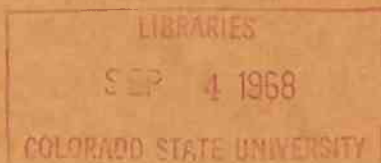


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THE STATE AGRICULTURAL COLLEGE  
OF COLORADO

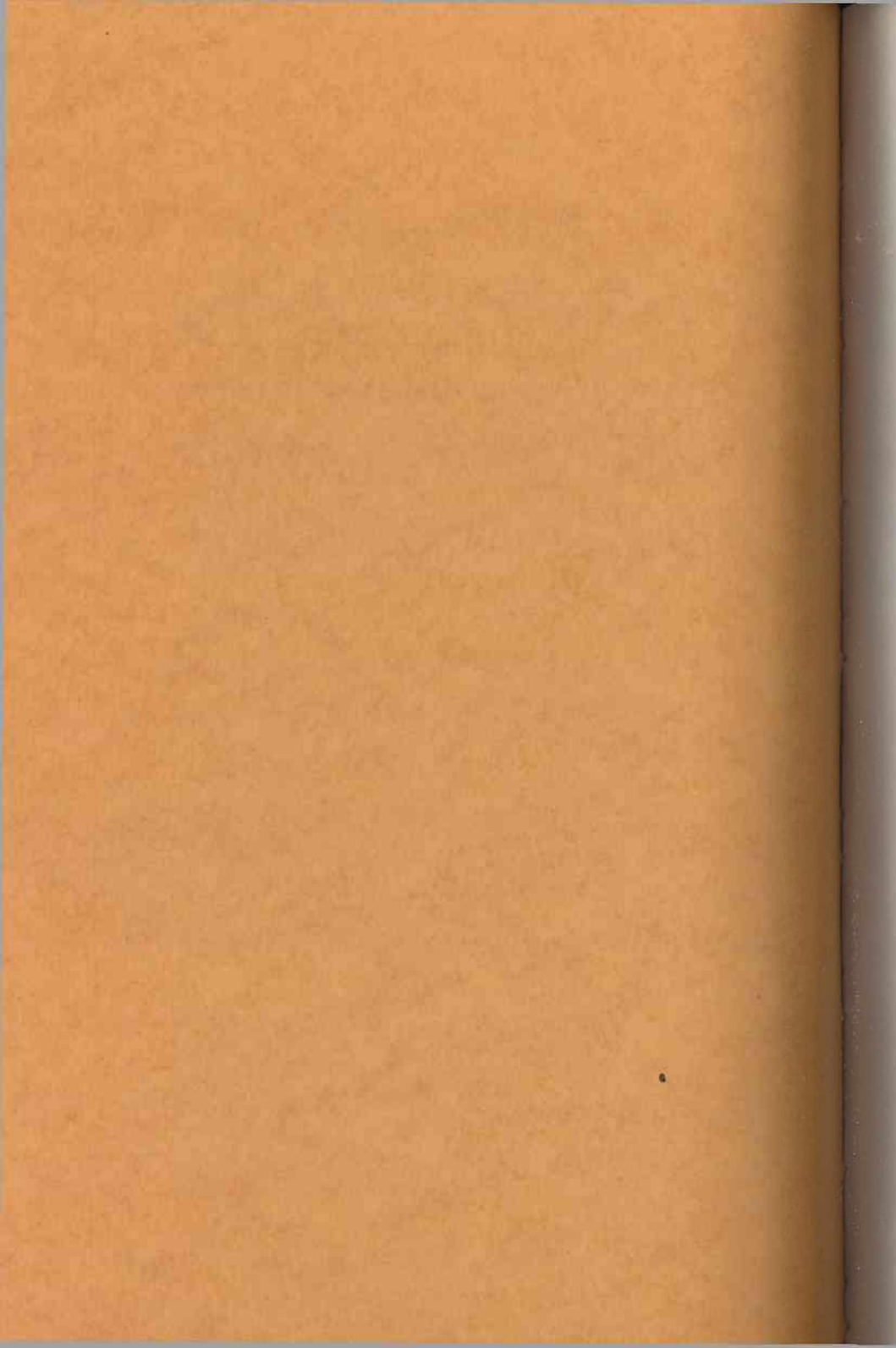
THE THIRTY-NINTH  
ANNUAL REPORT

— OF —

The Colorado Agricultural  
Experiment Station



FOR THE YEAR 1926



THE STATE AGRICULTURAL COLLEGE  
OF COLORADO

THE THIRTY-NINTH  
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The Colorado Agricultural  
Experiment Station



FOR THE YEAR 1926

# The Colorado Agricultural College

## FORT COLLINS, COLORADO

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CHARLES R. JONES, B.S., M.S.....	Associate in Entomology
GEO. M. LIST, B.S., M.S.....	Associate in Entomology
CHARLES I. BRAY, B.S., M.S., Ph.D.....	Associate in Animal Investigations
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R. T. BURDICK, B. S. M.S.....	Associate in Rural Economics
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MARJORIE J. PETERSON, B.A., M.S.....	Home Economics Investigations
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LUCILE CHURCH, B.S.....	Assistant in Home Economics

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O. V. ADAMS, B.S., M.S.....	Associate in Civil Engineering
G. A. CUMMINGS, B.S.....	Assistant in Mechanical Engineering

\*On leave, 1926-1927,

**FINANCIAL REPORT OF THE COLORADO AGRICULTURAL EXPERIMENT STATION  
FOR THE FISCAL YEAR ENDING JUNE 30, 1926**

	Hatch Fund	Adams Fund	Purnell Fund	State Mill Levy Fund	Special Fund	Pure Seed Fund	Special App'ns.	Total Funds
<b>DR.</b>								
Balance July 1, 1925.....	\$.....	\$.....	\$.....	\$ 12,876.54	\$ 2,419.24	\$8,579.49	\$4,000.00	\$ 27,875.27
From the Treasurer of the United States as per appropriations for the fiscal year ending June 30, 1926, under acts of Congress approved March 2, 1857, (Hatch Fund), March 16, 1906, (Adams Fund), and February 24, 1925, (Purnell Fund).....	15,000.00	15,000.00	20,000.00	.....	.....	.....	.....	50,000.00
Other sources than the United States.....	.....	.....	.....	104,343.37	36,721.07	.....	.....	141,064.44
	\$15,000.00	\$15,000.00	\$20,000.00	\$117,219.91	\$39,140.31	\$8,579.49	\$4,000.00	\$218,939.71
<b>CR.</b>								
To Salaries.....	14,570.80	.....	16,382.05	38,327.95	9,931.63	4,271.31	150.00	98,933.74
Labor.....	.....	.....	604.00	20,343.86	635.37	1,566.80	.....	23,150.03
Stationery and office supplies.....	8.35	.....	189.17	1,351.35	54.90	186.96	.....	1,790.73
Scientific apparatus, consumable.....	47.85	.....	131.96	582.69	2,348.47	43.80	.....	3,454.77
Feeding stuffs.....	.....	.....	6.85	7,177.83	880.69	.....	.....	8,065.37
Sundry Supplies.....	18.00	.....	47.66	2,735.83	826.00	163.73	60.65	3,851.87
Fertilizers.....	.....	.....	.....	35.66	.....	.....	.....	85.66
Communication service.....	.....	.....	33.39	745.83	4.32	9.35	2.52	795.41
Travel expense.....	.....	.....	1,975.76	0,190.11	52.21	269.73	22.18	8,509.99
Transportation of things.....	.....	.....	7.32	936.75	3.22	13.62	14.48	975.39
Publications.....	.....	.....	.....	2,157.16	207.50	30.00	.....	2,403.66
Heat, light, water and power.....	.....	.....	6.35	241.50	2.38	.....	.....	250.23
Furniture, furnishings and fixtures.....	45.00	.....	227.80	1,921.13	148.05	113.49	.....	2,455.47
Library.....	10.00	.....	91.29	706.97	123.71	41.24	.....	973.21
Scientific equipment.....	.....	.....	213.55	2,680.08	486.48	375.94	.....	3,658.05
Livestock.....	.....	.....	.....	3,103.01	5,619.35	.....	.....	8,722.36
Tools, machinery, appliances.....	.....	.....	1.80	3,361.38	15.09	13.35	.....	3,391.62
Buildings and land.....	.....	.....	6.05	14,391.95	1,277.32	.....	100.00	16,775.32
Contingent expenses.....	.....	.....	75.00	483.20	65.57	6.00	.....	629.77
Total expenditures.....	\$15,000.00	\$15,000.00	\$20,000.00	\$107,724.24	\$22,682.26	\$7,114.32	\$ 349.83	\$187,870.65
Balance on hand June 30, 1926.....	.....	.....	.....	9,495.67	16,458.05	1,465.17	3,650.17	31,069.06
Grand total.....	\$15,000.00	\$15,000.00	\$20,000.00	\$117,219.91	\$39,140.31	\$8,579.49	\$4,000.00	\$218,939.71

## LETTER OF TRANSMITTAL

To His Excellency, Clarence J. Morley, Governor of Colorado:

In accordance with the law of Congress establishing Agricultural Experiment Stations, I have the honor to transmit herewith the Thirty-ninth Annual Report of the Colorado Agricultural Experiment Station for the state fiscal year, December 1, 1925, to November 30, 1926, and the financial statement for the federal fiscal year, July 1, 1925, to June 30, 1926.

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 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, 1926

## AGRICULTURAL DIVISION

### Report of the Director

To the President:

I have the honor to present herewith the Thirty-ninth annual report of the Colorado Agricultural Experiment Station. It contains a brief account of the activities in the various lines of investigation during the last state fiscal year, December 1, 1925 to November 30, 1926; and contains a complete financial statement covering the last federal fiscal year, July 1, 1925, to June 30, 1926. The funds for the support of this work came in part from the general government, and in part from the state mill levies as follows: Federal funds, Hatch, Adams and Purnell, \$50,000; State of Colorado, \$104,343, a total of \$154,343. The total receipts and expenditures, as shown by the treasurer's books, considerably exceed this amount because of numerous receipts and expenditures in the revolving fund and in sales funds in the several sections. While the total money for experimental work may seem large, when considered apart from the work it is supposed to carry, it really is far below the amount necessary to carry anything like all the investigations that are urgently needed to solve the economic problems that face the agricultural industries in Colorado. Some important problems cannot even be touched.

