

SCIENCE

THE STATE AGRICULTURAL COLLEGE
OF COLORADO

The Thirty-Seventh Annual Report

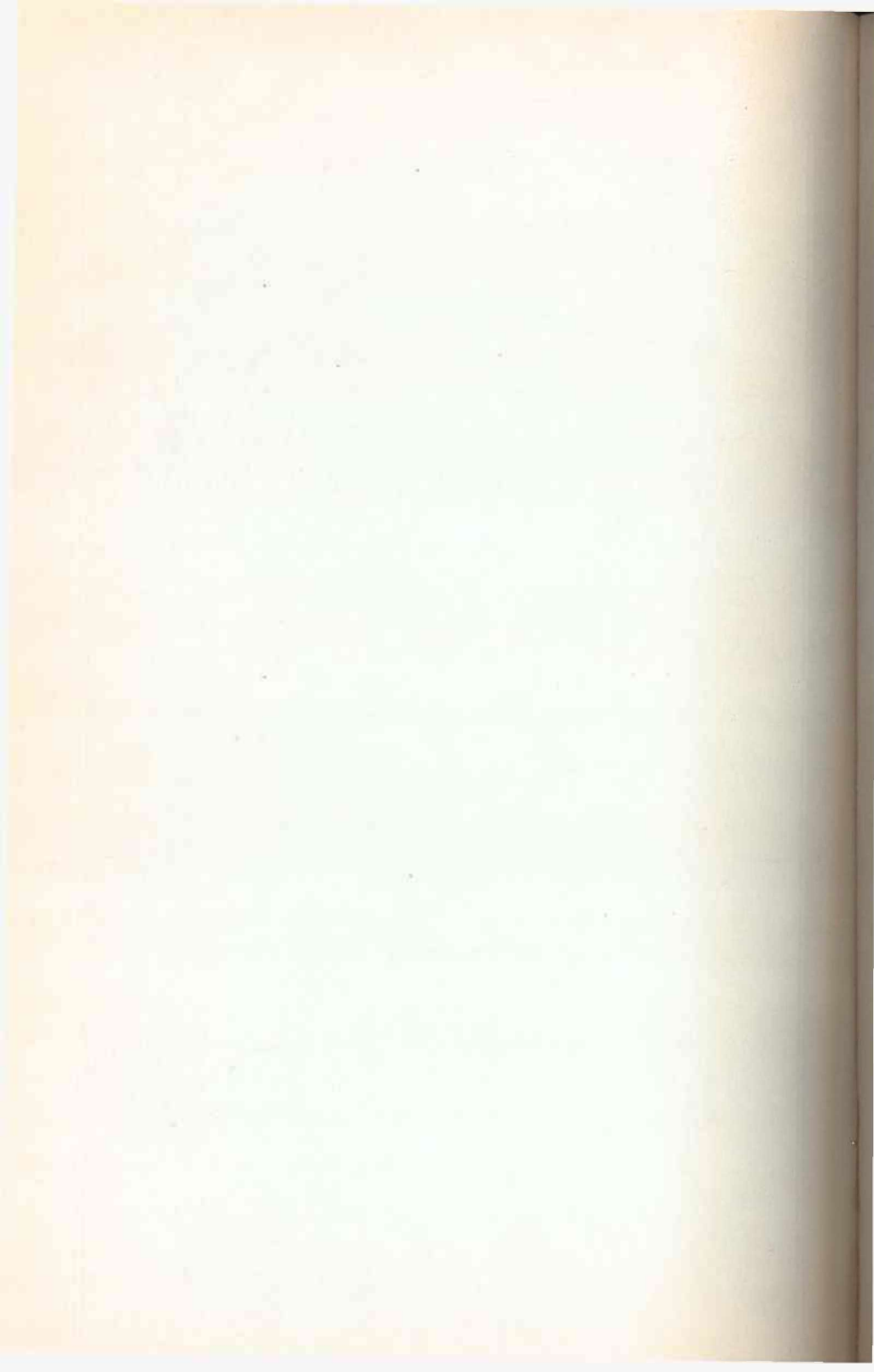
OF

The Colorado Agricultural Experiment
Station



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FOR THE YEAR 1924



THE STATE AGRICULTURAL COLLEGE
OF COLORADO

The Thirty-Seventh Annual Report

OF

The Colorado Agricultural Experiment
Station



FOR THE YEAR 1924

The Colorado Agricultural College

FORT COLLINS, COLORADO

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G. A. CUMINGS, B. S.,	Assistant in Mechanical Engineering

(1) Died February 23, 1924.

(2) Appointed September 1, 1924.

(3) On leave.

(4) Deceased July 1, 1924.

LETTER OF TRANSMITTAL

To His Excellency, William E. Sweet, 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-Seventh Annual Report of the Colorado Agricultural Experiment Station for the Federal fiscal year, July 1, 1923 to June 30, 1924.

The report contains a full financial statement of all receipts and disbursements, and brief summaries of the work done by those in charge of the different sections or departments of the Experiment Station. There is also given a full list of projects upon which work has been done during the year.

C. P. GILLETTE,
Director.

Agricultural Experiment Station
Fort Collins, Colorado.
December 1, 1924.

**FINANCIAL REPORT OF THE COLORADO AGRICULTURAL EXPERIMENT STATION
FOR THE FISCAL YEAR ENDING JUNE 30, 1924**

DR.	Hatch Fund	Adams Fund	State Mill Levy Fund	Special Fund	Pure Seed Fund App'n.	Special App'ns.	Total Funds
Balance, July 1, 1923 .....	.....	.....	\$ 10,688.15	\$ 9,793.39	\$8,470.18		\$ 28,951.72
From the Treasurer of the United as per appropriation for the fiscal year ending June 30, 1924, 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 Special appropriation for stations at Greeley and Cheyenne Wells			103,540.92	33,332.75		\$14,000.00*	136,873.67
	\$15,000.00	\$15,000.00	\$114,229.07	\$43,126.14	\$8,470.18	\$14,000.00	\$209,825.39

CR.	Hatch Fund	Adams Fund	State Mill Levy Fund	Special Fund	Pure Seed Fund App'n.	Special App'ns.	Total Funds
To Salaries	13,894.25	13,994.33	62,444.09	.....	3,930.31	.....	94,262.98
Labor	102.64	51.90	10,781.44	1,288.90	1,510.78	1,223.17	14,958.83
Stationery and office supplies	31.45	.....	1,087.42	112.61	192.17	8.00	1,431.65
Scientific supplies, consumable ..	140.99	142.75	799.69	3,844.87	108.31	.....	5,036.61
Feeding stuffs	44.79	5.97	2,575.84	5,408.59	.....	.....	8,035.19
Sundry supplies	125.37	22.40	1,427.20	433.41	102.65	74.21	2,185.24
Fertilizers .....	.....	.....	49.21	.....	.....	.....	49.21
Communication service	18.31	.....	456.44	70.67	9.81	0.25	555.48
Travel expenses	111.04	143.65	5,463.79	952.07	574.95	78.30	7,323.80
Transportation of things .....	.....	.....	881.21	75.25	10.04	6.79	973.29
Publications	2.32	.....	1,486.32	690.75	21.51	.....	2,200.90
Heat, light, water and power ....	.....	.....	160.99	38.94	.....	.....	199.93
Furniture, furnishings and fixtures	21.25	358.50	1,859.72	1.35	44.20	26.33	2,311.35
Library	8.83	9.91	502.81	50.66	8.00	.....	580.21
Scientific equipment	387.93	270.59	3,461.97	490.26	439.12	.....	5,049.87
Livestock .....	.....	.....	364.25	8,189.21	.....	.....	8,553.46
Tools, machinery, appliances	6.00	.....	1,488.23	633.78	.....	386.38	2,519.39
Buildings and lands	104.83	.....	6,798.12	1,439.90	50.35	1,172.12)	9,700.00)**
Contingent expenses .....	.....	.....	482.40	211.00	.....	.....	693.40
Total expenditures	\$15,000.00	\$15,000.00	\$102,571.14	\$23,937.22	\$7,002.20	\$12,675.55	\$176,186.11
Balance on hand June 30, 1924 .....	.....	.....	11,667.93	19,188.92	1,467.98	1,324.45	33,639.28

Grand Total \$15,000.00 \$15,000.00 \$114,229.07 \$43,126.14 \$8,470.18 \$14,000.00 \$209,825.39
**Special appropriation \$10,000 Cheyenne Wells \$4,000*

REPORT OF THE DIRECTOR

To the President:

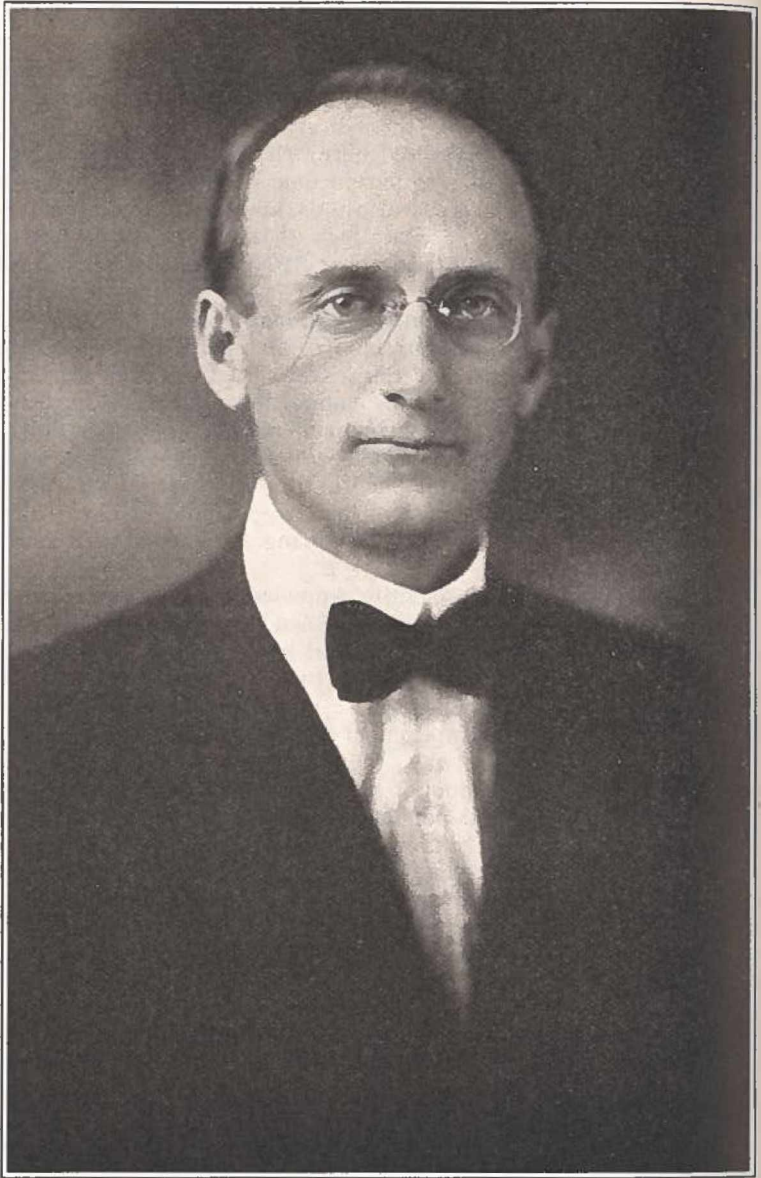
A short summary report of the activities of the Colorado Agricultural Experiment Station, together with a full financial statement of receipts and disbursements for the Government fiscal year, July 1, 1923, to June 30, 1924, is presented herewith for your information.

