlation of Characters in Grain. Hatch Fund and State Funds.
Method of Selection Breeding. State Funds.
High-Altitude Crops. State Funds.
Seed Crop Improvement. State Funds.
Plains Crops and Management. State Funds.
Arkansas Valley Nitrate Control. State Funds. (In co-operation with Bacteriology and Irrigation Investigations.)

The above projects have been approved for work during the fiscal year, July 1, 1922 to June 30, 1923.

Relation of Soil Moisture, Structural Development and Acre Yields in Small Grains.

Marquis Spring Wheat was again used as the grain receiving applications of water in different periods of its development. Each water treatment was replicated in different portions of the plat layout at least five times.

As the specific results have been reported to you from time to time, they will not be given in this Report. They may be summarized by saying that the year's results corroborate previous years' experiments.

The most critical period for water is that of germination time. But if sufficient water is given at germination time to germinate the crop and to start it on its young growth, the next most critical period seems to be, for wheat, the period previous to heading. Of course, the plats under test (fifty-five in number) have been covered during rainy or threatened rainy, daily periods, and at night, so as to prevent the plats receiving any natural precipitation. Thus, the total water supplied is applied under known and controlled conditions.

The amount of water in the soil at the beginning of the growing period, and at the close, is measured by standard methods. The covered field plots are being checked with potometers. We have found that we must learn a good many things about the management of potometers to have the results comparable to field conditions. Attention must be paid to the method of filling potometers with soil. We are now of the opinion that potometers must be filled freshly each year, or very grave errors will be thrown into the work.

At the present time, the project plats are giving the best results, as the conditions in the project plats more nearly approach field conditions, and we are able to control the moisture with a measurable degree of accuracy.

We think it desirable to make a few more seasonable replications with wheat, and then to carry similar work with barley and oats. Perhaps, later with other crops.

Correlation of Characters in Grain.

This project was instigated with the idea that it might be possible to find visible or easily measured characterics in our grains which might be correlated with production of grain per acre. It is relatively easy to find a correlation between some plant characteris-

ties and the yield of grain per plant. But the yield of grain per plant is not always an indication of the yield of grain per acre. The weight of grain per acre giving the desired quality is the end towards which we must always look. Because we have not been able to correlate with any consistency characteristics of grain with the yield per acre, our results on this project are largely negative. We have, however, worked out methods of handling other work thru this project, which is of value to us. We would like, as soon as the data seems to justify us, to drop this project, and take up some of the special phases which arise.

Alfalfa Breeding.

Alfalfa breeding has been carried on so we know that it is possible to breed up new and better strains. This phase of the work, however, is at a standstill at the present moment, because many of the alfalfa-seed-producing regions, where seed was formerly produced in abundance, do not now produce the seed with any consistency. Accordingly, our line of attack at present is to find out the underlying plant-growth conditions which enable alfalfa to produce seed and which retard the production of seed.

It is not helpful to produce new varieties of alfalfa, even if superior, if the production of seed is not a practical farm operation; or if the production of seed is so difficult as to make it unprofitable.

Hight-Altitude Crops.

The work with high-altitude crops at present is being largely carried on at Fort Lewis.

For the past three years, the work has been directly in charge of Mr. L. R. Quinlan. Mr. Quinlan resigned in the summer of 1922, leaving the Institution to take up graduate work at Harvard. He was replaced by Mr. Harrison D. Horton.

A detailed report of the year's work will be filed with you as soon as the compilation is complete.

Seed-Crop Improvement.

We are carrying on contemporaneously a number of lines of seed-improvement work.

First: We are attempting to isolate pure strains of our best-adapted standard sorts.

Second: We are importing and testing varieties of outside grains in order to determine their values under our conditions.

Third: We are doing definite cross and selection breeding work for the improvement and creation of new varieties.

For all of these lines of work, we are making careful comparative tests, in order to determine, as near as possible, the relative values of types and varieties for our agriculture. The best of these varieties and types are increased for distribution among farmers. It is our hope to get farmers growing the best-adapted pure seeds.

If we put our entire farm into one variety of pure seed, we could not supply seed enough to plant one-sixty-thousandth of the wheat acreage of the State. But we can start superior wheat varieties by purifying superior existing varieties, and get those good strains into the hands of the farmers, and thus help to create seed

centers, so the farmers themselves can produce the pure seed of the State.

It is only by some such method that we can get a sufficient acreage of pure seed to plant a considerable portion of our total acreage of any variety.

Plains Crops and Management.

The work on our Cheyenne Wells farm all comes under the project reading: "Plains Crops and Management." However, our work is not confined to the Cheyenne Wells farm. We are taking up with farmers, as a preliminary and more intensive work, a study of legumes and pasture crops.

As the plains become settled, the problems in attack change. Settled communities must have legumes for feed, and some sort of pastures for successful livestock production. Many of the crops, which do best, must be marketed thru livestock, so that the pasture and legume crops which will fit into the former system, under dry farm conditions, constitute a problem which we must meet. We should do more of this on our Cheyenne Wells plant. We have had an increase of our Cheyenne Wells plant in mind for some years. We can expand our work at Cheyenne Wells somewhat by hiring a little additional labor. But we are not yet in a position to carry on the investigations which the Great Plains region really needs.

We need to know the fundamentals of pasture cropping; legumes and their management; the control of soil blowing, which is in reality part of the problem of moisture control. We need to know a great deal about these problems in the very near future. Our work at Cheyenne Wells for several years has been along the line of experiment and practical demonstration in the operation of dry land farming.

We need to continue this type of work with some variations. But we need to add investigations in perennial and annual pastures. We need to find out whether perennial or annual pastures are more feasible, and why. We need to know the legume crops that are feasible, and methods for their management. The feeds which are easily and abundantly produced on plains are mostly carbonaceous. The efficiency of these carbonaceous foods could be multiplied many times with a proper mixture of legumes. It is up to us to find what legumes.