While there have been considerable crop injuries from the attacks of insect pests and plant diseases during the year, and locally some of the losses have been severe, the general losses have not exceeded those of the average year, and we are still spared the devastation due to many of the recently imported pests that destroy crops in the eastern and southern sections of the country. I refer particularly to such destructive insects as the Gypsy moth, the brown tail moth, the Japanese beetle, European corn borer and the cotton boll weevil. The alfalfa weevil, however, is greatly extending its occupied area on our Western Slope. The codling moth continues to be our major enemy to the apple-growing industry.

The ruling of the federal authorities, under the Pure Food and Drug Act, concerning the amount of arsenic that may be present on apples or pears offered for inter-state shipment in this country, has resulted in a very serious loss to the fruit growers of Colorado this year, but the work that the experiment stations are doing promises very largely to remove this loss in the future. The Chemical Section of this station has already developed a washing process that promises to provide a cheap, simple and effective method of removing

the poison from fruit, and our Mechanical Engineering Section is co-operating in the devising of a machine to handle the fruit in the washing vat.

Investigational work in the Home Economics Section has been in abeyance since the resignation of Dr. N. E. Goldthwaite more than a year ago, but Professor Allison has recently secured Mrs. Marjorie Peterson to take her place. Mrs. Peterson has already begun work upon a new Purnell project entitled "The Baking of Flour Mixtures at High Altitudes." The outlook for good experimental work in this section is promising.

The summary of work is so well given in the accompanying reports from section heads, I take pleasure in referring you to them rather than to take further space myself, except to give a list of all the projects in the several sections that are active at the present time. They are as follows:

## 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.
- High-Altitude Crops. State funds.
- Plains Crops and Management. State funds.
- Improved Seed. State funds.
- Arkansas Valley Nitre Control. (In cooperation with Bacteriology). State funds.

### Animal Investigations Section

- Ration Experiments with Cattle. State funds.
- Rations for Fattening Lambs. State funds.
- Death losses among lambs in Fedlots in the San Luis Valley. State funds.
- Range Improvement. (Cooperation with Botany). State funds.
- Summer-Fallow Experiment with Sheep at Akron, Colo. State funds.
- Acre Value of Irrigated Pasture. State funds.
- Agglutination Test for White Diarrhoea. State funds.
- Mineral Feeding. State funds.

### 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.
- Natural Inoculation of Colorado Soils with Legume Bacteria. Hatch and State funds.
- Arkansas Valley Nitre Control. (Cooperation with Agronomy). Purnell and State funds.

### Botany Section

- Cereal and Field-Crop Disease Studies. Hatch and State funds.
- Truck-Crop Disease Studies. Hatch and State funds.
- Physiology of Seeds. Purnell and State funds.
- Root Disease of Alfalfa. Adams fund.
- Range Improvement. (Cooperation with Animal Investigations). State funds.

### Chemistry Section

- The Part Played by Carbon Dioxide in Crop Rotation. Adams fund.

### Entomology Section

- Plant-Louse Investigations. Adams fund.
- Ants of Colorado in their Relation to Plant Lice. Hatch and State funds.
- Codling-Moth Control. Hatch and State funds.
- Grasshopper Control. State funds.
- General Insect Investigations. State funds.
- Alfalfa-Nematode Studies. State funds.

### Economics and Sociology Section

- Farm Organization and Costs of Production Survey in Typical Peach-Growing Districts. Purnell fund. Cooperative with U. S. Dept. of Agriculture.
- Detailed Farm Accounting and Farm Organization Research on 26 Irrigated Farms in Greeley Area. Purnell fund. Cooperative with U. S. Dept. of Agriculture.
- Costs and methods of Producing Cattle and Sheep in Colorado. Purnell fund. Cooperative with U. S. Dept. of Agriculture.
- The Social Status of Spanish People in Colorado. Purnell fund. Cooperative with U. S. Dept. of Agriculture.
- Taxation Problems Relating Particularly to the Agricultural Industry of Colorado. Purnell fund. In cooperation with Bureau of Agricultural Economics, U. S. Dept. of Agriculture.
- A Study Relating to the Marketing of Cantaloupes and Potatoes in Colorado. State funds. Cooperation with Division of Markets, Denver.

### Home Economics Section

The Baking of Flour Mixtures at High Altitudes. Purnell fund.

### Horticultural Section

Orchard Management on College Farm at Austin. State funds.

Potato Investigations. State funds.

Tomato Crosses at Manzanola, Colo. State funds.

Commercial Production of Hardy Vegetables in High Altitudes, Avon, Colo.; Onions, Cauliflower, Peas.

Fertilizer Project. State funds.

Celery Project. State funds.

Disease-Resistant Squash. State funds.

### Irrigation Investigations Section

Measurement of Water as Applied to Irrigation. Hatch and State funds.

Loss of Water by Evaporation. Hatch fund.

Meteorology. State funds.

### Pathology Section

Sheep Losses in Feedlots. Hatch fund.

Contagious Abortion. Hatch and State funds.

General Disease Investigations. State funds.

### Veterinary Section

Animal Diseases. State funds.

## ENGINEERING DIVISION

### Civil Engineering Section

Sub-Grade Soils of Colorado. State funds.

Road Materials of Colorado. State funds.

### Mechanical Engineering Section

Humidifying Air in Buildings. State funds.

Treatment of Alkali and Other Waters for Domestic Use. State funds.

Fire Protection by Carbon Dioxide Gas. State funds.

Apple-Washing Machinery. State funds.

Respectfully submitted,

C. P. GILETTE,

Director.

## REPORT OF THE AGRONOMIST

To the Director:

I am submitting a brief summary report of the activities of the Agronomy Section for the fiscal year December 1, 1925, to November 30, 1926.

The Agronomy staff for the fiscal year has consisted of Alvin Kezer, chief; D. W. Robertson, associate; G. W. Deming, assistant, with headquarters at Fort Collins; J. W. Adams, specialist at Cheyenne Wells; P. K. Blinn, specialist and Justus C. Ward, chemist, in cooperation with bacteriology, at Rocky Ford, and Dwight Koonce, assistant in high-altitude agriculture at Fort Lewis. This staff was increased on August 1 by the addition of Dr. Frederick B. Smith, who replaces Professor Marshall as associate professor in the Agronomy department and in addition is assigned certain Agronomy Section experimental duties. So far Mr. Smith has been trying to get acquainted with our western agriculture.

The projects in force at Fort Collins in the Agronomy Section have been Investigations on the Critical Periods in the Development of Crop Plants for Moisture; Improved Seed, Correlation of Plant Characteristics with Performance, and Rotations. Under improved seed we are carrying subsidiary projects of corn improvement, both wheat and barley improvements, pasture mixtures and a study of forage crops, including legumes, temporary pasture mixtures and many of the sorghums.

At Akron the Agronomy Section is cooperating with the Office of Dryland Agriculture. In addition to the regular cooperation, we have been using the Akron plant to test out wheats, mostly hybrids, which are being bred for superior qualities. The winter conditions at Akron are quite severe. Because of this fact, nature eliminates the weaklings among our hybrids. We are carrying each year at Akron something over a thousand hybrid progenies. As the severe winters eliminate the weaker ones, we add new progenies for trial. In addition to this work we are cooperating on dryland rotations, tillage methods and forage crops. A new series of plats was put out in 1926 under this cooperation.

For the biennial period 1925 and 1926, the legislature in 1925 made an appropriation for Cheyenne Wells. None of this appropriation was available during 1925. The first of the appropriation became available May 12, 1926. This was so late in the season that most of the general farm planting had been done. However, we im-

mediately ordered seeds for forage crops and pasture-mixture plats. We also ordered corn seed for variety testing and had some of these tests under way during the season. Altho the start was late, we were able to get out the tests on legumes, sorghums, forage and grain crops, pasture and forage mixtures and corn tests. We used a portion of the fund to put the building equipment in shape for work in case the state decides later to finance better this important dryland work. We also installed some needed equipment in the shape of scales and machinery, which will better enable us to carry on the work. We still need further equipment of this nature if we continue investigations at Cheyenne Wells.

The work at Rocky Ford has been in cooperation with the Bacteriology Section. It has consisted of the continuation of the studies on ways and means of controlling the excessive nitrate production. We have established three sets of rotations on the station farm. We are also studying the effect on nitrate production in the soil, of the applications of organic matter, having different nitrogen percentages. The applications are so made that the same amount of nitrogen is applied. The carriers, however, have different percentages. We are using sawdust, cut barley straw, cut corn stalks, cut alfalfa hay and dried blood. We now have two years preliminary work on this phase. These two years work indicate that the application of an organic manure, rich in carbon compounds but low in nitrogen, tends to decrease the nitrate production in the soil.

This study may lead to practical results because it may point the way to a successful and profitable use of organic residues such as straw, which have in the past been largely burned. We are also studying the effect of the application of different fertilizers and fertilizer compounds on nitrate production and balancing of soil nitrates.

The work at Ft. Lewis has been a continuation of our high-altitude crop program. We are testing out varieties of small grains, varieties of peas, alfalfa, clover, root crops and forage mixtures.

We will desire to continue work on all of these projects during the coming year and may want to add some features, especially the nitrate work and the dryland work.

We have published no bulletins during the year, but have submitted a manuscript on the Critical-Period work with the hope that it will be published in the Journal of the American Society of Agronomy. One paper entitled, "Effect of Time of Irrigation on Production of Crude Protein in Wheat," was published in Vol. III, No. 5 of Cereal Chemistry. This paper was presented before the Cereal Chemists at their meeting in Denver.

We have manuscripts prepared but not completely edited on the Residual Effect of Different Irrigation Treatments and on the fallacy of trying to make a state-crop program by experiments in one point in a state so varied as Colorado. We are working on material for a crops bulletin and dryland bulletin. We have material gathered for a bulletin on Critical-Period work but do not have it organized. The question of time between other duties is the only delaying feature on our part.

There is developing a considerable call for fertility work. In addition to the work we are already doing, we have had calls from the Arkansas Valley, from the Colorado Springs and Divide region and a rather persistent set of calls from the Western Slope. We can take care of part of these calls with our present support but we cannot enter into any very enlarged program without additional help. It would seem that these fertility inquiries would constitute the next phase of our agronomic work.

When the state was new, in fact, for the past several years, the great and most insistent demand was for information on crops—what types were adapted to the different regions, which varieties within those types were best, how to produce those crops and handle them to get the best product to market. This demand still persists and probably always will persist, but now there is coming forward an additional set of demands—what is the matter with our soil? Why will it not produce as much as formerly? What should we add to get this production? These questions simply show that our people have arrived at a different stage in their agricultural thinking and realize that even our rich soils have problems which must be solved if the best and most profitable production is to be continued. Some of these inquiries have come from organizations that have considered themselves self sufficing and independent in the past.