It will be noted that the regular income of the Station consisted of \$15,000 each, from the Federal funds known as the Hatch Act and Adams Act, respectively, a State levy of 0.0675 of a mill upon all taxable property, which amounts to about \$104,000, and a special fund of \$20,407.94 which was derived from the sale of livestock, fruits, grains and vegetables used in the investigational work of the year. The special fund was offset by the purchase of livestock, feeds, seeds and labor. The total net budget for the investigations of the year in all departments was \$134,128. In this connection should be mentioned two special appropriations for the biennial period, one of \$4,000 for improvements at the Cheyenne Wells Station, payable in two annual installments of \$2,000 each, and one for the purchase of land equipment for the Greeley Potato Station, in charge of the Federal Bureau of Plant Industry, of \$10,000, payable during 1923, making a total of \$146,128.

The acquisition of new scientific knowledge must always be expensive, but it is usually of great value when once obtained. It would seem a small matter to work out a method by which the wheat or corn crop of the State might be increased by only one bushel per acre, and yet, such an increase to either of these crops for one year would be sufficient to supply the full Experiment Station budget for at least five years. Or put it in another way; the entire annual mill levy for the Experiment Station would amount to a per capita tax in Colorado of only 11 cents. As the rural population pays about one-half the total State tax, the Experiment Station costs the farmers of the State an average of about \$1.00 each per year. The writer believes the Experiment Station returns a good annual dividend to the farmers of the State on the money they have invested in it, besides being of considerable value to surrounding states and to the Agricultural College as an educational factor.

When the average annual per capita expense for candy, tobacco, gum and cosmetics, and other useless or worse than useless luxuries, exceeds \$50.00, it does not seem that an excessive amount is being devoted to investigational work for the improvement of our agriculture which must be the chief basis for our material prosperity.

There are many lines of research receiving meager support and many new lines that should be undertaken, but we are endeavoring to do as much as possible on the more important problems with the funds available and hope that, from time to time, the State may see fit to increase its budget for the support of the investigational work of the Agricultural Experiment Station.



DR. ARNE K. PEITERSEN

The Station personnel has not changed much during the year. One department head and three other regular workers have left the Station for one reason or another, and one department head and two other workers have been added. At the present time there are 13 employees giving full time and 33 giving part time to the investigational work. The writer believes better results will be obtained when it is possible to have a larger proportion of the workers giving full time to research.

Dr. Arne K. Peitersen, head of the Department of Botany of the Colorado Agricultural College and also in charge of the investigational work in botany for the Experiment Station, died suddenly in Grand Junction, Colorado, February 23, 1924, while in the performance of his duties as botanist in charge of the State Seed Laboratory.

Arne K. Peitersen was born at Elkhorn, Iowa, March 9, 1884, and graduated from the University of Nebraska in 1911 with the degree of bachelor of arts. The year following he received the master of arts degree from the same institution, doing his major work in botany, and he was also elected to membership in the honorary society of Sigma Xi. In the same year, 1912, he was elected to be head of the Department of Botany in the University of Vermont, and in 1916 received his Doctor of Philosophy degree from that institution. The major work for this degree was upon "A Study and Revision of the genus *rebis* in North America." Dr. Peitersen was called early in 1920 to the chair of Botany at the Colorado Agricultural College, where he entered upon his duties June 1 of that year. As head of this department he was also in charge of the investigational work in Botany for the Experiment Station, and of the Colorado Pure Seed Laboratory established at the Agricultural College. In his direction of the work of the Seed Laboratory he did much to raise the standard of farm and garden seeds in the State and, consequently, the products of farm and garden.

Dr. Peitersen was a man who had a keen appreciation of honest, thorough-going scientific work, was himself a scientific investigator of high ability, and possessed a personality that caused him to be loved by all who were associated with him. His untimely death was a serious loss to the investigational work of the Colorado Agricultural Experiment Station, and was felt as a personal loss by all who were acquainted with him. His picture is shown on the opposite page.

The work on niter control, co-operated in by the sections of Agronomy and Bacteriology, and the American Beet Sugar Company at Rocky Ford, has made good progress again this year. Much additional information has been obtained from chemical analyses of the soils, all of which are in harmony with the conclusions formerly drawn by workers in this Station concerning the development and nature of our niter problems in the State.

Following is a list of the projects that are approved for the investigations of the different sections of the Experiment Station at the present time:

AGRICULTURAL DIVISION**Agronomy Section**

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

Correlation of Characters in Grain. Hatch and State funds.

Methods of Selection Breeding. State funds.

High-Altitude Crops. State funds.

Plains Crops and Management. State funds.

Arkansas Valley Nitre Control. (In co-operation with Bacteriology and Irrigation Investigations). State funds.

Improved Seed. State funds.

Animal Investigations Section

Acre Value of Pasture for Daily Cows. State mill levy.

Ration and Experiments with Steers. State mill levy.

Ration for Fattening Lambs. State mill levy.

Range Improvement. State mill levy.

Winter Maintenance of Breeding Ewes. State mill levy.

Summer-Fallow Experiment at Akron, Colo. State mill levy.

Supervision in Dairy-Cow Records. State mill levy.

Incubation Tests. State mill levy.

Corn Field Lamb Feeding. State mill levy.

Death Losses among Lambs in Feedlots in San Luis Valley. State mill levy.

Bacteriology Section

Heat-Resisting Bacteria in Fresh and Canned Vegetables. Adams fund.

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

Arkansas Valley Nitre Investigation. State mill levy. (In co-operation with Agronomy Section).

Bacterial Disease of the Wragg Cherry. Hatch Fund.

Botany Section

Hard Seed in Alfalfa. State mill levy.

Range Improvement (In co-operation with Animal Investigations). State mill levy.

Plant-Disease Survey. State mill levy.

Root Disease of Alfalfa. Adams fund.

Chemistry Section

Nitre in Colorado Soils, its Occurrence, 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 Control. Hatch and State mill levy.
Grasshopper Control. State mill levy.
General Insect Investigations. State mill levy.
Alfalfa Nematode Studies. State mill levy.

Economics and Sociology

Marketing Investigations, in co-operation with the Colorado Division of Markets, Denver, Colorado. State mill levy.

Settler's Progress Study, in co-operation with the Division of Land Economics and the Office of Farm Management and Farm Economics, U. S. Dept. of Agriculture. State mill levy.

Cost of Producing Beef Cattle on the Range, in co-operation with Cost of Production and Farm Management Division, U. S. Dept. of Agriculture. State mill levy.

Farm Organization and Costs on Farms in the Greeley Area in co-operation with Division of Farm Management and Farm Economics, U. S. Dept. of Agriculture. State mill levy.

Rural Life Studies, in co-operation with the Rural life Section of the Bureau of Agr. Economics, U. S. Dept. of Agriculture. State mill levy.

Forestry Section

Studies in the Decay of Wood. State mill levy.

Home Economics Section

Cooking Quality of Colorado Potatoes. State mill levy.

A Study of the Bread-making Qualities of Colorado Flours. State mill levy.

Principles of Making Fruit Jellies. State mill levy.

Horticultural Section

Potato Investigations. 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 Section

The Venturi Flume. 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.

Pathology Section

Sheep Losses in Feedlots. Hatch fund.

Contagious Abortion. State mill levy and Hatch funds.

Veterinary Section

Animal Diseases. State mill levy.

ENGINEERING DIVISION**Civil Engineering Section**

Road Materials of Colorado. State mill levy.

Mechanical Engineering Section

Treatment of Alkali and other Waters for Domestic Use. State mill levy.

Testing of Lubricating Oils. State mill levy.

The Humidifying of Air in Buildings. State mill levy.

Brief reports of the heads of sections are given on the following pages.

Respectfully submitted,
C. P. GILLETTE, Director.

REPORT OF THE AGRONOMIST

To the Director:

I am substituting herewith my report of the Agronomy Section of the Experiment Station for the Federal fiscal year, July 1, 1923 to June 30, 1924. The work of the Agronomy Section for the year was carried out with the following personnel:

At Fort Collins, Alvin Kezer, chief; D. W. Robertson, associate; G. Warren Deming, assistant; Asa Barnhart, laborer, with the further assistance of student help hired by the hour.

At Cheyenne Wells, Mr. J. W. Adams, superintendent; Irvin Rahe, Clyde O. Gregg, F. A. Wood, laborers.

At Rocky Ford, P. K. Blinn, superintendent; Justus C. Ward, chemist; and R. S. Harrison, laborer.

At Fort Lewis, Harrison D. Horton, assistant.

Work was conducted at Akron under a co-operative arrangement with the office of Dry Land Agriculture, helped out by visits and special trips of workers to take notes on products and crops in the course of their development.

At the Fort Collins plant the following projects were actively under way:

Critical Periods in the life history of plants for the need of moisture and physiological effects resulting from the application at those critical periods or the withholding of water from the plant at those critical periods. This project is an Adams fund project designed to discover the fundamental facts in the life history of small-grain crops, especially with respect to their needs for water. In carrying out this project two methods of attack have been followed: First: field plats one five-hundredth of an acre in size provided with moveable covers to prevent precipitation getting on the plats and with suitable drainage at the side to quickly remove drainage from the plat covers, and, second, potometers grown in the same field with similar cover protection. Up to the present time we have not been able to get

results in the potometers comparable with field development of crops. What the trouble is we do not know. We are attempting to find out, but we do know that the crops in the potometers do not develop in the same way as the crops develop in the field. In the case of the small field plats under removable covers, however, the plats do behave comparable to field conditions.

As a matter of practical administration and expense, we have been obliged to confine our investigations to one crop at a time. Accordingly, spring wheat has been used to work out the factors for that crop. We now have four years' consecutive results under the present plan of handling the work. These data show positive results. Only a brief statement of the trend of these results will be given here since manuscripts are nearly completed for publishing the results up to date.