Arkansas Valley Nitrate Control.

In 1920, the gradual increase of soil nitrate, thru bacteriological processes, had become so serious a problem in the Arkansas Valley that some methods of control had to be adopted. Accordingly, in three sections, Agronomy, Bacteriology and Irrigation Investigations conducted co-operative experiments in 1921. Plots were laid out upon farms in the Arkansas Valley. Those farms were located all the way from Rocky Ford to Lamar. Owing to the heavy floods of early June in 1921, a great deal of the plat work was destroyed. Careful soil analyses, however, were made, from time to time, on farms thru the region and on the plats, so that all of the 1921 work was not lost.

In 1922, our Station Farm at Rocky Ford was laid out in plats, under definite schemes of cropping and soil treatments. In the spring of 1922, rooms were leased adjoining the Rocky Ford Laundry and a small chemical laboratory was established.

Mr. Justus C. Ward was employed to carry on the analytical work. Analyses of work upon our own farm and the plats upon the Sugar Company farm, and upon chosen farms, were taken at regular intervals during the summer.

The results of the various treatments have been sent you regularly in monthly reports. Those data will not be repeated here. Suffice to say, that certain general tendencies have been shown. The cultivated plats are all relatively high in nitrates. The plats on which small grains, pastures or clover and alfalfa have been grown, have been relatively low. All the samples have been preserved and determinations are being made of other salts.

Mr. Ward was originally employed on the basis of about six months' working time. It is very apparent, however, that if we are to successfully carry on this project, that it will be necessary to employ Mr. Ward, or some other chemist, on practically continuous time so we can follow the analytical results thru the year and have a complete history of the changes. It is also highly advisable to have analyses of other salts, to obtain information on their movement.

Early in the season of 1922, The Irrigation Investigations section was able to supply a Ford automobile for Mr. Ward's use. However, about the middle of the summer, the work of the Irrigation Section became so pressing it was necessary to recall this machine.

I strongly recommend the advisability and necessity of furnishing Mr. Ward transportation, so that he can quickly get from the field to the laboratory, and then he will be able to watch field conditions and the sampling.

Mr. Ward's primary responsibility, of course, is the analytical work. But he must come in contact and do some of the sampling himself, in order to be able to interpret the results. Accordingly, he must have reliable transportation.

The problem of accumulating nitrates, while biological, is more or less cumulative in effect. We believe that the problem can be controlled by agricultural methods. However, it will take some years to try the effects of these methods. The more intensively we can carry on the work, the quicker we can reach decisive results and close up the problem.

It is highly desirable, therefore, that we have added to the budget, sufficient funds to carry on the scheme above outlined. I think it should be our aim to carry the projects vigorously, until definite results and conclusions may be reached. And when they are reached, close out the project and start on some other line of endeavor.

Respectfully submitted,

ALVIN KEZER,
Agronomist.

REPORT OF BACTERIOLOGIST

To the Director:

I have the honor to submit herewith the annual report of the Bacteriological Section of the Experiment Station for the year 1922.

Our investigations during the year which is about to close have been centered around five projects. Three of these have been carried on the Adams fund, one on the Hatch and one on State funds. All of them are continuations of former studies and more or less progress has been made on each of them.

Our correspondence has contained many requests for information requiring the routine examination of a variety of materials, particularly farm waters.

The demand for our vinegar cultures has increased considerably over former years; these have been sent all over the U. S. and as far as New Zealand.

ADAMS FUND PROJECTS

Energy Studies.

This investigation was a continuation of that of the previous year wherein we endeavored to learn something of the immediate effect of different green manures on the activity of nitrogen-fixing and nitrifying bacteria in soil. The present work has dealt with the residual effect of these same manures on microbial activity. Six different green crops have been studied in this connection and their action has been observed over a period of six months.

Spoilage in Canned Vegetables.

Spoilage in corn canned by the cold-pack method has been given special attention. One case of botulism came under our observation and B. botulinus, type A, was isolated from the corn in question. So far as we have carried this investigation, B. aerofetidus, another spore forming anaerobe, appears to be responsible for much of the trouble.

Milkweed Poisoning.

Further studies of the active principle of the whorled milkweed *(Asclepias galicides)* indicate that the potency of the poison varies with the different stages of growth, and that the blossoms are poisonous as well as the leaves.

HATCH FUND PROJECTS

Bacterial Disease of the Wragg Cherry.

This disease was present in a mild form in the Arkansas Valley during the past season. We have recovered the same micro-organisms from affected leaves and fruit as in former years, and have endeavored to produce the disease by re-inoculating healthy trees, but for reasons which are not now apparent, ninety percent of the inoculations failed to take and the remaining ten percent were doubtful. In all probability, the successful artificial inoculation depends upon introducing the casual micro-organisms at a particular stage in the development of fruit and leaves, and this within very narrow limits.

Arkansas Valley Nitre Control.

Lack of time and circumstances over which we had no control have prevented further work on this project, however, it is our intention to renew the investigation next spring.

Natural Inoculation of Colorado Soil with Legume Bacteria.

STATE FUNDS

In co-operation with the Agronomy and Irrigation Sections we have continued our experiments with the American Beet Sugar Company at Rocky Ford. Fifty acres of land are included in this part of our investigation in which we are endeavoring to determine any relations which may exist between different crop rotations, chemical soil treatments, methods of cultivation, and the application of water on the one hand and the development of excessive nitrates on the other.