I refer particularly to the Great Western Sugar Company. They have been putting forward an insistent demand for information on fertility and rotation. Of course, we were able to supply a very large amount of disconnected information but we do not have any well-organized set of experiments which answers the questions that should be answered, not only for the sugar company, but for the farmers who produce the crops which the sugar company markets. We could answer the question of these farmers and the company if we had had a definite set of rotation and fertility experiments of at least ten years duration, preferably longer. .

I think we must look forward in the very near future to the organization of such a set of experiments. A set which will include studies of crop rotations and soil treatments, which will be laid out

to be carried for an indefinite number of years. Conclusion should not be reached in less than 15 years; probably a much longer period should be contemplated. To carry out such a program as it should be carried out might require the acquisition of additional land in order that plat land could be laid out in a definite set of rotations and treatments, which could be followed without a break or interference with other experimental work for an indefinite period of years. These questions are fundamental because they lie at the base of our agriculture. Long-time experiments must be contemplated because we have seen examples where continuous cropping had been followed on a piece of land for twenty years without showing signs of deterioration, yet other lands have apparently been exhausted in much less time. If not exhausted certain troubles arise such as too heavy nitration, an exhaustion of organic matter, the presence of disease or insect pests or nematode infestation, or some similar trouble. In other words the land which has withstood the bad practice of continuous cropping for a long period of years has simply been lucky in not running into some of these difficulties. Inquiries are coming in which indicate the beginning of a demand for information on these subjects. We can supply some information but we will never be able to supply as complete information as the agricultural industry is entitled to until we attack this problem in different neighborhoods. Eventually we will be obliged to have experimental fields in different sections of the state, working on these problems. We should look forward now to such work. We should begin in a more thoro fashion at Fort Collins.

Respectfully submitted,

ALVIN KEZER,

Chief Agronomist.

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### REPORT OF THE ANIMAL HUSBANDMAN

To the Director:

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

#### PROJECTS CONDUCTED DURING THE YEAR 1925-26

Ration Experiments with Cattle—E. J. Maynard.

Range Improvement—E. J. Maynard.

Rations for Fattening Lambs—E. J. Maynard.

Death Losses Among Lambs in Peafields in San Luis Valley—E. J. Maynard.

Summer-Fallow Experiment with Sheep—E. J. Maynard and Geo. E. Morton.

Winter Maintenance of Ewes—C. I. Bray.

Mineral Investigations—C. I. Bray.

Agglutination Test for White Diarrhoea—O. C. Ufford.

Pastures—Geo. E. Morton.

## PROJECTS WHICH WE DESIRE TO CARRY DURING THE PRESENT YEAR

### Rations Experiments with Cattle—

#### (a) Calf Feeding.

Lot 1 Pulp, barley, ground corn fodder, cottonseed cake, alfalfa.

Lot 2 Wet pulp, barley, corn silage, cottonseed cake, alfalfa.

Lot 3 Dried pulp, barley, corn silage, cottonseed cake, alfalfa.

Lot 4 Dried molasses pulp, barley, corn silage, linseed cake, alfalfa.

Lot 5 Dried pulp, barley, corn silage, linseed cake, alfalfa.

Lot 6 Dried pulp, corn, corn silage, linseed cake, alfalfa.

### Range Improvement—

#### (a) Range Management.

Studying the value of early protection and early production plus rotation in building up low foothill range in Colorado.

### Rations for Fattening Lambs—

#### (a) Lamb Feeding, Fort Collins.

Lot 1 Corn (twice daily), alfalfa hay.

Lot 2 Corn (thrice daily), alfalfa hay.

Lot 3 Corn (hand fed to self fed), alfalfa hay.

Lot 4 Corn, ground corn fodder, linseed oil cake, alfalfa.

Lot 5 Corn, corn silage, linseed oil cake, alfalfa.

Lot 6 Corn, dried pulp, cottonseed cake, alfalfa.

Lot 7 Corn, dried pulp, linseed oil cake, alfalfa.

Lot 8 Corn, wet pulp, linseed oil cake, alfalfa.

Lot 9 Corn, dried molasses pulp, alfalfa.

Lot 10 Corn, dried pulp, alfalfa.

#### (b) Cornfield Lamb Feeding.

Lot 1 Corn and alfalfa.

Lot 2 Cornfield and alfalfa.

Lot 3 Cornfield, half sugar-beet field and alfalfa.

Lot 4 Ground corn fodder, half sugar-beet field and alfalfa.



**Death Losses Among Lambs in Peafields in San Luis Valley—**

(a) Lamb Feeding, Monte Vista.

Lot 1 Pastured at will in peafield.

Lot 2 Pastured at will in peafield, cull potatoes and alfalfa.

Lot 3 Pastured at will in peafield, mineral mixture.

Lot 4 Corn, alfalfa, peafield with shelter.

Lot 5 Corn, alfalfa, peafield without shelter.

**Summer-Fallow Experiment with Sheep—**

A number of years of work has shown definitely that a small flock of sheep may be maintained upon dryland at little extra cost beyond the use of a weed pasturage on fallow land and the roughage stored as a by-product from cash crops. Also, it has demonstrated the ability of the sheep to clean land of weeds in a marked degree. Since this experiment has shown results, there has been a very marked increase in the use of sheep in the Akron territory where experiments are conducted, and this undoubtedly will spread to other sections.

**Mineral Investigations—**

The use of minerals in livestock rations.

**Agglutination Test for White Diarrhoea—**

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

**Pastures—**

Investigation into the carrying capacity and value of irrigated pastures for dairy cows.

Respectfully submitted,

GEO. E. MORTON.

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**REPORT OF BACTERIOLOGIST**

To the Director:

I have the honor to submit herewith the annual report of the Bacteriological Section of the Experiment Station for the State fiscal year, December 1, 1925, to November 30, 1926.

While it has been our desire to confine our investigations to three lines of work supported by Adams and Purnell funds, it has been im-



possible to adhere to this as closely as we had wished. This has been due to the demand made upon our time by contemporary problems which we had not anticipated and which required immediate attention. As a result, we have not made the progress upon our major subjects that we had expected. Again, the amount of routine service which we are called upon to render in the form of examination of diseased plants, soil, water, milk, eggs, vinegar, etc., has increased to a point where it consumes a very appreciable amount of our time. While much of this work deserves prompt and careful consideration, the fact remains nevertheless, that it encroaches upon our research activities and due allowance should be made accordingly.

## PROJECTS

1. **Vegetable Spoilage.**—The present phase of the investigation has dealt with a comparative study of the production of spores by *Clostridium botulinum* in different vegetable broths and meat infusion.

The results indicate that both corn and pea extracts are equal if not superior to meat, while bean and spinach are less favorable.

2. **Azotobacter Studies.**—It is an established fact that the development of *Azotobacter* in soil, with the accompanying fixation of atmospheric nitrogen which results in excessive and harmful nitrate accumulation, is dependent upon the soil reaction.

We have endeavored to control this bacterial growth by means of the acid produced from decomposed green manures and crop residues plowed into the soil. Our first experiments failed to show any appreciable increase in the acidity, but more recent studies, in which the hydrogen-ion determinations were made upon moist samples, rather than upon dry as formerly, have shown a small amount of acid following the use of green barley, an amount so small however, as to be of little economic importance.

We have continued our efforts to isolate pure cultures of soil algae free from bacterial contaminations. When such cultures are secured, we wish to use them in certain experiments in associative action with *Azotobacter*.

**Rocky Ford Niter.**—This is a cooperative investigation between the Sections of Bacteriology and Agronomy.

Until the present year, our investigations have been directed toward the effect of different treatments, cultural practices and cropping systems upon nitrate production in the soil. Having reached rather definite conclusions as a result of the experiments of the past four years, we changed our objective somewhat this season, and have

studied the effect of soil treatment upon the quality and yield of the different crops in addition to the production of soil nitrates under the crops.

We have also undertaken a systematic survey of the soil nitrates in the Arkansas Valley from Pueblo east to the Kansas line to ascertain what correlation may exist between soil nitrates, crops grown and soil type.

A brief report upon this project by Mr. Ward, chemist in charge of the Rocky Ford Laboratory, follows:

The Colorado Experiment Station Laboratory located at Rocky Ford, Colorado, established in March, 1922, has now followed the results of five growing seasons.

In the year of 1926, additional data concerning the effects of crop rotations upon soil-nitrate accumulations were gathered. Three types of crop variation were studied, two of which were being grown on the Experiment Station Farm, and one on the American Beet Sugar Company's Research Department's land. The results again pointed most clearly to crop rotation as the most feasible of the control measures available in the treatment of excessive nitrates.

Further work was done on the problem of fertilization. Plots being treated with the varying combinations of fertilizers, and then a complete series kept fallow, while another series was cropped. These tests were conducted upon the Experiment Station Farm and proved to be quite interesting—the fallow ones especially so, as adverse hails vitiated the results expected in the cropped sections. The cooperative work on fertilizers, begun last year between the American Beet Sugar Company, the United States Department of Agriculture and the Colorado Experiment Station Laboratory, was continued and enlarged this year, and the exchange of complete data between the three should prove to be of mutual benefit.

Crop residues and their effects upon the soil nitrates were studied a little more elaborately again. Little of a conclusive nature has been secured from this work as yet, altho indications are being strengthened, and theories confirmed by the added progress of the experiment.

The work of watching the vertical movement of the nitrates within a six-foot soil column was continued, the samples being taken from fields cropped to alfalfa, corn and cantaloupes, and each four-inch section being saved separately for analyses. That made eighteen samples from each six-foot boring, and gave sufficient nicety to warrant very interesting deductions.

Reported above are those projects which were carried over from previous years. The only new venture of any considerable importance is that of a so-called valley survey. With such definite trends noted in the Rocky Ford district during the first four years of work, it was considered advisable to test those trends on both sides of the section already studied so a survey was started. Samples were taken from Lamar to Pueblo at intervals of about five miles, and these analyses repeated five times thru-out the growing season. At each sample point there were two fields selected—one on which some non-cultivated crop was growing, and one on which a cultivated one had been planted. The uncultivated fields in the east end of the valley uniformly carried higher percentages of available nitrogen than those in the west end. More work is desirable on this phase of the problem.

The availability of a soil map made it possible for a correlation to be made between soil type and nitrates along with the valley survey, and that factor should add to the value of the latter project.