It may not be out of the way to mention the fact that from the standpoint of yield and quality of the crop, if there is water enough in the soil to start the crop and keep it growing fairly well until the heading period, an application of water just prior to heading gives the greatest results in yield and quality of the grain. Later applications of water do little good if there is sufficient water applied at this period. Water applied at an early period and withheld later affects the shape, size and development of the wheat kernel. Since the details of these physical and physiologic changes are set forth in a separate manuscript now in preparation this need not be discussed in full in this annual report.

In addition to the Critical-Period project, we are carrying a general project known as Improved Seed. Under this project we are attempting some of the more practical phases of agronomic work. We are breeding new crops, testing them out to get their values as compared to existing crops; we are bringing in new varieties from the outside, testing them; we are increasing seed of the new varieties which prove their worth, whether bred up by ourselves or imported from the outside; we are purifying existing standard and proved varieties and distributing seed of all of these various operations to farmers.

We distributed in the spring of 1924, two tons of Colsess barley, a new variety which the Station produced by crossing Coast (California Feed) and Success. Coast is a high-yielding, vigorous barley, but it has long and coarse, barbed beards, which render it unfit for hay and often make the straw unfit for feeding purposes because the beards are apt to cause sore mouth when eaten by stock. The new variety, Colsess, in a six-year test at Fort Collins and at Fort Lewis yields practically as well as the best Coast and it has no beards. The beardless character makes this new barley available for use in our mountain districts and elsewhere as a grain, because it yields high, as a mixture in pea-grain mixtures, as a grain hay, or it may be harvested, thrashed and the straw fed without danger to animals. The variety is very tenacious of the berry so that shattering of the kernels in the field is reduced to a minimum. These qualities combined with a good yield of stiff straw make this barley a very decided addition to the barley

crop. It will very greatly increase the feed grain and barley hay possibilities of our mountain districts.

We are also conducting a continuation of the experiments in determining the best methods of planting and handling different crops in our experimental work, whether in breeding or crop or soil tests. The necessity for this work is seen when we realize that crops like corn or rye are cross fertilized abundantly and must be segregated if their strains are to be kept pure. Occasional crossing will take place with oats and wheat so that a moderate amount of segregation is necessary with these crops. Recognition must be kept in mind of the different physical behaviors of different crops in the field. Methods of handling and planting must be such as to make mechanical mixture impossible.

Rotations are also being given attention not only from the standpoint of improving products from the land but also from the standpoint of finding the best crop sequence. We realize thoroly that crops leave a residual effect. In some cases this residual effect is beneficial to the succeeding crop and in some cases injurious or retarding to the succeeding crop. In other words we are attempting to find the order of sequence which will give the best results so as to take advantage of these residual effects rather than to be hampered or have the yields reduced by such residual effects.

At Cheyenne Wells we doubled the number of forage test plats making something over seventy plats in all in addition to increasing the plantings for annual pasture experiments on a field scale. The appropriation has been, and is being used, to improve the fences, to add four new silos to our building equipment, to build an addition to the barn covering the silos, to build a new chicken house and to start work on two other buildings. Briefly summarized, the appropriation was used to put the physical plant in shape so that experimental work could be better carried on, and, second, to very greatly increase the amount of plat work with forage and pasture crops in an attempt to help solve the most insistent dry-land problems of the region.

At Rocky Ford the co-operative work between the sections of Agronomy and Bacteriology in the attempt to find means of control of the nitre problem at that point has been continued. The personnel in the work is the same as the previous year. Nineteen twenty-two was one of the driest years in the history of the Station. The year 1923 was the wettest year ever recorded since weather records have been kept at Rocky Ford. The 1923 precipitation broke the previous high record by over five inches. Our attempt at solving the excessive production of nitrates has been along two lines: First by the use of agricultural methods and rotations, and, second, by the application of chemicals. The two years' results which are complete, namely 1922 and 1923, show that the order of production of nitrates follows the same law. Briefly stated, nitrates are high where the land is cultivated and low when the land is in an uncultivated crop, such as alfalfa, clover, sweet clover, or in pasture or small grains. There are differences in the production of nitrates in different cultivated crops but the general

law holds that the production is high where the crop is cultivated in the course of its production. The general scheme of agricultural control is to devise a rotation to take advantage of these facts. Chemical treatment may be of assistance, but agricultural treatment thru rotations is sound because good rotations will result in better agricultural practice. Certain types of plats representing different treatments were sampled once a month to a depth of six feet, so that we have a picture of nitrate formation and movement in the soil to a depth of six feet.

In addition to the nitrate work at Rocky Ford, we have been spending considerable effort in the attempt to exterminate a bad bindweed infestation. We have had considerable success in that attempt. Thoro plowing and clean cultivation for two years will completely eradicate the bind weed. But thoro cultivation means the use of knives or a cultivator using sweeps so as to cut the entire surface, cutting off the bindweeds from one to two inches beneath the surface. This cultivation has to be done frequently enough to prevent any growth of tops. Sometimes in the middle of the summer the frequency has to be as often as each four days. The problem seems to be entirely one of controlling any growth. If the growth is entirely stopped the root will be starved in time. In fact, the process, if carried out with sufficient throness and frequency, will nearly kill out the patches in one year. However, such thoro work cannot be done and have a crop on the land. This intensive fighting can only be done with a fallow. By growing cultivated crops such as beets or beans, which permit of continuous cultivation or hoeing, it is possible to approximate the fallow and yet grow something of a crop.

The alfalfa work at Rocky Ford, due to the pressure of the nitrate work, is being held largely in abeyance. We are attempting to hold seed stocks of our superior strains so that we can go forward with that work when the nitrate is completed. In our alfalfa work we found out definitely that we can breed new and superior strains. We have done a great good to the State in the determining of the types adapted. Our greatest difficulty has been to solve the problem of consistent seed production. Our supply of land and our means of personnel are not sufficient to push the the alfalfa investigation and the nitrate investigation at the same time. Accordingly, we are trying to hold seed stock so as to take up the alfalfa problem.

We want to attempt to solve the seed production question and the factors controlling the same.

At Fort Lewis investigations are on high-altitude or mountain agriculture. Our first attempts at Fort Lewis are to find adapted crops and methods of handling those crops. With that end in mind we have carried out variety tests of oats, wheat and barley and some forage crops to determine the things most immediately needed in mountain agriculture. We have carried on these variety tests with peas, wheat, oats and barley. We have done minor work with corn and forage crops other than those mentioned. We are giving the

largest part of our attention to those crops which give the greatest promise in mountain agriculture at rather high altitudes.

Approximately two-thirds of the area of Colorado is more or less effected by mountain agriculture, high altitude in nature. Approximately one-third of Colorado lies east of the mountains on our high plains. The remaining two thirds consists of high plateaus, table lands, mesas, and valley lands. Much of the area is not adapted to farming other than grazing, but that which is adapted is capable of supporting a considerable agriculture. We are able to center our attempt to solve the cropping and soil problems of these high altitudes at Fort Lewis and supplement the tests with plantings arranged with farmers in North Park, Middle Park, South Park and the northwest.

There are many problems confronting the Agronomist which need definite experimentation. Our Great Plains and those mountain regions capable of dry farming constitute a distinct phase of investigation, which should be given much more attention than we have been able to give in the past. There are about 66,000,000 acres in Colorado. Approximately 22,000,000, or one-third of the State, lies east of the mountains. Perhaps 2,000,000 to 2,500,000 acres of this region is irrigated, leaving between 8,000,000 and 9,000,000 acres of land now under cultivation, which is cultivated by dry-land methods. Much of this land is going to be utilized. How to utilize this land is a problem of soil and crop management. We are doing something co-operatively to help solve this problem thru the work at Akron. We are doing what our means permit at Cheyenne Wells, but the need of the region is sufficiently large to justify more financial support and a heavier personnel for this particular region. We know considerable that has not yet been put into practice, but we need to be getting new facts to keep up with and ahead of the agriculture of that region.

High altitude, or mountain agriculture, needs more agronomic investigations. We are pushing the altitudes at which crops may be grown to higher reaches. We have learned a great deal of the fundamental cropping problems but there is much yet to be learned.

Our work in the Arkansas Valley with soil problems indicates that there are other features besides those under investigation that need much study. Most of the soils are rich in fertility. But that fertility in poorly balanced. The best method of balancing the fertility is not known, but higher productivity with desired quality is essential.

Respectfully submitted,

ALVIN KEZER,
Agronomist.

REPORT OF THE ANIMAL HUSBANDMAN

To the Director:

Following is a report upon the various projects carried by this section:

Ration Experiments With Steers—E. J. Maynard and Geo. E. Morton.

This year's work was the close of a three-year series, comparing, principally, rations containing corn silage and sunflower silage with the standard wet-pulp ration. We have secured sufficient data so that the sunflower-silage phase of the work will be discontinued. Dried pulp was also tested in comparison with grain in these silage rations.

Ration For Fattening Lambs.—E. J. Maynard.

A number of different rations were compared, the more interesting comparisons being the grain-replacement value of dried pulp; the feeding of beet molasses in a self-feeder; the value of oats and linseed meal in rations where alfalfa hay is used.

Corn-Field Lamb Feeding.—E. J. Maynard.

A test comparing lambing-off corn in the field with dry-lot feeding.

Death Losses Among Lambs in Feedlots in San Luis Valley.—

E. J. Maynard.

A series of investigations was carried on by the Veterinary Pathology Section of the Station with a view to finding the cause of death losses. They carried their investigations to a point where they were satisfied it was a disease condition connected with rations fed or methods of feeding, so our present investigations are being carried on to find whether the death losses can be reduced by means of addition of other feed stuffs to the rations in connection with lambing-off field peas.

Range Improvement.—E. J. Maynard.

This investigation necessarily covers a series of years with no definite time limit. At present, its scope comprises three different methods of handling cattle on the range. The work is being done in co-operation with the Botanical Section.

1. Ordinary early grazing is practiced, cattle being turned out as soon as there is grass in the spring.
2. Grazing is delayed until vegetative maturity of the grasses.
3. Rotation grazing with area divided in two parts, one-half being grazed off the fore part of the season; the other half, after seeding of the grasses.

Summer Fallow Experiment with Sheep at Akron, Colorado.—

Geo. E. Morton and E. J. Maynard.

An investigation designed to cover a considerable length of time with a view to discovering (over a series of years so as to include all rainfall conditions) the advisability of maintaining sheep upon dry-land farms for the purpose of grazing off weed growth on summer fallow and thereby reducing the labor required for summer tillage; also, to find the number of sheep which can be carried over a series of years on a given acreage of summer fallow and supplementary pasture of native grasses.

Winter Maintenance of Ewes.—Chas. I. Bray.

An investigation into methods of cheaply maintaining winter ewes. The experiment of the past year was with farm ewes.

Acre Value of Irrigated Pasture.—Geo. E. Morton.

An investigation into the carrying capacity and value of irrigated pasture for dairy cows.

Incubation Tests.—O. C. Ufford.