Early in the year our attention was called to the very urgent need for further investigation of the nitre question in connection with crops other than beets. As a result, a plan was formulated to carry out this work on the Experiment Station farm at Rocky Ford with Mr. P. K. Blinn in charge. The plan contemplates a five- to ten-year study of the effect of different crops, crop rotations and soil treatment upon the soil nitrates. Deeming it of the utmost importance to have frequent nitrate determinations made of the various plots and realizing the difficulties, technical and otherwise, in attempting to transport the numerous soil samples to Fort Collins, we have provided a small laboratory in the town of Rocky Ford for handling this chemical work with Mr. Justus C. Ward as chemist. In co-operation with Mr. Droge, County Agent, Mr. Ward has been following nitrate development on some thirty-five farms and orchards in the vicinity of La Junta, Rocky Ford, and Manzanola.

While the results of one year's work are manifestly altogether too inadequate to permit of definite recommendations for the handling of these soils, yet certain fundamental facts have been fairly well established, upon which, as a basis, we shall be able to plan our future experiments more intelligently.

In the laboratory at Fort Collins we have followed the development of the nitrogen fixing bacteria and the increase in the total nitrogen in two of the plots on the Experiment Station Farm at Rocky Ford and on seven of the outlying farms. In every case we find the soils heavily stocked with Azotobacter chroococcum and each has shown a notable increase in total nitrogen on incubation.

Mr. Ward has been seriously handicapped in the collection of soil samples the past season by the lack of adequate transportation facilities. Having no conveyance of his own, he has been forced to depend upon others to take him about while collecting samples. If possible, some provision should be made to furnish him with an automobile for next year.

The results of this season's work have shown the need of continuing the nitrate determinations throughout the year rather than conducting them during the growing period only. Under the present arrangement, we have had to discontinue the analyses at a time when the nitrates were beginning to increase after the crops had been removed, whereas we should have been able to follow their course

through the winter and into the next growing season. We know practically nothing about nitrate formation under winter conditions, and it is possible that analyses made at this time would cast further light upon the best methods of handling the soil in the spring. To this end it would be very desirable to have Mr. Ward available for chemical work the entire twelve months.

In all of the laboratory work I have been assisted by Miss Mildred Brown, whose efficient service I take great pleasure in acknowledging.

We are very grateful for the increased floor space in our main laboratory which has enabled us to work to much greater advantage during the past three months. The addition of the present quarters of the seed laboratory to our floor space will afford appreciable relief to the congestion which we have felt for the past ten years.

Respectfully submitted,
WALTER G. SACKETT,
Bacteriologist.

REPORT OF THE BOTANIST

To the Director:

Permit me to submit the following brief report on the investigational work of the Botany Section for the fiscal year ending November 30, 1922.

Work on the Range Improvement Project has been continued along the lines outlined a year or so ago. Quite intensive density studies have been made by the clipped quadrant method. A complete series of soil moisture determinations have been made during the entire season. The ground cover shows quite a noticeable change in the three pastures under the different methods of grazing.

Under the project, Microscopy of Stock Poisoning Plants, work is being continued. The histology of the principal stock poisoning plants is being worked out. Some of this material is already in manuscript form.

The work on Fungus Disease of Sunflower has been discontinued on account of lack of available material. The presence of the disease was not reported for Colorado this year. We have been unsuccessful in our attempt to inoculate plants with the supposed causal organism which we have in culture.

In our bean studies on the Biologic Specialization of Parasitic Fungus, we have grown about 150 varieties of beans, both at the Experiment Station gardens at Fort Collins and at Rocky Ford. A marked variation in the susceptibility to rust of the different varieties of beans was noted.

The Hard Seed in Alfalfa project has shown quite definite results. Data obtained from laboratory tests and field trials indicate that hard seeds are the result of environmental factors and is not due to hereditary characters.

In the Disease Survey work the following diseases have received special attention: A celery blight which is due to an unidentified organism; the peach blight which is especially prevalent on the West-

ern Slope and the cereal rusts and smuts. An extensive survey of the grain growing section of Colorado was made during the growing season for rusts and smuts.

During the year practically the entire State has been resurveyed for the presence of the common barberry. The State is now practically free from this bush.

A study of Colorado rubber-producing plants has been made during the year. Several species of Rabbit-brush have been especially investigated. Numerous analyses as to rubber contents have been made for different varieties which were collected from various parts of Colorado, as well as from plants grown in the Experiment Station gardens.

The analysis and inspectional work of the Seed Laboratory has been carried out very satisfactorily during the year under the efficient supervision of Miss Anna M. Lute. The hearty cooperation of the farmers and seedsmen in the State shows their appreciation of the work done by the Laboratory.

Respectfully submitted,
A. K. PEITERSEN,
Botanist.

REPORT OF ANIMAL INVESTIGATIONS SECTION

To the Director:

Following is the annual report of the Animal Investigations Section.

Range Management.

(In co-operation with Botany Section).

This work was carried on during its second year. Six to ten years' work will be needed from which to draw conclusions. A change in the number of cattle grazed in one pasture was made as a result of the previous year's work. The object of the experiment is to determine best grazing methods on unforested, short-grass range.

Rations for Fattening Steers.

Some of the comparisons made are as follows:

Pasturing sugar-beet tops in field as against feeding them at corral or making silage of them.

Dried beet pulp replacing part of grain ration.

Sunflower silage compared with corn silage and with wet beet pulp.

Irrigated Pastures for Dairy Cows.

An abnormally dry season forced us to withdraw the cattle from pasture for a time.

Summer Fallow Experiment at Akron.

This experiment continues the investigation to find the fitness of sheep for dry land farms. The year's work showed the necessity of silage or some other addition to dry forage taken from the rotation system, as the ewes did not come through the winter in good shape, nor give milk enough for their lambs. Silage is being provided for the coming winter.

Winter Maintenance of Breeding Ewes.

Another winter's work was completed. Grain will be added to the rations the coming winter.

In addition to the projects listed above, all of which are continuing projects, we expect to carry on a Ration Experiment with Lambs.

Respectfully submitted,
GEO. E. MORTON,
Animal Husbandman.