Additional equipment and improved technique has enabled the laboratory to handle more samples than were analyzed last year, altho less time could be spent in the laboratory on account of increased sampling duties. A total of two thousand five hundred thirty-eight soils were handled during the period reported herein.

Further work along the lines of the fertilizer problems, nitrate and crop yields, valley survey, nitrates and soil type, crop residue phenomena, is contemplated for future effort—as well as a new project upon salt toxicities related to soil colloids.

Respectfully submitted,

JUSTUS C. WARD, Assistant in Chemistry.

4. **Legume Inoculation.**—A serious handicap to the progress of this investigation in the past has been the transportation of large quantities of soil from the remote parts of the state. This difficulty has been overcome by a new method of making the test developed by us which will accomplish our end with much less soil, and which will be free from the previous annoyances we have experienced from dust and air contaminations. It is our plan to continue the work another year.

5. **Bacterial Wilt and Root-Rot of Alfalfa.**—Corroborative evidence has been secured that bacteria are at least one of the factors causing the recent wilt and root-rot of alfalfa. Forty-five bacterial cultures have been isolated from affected roots and stems of alfalfa, out of which nineteen have been identified as *Aplanobacter insidiosum* (L. McC). Studies by the Botanical Section cooperating with us on this project, suggest that other agents than bacteria may cause pathological changes which would produce wilted plants similar to those found under field conditions.

6. **Bacterial Rot of Green Tomato Fruits.**—A new disease of green tomatoes, which manifests itself as a soft, black rot of the fruit, has caused heavy losses in the commercial greenhouses in Denver. No other parts of the plant appear to be affected. Our investigations have shown that the trouble is caused by an actively motile, spore-forming bacillus.

7. **Soil Sterilization for Greenhouses and Seedbeds.**—Cooperative experiments have been carried on with greenhouse managers and truck growers for the purpose of obtaining a satisfactory method of sterilizing the soil of greenhouses and seedbeds. Steam under pressure discharged into the soil thru removable perforated pipes has proved entirely satisfactory. The detailed procedure has been written up for publication as an Experiment Station bulletin.

8. **Control of Bacteriosis of Beans by the use of Two-Year-Old Seed.**—Field experiments for the control of bacteriosis of beans by planting two-year-old seed were conducted in the Arkansas Valley. A very appreciable reduction in the number of diseased plants resulted from this seed as compared with one-year-old stock.

9. **Sulphogerm as a Fertilizer and Soil Inoculum.**—Extensive field tests, located at Fowler, Grand Junction, Avon, Manzanola, Rocky Ford, Cheyenne Wells and Windsor, Colorado, were carried on with Sulphogerm, a soil inoculum, to determine its value for crops in Colorado soils. Returns from the different experiments at the end of the season show that the yield of tomatoes was increased somewhat, and that nematode infestation on sugar beets was less where Sulphogerm was applied.

Bacteriological tests of the water of the swimming pools in Ammon's Hall and the Men's Gymnasium have been made at regular intervals as a check on the sanitary condition of the water and the efficiency of the purifying mechanism.

In the various phases of our work, I have been ably assisted by Miss Ida Wray Ferguson, Mr. Justus C. Ward, Miss Alpha Powell, Mr. Arthur Moinat and Miss Vernice Ewart, whose efficient services I take pleasure in acknowledging.

Respectfully submitted,

WALTER C SACKETT,  
Bacteriologist.

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## REPORT OF BOTANIST

To the Director :

Herewith I am submitting a report of the Station activities for the past year, 1926.

The following projects have been carried by the Botanical section of the Station :

### Alfalfa Root-Rot

Investigation of the root-rot of alfalfa has been continued, in cooperation with the Station Bacteriologist. The findings to date show that the plants die thru lack of water induced by a plugging of the water ducts with a pentosan gum. This reduces the water supply to one-fourth of normal, resulting in a wilting and failure of starch production and storage. Such plugging can be produced independent

of organism by use of certain salt solutions in as weak a solution as 1-100 normal. Study has been made of normal and abnormal anatomy of the root and stem of alfalfa.

### Cereal Diseases

Study of stinking smut of wheat is being continued. Tests have been carried on the past year in five localities in the state. Twenty-five hundred test plots have given indication of the effect of copper carbonate as a remedy for smut as compared to formalin, bluestone and a number of commercial compounds such as Gemisan, Uspulun, etc. Moisture and soil—temperature records and records for growth gave valuable data on conditions of infection of wheat. Tests were also made on treatments for sorghum smut; also hulless barley and oats were treated successfully for smut with copper carbonate. Some 1200 Colorado strains of wheat were again tested for resistance to rust and selections made.

### Truck-Crop Diseases

Spraying and dusting experiments for mildew were carried with success on cucumbers under glass near Denver. In field tests on pumpkins, with the same disease at Montrose, control was effected but proved too expensive.

### Range Improvement

I. **Range-Management Studies.**—The effects of various management systems upon the vegetation and grazing capacity of ranges were studied in considerable detail in the low foothill pasture near Fort Collins and also near Akron. These studies included quadrat measurements, precise observations and photographs. A large amount of data was collected in each place which is being digested and prepared for publication during this winter. In the foothill pasture (cattle) clear evidence of overgrazing and injury to vegetation was found under the continuous system, and recommendations, based on the condition of the vegetation, will be made favoring the deferred, rotation system. At Akron on the continuously grazed native-sod pasture (sheep) prickly pear and buffalo grass are invading. A change in management is recommended to determine if the grazing capacity (1 ewe and her lamb) per acre, can be maintained without depleting the range. Surveys of North Park and San Luis Valley furnished valuable data and resulted in contacts that will serve as a basis for cooperative range-management studies, as well as for studying other phases of range improvement.

**II. Improvement of Depleted Ranges.—1 Artificial Reseeding.**—A trip to North Park yielded data on results on several plots that were seeded last spring. The results were mostly negative at this time.

**2. Natural Revegetation.**—All of the work done on the range this summer has bearing on natural revegetation. The enclosures protected from grazing in the national forests give evidence that natural revegetation is fairly rapid, provided that natural stand of palatable plants has not become too thin.

**III. Improvement and Maintenance of Pastures and Meadows.—(Irrigated, Dryland, Mountain).**—Over 80 plots on the Agronomy Farm at Fort Collins, containing mixtures of different tame grasses under various degrees of clipping, were studied intensively using quadrats, measurements, photographs and precise observation. Certain plants as orchard grass and red clover were found to dominate other grasses in the first year or two after planting. Much information on the habits of the plants in relation to competition between species, on longevity, etc., was secured. Similar studies were made on irrigated pastures under grazing conditions. This large mass of data that has accumulated is being prepared for publication. Seed is being collected from various sources for testing out forage species under dryland and irrigated conditions. Careful observations, measurements and photographs have been made of forage plants that are being tried at Akron and at Fort Collins. The dryland pastures planted last spring at Akron have been carefully studied.

**IV. Basic Ecologic Studies.**—The amount of forage and the methods of handling the forage plants depend upon ecologic factors. Hence, before any system of range management can be recommended, basic ecologic data must be secured. In connection with trips to Akron, North Park and San Luis Valley for other specific grazing purposes, considerable basic ecologic data has been collected for the plains, sandhills, eastern foothills North Park and San Luis Valley. Preliminary reports of a reconnaissance nature is being prepared for the two latter areas.

An ecologic-forage study has been started of the wild hay meadows under irrigation in North Park and San Luis Valley. Determination of species, ecological habits, nutritive value, history and methods of handling the meadows are being made.

**V. Miscellaneous Problems** on which observations have been made:



- a. Grazing in relation to erosion.
- b. Grazing in relation to reproduction and growth of trees.
- c. Seeding and germination habits of the more important range plants.

### Physiology of Seed

Work on hard seed of alfalfa has been completed and is being written as a bulletin. It has been found that heating alfalfa seed at 60°C., for 1 hour corrects the condition of alfalfa seed known as hardness and brings the germination to 95 or 98 percent. Study of the seed coats shows the epidermal layer to be the factor influencing permeability and the use of certain dyes indicates that heating changes the chemical composition of the cells of this layer so they can absorb water. No loss of viability follows heating as is the case with scarification.

A special study of methods of germinating vine seeds by use of various temperatures, and substrata was made in an attempt to discover whether low germination in several hundred lots of vine seeds was due to faulty method of harvesting and curing, to storage conditions, or to methods of germination.

Tests of sugar-beet seeds were made comparing blotters and sand as substrata in comparison with sand tests made by the Great Western Sugar and the American Beet Sugar Companies.

Some special work was carried on with a view to determining the field value of frosted seeds of oats and barley. Such seeds are frequently produced in our high altitudes. It was found that by the use of low temperatures these frosted seeds will germinate nearly as well as normal seeds do by the usual methods. Field plantings in various parts of the state show that frosted barley which shows 95 percent germination by the low-temperature method produces approximately 90 percent as good a stand as normal barley with a germination of 95 percent, while similar oats produces only about 70 percent as good a stand as normal oats.

A study was made of the dormant period of seed of *Stipa nelsonii* and *Stipa comata* with a view to assisting in range studies. Study was also made of the germination of the seed of wild oats, *Avena fatua*, which has been found to germinate when produced in our region and contrary to usual belief does not have to pass a resting period before germination.

### Report of the Seed Laboratory, Dec. 1, 1925 to Nov. 30, 1926

1. Total number of samples sent in voluntarily by dealers and farmers for the year ending Nov. 30, 1926, was 2,666, approximately 350 more than for the preceding year.

2. Three hundred fifty-seven inspection samples were taken in various parts of the state. One case based on flagrant violations of the seed law resulted in the preparation of the case and putting it into the hands of the district attorney of Mesa county for prosecution.

3. Four hundred samples of cereals, alfalfa and vine seeds were tested in connection with the certification of seeds by the Extension Agronomist and the State Horticulturist.

4. Seventy-five samples of cereals were tested for the Experiment Station Agronomist in connection with studies on longevity of cereal seeds.

5. Forty samples of soybeans were tested for the Experiment Station Agronomist in connection with a study of the inheritance of impermeability in soybean seed.

6. Tests were made as follows:

Purity	2435
Germination	3720
Identifications	250
Examinations	23
<b>Totals</b>	<b>6628</b>

7. Five hundred twenty tests of alfalfa seeds were made in connection with the study of impermeable seeds in alfalfa.

8. Continued publicity and inspection work on lawn-grass seed frauds resulted in a fraud order being issued by the Post Office department against Allen W. Miller and in his arrest.