An investigation of moisture and aeration conditions required for hatching hen's eggs at this altitude.

Advanced Registry Testing.—Chas. N. Shepardson.

The projects for the coming year are the same as for last year, with changes in details of the investigations.

In steer experiments, calves will be used this year instead of yearlings, as in the series just closing. Rations for the calves will cover the comparative values of corn fodder, corn silage, corn and soy-bean silage, potatoes, and potato silage, with supplementary grain rations.

In the ration experiments with lambs, the following feed stuffs will be used to determine their value as partial supplements to corn: Dried Beet Pulp, Corn Silage, Corn and Soy-Bean Silage, Potato Silage, Cull Potatoes, Wet Pulp. One lot will be self-fed on the ground mixture of corn, dried beet pulp and alfalfa.

The range-management experiment will be continued with cows instead of steers.

Winter maintenance-of-ewes investigation will be carried on with range ewes instead of farm ewes, although the feeding will be done under farm conditions.

Other investigations will be carried on the same lines as last year.

The results from our ration experiments with steers and fattening lambs, particularly, are going into use among the feeders of Colorado, especially in this section and the Platte Valley. Lamb Feeders' Day and Steer Feeders' Day held at the close of the ration experiments, bring to the campus, for discussion of investigational results, the largest bodies of bonafide stockmen and farmers that come to the College for any meetings. This enables us to get our results immediately in use and also bring a closer connection between the actual feeders and the Experiment Station.

Respectfully yours,

GEO. E. MORTON,
Animal Husbandman.

REPORT OF THE BACTERIOLOGIST

To the Director:

I have the honor to submit herewith the annual report of the Bacteriological Section of the Experiment Station for the fiscal year ending June 30, 1924:

As our investigational work progresses, we are coming to realize more and more the wisdom of concentrating our efforts on a few problems. Two lines of work have been supported by the Adams fund, one by the Hatch fund, and one by State funds. Marked progress has been made in three of these, while the fourth has been more or less quiescent, because of the lack of time necessary to pursue it. In addition to this, we have given some time to minor problems demanding immediate consideration and to laboratory service for other sections of the Experiment Station. A great deal of material calling for laboratory examination is referred to this section through correspondence, and while the individual specimen may require but little attention, the examination of the aggregate demands an appreciable amount of time. Service of this character is legitimate and should receive careful and prompt consideration; however, the fact should not be overlooked that it takes time from investigational work, and due allowance should be made for this.

Adams Fund Projects

1. Vegetable Spoilage:

When this project was drafted originally, it was intended to make it a study of the different agencies which cause spoilage in canned food products, but since its inception it has been modified to include certain phases of *botulinus* poisoning.

The investigation of the year may be divided into two parts: The first has been carried on in co-operation with Miss Sheridan of the Extension Department, and has dealt with the lag encountered in canning different vegetables by the wash-boiler method, at altitudes of 4000, 5000, 6000, and 7000 feet. In a general way, we have found that the lag varies inversely as the altitude and that it ranges from eighteen minutes to one hour and fifty-three minutes, depending upon the kind of vegetable that is being processed.

The second part has been a study of the occurrence of *Bacillus botulinus* in Colorado soils, collected from widely separated localities and representing both virgin and cultivated areas. The results thus far indicate that approximately 11 percent of the samples examined contain the germs responsible for *botulinus* poisoning. Both virgin and cultivated soils have reacted positively.

2. *Azotobacter* Energy Studies:

The work of previous years on this project had dealt with the relation of green manures and sulphur to the fixation of atmospheric nitrogen by *Azotobacter* and other non-symbiotic soil organisms. The results of this investigation pointed to the desirability of undertaking

a study of the relation of green manures and sulphur to soil acidity as a limiting factor to nitrogen fixation.

To this end, some preliminary work has been carried on in the determination of the hydrogen ion concentration of soils to which sulphur has been applied, but lack of time has prevented us from making any material progress. Recently our laboratory has been equipped with suitable apparatus for making hydrogen ion determinations electrometrically, which will enable us to handle many more samples in a given time than formerly by the colorimetric method.

Hatch Fund Project

1. Bacterial Disease of the Wragg Cherry:

The completion of this project has been delayed for several years because of our inability to produce the disease in cherries by inoculations with pure cultures of the micro-organism thought to be responsible for the trouble.

By employing a culture, isolated in 1923, which had been grown in laboratory media for nearly one year, we succeeded in the spring of 1924 in producing 100 percent infections in green cherries under field conditions. The inoculations in the present instance were made earlier in the season than previously and before any natural infections were visible.

At this early date, the natural acidity of the green cherries was found to be relatively low, which increased quite appreciably as the fruit developed. This change in acidity may explain our failure to secure successful infections in former years, as our inoculations were probably made after the cherries had become too acid to permit the normal progress of the disease.

All that remains to complete this investigation is a little further cultural work upon the castral organisms which appears to be similar to, if not identical with, *Pseudomonas pruni*.

State Fund Project

1. Rocky Ford Niter (Sections of Agronomy and Bacteriology)

Co-operation

Owing to the heavy rainfall in 1923, the accumulation of soil nitrates did not reach as high a point as in 1922, but the same general relation to crops and methods of handling the soil maintained as in former years. The nitrates under alfalfa, clovers, and small grains remained consistently low, while they were uniformly high under cultivated crops, notably onions and cantaloupes.

Chemical treatments in the form of applications of sulphur, alum, and ammonium sulphate were made to different fallow plots to determine the effect upon nitrate production. Of the three, sulphur was the only one that showed any decided action. Here nitrate formation was so retarded that only a trace was present by the close of the season of 1923.

Parallel nitrate and chloride determinations, made upon all of the samples, have failed to show any correlation between the two salts.

Because of the badly diseased condition of the vine crops on our experimental plots in past years, it has been difficult to say how much of the poor quality of the melons should be attributed to excessive nitrates and how much to disease. This year, we are endeavoring to control the various diseases by spraying with Bordeaux mixture.

A brief report by Mr. Ward, chemist in charge of the Rocky Ford laboratory, follows:

"To the Director:

"During the past year the Colorado experiment Station Laboratory at Rocky Ford, Colorado, has advanced its investigational work under the joint supervision of the Agronomy and Bacteriological Sections of the Experiment Station.

Analyses of twenty-eight hundred and two silos were made, both the nitro nitrogen and the chlorine values being determined. And since the nitric nitrogen values are secured by duplicate analyses, a total of eight thousand four hundred and six separate determinations was made.

Soil samples were taken from the plots on the Station Farm, from selected plots on the American Beet Sugar Company's experimental farm, and from seven privately owned farms in the vicinity of Rocky Ford. The methods of sampling were the same as have been followed in previous years; namely, the surface samples were taken to the depth of four inches every two weeks from all fields studied, while deep samples to the depth of six feet were taken from selected plots each month.

The findings of the year fully support previous results, so that justification is had for the extension of the investigation along certain well-defined lines.

In the light of the results so far obtained, it would seem profitable to include a more definite investigation of proper rotational systems in the coming year's work. Also, it would seem advisable to follow the effects of the application of commercial fertilizers upon nitrogen fixation wherever the opportunity offers.

A continuation of the established investigations, as well as the addition of the two mentioned, is contemplated for the coming year."

Miscellaneous Investigations

1. Alfalfa Wilt or Root Rot:

A very serious wilt or root rot of alfalfa, resulting in the destruction of hundreds of acres of alfalfa, appeared in an aggravated form in the spring of 1924. The plants stop growing, wilt, dry up green, finally bleach and die. An examination of the root shows the crown to be badly decayed while the lower part may be perfectly sound. In a few cases a slimy exudate was observed issuing from the brown vascular bundles of the roots, from which bacteria have been isolated.

The disease was general over the State, but caused greater losses in some parts than in others. A similar disease has been reported in previous years, but not with the present severity.

The exact cause remains as yet undetermined, but it is probably of either bacterial or fungous origin.

2. Cantaloupe Vinegar:

The utilization of waste cantaloupes from the seed-producing sections of the State for vinegar has been given some consideration. Cantaloupes contain between 6.5 and 7 percent of fermentable sugar, which

could be converted into alcohol and vinegar at a relatively small expense, providing the finished product possessed no objectionable flavor.

3. Ice Cream:

A rather interesting case of bitter ice cream was referred to us for investigation by a Colorado ice-cream factory. The bitter flavor was found to be due to a bacterium which produced spores that resisted the heat employed in the pasteurization of the ice-cream mixture.

4. Vinegar Cultures:

Pure cultures for making vinegar are still being supplied by the Bacteriological Laboratory. Requests for these are by no means confined to Colorado, but are received from all over the United States and occasionally from foreign countries.

5. Seed Disinfection

Because of the prevalence of diseases on the vine crops in the Arkansas Valley, there has been considerable agitation among both growers and seedsmen over the necessity and value of disinfecting their seed. The method recommended consisted of treating the seed for five minutes with a 1-1000 solution of mercuric chloride. This appears to be efficient so far as disinfection is concerned, but there was some question about the effect of the treatment on germination.

To determine this, we subjected cantaloupe, cucumber and honeydew seeds to the prescribed treatment. Our results indicated that seeds which possessed a high initial germination were practically unaffected, while those with a relatively poor germination in the beginning, were damaged appreciably.

6. Water Supplies:

Chemical and bacteriological examinations have been made of a large number of farm well-waters. This consists as a rule of a qualitative test only, designed to give a general idea of the suitability of the water for domestic, livestock and irrigating purposes.

In this connection, it may be mentioned that the sanitary condition of the water in the swimming pool of the Women's Club is checked regularly by our analyses at stated intervals.

Projects for 1924-1925

The projects for the coming year will be continuations of the present ones, with the probable addition of one relating to the Alfalfa Wilt or Root Rot.

I regret to report the resignation of Miss Mildred Brown, effective July first, who has assisted me so faithfully during the past three years. Miss Brown will be succeeded by Miss Ida Wray Ferguson, as assistant Bacteriologist.

This report would be incomplete without a word of appreciation to the Director of the Experiment Station for his most friendly cooperation and generous support in all of our investigations.

Respectfully submitted,

WALTER G. SACKETT,

Bacteriologist.

REPORT OF THE BOTANIST

To the Director:

The activities of the Botanical Section for the past fiscal year are herewith submitted.

On September 1, 1924, the writer, formerly assistant chief in Plant Pathology, Iowa Agricultural Experiment Station, assumed the duties of the head of the Botanical Department, Colorado Agricultural College.

The following projects have been carried on during the year:

Range Improvement

This project has been carried along the course outlined. Special studies made of quadrats on the Experiment Station farm and at Akron indicate deferred grazing will be of material benefit in native pastures. Such deferred grazing, one year in three, will allow natural reseeding of the native grasses and perpetuation of the forage. The continuous croppings of certain of the native grasses completely kills them out and they become displaced by worthless grasses and weeds. A preliminary paper is in progress on this project.