REPORT OF THE CHEMIST

To the Director:

The Chemical Section of the Station was very unfortunate in that its work room and some vital records were destroyed by fire in December, 1921. Our most serious loss was the records, for they represented the most essential portions of our work for the season of 1921.

During the season of 1922 we have prosecuted the study of the Potato Project as best we could. We extended the scope of our experiment a little in accordance with the results of our previous work. This extension was made to make our soil study a little more conclusive. We have studied the changes in the composition of the potato vines throughout the season, and have put the samples of tubers in cold storage and will analyze them as soon as our quarters become available. Of course the inconveniences and necessary delays consequent to the rebuilding operations are regrettable and render it desirable that we should do our season's work over from the beginning. The work is not by any means wholly lost; on the contrary we shall get much profit from it. This profit is not, perhaps, in the form that we could wish or indeed expected. In so far as it was not anticipated, it is a little surprising, but our investigation has demonstrated an unexpectedly close relation between surface moisture, rainfall, and the development of the nitrates. This season, 1922, we endeavored to ascertain the effect of fallow cultivation upon this process compared with that of cropping to potatoes. We hope that our rainfall during the season of 1923 may be more favorable to our project.

We have continued the study of the soil atmosphere; i. e., the determination of the carbonic acid in it under cropping to clover and grasses, also fallow.

We have issued one bulletin, No. 277, during the year, entitled Fixation of Nitrogen in Colorado Soils; Occurrence of Nitrates on Rocks.

Our monetary loss, due to the fire and rebuilding, has been very considerable and many facilities have still to be replaced.

We do not wish to take up any new projects but to continue the old ones.

Respectfully submitted,
WM. P. HEADDEN,
Chemist.

REPORT OF THE ENTOMOLOGIST

To the Director:

I am presenting herewith my report of work carried on in the Entomology Section of the Experiment Station during the fiscal year closing June 30, 1922. The projects upon which work has been carried are identical with those of one year ago, and the personnel has not changed during the year.

Brief statements concerning the work done under each project are given below:

Plant-Louse Investigations:

Miss M. A. Palmer and the writer have continued work on this project during the year, giving special attention to the aphids attacking conifers in the State, and especially those belonging to the genus Lachnus. A paper covering this subject is well under way and should be ready for publication in the near future.

Life Habits of the Syrphus Flies:

This project is under the direction of Mr. C. R. Jones. With the publication of Bulletin 269 entitled "A Contribution to our Knowledge of the Syrphidae of Colorado," the active work on this project may be regarded as completed. Any further work that may be done in this line will be taken up under the last project mentioned in this report.

Ants of Colorado in Their Relation to Plant Lice:

This project is also under the direction of Professor Jones. A considerable number of ants visiting different species of plant lice have been collected during the year and the data on them taken. The work upon this project is necessarily continuous over a considerable period of time. It will probably require a year or more before results on this project can be put in bulletin form.

Control of Insects by Egg Treatment:

The writer has added some data to that collected in former years to determine the efficiency of different applications for the control of insects in the egg stage, most attention being given to the eggs of the *Aphididae.*

Codling Moth Studies:

Considerable work has been done on our codling moth studies during the past year, especially in the region about Grand Junction in Mesa County and in eastern Delta County, the work being under the general direction of Mr. George M. List and immediately in charge of Mr. J. H. Newton, who has been assisted in this work by Mr. J. L. Hamilton. The work on collecting the life-history data at Grand Junction was in the immediate charge of Mr. William Yetter, of the State Entomologist's office. Mr. Newton has also been in charge of the Alfalfa Weevil Control work in Delta County, where he has had the assistance of Mr. Hamilton during the summer. For a full account on this work, see the report of the State Entomologist. The experi-

ments carried on in Delta County for the control of the codling moth during the past summer met with excellent results.

Grasshopper Control:

Considerable work has been done on this project, which has been in immediate charge of Mr. C. L. Corkins. Mr. Corkins has been working with crude arsenic as an active poison in the arsenic bran mash and has been meeting with very good results, even in the control of the Mormon cricket—*Anabrus simplex*. Indications of rather serious grasshopper troubles for the summer of 1922 are already evident and plans have been made to supply concentrated arsenic bran-mash to the farmers of the State in small quantities at cost. We believe in this way we can do real service to the farmers who are working to destroy the grasshoppers upon their own lands, and who would not go to the trouble of purchasing and mixing the necessary materials.

General Insect Investigations:

The object of this project is to enable the Entomological Section to take care of unexpected outbreaks of insect pests in the State. During the year numerous complaints have come to the Station concerning a worm that has destroyed large acreages of wheat, oats, barley and rye, especially in the dry farming sections. The worms sent in for determination have nearly all been false-wire worms probably belonging to the genus *Eleodes*. If the injuries from these worms continue, it will be necessary to take up a rather extensive investigation in the hope of getting data that will lead to economic methods of control.

Work with the bean beetle, in charge of Mr. George M. List, is continued. Good results have been obtained from the use of arsenate of lead and arsenite of zinc for this control, and Bulletin 271 by Mr. List, on The Mexican Bean-Beetle, giving a very full account of the life history and control methods of this insect in Colorado, has been published.

The numerous complaints coming to this office of scabby potatoes, especially in the Greeley District, make it important to do some life-history work on the common flea-bettles so abundant upon the potato plants in the potato-growing sections of the State. It is estimated that not less than $100,000 were lost to the potato growers in the Greeley District alone last year, because of the injuries done by the flea-beetles to the tubers. Life-history work on these beetles has already been undertaken.

Brief mention of a considerable number of the common insect pests of the State will be found in the reports of the State Entomologist in recent years.

Respectfully submitted,
C. P. GILLETTE,
Entomologist.