9. Fifteen short articles on seeds were prepared in connection with campaigns for the use of better seeds.

10. One paper was prepared for the meeting of the Colorado Seed Trade Association.

11. Several hundred specimens of grasses, weeds and seeds were identified for farmers and others.

12. A large amount of work has been continued with the study of impermeable seeds of alfalfa. A report on this work is now being prepared for publication.

13. One exhibit was prepared for the State Pure Seed Show.



## Weed Work

### In Cooperation with State Entomologist

The four large divisions of the weed work done in 1926 are:

1. Poison experimental work; 2. physiology of root systems; 3. cultivation and smothering and 4. educational work.

1. **Poisons.**—Poisons of several kinds have been applied to the leaves of plants and roots to note the potency of each under the conditions of application.

a. **Spray Poisons.**—A number of arsenical sprays were applied to annual weeds in plots in different concentrations. The effectiveness of the spray poisons was demonstrated by the fact that one poison in concentration of 1-120 was equal to another of concentration 1-8. Application of arsenicals to vegetative parts at different stages of growth showed that the spray was injurious at all times, tho it killed just to the ground level.

No penetration of the poisons in quantities sufficient to kill the subterranean organs was evident.

Roots have been taken from all levels at 15 cm. intervals down to 90 cm. to be analyzed for arsenic.

Poisons applied as sprays have been analyzed in this laboratory for their ingredients. With minor impurities, all are arsenical compounds of high concentration.

b. **Soil Poisons.**—Two kinds of soil poisons have been tried. "Cyanogas," a commercial low-grade calcium cyanide preparation, when placed in properly spaced holes in the ground, has been found to be useful in killing perennial-weed roots, if the soil is open and dry. This is not true with a damp, heavy soil, for penetration of the HCN gas is practically stopped. This gas quickly decomposes into a nitrogenous fertilizer. Carbon disulfide behaves as does the HCN with respect to soil moisture and structure. Attempts have been made to find an emulsifying agent for CS which will not be precipitated by soil, and thus make it possible to use. Cyanamide, a nitrogen compound of calcium, was tried as a dust to kill broad-leaved weeds, but due partly to unfavorable weather, was not found successful.

2. **Physiology of Root Systems.**—a. The extent of root systems of perennial weeds has been carefully studied. It has been found that horizontal roots of the poverty weeds grow from 4-10 feet a year in natural conditions in soft soil. Morning-glory roots spread but little more than the poverty weeds, but in many cases grow deeper. Their food-storage capacity is greater as shown by cross sectional studies, of which drawings have been made.

It has been established that the poverty-weed roots live thru three growing seasons, but the length of life of the wild-morning-glory root is not yet known. It has been shown that the size of and gross morphology of the roots of these plants depends on the physical characteristics of the soil.

b. Regenerative capacities of roots were investigated by planting sections from depths varying by 15 cm. down to 90 cm. and all below 90 cm. in a single piece. The morning glory showed no difference in regenerative activity due to differing depths, as did the poverty weed. In all cases the regenerative capacity was a function of the size of the root—the mass of reserve energy. There was found also to be a definite relation between the rate of regeneration and season, those taken in the fall, for some unknown reason, showing the highest rate. It was found too, that roots of these weeds can withstand great desiccation in the soil. Habitat pictures of a number of weeds were taken for use in future publications.

3. **Cultivation Practices.**—a. Cultivation practices were tried on plots ten feet square. Moisture determinations were made every week from May to August until the plots were accidentally flooded late in August.

b. Effects of cutting all plants even with the ground, on a 10-foot square showed complete control of annuals, except those that came up from seed. The poverty weeds were materially injured by the four cuttings.

c. **Smothering of Weeds.**—(1) **Use of Soil.**—Plots of annual weeds were covered with 6, 12 and 18 inches of soil. All annuals were killed in all depths but perennials were able to come up thru the 18 inches of soil piled on them.

When morning glories were dug up to 6, 12 and 18 inches and all roots removed, they succeeded in coming thru the 6 inches of soil, but roots destroyed to 12 and 18 inches did not return to the surface in 1926.

d. The effects of burning weeds upon the kinds that come up afterwards have been begun. The 1927 growing season will show the results.

e. Weed seeds were collected at various periods of the ripening season. These are to be germinated to study the viability and vitality with respect to age of plant when they were produced. Observations were made on time of blossoming and seeding of Shepherd's purse, poverty weed, vetch, morning glory, hare's ear mustard, dandelion, wild salsify, wild lettuce and sunflower.

## Publications

The following 19 publications have been made by the members of the section the past year.

- E. A. Lungren—*Berberis fendleri*—an alternate host of *Puccinia graminis tritic.* *Phytopathology* 16:234-235. 1926.
- Durrell, Person and Rogers—The measurement of surface tension by the use of a chainomatic balance. *Science* 64:20. 1926.
- Mary F. Howe—Changes in hydrogen-ion concentration induced by  $\text{CO}_2$  in relation to the germination of spores of *Ustilago levis.* *Abst. Phytopathology* 16:69-70. 1926.
- C. F. Rogers—Notes on the carbohydrate metabolism of Canada thistle *Abst. in Plant Physiology.* 1926.
- The use of the Quisumbing—Thomas method for the analysis of plant tissue. *Abst. Plant Physiology.* 1926.
- A simple apparatus for digestion and extraction *Science* 64: 1926.
- A comparison of the Bailey and Hertwig with the Official method of ashing plant tissue. *Cereal Chemistry* 3:226-232. 1926.
- Durrell and Kidder—Use copper carbonate dust to control stinking smut of wheat. *Extension Circ. 1, C. A. C.* 1926.
- Kidder and Lungren—Smut prevention campaign in Colorado, 1925. *Extension Circ. 44.* 1926.
- Durrell and Kidder—Smuts of small grains and methods of control. *Extension Circ. 7.* 1926.
- L. W. Durrell—Common weeds of Colorado Lawns, Colo. *Agr. Exp. Station Bulletin No. 310.* 1926.
- Rogers, Durrell and Daniels—Three important perennial weeds in Colorado, *Sta. Bul. 313.* 1926.
- Durrell and Lute—The Puncture vine—a serious weed in Colorado. *Extension Circ. 46.* 1926.
- E. A. Lungren—How to determine smut losses in grain fields. *Extension Circ. 44.* 1926.
- Leonard Johnson—An instrument for list charting. *Ecology.*
- A. M. Lute—Impermeable seeds of alfalfa made permeable by heat. *Science.* 1926.
- E. L. LeClerc—Temperature in relation to tipburn of lettuce. *Abst. in Phytopathology.* 1926.
- H. C. Hanson—Field Symposium of European Ecologists at Fort Collins, Colorado—*Ecology, October 4:17.* 1926.
- Handbook of the Department of Botany.

**Manuscripts Submitted:**

Poisonous Plants of Colorado—A bulletin with 17 plates.

Barberry eradication and sources of rust in Colorado.

The effect of carbon dioxide upon the germination of the chlamydo-spores of *Ustilago zeae*.

The relation of the anion to rate of cell permeability.

A study of hard seed of alfalfa.

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**REPORT OF THE CHEMIST**

To the Director:

The Chemical Section of the Experiment Station has at the present time but one project on which it has been engaged during the past year—The Part Played by Carbon Dioxide in Crop Rotation.

The object of this work is to obtain more definite knowledge of the manner in which rotations of crops benefit the land. The particular rotation that we are studying is that of alfalfa.

Of the various factors involved in these changes, some have taken the development of nitric acid in the soil from time to time, others have taken the ammonia. These measures of the changes going on are specific ones, namely, the products of changes brought about by certain biological agents; but for the purposes of our study, we desired a more general measure and we have chosen the amount of carbon dioxide in the soil atmosphere.

The questions arising in this connection are: What amount of carbon dioxide is present in fallow soil under ordinary conditions? Second, How is this quantity affected by the growing crops?

Another question arising is: How and to what extent is the nitrogen content of the soil modified by practice of rotation, in this case by alfalfa?

A further question arises in regard to the action of carbon dioxide upon the soil life and also upon the soil particles. The chemist is limited to the latter question, altho the former may be the more important.

We find the amount of carbon dioxide in the soil atmosphere to be very significant in amount. It is nowhere stated that a sterile soil will not produce carbon dioxide, but it seems very improbable that it would. All of our soils are giving off this compound, which means that living processes are going on in them even when they are kept in a clean fallow condition. The amount found when the soil is

occupied by a crop such as grass or clover or alfalfa is much greater—three, or even six or ten times as great.

The result indicated by our investigation so far as it has gone is that the carbon dioxide is the most efficient agent in producing the beneficial changes.

Respectfully submitted,

WM. P. HEADDEN,  
Station Chemist.

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## REPORT OF THE AGRICULTURAL ECONOMIST

To the Director:

Six projects received active consideration during the year Nov. 30, 1926. Four of these projects were carried by Purnell funds.

Project No. 1. Farm organization and cost-of-production survey in typical peach-growing districts; in cooperation with the Bureau of Agricultural Economics, U. S. Department of Agriculture.

Project No. 2. Detailed farm accounting and farm organization research on 26 irrigated farms in the Greeley area; in cooperation with the Division of Farm Management and Costs, U. S. Department of Agriculture.

Project No. 3. Costs and methods of producing cattle and sheep on the range in Colorado; in cooperation with the Division of Farm Management and Costs, U. S. Department of Agriculture.

Project No. 4. The social status of Spanish people in rural Colorado. In my preceding report it was pointed out that our efforts in the field of rural sociology have been directed toward an intensive study of child-labor conditions in the north-central part of Colorado. Some of the material collected in this investigation will be utilized under the present project title.

Project No. 5. Taxation problems relating particularly to the agricultural industry of Colorado; in cooperation with the Bureau of Agricultural Economics, U. S. Department of Agriculture.

Project No. 6. A study relating to the marketing of cantaloupes and potatoes in Colorado; in cooperation with the Division of Markets, Denver, Colo.

**Project No. 1.**—Two preliminary reports were issued by the Bureau of Agricultural Economics, U. S. Department of Agriculture, relative to the progress of this investigation during this year. One of these reports included a statistical analysis of the number of peach

trees of each age and variety in commercial orchards reported from this state. Details are given for the principal counties in Colorado. This study has provided an excellent background for a comparison of the Colorado peach industry with other regions, especially in relation to our contribution from the standpoint of national production.