Hard Seed in Alfalfa

This project has been in immediate charge of Miss Anna M. Lute, Station seed analyst, and certain completed phases of the project are now being prepared for publication. A summary of the findings to be discussed are as follows:

1. The average hard seed percentage for Colorado-grown alfalfa seed is approximately 22 percent each year.

2. Various lots of seed from different localities containing different percentages of "hard seed" planted at the same time, in the same locality, produce the same percentage of "hard seed" at harvest.

3. The percentage of hard seed found in machine-threshed seed from a field in different years varies greatly.

4. There is much more "hard seed" in hand-threshed than in machine-threshed seed.

5. There is great variation in hand-threshed seeds from individual plants in the same field.

6. Seed harvested when slightly immature has a lower germination and a slightly higher "hard seed" content than mature seed.

7. For a given sample, repeated tests show that the percentage of germination and of "hard seed" is constant within the accepted tolerance.

8. The rate of deterioration in germination due to old age is extremely variable.

9. "Hard seed" practically disappears from alfalfa seed after 11 years storage.

10. One-half or more of "hard seed" disappears after three years storage.

11. At least some of these "hard seed" germinate as early as the third year of storage.

12. "Hard seed" of alfalfa kept under good storage conditions germinates more than 70 percent when three years old.

The seed analysis of the laboratory and inspection work has been carried on satisfactorily, and has received good support from both farmers and seedsmen throughout the State. This was particularly reflected at the State seed trade conference recently held here in the seed laboratory.

Plant Disease Survey

This project has been continued and the usual reports made. Due to comparatively low rainfall, plants have been quite free of diseases this past season. The discovery of the alfalfa nematode in Colorado this year was occasion for great alarm. Careful survey of the State, however, proved its distribution and injury quite limited.

Other diseases as root rot in alfalfa, celery rot and stinking smut called for attention this season and suggested investigations now in progress.

Respectfully submitted,
L. W. DURRELL
Botanist.

REPORT OF THE CHEMIST

To the Director:

The Chemistry Section of the Station has engaged itself during the past year very largely with work connected with the experiments carried on at Greeley in conjunction with the pathologist of the Bureau of Plant Industry of the United States Department of Agriculture. This work is not yet completed. There remains a considerable amount to be done, arising from field observations in this connection. These observations emphasize the views that we have expressed repeatedly in the beneficial effects of green manuring and rotation as corrective measures in the case of the nitre question, and give an irrefutable explanation for the inconclusive character of the results obtained in our Greeley series of experiments. These results are much more satisfactory than we had any reason to expect, which appears very conclusively from the observations first made by Prof. Whipple at Delta, who was kind enough to call our attention to two cases in particular in which two different growers had planted potatoes after potatoes, or other cultivated crops along side of land that had been in alfalfa for one or two years—two years, I think, in both cases. The sections of land that had been in potatoes the previous year developed nitrates on a large scale, while the land that had been in alfalfa did not develop them to any unusual extent. The yield on the niter land in one case was 20 sacks (estimated) against 75 sacks after the alfalfa. In the other case, there was no crop on the niter land and 140 sacks to the acre after alfalfa.

We are continuing work on these lines to round out our Greeley experiments whose value has been greatly enhanced by this season's observations in the field.

This season's field work has emphasized the importance of this class of work in the most striking manner imaginable; not that its value has ever been doubted but that it has been demonstrated with unusual force by this season's experience.

The conditions obtaining in our orchards have again come up for consideration from our standpoint. These conditions are, in large sections, very bad indeed, with the promise of unwished-for issues. In fact, they are already so bad in some sections that the issue is no longer in doubt. The abundance and persistency of the codling moth, which renders excessive and expensive spraying indispensable, the general presence of the so-called alkali salts in our soils, and, in many places the occurrence of marl and gypsum, which, either owing to the action of lime alone or to its content of arsenic, is proving exceedingly deleterious in many instances.

The Chemistry Section has prosecuted this subject about as far as it can prosecute it with its present facilities. The questions involved are too big, and from this on we can only repeat our former observations. This does not deny that there are probably some details, perhaps many of them, that might be worth solving, but the main features of the problems involved, so far as the chemist is concerned, have been canvassed—in fact, were for the most part canvassed 17 years ago; but subsequent observations have made it amply worth while to extend the presentation of the whole subject.

We have published but one bulletin during the current year. This presented the work of the year 1920 on the Greeley potato problem. The report on the work of 1921, 22, 23 and 1924 will not be made until the work is completed and will be presented as a single bulletin.

There is some accumulated material pertaining to the condition of our orchards which I intend to gather together and present as a short bulletin early in the next year. I deem this advisable as a means of putting our observations on record. The fourteen years that have elapsed since Bulletin 157 was published have brought with them many changes, and it is to give a brief account of the conditions now prevailing that I propose to present a new bulletin and not republish bulletins 131 and 157. The facts then given are still true, but other phases now claim greater attention than they claimed at that time.

There has been published one scientific article by the section during the year. This was entitled "The Relation of Color and Composition to Luminescence in Calcites." It appeared in the Proceedings of the Colorado Scientific Society.

Respectfully submitted,
WM. P. HEADDEN.
Chief of Chemistry Section.

REPORT OF ECONOMICS AND SOCIOLOGY SECTION

To the Director:

This department has continued its studies in the development of the five projects which were outlined in the annual Experiment Station report for the year 1923. The list of projects as reported at that time were as follows:

1. Marketing Investigations; in co-operation with the Colorado Division of Markets, State House, Denver, Colorado.

2. Settlers' Progress Study; in co-operation with the Division of Land Economics and the Office of Farm Management and Farm Economics, U. S. Department of Agriculture.

3. Cost of Producing Beef Cattle on the Range; in co-operation with Cost of Production and Farm Management Division, U. S. Department of Agriculture.

4. Detailed Farm Accounting and Farm Organization Analysis; in co-operation with 25 farmers in the Greeley district and the Division of Farm Management and Farm Economics, U. S. Department of Agriculture.

5. Rural-Life Studies. The investigations to which reference was made last year have been continued and co-operative work was begun with the National Child Welfare Bureau for the purpose of securing information with respect to child-labor conditions in the sugar-beet districts of Colorado.

Report of Progress on Project No. 1.

The causes that bring about carlot rejections of fruit and vegetables constituted the major inquiry in this co-operative enterprise. Representative records were secured from dealers engaged in handling these products. The statistical records which were assembled have been summarized, in part, and a report giving the results of this investigation will be made available in the near future. In view of the fact that the conditions which obtain thruout a given marketing season are often entirely different from the conditions which prevail the succeeding year, it has appeared to be desirable to continue this investigation for two or more seasons. Some observations were also made in regard to results secured in holding head lettuce in cold storage under different conditions. A report giving some suggestions relative to these observations and findings has been prepared and submitted for publication.

Report of Progress on Project No. 2.

The field work for the Settlers' Progress Study was completed in August, 1923. The Division of Land Economics, U. S. Department of Agriculture, carried thru the statistical work on these records and a preliminary report under the title "Dry Farming in Eastern Colorado" was prepared by Mr. E. O. Wooton, Associate Agricultural Economist of this division. This will conclude our co-operative efforts on this project for a temporary period. It is our purpose to make further observations in this same area in the near future.

Generally considered, the farming business in the plains area, according to our preliminary report, is safely solvent. From 10 to 15 percent of the farms included in this survey had no mortgage indebtedness, nearly half of them had only a small indebtedness, only about one-third had heavy indebtedness and of these only a small part were in danger of financial ruin. It is of interest to observe that many of the farm operators who were consulted reduced the amount of their indebtedness during the year 1922. It was shown further that about two-thirds of the 70 farmers in Lincoln County and three-fourths of the 81 farmers in Washington County had made gains in net worth since settling in this region. This was accomplished without taking into consideration the natural increment in the value of their lands. The increase in the value of farm lands in this area, especially for those who came into these districts several years ago when land was cheap, was considerable. There is no question but that some of the men who bought their farms during the war-time boom period paid, or agreed to pay, too much money for their land.

Report of Progress on Project No. 3.

The cost records which were secured from men who are producing beef cattle on the range were analyzed and a preliminary report entitled "An Economic Study of the Costs and Methods of Range Cattle Production on 41 Ranches in Colorado for the year 1922" was published and distributed. This report was written by Mr. G. S. Klemmedson of the Bureau of Agricultural Economics, U. S. Department of Agriculture. An additional report relating to costs and methods of carrying cattle on national forest ranges in Colorado, Wyoming, Montana, Utah and Idaho in 1923 was also prepared and distributed. Plans have been made to continue this project another year at least.

In the preliminary statement which has been issued relative to costs and methods in the range-cattle business, it has been suggested that if cattle are to be produced at a profit in the immediate future it will be necessary to have a perceptible increase in the market price of beef cattle or the operator must face the other alternative, namely, to decrease production costs. In order to reduce present costs, operators must of necessity give more attention to the better utilization of the range. The condition of the range determines largely the marketability and price which well-bred cattle command. Serious consideration should also be given to the means of increasing the calf crop by better management of the breeding herd. This may be done by providing the proper amount of range to maintain the cattle in good flesh, by owning the proper number of well-bred bulls, by culling non-productive cows, and by holding the breeding herd in small pastures before turning out on the open range.

Report of Progress on Project No. 4

Detailed farm-accounting records were maintained on some 26 farms during the past year. These records include complete information regarding the hours of man and horse labor required in handling

each farm enterprise; also the measured acreage and the total production for the crops grown together with the details showing the current farm expenses, crop sales and livestock-feeding operations. Two preliminary reports were issued during the year. One of these contains an analysis of the sheep-feeding operations on these farms for the year 1922-23 and 1923-24; the other involves an analysis of the cattle-feeding operations on these farms for the same periods.

Sheep feeding as conducted in the Poudre Valley may be counted as a supplement to the regular farming operations. It uses labor that would otherwise be idle during the entire season; it makes it possible to grow roughage which may be utilized in the feedlot. The accumulated manure when returned to the soil not only adds to the store of plant food in the soil but it assists in bringing about a better physical condition. If these indirect benefits were omitted entirely, the records show that the returns from sheep feeding pay market prices for everything fed or used and approximately one dollar per head remained clear profit. Price fluctuations introduce a certain degree of risk into the business but apparently this risk is no greater than in other farm enterprises.

Report of Progress on Project No. 5

The report on Rural-Life Studies last year indicated that records had been obtained from approximately 1000 families in a typical small town located in a prosperous agricultural district. Similarly 100 successful farm families representing important types of farming in different parts of the State were interviewed. These records are being tabulated and summarized. It is our expectation that it will be possible to prepare and distribute at least two preliminary reports giving the results of these two rural surveys.