REPORT OF THE FORESTER

To the Director:

I herewith submit the annual report of the section of Forestry:

Practically no work has been done upon any project since the closing of the regular College courses last June. Our forestry sum-

mer courses in field-camp work started soon after Commencement and took me away from the campus until July.

No progress has been made in completing the report on the timber decay project. This report involves the making of numerous graphs following the checking over of the data most recently secured. In view of the present conditions I do not see my way clear to undertake work on a new project.

Respectfully submitted,
B. O. LONGYEAR,
Forestry Investigations.

REPORT OF THE HOME ECONOMICS SECTION

To the Director:

Continuing our research during 1921-22 on The Cooking Quality of Colorado Potatoes, we obtained tubers, both mature and immature, as far as possible, of the following varieties:

(a) Burbank, Cobbler, Blue Victor, Brown Beauty, and Peachblow from the San Luis Valley.

(b) Burbank, Cobbler, Ohio, Peachblow, Pearl, Rural and Downing from the Greeley district.

(c) Burbank (from several growers) and Gold Coin from Carbondale.

(d) Ohio, Peachblow, Pearl, Rural and Late Rose from the Briggsdale district. These last were entirely unirrigated and of like maturity.

(e) In addition to the types enumerated above, we also succeeded in obtaining from the Greeley district tubers of the Pearl and Rural types, each being represented by samples of 3-, 5- and 7- irrigations.

All these different types of potatoes from all these districts were subjected to rigorous, individual, quantitative analyses for moisture, starch, nitrogen and ash; these analyses were also extended, in a number of types, to the cooked as well as to the corresponding raw tubers.

To confirm or refute the interesting average results obtained from the analyses of the 3-, 5- and 7- irrigation Pearls and Rurals of 1921 from the Greeley district, it is expected to have more of the same types similarly raised in 1922 for further analyses this year.

Also during the year 1922-23, it is expected to carry out scientific experiments on the bread-making qualities of Colorado flours. In the process of this latter work it is hoped also to make some investigation of the chemical changes which occur in these flours during the bread-making processes.

The laboratory equipment of this section has been added to during the past year, as in other years, with the hope finally to make this a very completely fitted-up research food laboratory.

To do scientific research and economize on the time of the investigator, a library fully equipped with scientific periodical literature, both current and past, not only in English but in other languages as well, is a necessity. Careful study of what has already been accomplished scientifically, in a given field is the most secure basis on which

an investigator can proceed along the unknown paths he must travel. Lack of such complete library facilities has been a serious handicap in the experience of the writer.

We are fortunate in securing Miss Vera F. Warren, '22, who acted as part-time assistant during the latter half of last year, to act as full-time laboratory assistant during 1922-23.

Respectfully submitted,
N. E. GOLDTHWAITE,
Home Economics Investigations.

REPORT OF THE HORTICULTURIST

To the Director:

I beg to submit the following brief report on the work in the Horticultural Section during the past year.

One project, the Study of Degeneration of Potato Seed in the State, has been completed and the results are ready for publication. This project has been in progress for the last four years. It is demonstrated that seed selection is necessary to maintain a high yield. It is also shown that knotty potatoes are not necessarily poor seed; that the shape of ill-grown potatoes resulting from improper cultivation and irrigation is not transmitted through the seed and does not show in the following crop. The results also show that potatoes grown in our high mountain sections and in the mountain valley do not run out, the decline in yield being due to disease and to the planting of small and inferior seed.

The project, Growing Hardy Apples in Northern Colorado is still in progress. So far indications are that only the hardier varieties of apples can be grown successfully on the open plains; that the hardiness of any variety is not dependent upon the hardiness of the stock, but upon the ability of the part above ground to withstand our dry winters.

The project on Seed Potatoes in High Altitudes is continued. There is one problem in connection with this project that is vitally important, namely, the storing of seed potatoes. As a rule the growers have unsuitable storage space and the vitality of the stored seed is greatly injured during the winter. This particular project has been more or less tied up with the project on degeneration of potatoes in the State. It is hoped that this project can be closed by another season.

The project on Fruit Growing in High Altitudes is progressing favorably. This project is centered at Fort Lewis. The past season was rather favorable and some of the different fruits produced fair crops. This project should be continued for an indefinite period, but a report on the work should be given within the next year.

The new project on Growing of Head Lettuce in High Altitudes, started last spring, is showing considerable promise. The head lettuce industry is in its infancy but promises to be of considerable economic importance. Last year 4600 acres were planted to head lettuce. The normal yield should have given us from 2500 to 3000 carloads. The season was, on the whole, unfavorable, being too hot and dry, resulting

in a majority of the plants going to seed without developing heads. A large share of the failure should, however, be charged to the growers. In a new industry which requires considerable attention to details in the matter of culture, one would naturally expect failures, but hardly to the extent that was experienced this year. From our experimental work it was apparent that the failure could have been, in the main, averted by giving greater care to cultivation and irrigation. From about one acre in the experimental plots we harvested and sold a little over a carload of head lettuce, while from the adjoining fields not a head was harvested. The main problems studied in this project are the effect of cultivation and irrigation upon the heading of plants; the quality of seed and its ability to produce good heads instead of seed stock; the diseases that are present in the field, and the possibilities of seed production in high altitudes.

The tomato project has been continued and with the data obtained this year we feel justified in drawing certain conclusions which will be embodied in a bulletin.

Publications

During the year the following bulletins have been published:
Fruit Survey of Northeastern Colorado.
Fruit Survey of the Arkansas Valley.
Fruit Survey of the Gunnison and Uncompahgre Valley.
Fruit Survey of Southwestern Colorado.

Respectfully submitted,
E. P. SANDSTEN,
Horticulturist.