The other report deals with the cost of developing orchards and the cost of producing peaches. This information should prove to be suggestive at least in pointing out the more important cost items for men who are engaged in this enterprise. A knowledge of the outstanding expenses of production may be used in reducing costs and in establishing the enterprise upon a more profitable basis. The work which has been accomplished to date will be supplemented by a further study of farm organization plans and farm management practices in districts where special attention is given to the production of peaches.

**Project No. 2.**—This project has been under way for approximately five years. The results thus far have been used as a basis for the discussion of profitable systems of farm organization and management in the irrigated districts of Colorado. Two preliminary reports were issued and distributed during the year. One of these reports contained a comparison of the financial returns on a group of farms where livestock feeding constitutes an essential part of the business with returns on a group of farms where no attention is given to livestock production. From the standpoint of the farm as a whole, this analysis appears to indicate the desirability of combining winter feeding with the business of producing cash crops. This conclusion is not based upon the results of any one year but is drawn from farm records that have been assembled for several years in succession. The other preliminary report includes a statistical analysis of sheep and steer-feeding operations on these farms during the year 1925-26. It also embraces a summary of feeding returns on these farms for a four-year period.

**Project No. 3.**—Complete records were obtained from approximately 40 ranches relative to the business conducted by these units during the year 1925. This group was represented by 15 plains ranches and 25 mountain ranches for the year ending Dec. 31, 1924. The plains ranches averaged 27.3 sections, or 17,451 acres, the major portion of which was classified as grazing land. At the beginning of the business year, 1924, these ranch operators were running an average of 1,075 head of cattle of all classes. The mountain ranches, on the other hand, averaged 13.2 sections, or 8,451 acres. This was classified as 7,368 acres grazing land and 1,083 acres of hay and crop



land. Mountain ranches had 858 cattle of all classes as an average at the beginning of the year Jan. 1, 1924. The details of the ranch business for the year 1924 are given in two preliminary reports entitled "An economic study of costs and methods of range cattle production, first, on 15 plains ranches for 1924; and second, on 25 mountain ranches for 1924."

**Project No. 4.**—In the study of the social status of the Spanish in rural Colorado our first step included the development of an outline which might be used as a basis for future procedure.

The following items are to be considered: (a) Introductory discussion of movements of population, causes and consequences; (b) Spanish movement to the United States; (c) background of culture and customs; (d) background of occupation and economic success; (e) those Spanish originally in the United States and those coming in; (f) Spanish in Colorado (in the year round, and during the work season). (g) the work done; (h) citizenship; (i) education; (j) religion; (k) amalgamation; (l) summer and winter problems; (m) conclusion.

Thus far all the available material, from one large university library has been secured, that dealt with the background material as mentioned above. Many bulletins and books from other sources have been secured dealing with the conditions in Mexico and in several of the states of the United States. One bulletin dealing with Colorado conditions is included. Conferences have been held with a professor in the University of the City of Mexico; with persons who have lived several years on large plantations in Old Mexico; and with many other persons who have had almost daily contact with Spanish and Mexicans. The police and court officials in a few towns have been seen to find out the citizenship status of these people. Social workers and church workers also have given very generously of their information in regard to the problems as they see them. The managers of sugar factories and other factory officials have furnished much information. The Mexican Consul in Denver has been interviewed and has given information and has written to Mexico for more. Arrangements have been made to get together about 500 Spanish and Mexican family records that were secured in the Colorado studies of children working on farms. These records give in detail the economic, educational and social status of between three and four thousand Spanish and Mexicans.

**Project No. 5.**—The object of this study is to ascertain the present status of farm taxation in Colorado and the total burden of taxation for selected years; also to determine whether a revision of

existing tax laws would lead to more equitable taxation. A questionnaire was prepared and sent out to approximately 15,000 owners of rented farms thruout the state. Between three and four thousand of these forms were completed and mailed to the Division of Finance, Bureau of Agricultural Economics, Washington, D. C. This division has agreed to tabulate the information included in these schedules.

The Department of Economics and Sociology has made a study of a limited number of farm business analysis records for the purpose of securing detailed information with respect to the taxes paid on these farms. At the present time an intensive study is in progress relative to a limited number of special schedules which were obtained in Boulder, Larimer, Weld, Morgan, Logan and Washington counties.

**Project No. 6.**—During the year a report was completed relative to the marketing of cantaloupes in the Arkansas Valley. This outline included a summary of records collected during the years 1924 and 1925.

Last autumn a study was begun in the San Luis Valley relative to costs and methods of potato storage. During the 1925-26 season potato cellars in this area were filled to capacity. Most of them were filled solid from floor to roof, including gangway. During the late autumn 25 to 30 potato growers were visited and detailed records were secured with reference to their methods of storage. Later in the winter these men were visited once more and further suggestions were obtained concerning the results of their methods of storage. Further suggestions will be secured during the present autumn on this project.

Respectfully submitted,

L. A. MOORHOUSE,  
Agricultural Economist.

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## REPORT OF THE ENTOMOLOGIST

To the Director:

The past year has been a normal one so far as injuries to crops from insect pests are concerned. At least one new pest, the Rose chafer (*Macrodactylus subspinosus*), long recognized as of considerable economic importance in the eastern portion of the United States, has been apprehended in Colorado in the vicinity of Pueblo the past summer. The alfalfa weevil, which we have succeeded in confining to Delta and small portions of adjacent land in Montrose and Gunni-



son counties, was discovered the past summer by Mr. J. H. Newton in portions of Routt, Rio Blanco and Ouray counties in this state, which has made it necessary to extend our State Entomologist quarantines on the shipment of hay from infested areas. It seems quite probable that the infestation along the Yampa River in Routt and Rio Blanca counties is due to an extension of the infested area in southwestern Wyoming and not to a spread of this insect from infested areas in western Colorado. For fuller information on this pest in Colorado, see reports of the State Entomologist of Colorado from 1917 on. This section has cooperated with the office of the State Entomologist in carrying on this work, as it has also in the work of codling-moth control in Delta and Mesa counties.

The personnel of the section has remained as it was last year.

### Plant-Louse Investigations

A paper by Miss Miriam A. Palmer, mostly technical in nature and entitled "Life History Studies of Seven Described Species of the genus *Lachnus*," was published in the September number of "Annals of the Entomological Society of America." Work on the life habits of other species and in the assembling of data for a report upon the Aphids of Colorado is also continuing.

### Ants of Colorado in Their Relation to Plant Lice

Professor Chas. R. Jones has continued his studies on the relation of ants to the plant lice or Aphids, and has accumulated a large amount of additional data during the past summer. He hopes to be ready to write up his investigations in this project in the near future.

### Codling Moth Studies

Mr. William Yetter, Jr., has continued his work upon the life habits and methods for the control of the codling moth in Mesa County, and Mr. J. H. Newton has been carrying similar work with this insect in Delta County. In the latter county the control with sprays of arsenate of lead has been very successful. In Mesa County, because of an additional annual brood of this pest over what occurs in Delta County, the control has been less successful and rather discouraging. Mr. Yetter's success in trapping the moths at specially prepared baits, however, gives promise of being a valuable supplementary means of controlling this pest. The trouble that has arisen because of the necessity of removing the arsenical spray residues from the fruit before it is placed upon the market, has given serious concern and caused heavy losses especially to the apple growers on the Western Slope, the past summer.

### Grasshopper Control

On the whole, grasshopper injuries in Colorado have been well below the average the past summer, and, consequently, less grasshopper poison was called for by the farmers than during either of the two preceding years. It is believed that this reduction in the number of grasshoppers is very largely due to the large quantities of grasshopper poison that the farmers have been using during the past three or four years. The grasshopper work in the state has been immediately in charge of Mr. George Langford, Deputy State Entomologist, who has also conducted a rather extensive research for the purpose of determining more definitely the feeding habits of our most destructive species during their feeding hours and thruout the season, in order to get necessary data to enable him to better plan the methods of control.

### General Insect Investigations

Nearly every year it becomes necessary to undertake work for the control of insect pests that have not been reckoned with in the regularly planned work for the year. During the past summer special attention was given to the control of a few of the more common truck-crop pests among which were: White cabbage butterfly (*Pontia brassicae*), the Mexican Bean-Beetle (*Epilachna corrupta*), the Melon Louse (*Aphis gossypii*). Mr. John Hoerner gave attention especially to the breeding-cage work in the insectory and to a fuller knowledge of the life history and methods of control for the Potato flea-beetle (*Epitrix cucumeris*).

Respectfully submitted,

C. P. GILLETTE,

Entomologist.

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### Report of the Forester

To the Director :

The project on the Decay of Wood was completed early in the fiscal year December 1, 1925, to November 30, 1926, and the manuscript has recently been published as Station Bulletin No. 307. The bulletin has had a favorable reception from workers in technical forestry subjects, particularly in timber diseases.

No new projects of a purely investigational character have been proposed by myself for the coming year. The one outlined for pos-

sible work, and which was submitted earlier in the year, has to do with a state-wide survey of the trees and shrubs that have been successfully grown in the different sections of the state.

A book manuscript covering the native trees and shrubs of the Rocky Mountain region has been accepted for publication by an eastern book publisher, and is expected to be in print during the coming spring.

Respectfully submitted,

B. O. LONGYEAR

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### REPORT OF THE HOME ECONOMICS SECTION

To the Director:

The work of the Home Economics Section of the Experiment Station on the one project now under way was begun September the first of the current year.

The title of the project is "The Baking of Flour Mixtures at High Altitudes." This statement, made by Dr. E. W. Allen, Chief of the Office of Experiment Stations, in his letter of approval was heartening: It is well thought out and appears to be of real research value."

Obviously, in so short a time, no phase of the work has been sufficiently rounded out to warrant any deductions.

INGA M. K. ALLISON,  
Head of Division of Home Economics.

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### REPORT OF THE HORTICULTURIST

To the Director:

The following is a brief report of the different horticultural projects as far as we have had opportunity to check up on the work.

#### Celery Project

The variety tests at the college are completed and we have selected three strains, two of early celery and one of late celery, which we are going to recommend to the growers in a later publication. The storage project at Littleton will not be completed until after the holidays. We have a little over one acre of celery now in storage. We have provided for ordinary dirt-pit storage, used in the Denver district, and

also the cement pits which are a slight modification from the ordinary earth pits and which we believe will prove satisfactory. We have also cellar storage and all of these are now filled with celery, part of which will be opened for Thanksgiving, but no final conclusions can be reached until after the holidays, as we plan to continue the work thruout the winter

### Tomato Project

The tomato project has to do with the growing of tomatoes for the canning factories, from first generation hybrids. This work has been in progress for several years at Manzanola. At first it was believed that this method of obtaining higher yields would be a success, but later work makes it problematic since the cost of seed production is relatively high and the results that we have obtained from our hybrids have not been sufficiently high above the ordinary strains to warrant the extra expense in obtaining the seed.