Respectfully submitted,
L. A. MOORHOUSE,
Agricultural Economist.

REPORT OF THE ENTOMOLOGIST

To the Director:

Following is a brief report of the work of the Entomology Section during the past year:

There have been no changes in projects or personnel since my last report. Some of the lines of work under the project, General Insect Investigations, have been different than in former years. The losses from insect pests have not been greater than in average years.

Mr. George M. List, who devoted most of his time to the work of the State Entomologist, has been granted a leave of absence for one year to pursue graduate work at the Iowa State College.

Plant-Louse Investigations

The work on this project by Miss Palmer and the writer has been continued chiefly in the preparation of an annotated list of the aphids occurring in this State. It is anticipated that a portion of this list may be ready for publication during the coming year.

Ants of Colorado in their Relation to Plant Lice.

Professor C. R. Jones, who is in charge of this project, has made good progress in his work during the year, but the number of species that are being studied is large and it is probable there will be no paper for publication for some time to come.

Codling-Moth Studies

The work on this project has been carried chiefly on the funds of the State Entomologist, in the vicinity of Grand Junction by Mr. Wm. P. Yetter, Jr., and in Delta County by Mr. J. H. Newton. Considerable attention has been given to the use of attractive liquids for the capture of the moths. The results of this work will be given out in circulars from the office of the State Entomologist or in bulletins from the Experiment Station from time to time.

Considerable work has also been given to a study of the use of oils as ovicides for the Codling Moth, and to keeping orchardists informed as to the seasonal development of the Codling Moth so that the sprays might be applied at the proper dates.

Grasshopper Control:

Grasshoppers have been more severe the past summer in their attacks upon field crops, especially alfalfa, corn and wheat, than for several years past. A large amount of poisoned-bran mash has been used in the State for their control, and, in most instances, with quite satisfactory results. More than 1000 packages of prepared poison in condensed form have been sent to farmers from this office at actual cost during the summer and early fall.

Anabrus simplex, which was so very destructive to crops in Moffat counties last year, appeared in large numbers the past spring and was again quite destructive, but we did not have funds to put on a special campaign for its control as we did last year.

General Insect Investigations

Under this general project our chief work during the year has been with the Mexican Bean-Beetle, *Epilachna corrupta*, and with the Oyster Shell Bark Louse, *Lepidosaphes ulmi*. The former has been spreading thru Delta County and has become established in Mesa County the past year. It promises to be one of the most serious pests to beans on the Western Slope in the future. It did rather serious damage to beans being grown for the cannery in Delta County this year.

The Oyster Shell Bark Louse has become a very serious pest to the shade trees in Fort Collins and in some other sections of the State, especially to the ashes, cottonwoods, willows and purple lilacs. Investigations to determine the best means of control are in progress and have been in charge of Mr. List. This work will be reported upon later thru bulletins or circulars.

The Alfalfa Nematode, or Eel-worm, *Tylenchus dipsaci*, which was first reported in the State in the vicinity of Canon City in the spring of 1923, has been found upon a fairly thoro but hasty survey of the State, made in co-operation with the Federal Bureau of Plant In-

dustry and the Botanical and Bacteriological sections of this Station, to be very widely distributed in Colorado. It was found to occur in practically all of the alfalfa-growing sections. It was found to be rather common in the alfalfa fields of the Western Slope, and to occur occasionally in northern Colorado in Weld and Larimer counties, and it was also taken in the Arkansas Valley from Canon City to Lamar. As a study of the distribution of this nematode progressed, it became more and more evident that the severe dying out of alfalfa that occurred in many places the past spring and summer was not, to any considerable extent, due to this parasite.

In many fields the alfalfa crowns were decaying and dying to such an extent that it was almost impossible to find a healthy plant; while in others, where the nematode could be readily found in any part of the field, the alfalfa was doing well and the owners did not notice that there was any diseased condition present. While it is entirely possible that this Eel-worm may be found, on fuller investigation and under conditions favorable to its development, to be serious enough to demand close attention, I believe it would be a mistake, at this time, to put out any incendiary articles concerning it. It can probably be controlled by suitable methods of crop rotation. We plan to continue our investigations concerning this important pest to determine more fully its abundance, its distribution in the State, and the extent of its injuries and to report conditions from time to time.

The Alfalfa-Weevil control has been in direct charge of Mr. J. H. Newton, who is stationed during the greater part of the year at Paonia, Delta County. A considerable part of Delta County, a comparatively small area in Montrose County, and a very small area in Gunnison County, are infested with this insect, but so mildly that, for the past two years, very little damage has been done. In fact, the weevil has not been present in sufficient numbers to enable Mr. Newton to get a good test upon control measures. It seems further, that the little parasite *Bathoplectes curculionis*, which we introduced into the infested area soon after the presence of this weevil became known, may be largely, or possibly entirely, responsible for the large reduction in its numbers in the infested areas.

Mr. J. L. Hoerner has given his time chiefly to the work in the insectary, to the insect collection, and to a few important garden pests, especially the Potato Flea-beetle, *Epitrix cucumeris*, and the Mexican Bean-Beetle.

A technical paper of 58 pages, entitled "New Colorado Lachnini," giving the results of a rather thoro study of the plant lice attacking conifers in Colorado, was published in the March number of Annals of the Entomological Society of America, in joint authorship with Miss M. A. Palmer. The paper describes 18 new species and contains four full pages of colored plates, two pages of halftones, six pages of zinc etchings and two figures in the text.

Respectfully Submitted,
C. P. GILLETTE,
Entomologist.

REPORT OF THE FORESTER

To the Director:

The work of the year has been concerned with completing the project on Timber Decay, which is the only one in force. The last of the test specimens was removed from the culture box in June, last, and during the summer the data from the investigation were plotted in graphic form to show the relation between loss of weight, due to decay, and loss of strength in the wood.

A report on the project is now being prepared as rapidly as time left from teaching permits. Considerable library and reference work has been found necessary in order to learn what has been done along similar lines.

Arrangements have been made with the Forestry Department of the Michigan Agricultural College to use part of the report in connection with a thesis for the degree of Master of Forestry from that institution. The part of the report to be used is the description of a preliminary investigation carried on just before the present project was inaugurated under the Experiment Station.

Respectfully submitted,
B. O. LONGYEAR,
Assistant in Forestry.

REPORT OF THE HOME ECONOMICS SECTION

To the Director:

During the year 1923-24 work on the different problems of this section has been carried on as follows:

I. The Cooking Quality of Colorado Potatoes.

a. The scientific data obtained in the course of the experimental work of this laboratory has been compiled for comparisons and conclusions. The bulletin embodying this data is being written.

b. The manuscript for a housekeeper's bulletin on this subject is nearly ready for publication. A food supplement to this bulletin seemed necessary. The manuscript for this supplement is ready.

II. Bread-making Qualities of Colorado Flours.

Experimental work on this problem is nearly completed. A housekeeper's bulletin on the subject has been begun. It is hoped it will be completed within a few months.

III. Principles of Making Fruit Jellies.

Examinations of and experiments with Colorado fruits regarding their jelly-making properties have been in process. This research supplements a detailed study of the principles of jelly-making carried out and published by the writer in 1908-'11 at the University of Illinois. A new bulletin for housekeepers, embodying the results of all these researches is nearly ready for publication.

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

REPORT OF THE HORTICULTURIST

To the Director:

I beg to submit the following brief report of the status of the experimental work carried on by the Horticultural Section.

ORCHARD-MANAGEMENT PROJECT

The work is carried on at the College fruit farm, Austin, Delta County. The project includes methods of cultivation, cover crops, pruning and thinning. The results show conclusively a lack of thorough cultivation in Colorado orchards. This neglect necessitates more frequent irrigation and the use of large quantities of water. Proper soil conditions cannot be maintained with this practice and the effect upon production is very apparent.

Experiments with the use of cover crops have been delayed in order to get the orchard into a uniform condition so that the results will be comparable between the different kinds of crops to be used. Cover crops are now extensively used in Colorado orchards, but as yet no definite system has been worked out. There is a tendency to sow perennial crops and to let them grow for a number of years,—a practice that is not conducive to best results.

The work in pruning shows that our apple trees carry too much wood for the production of high-grade fruit. This is particularly true of the older orchards. Size of fruit is greatly affected by the growth vigor of the trees and in order to maintain size of the fruit, more thorough pruning is necessary.

Thinning Fruit

Experiments on thinning peaches have been in progress for the past two years. The results are conclusive. A block of peaches was carefully thinned after the June drop. This block packed out 99½ percent extra fancy, while the unthinned block packed out 60 percent. The results for the two years were almost identical.

Variety Testing

During the past two years, testing plots of apples, pears and plums have been planted. These variety plots are all doing well with the exception of the sweet cherries. A number of new varieties are being tried, as well as varieties which are not at present grown in the State commercially.

GRAPE PROJECT

The grape industry in Colorado has, in the past, been neglected. The results obtained from the small home plantings show that both the European and the American varieties of grapes can be grown successfully in the warmer valleys on the Western Slope, and that the American varieties succeed exceptionally well in the Arkansas valley from Canon City to LaJunta. In order to furnish the needed information on grape growing in Colorado, an experimental vineyard was started two years ago on the College fruit farm and additional plantings

were made last spring. Both American and European varieties are being used, the object being to determine hardiness and adaptability of different varieties and also to study their behavior under different methods of culture and training. The outlook for the grape industry is very promising.

POTATO PROJECT

Potato Certification

This work is very important to the potato-growing industry, as it tends to keep up the yield of the crop. It has been in operation for the past five years and is constantly growing. Certified seed is grown under close supervision of the department, and two field inspections are made during the growing season. Before certification is given, the grower must comply with all the rules and directions laid down by the department as well as pass the field inspection. The rules cover the character and source of the seed planted and cultural methods. The inspection covers freedom from diseases, vigor of the plants and trueness to type. The grade must be U. S. No. 1.

Seed potatoes, grown under the conditions described above and certified, carry the department certification tag and are sold under it. The price obtained by the growers for certified seed has been \$3.00 per 100 pounds during the past five years. The growing of certified seed is mostly confined to the non-irrigated lands and to higher altitudes.

Farmers' Seed Plot

To encourage the individual potato growers in planting better seed potatoes, the seed-plot method of seed improvement was inaugurated this year in co-operation with the county agents in the San Luis Valley. The growers were to select the best possible tubers from their past year's crop and plant these separately, enough seed to be selected to furnish seed for the total planting next year. These plots were to be given the best care possible during the growing season. The plots were inspected by the department and rogued of diseased plants, of weak hills and of mixture.

By this method we hope to build up a given variety or strain and increase the production of higher grades of table stock. Seed plot potatoes should not be confused with certified seed.