REPORT OF IRRIGATION AND DRAINAGE INVESTIGATIONS SECTION

To the Director:

During the past fiscal year ending June 30, 1922, the work in this section has been divided among the following various projects:

Under the Adams Fund two projects have been carried, viz., Current Meters and the Venturi Flume. The work on the Current Meter project consisted first of careful study of the various types of instruments in use, and, further, the actual use of such instruments under conditions where the measurements determined by the meters could be carefully checked against a known discharge as a means of comparison. This latter part of the study on Current Meters was conducted at the Bellvue Laboratory where discharges of approximately 100 second-feet and less were used in the study of comparisons. It is not thought that a great deal more work will be necessary on this project, and at present preliminary reports have been issued covering parts of this study.

During the past year no work has been done on the Venturi Flume. This project deserves further consideration, and because of our previous studies it is now apparent that the original design of

this measuring device was not projected on the most practical lines, and further experimentation should be done to work out the most efficient design which will give accurate and dependable results. One other feature of the Venturi Flume is the extremely small difference in head, sometimes resulting in conditions of submergence. Much more dependable results in operation can be obtained if the difference in head can be made greater. Because of recent work on another device, it now seems possible to adapt this principle to the Venturi flume, which will be a marked improvement. Bulletin 265 has been issued covering the Venturi flume studies.

The two principal projects being carried under the Hatch Fund are, Evaporation Experiment and the Measurement of Water as applied to Irrigation. The evaporation studies have now been carried three years under careful observation. The first year the work was conducted at the hydraulic laboratory under still air conditions. The following year the apparatus was installed outside of the building under what might be considered semi-exposed conditions. The past year two sets of apparatus have been in use, one installed in the hydraulic laboratory where the effect of wind could be observed, while the other apparatus was installed outside the laboratory under fully exposed conditions. The results of the past year have not been completely computed and the effect of the various influencing factors cannot, at this time, be stated. However, in the rough plotting of the data it is observed that a very consistent relation exists and it is expected that a definite knowledge will be obtained of the relation existing between the rate of evaporation and the influencing factors.

The Measurement of Water studies consist of several parts, two of which have been practically completed. The calibration of the Farmmers' Short Box Measuring Flume has been completed and a report prepared for publication. The work on the study of water stage recording instruments has been finished and a report is now under preparation. Work was started on the Herschel hollow-crest weir which is part of the project on the Measurement of Water.

Under State funds the projects on Meteorology, South Platte Investigation and the Arkansas Valley Project have been carried during the past fiscal year. The work in Meteorology has been a continuation of that in past years, consisting in the observation of meteorological conditions twice daily, the posting of weather bulletins each day and the publishing in local papers of the weather report.

The work of the South Platte Investigation was concluded in November, 1920, and the results of this investigation have been presented in the form of a bulletin and submitted to the Station for publication.

During the spring of 1921 a co-operative investigation was started in the Arkansas Valley for the purpose of studying agricultural conditions in that section of the State. The results of past years would indicate that the yield and quality of the common field crops are lower than they should be, and under the co-operative agreement of the Agronomy, Bacteriology, and Chemistry Sections, and the American Beet Sugar Company, a concerted effort has been put forth to determine the various causes for this apparent depletion in yield of farm crops. During the month of April, 1922, fifteen farms were selected

between Avondale and Lamar where special arrangements were made to measure the water used on the farm, and thru the assistance and co-operation of the farmers the record of yield, crops irrigated and other necessary data will be collected sufficient to determine the duty of water for the various crops common to the Arkansas Valley. Approximately 1800 acres are under observation, and at the experimental plots of the American Beet Sugar Company at Rocky Ford 75 acres have been set aside for our studies, this area being largely laid out in one-acre plots where wheat, corn, alfalfa, and sugar beets were planted under duplicate conditions with treatment of green fertilizer, sulphur, and with varying amounts of irrigation.

One phase of the work of this section has been the attention given to drainage matters in the State. The Drainage Law passed in 1911 has been the means of the reclamation of thousands of acres of seeped lands which were once highly productive. This law permits the bonding of the district to provide funds for the construction of suitable drainage systems, and, for the past few years, marked success has been obtained in the lower Arkansas Valley, the San Luis Valley and other parts of the State. This section has assisted in the organization of a number of these drainage districts, especially near Lamar, and acted as a member of the assessing board for the purpose of determining a just and equitable rate of tax on the land. Approximately 50,000 acres have been included in drainage districts in the vicinity of Lamar, and of this area possibly 90 or 95 percent has been successfully reclaimed.

Of the projects which will be under consideration during the fiscal year ending June 30, 1923, the following will be given attention:

Current Meters, Evaporation Experiment, Meteorology, Measurement of Water as Applied to Irrigation, Arkansas Valley Project, and general work thruout the State pertaining to special assignments, such as drainage, giving advice and assistance to farmers in their measurement of water problems, and the investigation of conditions having to do with general irrigation conditions of the State.

At Bellvue there is established a field laboratory at the headworks of the Jackson Ditch. This laboratory was primarily used for the purpose of making further studies of the Venturi flume, but it was so designed that it could be used for general purposes. Some of the work on the Current Meter project was carried on here, and because of its cheapness in operation and the large quantities of water available, it seems highly desirable to make further improvements there by which this could be made a permanent laboratory. Nowhere in the West is there a laboratory having available so much water as at Bellvue, and it is believed that could this laboratory be established on a permanent basis it would be the means of assisting in the solution of problems, not only arising in our own work, but coming to us from various states of the irrigated west. The expense necessary in putting this laboratory in first-class condition is relatively small, since at the present time a great deal of permanent work has already been done. Because of the very limited flow in our hydraulic laboratory here, this field laboratory is highly desirable.

During June, improvements were made at the hydraulic laboratory consisting of replacing the old 16-inch steel pipe line from the pumps to the upper reservoir with a new steel pipe of similar dimension but of thicker gauge. There was also provided a by-pass from tank Z to the auxiliary reservoir, making the operation of the laboratory considerably more efficient. With these improvements the laboratory is in good condition.