We also started the work of selection from productive plants, and we find this work much more satisfactory and we believe that the selection will not only produce better results but will be more economical and the time required much shorter. We have not the complete work tabulated, so that I cannot give you the figures at this time. However, the selection work stands out very prominently.

### Disease-Resistant Squash Project

This work was continued during the past season and many selections were made. The progress of this work has been rather slow and more or less disappointing, but we believe that the work should be continued for several seasons, as there are so many factors that enter into the work and one trial is not sufficient to test the resistance of the progeny of an apparent, resistant, mother plant. The plant may escape the disease without being disease resistant, and this is the problem that makes the work so slow and the results so unsatisfactory.

### Orchard-Management Project

This work has been centered on the value of cover crops and the results obtained during the past season at the farm at Austin are conclusive because of the higher quality, both in size and in appearance, which have been obtained from a system of cover crops. The percentage of extra fancy fruit from the land in cover crops shows conclusively the value of this method of orchard management. This work will continue so that we may be able to make more extensive comparisons on the different varieties.

### Potato Project

The potato project which has been carried on, principally at Avon, has not yielded the results that we originally hoped for. This is due almost entirely to the soil conditions on the farm. It will take two or three years before we can hope to bring the land into proper condition for the production of a maximum crop. In growing the different varieties of potatoes on the farm, we have found that there is a wide variation which undoubtedly is due to the soil and climatic conditions. In other words, different varieties of potatoes require different soil and different climatic conditions to produce the largest crop and this is a verification of the teachings of the department and our endeavor to standardize two or three different varieties of potatoes for each potato-growing district. We have found from experience and observation that a given variety will do better in a given locality; for example, the Brown Beauty potato will do best in the San Luis Valley, the Peach Blow in the higher mountain districts, and the russeted varieties on the alluvial soil of the mountain valleys. The People's will do better in districts where the summer temperature is high. These facts are clearly brought out when we endeavor to grow the different varieties at Avon. There is much work to be done on developing high-yielding strains of the different varieties and this work is progressing rapidly in the state, aided by the department, particularly thru the work of seed certification.

Another side of the potato project is the seed certification. This work is necessarily scattered over the state and it is continually increasing because of the demand for better seed. The number of fields certified this year is double that of last year, and judging from our correspondence and from the work of Mr. Metzger in the field, we may more than double the present year's output of seed next year. The general result is very gratifying as it shows conclusively the interest that the growers take in better seed and greater production and quality of our Colorado potatoes. The only problem that stares us in the face is that of financing the work of inspection. It is already consuming more of our funds than were allotted to it.

### Grape Project

The growing of grapes in Colorado, another project we are carrying on at the college farm, gives great promise. This year we harvested a few bunches, being the first from the plants. Both the European and American varieties are doing well, and we are accumulating valuable data for the use of the growers in the state.

Variety orchards of different kinds of tree fruits are also doing well, but nothing can be published for several seasons.

### Seed Pea Selection

At Avon we have been carrying on a project on the selection of seed peas for the green-pod market. This work has been very successful and we now have a strain of Dwarf Telephone that this year produced nearly thirty-five bushels of clean seed per acre.

### Onion Project

For several years past we have been experimenting with the growing of Denia and Valencia onions in northern Colorado. We have grown the Valencia onion for the first time this year and the results are very satisfactory. Undoubtedly the Valencia will prove more productive and valuable than the Denia. The yield of Valencia this year was over 1200 bushels to the acre. The Denia produced a little over 1000 bushels. The keeping quality as well as the eating quality of these two varieties is excellent. A short publication will be issued on this work during the year.

### Fertilizer Project

This project has been carried on both at Avon with lettuce and at the home garden on tomatoes. From the results thus far obtained, it is evident that the use of commercial fertilizers will not be profitable on most soils and for most kinds of vegetables, for the present at least. The results seem to indicate that stable manures are more effective, not perhaps in the supplying of essential elements of fertility, but in fact supplying vegetable matter to the soil. We are inclined to believe that with an adequate supply of vegetable matter in the soils, commercial fertilizers, particularly potash, will be beneficial.

### Cauliflower Project

This project was undertaken to test the commercial possibilities of growing cauliflowers on a large acreage for pickling purposes. Eight acres were devoted to this project. A poor stand was obtained and in addition to this the field became infested with the root maggot to the extent that the crop was almost a failure. The gross return was about \$40.00 per acre. With a good stand and full crop, cauliflowers would be a safe and profitable crop to grow in the mountain districts.

The conditions at Avon are gradually improving, but we have a task before us in putting the soil in a high state of cultivation. It had been farmed too long without anything being returned to the land, and it will take several years to bring it up to where it should be. With the presence of livestock and with proper rotation, we should be able to bring the soil into a high state of fertility.



In addition to the projects above enumerated, we are doing lots of work in testing different varieties and also in the selection of seed of lettuce and other garden crops from productive plants.

The packing and storage house at Austin was completed and is giving us excellent service.

Respectfully submitted,

E. P. SANDSTEN,  
Horticulturist.

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## REPORT OF THE IRRIGATION ENGINEER

To the Director:

The projects under immediate consideration are: Measurement of Water and Evaporation Studies. The field work of the project on the duty of water in the Arkansas Valley has been completed, and much of the computations and tabulations finished. The final report on this study should be concluded within a short time.

To supplement data now on file, further field investigations relative to drainage districts will be made sometime this coming spring. There are a great number of completed drainage systems now operating under the Drainage District Law of Colorado, and also numerous places where sooner or later drainage districts will be organized for the purpose of reclaiming areas that are now practically non-productive. The several years of experience of drainage-district organization, together with the success or failure of these several enterprises, records of reclaimed seeped lands on farms as well as the enhanced values of these farms, would be valuable information to those who are contemplating the organization of drainage districts.

In the study of the measurement of water, considerable attention has been given to testing of large-sized improved Venturi flumes. Because of limiting facilities at the hydraulic laboratories, the 8-foot flume is the largest-sized test structure possible. To investigate the law of flow for the still larger-sized flumes, it is necessary to have these bigger structures built in the field, under existing practical conditions, and then test them under actual working conditions. The largest improved Venturi flume yet constructed has a throat width of 12 feet and is located on Box Elder Creek near Fort Collins. There are, in operation in the Arkansas Valley, two 10-foot flumes which are operating satisfactorily, as well as several small structures. The larger flumes indicate the reliability of the principle of the device

when extended from the models tested in the laboratories. Further tests at the Bellvue laboratory on several different-sized structures, when tested against a 15-foot rectangular weir, show good agreement with the results determined by means of a 10-foot weir which was originally established at the Bellvue laboratory. Smaller-sized flumes were calibrated at the Fort Collins hydraulic laboratory by means of volumetric methods, and duplicate structures later tested at Bellvue by means of weirs show consistent agreement.

Information has reached us that the improved Venturi flume is being used in the Union Colony of South Africa, Argentine Republic, Honduras, Hawaii, British Columbia, Alberta, and numerous places in the irrigated western states of our country.

After considerable study of the subject of evaporation confined to laboratory conditions, an expression was evolved giving the rate of loss of evaporation from a free water surface. Numerous attempts have been made by engineers to establish the rate of loss of evaporation from large bodies of water but with little success. The natural lake or reservoir loses in volume by both leakage and evaporation, and that portion due to evaporation is not readily determined. Records of other investigators show that a watertight tank, whose diameter was 12 feet, was heretofore the largest basin where reliable evaporation data have been secured.

To apply these data to large natural water surfaces would, in all probability, give erroneous results. In order to obtain data on the evaporation from a large watertight basin, there has been provided at the hydraulic laboratory here on the college campus a copper lined reservoir having an exposed area of a diameter of approximately 85 feet and a water depth of  $6\frac{1}{2}$  feet. This copper lining was very carefully placed and inspected for leakage before being put into commission. The results of a 30-day period of observation on the evaporation from this large basin, when compared with the loss from a standard floating pan, Colorado-type buried pan, and Class A Weather Bureau evaporation pan, show that the large reservoir loses 22.0 percent less than the standard floating pan, 15.3 percent less than the Colorado-type buried pan, and 25.1 percent less than the Class A Weather Bureau pan. A comparison of the observed evaporation loss from the Weather Bureau pan and the results computed from the evaporation formula derived from our previous experiments shows a very close agreement, the results differing by less than  $1\frac{1}{2}$  percent. A direct comparison is not possible in the case of the other pans because the wind records are not yet computed. Because of the evaporation equipment now provided at the station, others interested in this sub-



ject have been attracted here to perform scientific studies in connection with this great problem.

In connection with the evaporation studies, a series of observations have been conducted on the evaporation loss from moist soils. Five different soils have been observed, with varying depths to water table. A short progress report has been prepared where only two soil types have been compared.

During the past year there have been prepared various scientific articles relating to the work of this section. An article on The Improved Venturi Flume, together with discussion, has been published in the Transactions of the American Society of Civil Engineers, and a discussion on the subject of Evaporation has also been published in the Proceedings of this society. A short article entitled "Services of Colleges in participating in and cooperating with Government Work" has been prepared for publication in Modern Irrigation, a California journal devoted to irrigation engineering problems. A progress report has been submitted to Washington, D. C., on the subject of Evaporation Losses from Moist Soils, prepared for the purpose of publishing in the Journal of Agriculture Research. Numerous articles have been submitted to News Notes, published by the Extension Service.

Respectfully submitted,

R. L PARSHALL,  
Irrigation Engineer.

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## REPORT OF THE VETERINARY PATHOLOGIST

To the Director:

List of Projects:

1. Sheep Losses in the Feedlots.
2. Contagious Abortion.
3. General.

We wish to continue the same projects as those of last year.

### Sheep Losses in the Feedlots

Much attention has been given to the anaerobes that may be present in the carcasses of sheep which have died of various diseases but particularly those that are presumed to have died from overeating. In the continuation of this phase of the work, the undersigned spent six weeks in the University of Colorado Medical School under direc-

tion of Dr. Ivan C. Hall during last summer, in classifying the organisms that had been isolated. While all of this has taken much time there are no definite results as yet for publication.

Sore mouth in lambs was unusually prevalent during the last feeding season and in at least one instance caused a loss of a considerable number of animals. Our observations indicated that actinomyces necrophorus was present in most of the cases and that it might be properly considered a necrobacillosis.