Potatoes on College Farm at Avon

The first year's work at Avon was more or less unsatisfactory. In the first place the rotation system practiced before we took over the farm was such as to make potato growing unsatisfactory. Further, the land was "potato sick." A longer rotation period must be followed together with a greater diversity of crop. This will be possible in the future.

VEGETABLE PROJECT

Head Lettuce

The head-lettuce industry is still expanding and the high prices obtained this year will stimulate the industry further. We are carrying on work with head lettuce along the following lines: Cultural methods, irrigation, early and late planting, planting of seed obtained from different sources, and control of tipburn, as well as studying the effect of temperature and moisture upon the development of disease. Testing plots of cauliflowers, carrots and rutabagas were grown to determine their adaptability to high altitude. These plots were of sufficient size to produce trial shipments to obtain data on prices and profits of production.

Green-Pod Peas

The growing of green-pod peas in high altitudes started three years ago. The peas arrive on the market when pod peas grown in the lower altitudes are not obtainable. The high quality prices obtained, assure the growers of a handsome return. The crop would be grown more extensively, were it not for the problem of obtaining the necessary labor in picking the pods.

Seed Peas

This year an experiment was started to determine whether seed peas could be grown in high altitudes. Four and one-half acres were planted under ordinary field conditions. The varieties grown were the Dwarf Telephone and the Alderman. During the growing season the field was carefully rouged to eliminate mixtures and weak plants. The crop matured perfectly and was harvested. Threshing is now in progress. The yield promises to be good. The seed has been sold to a seed company in Denver for 10 cents per pound, and they are anxious to make a contract for next year. The prices should give a handsome profit to the farms, since the cost of production is low.

Peas for Canning

In order to test the quality of our mountain peas for canning, a number of canning varieties were grown on limited areas. When they were in proper state of maturity, 500 pounds were shipped to the Libby, McNeil and Libby canning plant at Manzanola to be canned. The result of the canning test was very encouraging. The foreman expressed the hope that they might obtain canning peas of like quality. He also stated that it is very difficult to obtain high-grade canning peas, and the market was paying almost any price for the right quality. There is a wonderful future for the pea-canning industry in our high altitudes, for the quality of our mountain pea is unexcelled. They yield heavily and can be grown at a low cost.

VEGETABLE PROJECTS AT THE COLLEGE FARM

Celery

For the past three years, we have been testing varieties and strains of celery. This work was undertaken to aid the celery growers around

Denver in finding a variety or a strain that would meet the demands of the market and at the same time produce a satisfactory return to the growers. The Denver section produces large quantities of both early and late celery, but the standard varieties of these two kinds have not proved satisfactory. The result of our work, thus far, has shown that certain strains of both early and late varieties possess the required qualities, and these will be recommended to the growers in a bulletin to be published shortly.

Hubbard Squash

Efforts are also being made to develop a strain of wilt-resistant squash by selection. This work is necessarily slow, and will require several years to complete.

TOMATO PROJECT

For the past two years, we have been co-operating with Libby, McNeill and Libby in the development of better canning tomatoes. This work has been in progress for two years. Last year, due to the late spring frosts and destructive hail storms, no results were obtained. This year we had ideal weather conditions and the work accomplished was satisfactory.

The work is centered on two lines: First, to find a variety or varieties of tomatoes that will make a satisfactory yield and have the required canning qualities; Second, to cross the best canning varieties and to grow or plant from the cross-bred seed. It has been found that cross-bred seed produces high yield and high quality for the first year. We now have on hand from the summer's work a sufficient amount of cross-bred seed to grow at least an acre under average farm conditions. This work will be continued.

In conclusion, I wish to express my appreciation for the uniform support the department has received and for the personal interest you have taken in our work.

Respectfully submitted,
E. P. SANDSTEN,
Horticulturist.

REPORT OF IRRIGATION AND DRAINAGE INVESTIGATIONS SECTION

To the Director:

During the fiscal year ending June 30, 1924, the work of this section has been confined to the projects mentioned below.

As reported last year, the improvements made to the Venturi flume, an Adams project, have now been verified, both by laboratory and field tests, and show that this new device has wonderful possibilities. The laboratory work necessary in the development of this improved Venturi flume was done both at the Fort Collins and Bellvue laboratories. The calibration covered flumes of 1, 2, 3, 4, 6 and 8 feet in length for both free-flow and submerged conditions. A maximum of 62.5 second-feet

was used in the calibration of the larger sized flumes with a minimum of 0.3 second-foot for the 1-foot flume. The study of this type of flume reveals the fact that, due to the formation of a hydraulic jump within the structure, a marked degree of submergence is possible before the discharge is reduced from that of the free-flow. It is observed that as the width of the throat, or size of flume, increases, the degree of the resistance to submergence also increases. For the smaller flumes, the degree of submergence allowable is 70 to 75 percent, while for the larger sizes, this degree of submergence is from 75 to 80 percent. One great improvement over the Venturi flume has been the elimination of the throat reading as a function of the discharge, where the degree of submergence is not greater than about 75 percent. During April, a number of these flumes were installed in the Arkansas Valley, being used in connection with the Duty-of-Water study. These flumes varied in size from a throat width of 6 to 36 inches. Because of the great quantity of sand and silt carried in the irrigation water of the Arkansas Valley, this improved device has been found to be especially well adapted to meet the conditions as found there.

To observe the action of this type of measuring device a wooden flume with a 6-foot throat was constructed in the Rocky Ford ditch at Rocky Ford. The capacity of this ditch was about 90 second-feet. This flume has been under constant observation and at all times has been clean of deposit; however, the width of throat is somewhat too great to insure a free-flow condition. Under the present dimensions it has a submergence of from 85 to 95 percent. On a large lateral from the same ditch an improved Venturi flume was built with a throat width of 3 feet and a depth of 3 feet. Close observations have been made as to the action of this flume and it was found that if the difference in head (upper head minus throat head) was not less than 0.05 foot, no deposit would occur; however, if the difference be reduced to 0.02 foot, a deposit was immediately accumulated in the depressed floor of the throat section. A large flume with a 10-foot throat was constructed in the Holbrook Ditch near Rocky Ford. Since the installation, only general observational data have been secured. Nearly 600 second-feet have been measured through this structure, but because of shortage of water a complete calibration of this large flume has not been possible.

The improved Venturi flume possesses three important characteristics, namely, it is accurate, is self-cleaning, and successfully operates under a small loss of head.

Under the Hatch fund two projects have been carried; the Evaporation Experiment and the Measurement of Water as applied in irrigation. As reported last year, the Evaporation-Experiment studies have been carried both within and without the laboratory. Inside the laboratory further observations were made relative to the effect of wind. Under still-air conditions within the laboratory, the data indicate that as the difference in temperature increases, that is, temperature of air minus temperature of water, the rate of evaporation decreases. Wind affects the rate of evaporation, but sufficient study has not yet been

made to isolate the direct effects of this factor. Sufficient observations, under still-air conditions, have now been made to definitely say that within the laboratory the maximum rate of evaporation occurs about sunrise in the morning. The evaporation observations taken under fully exposed conditions outside the laboratory show the rate of evaporation to be greatest during the afternoon. The experiments in evaporation have been confined to observation on pans three feet square. To ascertain the relation of these smaller pans to a water surface of moderate size, it was necessary to waterproof carefully the circular reservoir at the hydraulic laboratory for the purpose. The comparative results of these observations are not yet available.

The project on Measurement of Water has included special studies on devices at the hydraulic laboratory. A series of observations was made to determine the accuracy of the Great Western irrigation meter. This instrument operates in connection with a submerged orifice; that is, for a certain effective head on the orifice this same head is operative on the instrument. Because of the variation in the constant discharge, and further, because of the instrument being built for a definite constant of discharge, the relation only agreed within certain limits of head.

Under this project special study was made concerning the effect upon the hydraulic jump formed in a contracted section caused by a parabolic floor. It was discovered that such an arrangement might be a very desirable improvement to the present improved Venturi flume. Tests were conducted as to the possibility of using positive and negative pressure heads as a means of indicating the effective heads in connection with the discharge through the improved Venturi flume.

No improvements have been made at the Bellvue laboratory this year.

Under State funds, the projects in Meteorology and Duty-of-Water Study in the Arkansas Valley have been carried during the past fiscal year. The work in Meteorology has been a continuation of that in past fiscal years, consisting in the observation of meteorological conditions twice daily (7 a. m. and 7 p. m.), the posting of weather bulletins each day, and the publishing in local papers of the more important weather data and reports.

The Duty-of-Water Study in the Arkansas Valley has now been conducted over a period of three consecutive years. This study has been carried on in two parts; first, where special observations have been made on experimental plots, and, second, where close record has been made as to the use of water on several farms in the valley. Our irrigation studies made in connection with the experimental plots, especially with sugar beets, have not been entirely successful. Fair records were obtained the first year from our plot studies. However, no marked effect was observed in yields where varying increased or decreased amounts of water were applied to various individual plots. Considerable variation in yield also existed as to the amount of water used per acre of beets by the several farmers co-operating in our study.

At the outset of our co-operative work with the American Beet Sugar Company at Rocky Ford, a comprehensive program as to

rotation was assumed. The second year's work on the plots required the planting of beets on ground previously planted to this crop. Adverse weather conditions existing after the young plants were started necessitated three different times. This handicap, together with bacterial infection later in the season, resulted in a poor yield sufficient to vitiate results or effects of irrigation. During this second year, the farm studies were continued and some substantial results obtained. In general it may be said that on a medium sandy-loam soil frequent and light irrigation of sugar beets is to be recommended. A rather wide variation in the duty of water for various crops, as observed on the special farms, was again noted. The records relative to the season of 1924 are not yet available, but it is expected that some very interesting and important information will result from the standpoint of irrigation.

In addition to the work on projects, considerable time has been given to special assignments throughout the State, this additional work consisting in giving assistance in the drainage of irrigated lands and measurement-of-water problems, both for farmers and ditch companies.

Respectfully submitted,
 RALPH L. PARSHALL,
 Irrigation Engineer.

REPORT OF THE VETERINARY PATHOLOGIST

To the Director:

PROJECTS IN FORCE

- I. Sheep Losses in the Feedlots
 - (a) Hemorrhagic Septicemia,
 - (b) Paratyphoid Dysentery,
 - (c) Icterohematuria,
 - (d) San Luis Valley,
 - (e) Overfeeding on grain.
- II. Contagious Abortion
- III. General

SHEEP LOSSES IN THE FEEDLOTS

Hemorrhagic Septicemia

This disease was very rare during the last year, consequently only routine typing work on the organisms previously isolated was attempted. This seems to indicate that the organisms do fall into different groups as measured by the agglutination tests.