Respectfully submitted,
R. L. PARSHALL,
Senior Irrigation Engineer.

REPORT OF MARKETING INVESTIGATIONS SECTION

To the Director:

The Marketing Investigations project of the Colorado Agricultural Experiment Station has been conducted in co-operation with the Colorado Division of Marketing since July 1, 1921.

This co-operation has afforded the two joint employees excellent opportunities to investigate the marketing conditions of all perishable and semi-perishable fruit and vegetable products shipped in Colorado, because of their close association with the growing, harvesting, storing and shipping of these products.

During the past year several cases were found where insects or diseases were causing considerable loss to growers or shippers, by affecting the yield, keeping qualities or appearance of some of the most important crops. These facts were brought to the attention of the proper authorities, resulting in investigations relative to the control of the various problems. The most important of these are:

Flea Beetle Injury of Potatoes.

Occurring principally in Weld County and eastern Larimer County, there was a serious infestation of small black beetles, known as Flea-beetles. These insects attack both the foliage and tubers of potatoes, causing a decided loss in yield, a waste in preparation for table use, and a rough appearance. It is estimated that the annual loss caused by this pest to growers in this district amounts to over $100,000.

Storage Disease of Potatoes.

The growers of the San Luis Valley district suffered severe losses the past season because of a peculiar storage disease in their potatoes. Specimens affected with this disease were sent to prominent plant pathologists throughout the United States resulting in the identification in these lesions of the disease organisms of various Fusarium species and Alternaria, occurring after mechanical injuries.

Head Lettuce Problems.

The head lettuce growers of the State were able to market only approximately fifteen percent of their crop during the 1921 season, because of various lettuce diseases and lack of proper head formation. This fact was called to the attention of the Director of the Experiment

Station and head of the Department of Horticulture of the Agricultural College, who inaugurated experimental investigations of culture problems during the 1922 season.

Thrips in Cabbage.

Cabbage growers throughout the State found it necessary to cull a small percentage of their crop because of the presence of "Thrip injury." Cabbage so affected has discolored spots on the leaves within the heads, which cause a bad, unsightly appearance, and injure the keeping quality.

Codling Moth.

The tabulation of the inspection data on apples verifies the fact that Colorado must continue to increase her efforts to control the Codling Moth if she wishes to retain her present high position among the fruit-producing states.

Statistics have been compiled from data obtained from inspection reports made by the Colorado Division of Marketing during the year ending July 1, 1922. This tabulation shows the number of cars of produce inspected by products and by districts, and the number of cars of each product which met the requirements of the first grade, and the number of cars which failed to make this grade, for each producing district in the State. These figures are very significant, not only in connection with marketing, but in their relation to problems of production.

Respectfully submitted,
W. F. ALLEWELT,
Director, Division of Marketing.

REPORT OF THE PATHOLOGIST

To the Director:

Following is a list of the projects on which this Section has been engaged during the past year.

Sheep Losses in Feedlots.
- a. *Hemorrhagic Septicemia*
- b. San Luis Valley Losses.
- c. *Ictero Hematuria*

Contagious Abortion.

For the coming year we desire to take up our new project, namely, Forage Poisoning in Horses, provided there is material available for the investigation.

Hemorrhagic Septicemia.

This disease has been less prevalent during the past year than in some of the years previous, only a few confirmed outbreaks having been studied. The routine work has consisted of experiments with a view to determining the value of vaccines for this condition. Our work seemed to indicate that a higher degree of immunity could be obtained in sheep by the use of a vaccine made from a live organism. We have also done considerable work on determining types in the hemorrhagic septicemia group of organisms.

San Luis Valley Sheep Losses.

A feeding experiment in which 500 lambs were used, was carried on in the San Luis Valley under the immediate supervision of Dr. Floyd Cross. The object was to determine whether a safe method of feeding peas could be devised. The lambs were divided into five lots and were fed in various ways. The results of the experiment were not conclusive and the experiment is being repeated this year.

Ictero Hematuria.

Two more outbreaks of this disease were studied during the year, but nothing definite has been determined as to the cause. The outbreaks appear to come in September, October and November. No ticks have been found on the sheep at this time. No parasites have been demonstrated within the red blood corpuscles. The sheep are all more than one year old and come from a mountainous district. While the symptoms of this disease appear to harmonize with those of the disease described in Roumania many years ago, yet the fact that the disease cannot artificially be transmitted, that no definite association with ticks has been proved and that no parasites have been found in the red corpuscles, would seem to indicate that this is a separate and distinct disease. It is our purpose to carry on some field experiments in Routt County during the season of 1923.

Contagious Abortion.

During the year, we added another range herd to those we have under observation, to determine the value of live organism vaccine. This herd showed a high percentage of abortions, and also a considerable percentage of reactions to the agglutination test. It is proposed to carry on these observations for a number of years, in order to determine the feasibility of vaccinating range animals with the live organism.

Blood samples from a considerable number of range animals in the mountainous district were drawn and tested by means of the agglutination test. While some herds showed a considerable percentage of reactors, the indication is that a considerable proportion of the abortions seen in these herds may be due to some factor other than the *Bang bacillus.*

A considerable proportion of time is given to routine laboratory work in the diagnosis of various diseases. While this is tied up to no definite project, it seems to be very desirable, not only from the standpoint of general helpfulness to the livestock industry, but from the fact that it keeps us in touch with the prevalence of disease. Interest in poultry diseases seems to be increasing materially, judging from the number of specimens which we receive.

Fortunately, no changes either in the staff or in the general methods of procedure have been necessary during the past year, and no changes are contemplated during the ensuing year.

Respectfully submitted,

I. E. NEWSOM,
Pathologist.

REPORT OF THE VETERINARIAN

To the Director:

The work of the veterinarian is confined to the one rather comprehensive project, Animal Diseases, under the State fund.