Coccidiosis seems to be on the increase and has in some instances caused rather serious losses.

### Contagious Abortion

We are just now summarizing the results of our work in the college herd during the past three years and expect to submit it as a bulletin shortly after the first of the year. We are gathering information of a similar nature from several other herds, which will doubtless be of value in the future. We have one herd consisting of twelve hundred animals in which an attempt is being made to eradicate abortion by means of the blood test.

### General

The diagnostic work of the laboratory is tabulated as follows:

#### Diagnostic Work (exclusive of blood tests)

Poultry .....	298	Sheep .....	31
Cattle .....	73	Hogs .....	13
Horses .....	22	Miscellaneous .....	197
Dogs .....	15		
		Total.....	649

### Blood Tests

#### Contagious Abortion

Number	Positive	Percent Positive
2,617	370	14.13
4,310	443	10.28

Respectfully submitted,

I. E. NEWSOM,

Veterinary Pathologist.

**REPORT OF THE VETERINARIAN**

To the Director :

We have but one project in the Veterinary Section and that is on Animal Diseases.

We wish to continue with this one project for the present year.

This project is a general one and does not contemplate protracted specific investigations. Work of this character is carried on by the Department of Pathology. However, it does take care of certain phases of animal-disease investigation and supervision in a very satisfactory way. It is especially helpful in emergency outbreaks of disease that are of frequent occurrence. Furthermore, it enables us to keep in touch with livestock conditions and to render assistance when called on by state and national authorities.

Numerous short articles pertaining to animal disease have been prepared for publication. The past summer was spent in Europe investigating animal diseases under commission of the Secretary of Agriculture. Several brief reports have been given orally and by publication thru the agency of various farm journals.

Respectfully,

GEO. H. GLOVER,  
Veterinarian.

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**ENGINEERING DIVISION**

To the Director :

I am transmitting reports of the Civil Engineering and the Mechanical Engineering Sections of the Engineering Division of the Experiment Station.

Respectfully submitted,

L D CRAIN,  
Chairman and Vice-Director.

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**REPORT OF CIVIL ENGINEER**

To the Chairman Engineering Division :

I submit herewith the annual report of the Civil and Irrigation Engineering Section of the Colorado Agricultural Experiment Station covering the work done by the department during the year just closing.

The live experimental projects that are being carried by this department at this time are:

(1.) **Subgrade Soils of Colorado.**—This project has been in active operation for over a year. At present the field party under the direction of the State Highway Department is at work in the field and has been at work since June, 1925. This party is working on the concrete pavements of the state, taking 4-inch concrete cores from the pavements and a sample of the subgrade lying directly thereunder. Both cores and sub-grade samples are sent to the Road Materials Laboratory of this department for testing. The tests are made and reported to the State Highway Department.

All paving projects constructed in 1926 have been investigated to determine the suitability of the soil for subgrade purposes. By these tests it is possible to determine the drainage features of the particular section of road and to plan special subgrade treatment where necessary.

A progress report of the work done in 1925 has been prepared in the office of the United States Bureau of Public Roads in cooperation with this department. This report is about ready for the printer.

The more important results of the work indicated at this time are:

(a) Cracks in concrete pavement are less where there is a longitudinal center joint and the pavement is thicker at the edges than at the center and when dowel is used.

(b) Where the grade is low the larger number of cracks are transverse to the center line of the road.

(c) Where the grade line is high the larger number of cracks are parallel to the center line of the road.

(d) Drainage for the removal of both surface and subgrade water is important.

(e) The average unit compressive strength of all pavement samples in 1925 was 4724 lbs. per square inch.

(f) Further investigations are needed to determine a satisfactory field method for investigating subgrade soils.

(2.) **Road Materials of Colorado.**—Little work was done on this project during the spring, summer and fall of this year, but during the winter months when it was impossible to operate the core drill, considerable work was done. The work consists of locating and testing materials suitable for concrete paving and gravel surfacing of our highways, determining the amount of material available, its location and its suitability for surfacing purposes.

One technical paper has been prepared by this section entitled, "The Use of Lumnite Cement for Capping Specimens of Concrete." It will be published in the Engineering News-Record.

No important changes have taken place in the staff during the year. No new buildings have been constructed. Some new equipment has been purchased and installed for experimental work on bitulithic compounds.

The cooperative agreement between our department and the State Highway Commission is still in force. It is our plan to continue work on these two projects during 1927.

Respectfully submitted,

E. B. HOUSE,

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## REPORT OF THE MECHANICAL ENGINEER

To the Chairman, Engineering Division :

The Mechanical Engineering Section of the Engineering Experiment Station, has been engaged during the past state fiscal year upon the following projects: (1) Humidifying Air in Buildings; (2) Treatment of Alkali and Other Waters for Domestic Use; (3) Fire Protection by Carbon Dioxide Gas; (4) Apple-Washing Machinery.

Three projects which may be started during the present year, in cooperation with the Poultry Department, are: (1) The Effect of Artificial Lighting on Egg Production; (2) The Temperatures in various types of Poultry Houses; (3) Incubation of Eggs at High Altitudes.

The investigational work on the project, "Humidifying Air in Buildings," has been a continuation of the work previously started and reported. The Minnehaha and Buddington humidifiers which operate on the top of radiators and use absorbant material to increase the evaporation surface, were tested and found to be of little value in public buildings. The following is a comparison of the different types of humidifiers tested, in pounds of water evaporated per hour per linear foot of humidifier :

Minnehaha	.325
Buddington	.258
Colorado Agricultural College No. 13	.200
Savo	.065

In no case would the above-mentioned humidifiers raise the relative humidity of the air more than 2 percent in a room with normal conditions. The average increase in relative humidity would probably be less than 1 percent.

To show further the improbability of humidifying inside air by placing humidifiers on steam or hot-water radiators, a class-room with normal conditions was chosen, and humidifiers placed on both sides and on top of the radiators. The increase in the relative humidity of the air in comparison with other similar rooms in the same building was .4 percent. To raise the relative humidity of the air 30 to 40 percent, which is necessary under Colorado conditions, it appears that a combined system of indirect heating and humidifying would be necessary.

The project, "Treatment of Alkali and Other Waters for Domestic Use," has also been continued since the last annual report. The investigational work has been the construction and testing of combined domestic hot-water and purifying systems.

The results show the system to have sufficient capacity to supply an average family with both hot water and purified water at a very small cost. The presence of hard alkali deposit in purifying alkali water makes the use of the system impracticable.

Three types of water fronts were tested in a coal kitchen range and gave the following results:

	Lbs. of water purified per hour	Gallons of Water heated per hour
Cast iron water front	5.904	8.80
Shelby steel water front	5.877	6.38
Gas pipe water front	5.807	6.61

Alkali deposit filled the lower tubes of the water fronts and shut off the flow of water after 30 hours operation. The deposit was so hard that it could not be drilled out with a breast drill. When the supply of water was shut off by the collection of the deposit, the front became over heated and some of the very offensive alkaline substances were carried over into the condenser.

Attempting to eliminate the difficulties presented by alkali deposits on the inner walls of water fronts, an evaporator was built using submerged steam coils carrying steam under pressure, to evaporate the water. Due to the large quantity of water surrounding the coils, the alkali salts remained in solution and little deposit was left on the coils. The deposit was readily removed. The principal diffi-

culty was caused by the excessive foaming of alkali water, which extended into the condenser. The use of a large steam dome failed to correct the difficulty. To prevent the foam from being carried to the condenser, a space of unusually large size must be allowed to provide for the expansion of the foam. This particular apparatus would be impractical for domestic use, unless further development should be made.

The project, "Fire Protection by Carbon Dioxide Gas," was started with the object of giving fire protection to places such as library stack rooms where the ordinary means of fire protection would do practically as much damage to the books and supplies as the fire itself. The preliminary work has shown that carbon dioxide gas may be used efficiently and economically to extinguish small fires. This project will be continued.

The project, "Apple-Washing Machinery," has been started recently to provide an economical method if possible, by which fruit growers may remove the injurious ingredients of the spray left on their fruit. An apple-washing machine has been built and is now being tested. This department is being assisted on this project by the Chemistry, Entomology and Horticultural departments of the Experiment Station.

Respectfully submitted,

G. A. CUMINGS,

Asst. in Mechanical Engineering.

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## REPORT OF EDITOR OF PUBLICATIONS

To the Director:

Just half as many bulletins have been issued in 1926 as we published in 1925, and the station work in this office has been comparatively light.

Special stories concerning different phases of the Experiment Station work have been prepared whenever the news arose.

Thru your cooperation and that from the President's office, I was enabled to attend the annual convention of the Agricultural College Editors at East Lansing, Michigan, last July. I wish to thank you again for that opportunity. With the assistance of other western editors I was able to bring the next convention to our own campus. The date for the meetings has not yet been set, but I am certain all



station workers will be interested in attending as many of the sessions as possible, and I am sure they will be very welcome.

While this year's editorial work has been light, I believe the bulletins have been above the average in quality. Bulletin 305, which had an exceptional run of popularity, was reprinted during the year.

Following is a detailed report of publications by numbers, pages, editions and authors:

- No. 307—A Study of the Decay in Wood. B. O. Longyear.  
2000 copies. 58 pages.
- No. 308—Adobe Brick for Farm Buildings. J. W. Sjogren and  
J. W. Adams. 2500 copies. 24 pages.
- No. 309—High Altitude Vegetable Growing; Lettuce, Cauliflower,  
Peas. R. A. McGinty. 6000 copies. 34 pages.
- No. 310—Common Weeds of Colorado Lawns. L. W. Durrell.  
6000 copies. 8 pages.
- No. 311—Tipburn of Lettuce. Ross C. Thompson.  
3000 copies. 31 pages.
- No. 312—Marketing of Colorado Cantaloupes. N. D. Sanborn.  
3000 copies. 72 pages.
- No. 313—Three Important Perennial Weeds of Colorado. Charles  
F. Rogers, L. W. Durrell, Leslie B. Daniels. 3000 copies.  
15 pages.
- 38th Annual Report. 1500 copies. 45 pages.
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- No. 305—(Reprint) Diseases of Colorado Feeding Lambs.  
I. E. Newsom. 5000 copies. 26 pages.
- No. 314—(In press) Potato Growing in Colorado. E. P. Sandsten.  
3000 copies. \_\_\_\_\_ pages.

Respectfully submitted,

I. G. KINGHORN,  
Editor of Publications.