Paratyphoid Dysentery

A very serious outbreak of paratyphoid dysentery, involving some 30,000 lambs, occurred in the Fort Collins district during October, 1923. The total loss was approximately 2,000 head. A very thorough investigation was made by this Section, which resulted in the isolation of the organism responsible, in the reproduction of the disease in

healthy animals, and in the determination of the relation of fasting to the disease. A complete report was presented under the authorship of the undersigned and Floyd Cross, at the meeting of the American Veterinary Medical Ass'n, at Des Moines, held in August, 1924. This will be published in an early number of the journal of this association.

Briefly, this disease was described in sheep for the first time. It was shown that large doses of the organism could be given to healthy animals without their showing any symptoms, provided they were fed continuously. If however, they were fasted for forty-eight hours, small doses by the mouth would produce a fatal disease. This work was suggested by the fact that the outbreak was in lambs which had gone a considerable length of time without feeding, during shipping. It indicated that special precautions should be taken to see that lambs be fed at frequent intervals while in transit. Mere fasting would not produce the disease, but fasting in connection with the organism was fatal.

Icterohematuria

This disease continues to take its toll from the older sheep in the mountainous districts. We have now definitely located it in practically all of the mountainous areas from Steamboat Springs to Durango. It seems to be getting more serious. While we have been able to visit a number of outbreaks and have gathered material for study, we are still very much in the dark as to its cause and means of control.

San Luis Valley

Last year we turned this experiment over to the Animal Husbandry Section, retaining only an advisory relationship. Since the disease has been thought by some to be due to the malignant *Edema bacillus*, we prepared filtrates from these organisms and vaccinated one-half of the lambs used this year, simply to obtain information as to the possibility of this filtrate being of value in the prevention of the trouble.

Overfeeding of Grain

The losses in the Fort Collins district during the last season were approximately three percent, being the same as the previous year. Most of this loss occurred in the corn-fields or on heavy grain-feeding in the pens. It took place in the lambs that were nearly ready for market and in those that were getting heavy grain rations. In all cases cutting off the grain ration was sufficient to stop the loss. Mr. Bartels kept an accurate record of the amount of grain fed, and the loss for each day during the feeding period. A chart showing this relationship was prepared and exhibited by Mr. Bartels to the sheep feeders on Feeders' Day. This established very conclusively, that with the increase in the grain ration the death loss mounted up. When the grain ration was cut the death loss ceased. We have this year distributed charts to a large number of the feeders with a view to getting this record kept on a large number of lambs, in the hope that by spring we shall have a larger amount of data on this very important question.

CONTAGIOUS ABORTION

Two years ago we entered into a co-operative arrangement getting more correct data on the use of the live-organism vaccine for contagious abortion. After carrying on these studies for two years we have found it necessary to discontinue the work, because of the lack of co-operation on the part of the owners. In the meantime the disease has vanished from the herds.

There was, however, a very serious explosion in the College herd during the past year which we have followed very carefully, making blood tests at frequent intervals, and separating the animals into two groups on the basis of test. By close co-operation on the part of the Animal Husbandry Department we have been able to eliminate the disease entirely from the herd. In the future, no animals are to be added except after two tests made at a thirty-day-interval, with isolation of the animal in the meantime. We believe we have shown here a practical application of the present theoretical knowledge in relation to this most serious malady.

Abortion tests have been made as usual for all those sending in blood. As a result, during the past year, we have made 684 tests, 119 of which were positive, or 17.3 percent.

GENERAL

We have continued to make diagnoses in the laboratory for all those wishing to make use of our services. Six hundred twenty-two (622) lots of specimens have been examined during the past year.

Owing to the seriousness of White Diarrhoea in chickens, special attention has been given to eliminating the disease from the flocks of the State. In connection with this work we have made 2325 blood tests which showed 438 positive reactions, or 19 percent. We are expecting this work to increase very materially in the next year.

A considerable number of trips have been made with a view to investigating special outbreaks of disease, among the most prominent of which have been:

Arsenical poisoning in sheep, with a loss of 70 head, near Brush, Colo.

Potato poisoning in horses in the San Luis Valley with quite a heavy loss.

Forage poisoning the Arkansas Valley.

Miss Beulah Malone, technician, resigned to take effect September 1, and was replaced by Miss Ruth Harrison.

Respectfully submitted,
I. E. NEWSOM,
Veterinary Pathologist

REPORT OF THE VETERINARIAN

To the Director :

The only project allowed in the Veterinary Section is the one on Animal Diseases. This is a general project and takes care of a certain phase of animal-disease investigation in a very satisfactory way. It is not only helpful in emergency cases, which appear from time to time, but enables us to keep in touch with livestock conditions throughout the State in a general way, and to lend assistance when called upon by State or National authorities.

Only one disease, assuming epizootic proportions, has appeared among animals in the State during the past twelve months. *Mycotic stomatitis* has been wide-spread among horses and cattle in the western states during the past summer and fall. It is now apparently subsiding. The mortality has been comparatively insignificant, but the economic loss has been considerable, mostly because of the loss of flesh and milk during the periods of sickness and convalescence.

The dread foot and mouth disease, which appeared in California and Texas, seems to be well under control, but is still an element of danger which will require eternal vigilance until it is definitely stamped out.

An experiment conducted at Walsenburg during the early summer was decisive in establishing the fact that cattle, at least, are seriously poisoned by eating the leaves of scrub oak.

From the standpoint of communicable diseases, the domestic animals of the State are exceptionally free at this time.

We wish to continue during the present fiscal year with the one project of Animal Diseases.

Respectfully submitted,
GEO. H. GLOVER,
Veterinarian

ENGINEERING DIVISION

To the Director :

I am transmitting herewith the report of the Civil Engineering and Mechanical Engineering sections of the Experiment Station.

Respectfully submitted,
L D CRAIN,
Vice-Director

REPORT OF THE MECHANICAL ENGINEERING SECTION

To the Chairman, Engineering Division :

The following is a summary report of the investigational work carried on in the Mechanical Engineering Department of the Engineering Experiment Station during the Federal fiscal year, July 1, 1923, to June 30, 1924:

The projects upon which the Mechanical Engineering Department was engaged were: (1) Testing of Lubricating Oils; (2) Treatment of Alkali and Other Waters for Domestic Use.

The projects upon which we would like to prosecute work during the present fiscal year are: (1) Completion of the project Testing of Lubrication Oils; (2) The Humidity of Air in Buildings. The project, Treatment of Alkali and Other Waters for Domestic Use, was completed during the first part of the present fiscal year.

Further outline of the work has not been made to date since the projects under investigation at present will probably occupy the entire fiscal year.

The more important conclusions reached during the investigation on "The Treatment of Alkali and Other Waters for Domestic Use" are:

(1) The domestic water supplies of Colorado, as a whole, are good, although alkali waters may be found in practically every section of the State.

(2) The ill effects of alkali water, although they may not disappear, are not particularly objectionable after a person becomes accustomed to drinking alkali water unless it is extremely alkaline.

(3) A deep well, either for an individual or a community, will often solve the problem of domestic water supply.

(4) Distillation is the only method by which alkali water may be purified for drinking purposes.

(5) Household water stills now on the market are simple, convenient to operate, and inexpensive, but considerably over rated. For instance, one still was rated as high as 1 to 6 quarts per hour and the maximum capacity under laboratory conditions was found to be .86 quarts per hour. A household still operated on the back of a kitchen stove with an ordinary fire will not produce enough distilled water for an average family, but it must be operated directly over a fairly hot fire to produce from 1 to 2 gallons of distilled water every 10 hours.

(6) Water may be distilled from 10 to 15 percent cheaper with coal than with artificial gas, although 9 times as much heat must be produced in a coal stove as with a gas burner to distill the same amount of water.

Respectfully submitted,
G. A. CUMINGS,
Assistant in Mechanical Engineering

REPORT OF CIVIL ENGINEER

To the Vice Director:

Following is the report of the Civil Engineering section of the Experiment Station and covers the experimental work done by the section from July 1, 1923, to June 30, 1924.

Two projects have been under way during this time; (1) The Effect of Beet Pulp on Concrete; (2) Co-operative Work with the State Highway Department covering the Road Materials of Colorado.

A report covering the results of the investigation to determine the effects of beet pulp on portland cement mortar and concrete is nearly complete, but is being delayed in order that additional data may be secured on a few minor points. A bulletin covering this work should be ready for publication early in 1925.

The co-operative agreement between the State Highway Department of Colorado and this section, entered into in 1921, is still in effect. The field party during the year has consisted of two men. The chief of party, who worked throughout the entire year, was employed by the Highway Department. One helper, who worked during the summer season only, was furnished by this section.

In the laboratory, no regular extra help has been required. Student assistants have been employed when the work was more than the testing engineer could do.

During the period covered by this report, samples from 192 deposits of road materials located by the field party have been tested in the laboratory. A total of 244 samples from all sources have been tested. A system of State highways has now been practically covered by the field party.

We are unable to state as this time just what our plans will be for next year, as they will depend to a large extent on the State Highway Department. If the co-operative agreement is continued, their wishes of course will be paramount.

The purpose of this project, as originally stated, was "To Test the Road materials of Colorado and determine those best suited for surfacing the earth roads of the State; to construct sample sections of roads surfaced with the materials available; and to secure data wherever possible as to the wearing quality of these materials." Our work to date has dealt largely with the first phase of the project. Future plans should include a consideration of the last two phases, at the same time keeping the laboratory equipment in readiness at all times to do such testing as may be requested by State, county or city officials within this State.

Respectfully submitted,
E. B. HOUSE,
Civil Engineer

REPORT OF THE EDITOR OF PUBLICATIONS

To the Director:

Although a less number of bulletins was published by the Experiment Station this year than last, Station workers are preparing several which cannot be included in this year's report. This office has assisted in preparing illustrations for several of them.

In addition to several news stories concerning the work of the Station, special publicity was given the division through special stories for New Year and other editions of State papers.

Programs and circulars announcing the annual Lamb Feeders' and Cattle Feeders' Days were handled through this office. Several stories were also distributed concerning these particular events.

Six new bulletins, two reprints and the annual report, consisting in all, of 248 pages, and a combined edition of 28,000 copies, were published for the Experiment Station during the year.

Following is a complete list of the publications:

Title and Author	Pages	Edition
287—Grasshoppers Control in Colorado C. L. Corkins	20	4000
288—The Pit Silo John W. Sjogren	12	3000
289—Necrobacillosis Geo. H. Glover	12	3000
290—Beautifying the Home Grounds E. Monroe Lowry	20	4000
291—The Effects of Nitrates on the Composition —of the Potato William P. Headden	32	2000
292—Hardy Varieties of Apples for Northeastern Colorado E. P. Sandsten	8	5000
Thirty-Sixth Annual Report Reprints	40	1500
259—Colorado Plant Diseases Julian G. Leach	96	3000
262—Sod Disease of Chickens I. E. Newsom and W. H. Feldman	8	2500
	248	28,000

Respectfully submitted,
I. G. KINGHORN,
Editor of Publications.