From the standpoint of health, livestock conditions are quite satisfactory at this time. There is a freedom from epizootics, which is rather exceptional for this State and at this season of the year. There are a few herds of hogs affected with cholera, but they are under close observation and there is little danger of the disease spreading to any great extent. We have a fairly efficient organization in Colorado for the control of animal diseases. There are the usual reports of enzootic and sporadic diseases of more or less consequence.

We have a large correspondence relating to animal diseases and there are many calls upon our laboratories for diagnosis. Several visits have been made within the State by special request of farmers and stockmen.

During the present Government fiscal year, permission is asked to continue the project on Animal Diseases, and to add to this a special project on Paralysis of Swine.

Respectfully submitted,
GEO. H. GLOVER,
Veterinarian.

REPORT OF ENGINEERING DIVISION

To the Director:

I am submitting herewith reports from the Civil Engineering and Mechanical Engineering Sections of the Experiment Station. These reports show the activities of the Departments for the past year and briefly outline the work for the coming year.

Respectfully submitted,
LD CRAIN,
Chairman of Division and Vice-Director.

REPORT OF THE CIVIL AND IRRIGATION ENGINEERING DEPARTMENT

To the Chairman, Engineering Division:

The experimental work in this department is carried on by Mr. O. V. Adams, who is doing experimental work upon Road Materials of Colorado and is working in co-operation with the State Highway Department of Colorado.

He will submit reports covering his work for the past year.

Respectfully submitted,
E. B. HOUSE,
Civil and Irrigation Engineer.

REPORT OF MECHANICAL ENGINEER

To the Chairman, Engineering Division:

The projects which have received attention during the past year in the Department of Mechanical Engineering are: First, Heat Transmission of Commercial Wallboard; and secondly, Methods of Handling Hay in Colorado. Both projects have been completed and a popular bulletin on each project is under preparation.

The above-mentioned projects have been investigated by Mr. G. A. Cumings, who is spending half of his time on investigational work in this department.

The approved project which will receive attention during the present fiscal year will be that of: Treatment of Alkali and Other Waters for Domestic Use. Another project upon which we would like to do investigational work is that of Conservation of Fuel at the Time of Burning.

The projects receiving attention during the present fiscal year will be under the immediate supervision of Mr. Cumings, who will devote his entire time to that work.

Respectfully submitted,
LD CRAIN,
Professor Mechanical Engineering.

REPORT OF THE CIVIL ENGINEERING SECTION

To the Chairman, Engineering Division:

In this section the only project carried during the year has been that on Road Materials of the State.

The co-operative agreement between the State Highway Department and this section, made in 1921, has, by mutual understanding, remained in force during the season of 1922. The organization has consisted of a field party of three men, the foreman and one helper being furnished by the Highway Department, and one helper by this section. On account of increased field forces one assistant has been employed in the laboratory on full time since June 1, 1922.

During the period covered by this report the laboratory has tested materials from one hundred and ninety-seven deposits located by the field party. A total of two hundred and sixty-six samples have been tested. The field party began work early in May and is still out at this time. From July 5 to October 5 the party was on the western slope. Materials have been located on two thousand one hundred and fifty-seven miles of State Highway in thirty-nine counties. This is approximately sixty-one and six-tenths percent of the total mileage of State highways.

A progress report of the work done in this section is now in process of preparation. It is planned to include in this report all samples tested up to December 1, 1922.

The investigation to determine the effect of beet pulp upon mortar and concrete is still in progress.

The work to date has been done almost entirely upon our system of State Highways. Approximately one thousand three hundred and forty-three miles of these remain to be covered. No definite work has been done on the location of materials for our secondary highway system, except as the deposits already located may be made to serve in the improvement of these roads.

Respectfully submitted,
O. V. ADAMS,
Testing Engineer.

REPORT OF THE EDITOR OF PUBLICATIONS

To the Director:

Herewith is a brief report of the activities of this office in behalf of the Experiment Station for the year ending November 30, 1922.

The same general policy of publicity for the Station thru timely news articles, regarding work of the individual workers and their projects, has been carried out, not in as large a way as desired, but with good results.

Perhaps the greatest item of publicity for the Station during the past year was that for Feeders' Day. In co-operation with Mr. Maynard, of the Animal Investigations Section, this office placed good stories in a large percentage of the State papers regarding the work done under this project.

Considerable time was spent in gathering and writing the brief on the Experiment Station for the biennial report of the State Board of Agriculture to the General Assembly. Illustrations in the brief were also prepared by this office.

Following is the list of bulletins, edition and pages of each, which have been published thru this office for the Station during the past year:

PUBLICATIONS FOR THE FISCAL YEAR 1921-'22

Bulletin Number	Title and Author	Pages	Edition
269	A Contribution to Our Knowledge of the Syrphidae in Colorado—C. R. Jones	72	2,000
270	Sheep Losses in Colorado Feedlots—I. E. Newsom	25	2,500

271	The Mexican Bean-Beetle—Geo. M. List	58	3,000
272	Orchard Survey of Northeastern Colorado—E. P. Sandsten and C. M. Tompkins	28	2,500
273	Orchard Survey of the Arkansas Valley—E. P. Sandsten and C. M. Tompkins	24	2,500
274	Orchard Survey of Southwestern Colorado—E. P. Sandsten and C. M. Tompkins	21	2,000
275	Orchard Survey of Western Colorado —E. P. Sandsten and C. M. Tompkins	45	2,500
276	The Home Vegetable Garden—R. A. McGinty	36	5,000
277	The Occurrence of Nitrates on Rocks—Wm. P. Headden	48	2,000
	Thirty-fourth Annual Report of the Colorado Experiment Station	43	1,500
	Totals	400	25,500

Respectfully submitted,

I. G. KINGHORN,

Editor of Publications.