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SCIENCES

THE STATE AGRICULTURAL COLLEGE  
OF COLORADO

THE FORTY-FOURTH  
ANNUAL REPORT

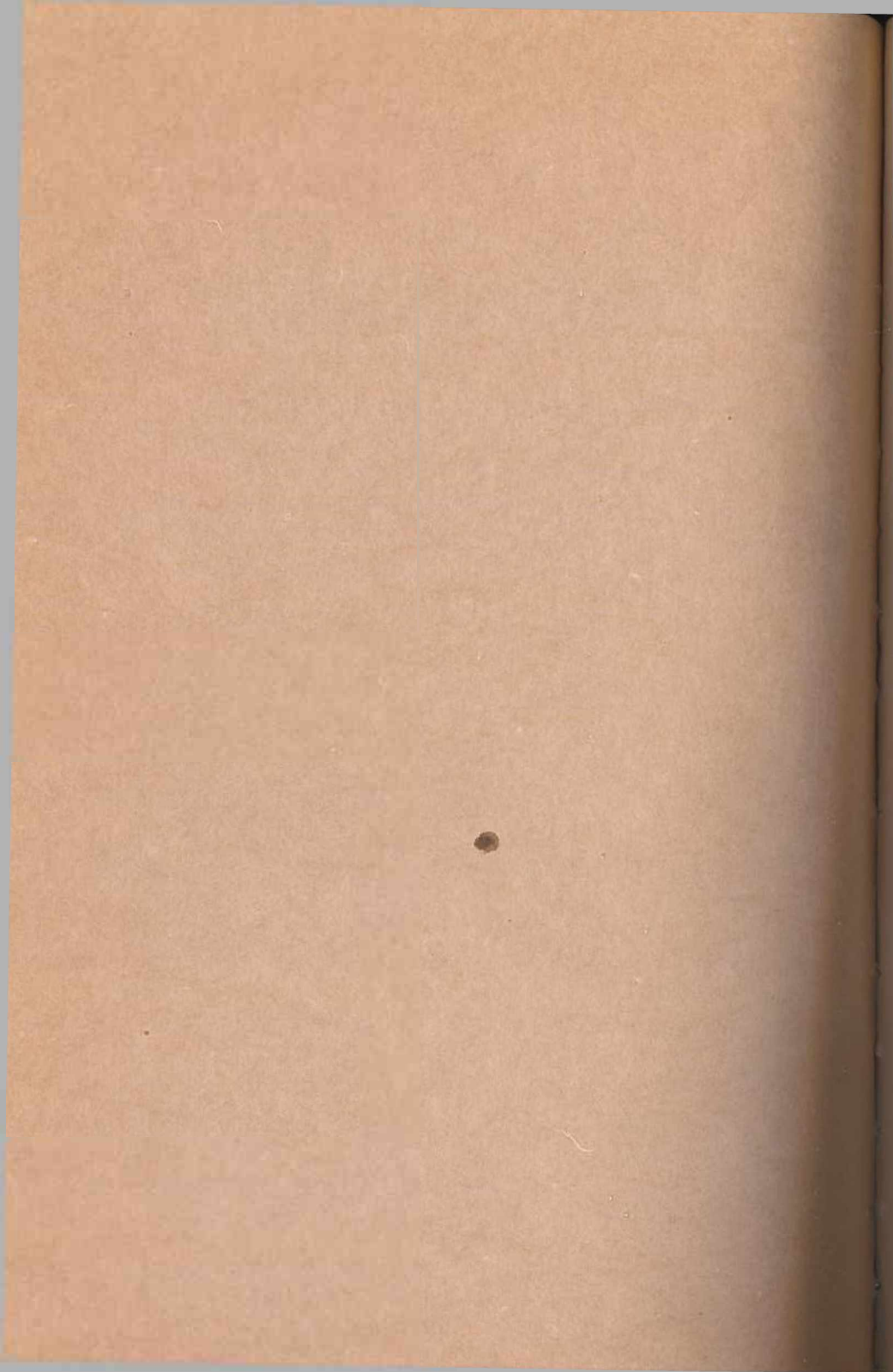
— OF —

The Colorado Agricultural  
Experiment Station



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FOR THE FISCAL YEAR 1930-31



THE STATE AGRICULTURAL COLLEGE  
OF COLORADO

THE FORTY-FOURTH  
ANNUAL REPORT

— OF —

The Colorado Agricultural  
Experiment Station



FOR THE FISCAL YEAR 1930-31

# The Colorado Agricultural College

FORT COLLINS, COLORADO

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 C. E. Vail, B.S., M.A., Associate

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 Sam McCampbell, B.S., Assistant  
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FINANCIAL REPORT OF THE EXPERIMENT STATION

	For the Year ending June 30, 1931							Total
	Hatch Fund	Adams Fund	Purnell Fund	State Mill Levy Fund	Special Fund	Pure Seed Fund	Irrig. Cash Fund	Funds
DR.								
Balance July 1, 1930.....				\$ 6,834.19	\$20,315.34	\$8,000.00		\$ 35,149.53
From the Treasurer of the United States as per appropriations for the fiscal year ending June 30, 1931, under acts of Congress approved March 2, 1887, (Hatch Fund), March 16, 1906, (Adams Fund), and February 24, 1925, (Purnell Fund)....	\$15,000.00	\$15,000.00	\$60,000.00					90,000.00
Other sources than the United States.....				104,506.69	29,045.89		4,670.00	138,222.58
	\$15,000.00	\$15,000.00	\$60,000.00	\$111,340.88	\$49,361.23	\$8,000.00	\$4,670.00	\$263,372.11
CR.								
To Salaries.....	15,000.00	15,000.00	48,842.57	28,072.47	26,864.53	5,049.27	2,874.95	141,703.79
Labor.....			2,968.67	29,080.64	3,777.67	2,187.18	35.00	38,049.16
Stationery and Office Supplies.....			405.04	1,279.18	146.32	163.37	52.68	2,046.59
Scientific supplies, consumable.....			755.74	2,380.11	3,547.91		15.50	6,699.26
Feeding stuffs..... consumable.....			301.91	10,630.65	264.52			11,197.08
Sundry supplies.....			197.81	3,149.00	2,856.49	23.98	6.88	6,234.16
Fertilizers.....				261.46	17.50			278.96
Communication service.....			125.57	1,085.82	70.39	16.28	10.40	1,308.46
Travel expense.....			3,785.21	8,672.32	1,213.60	97.87	331.03	14,100.03
Transportation of things.....			3.38	1,480.62	101.71	6.04	5.18	1,596.93
Publications.....			1,470.47	3,354.30	189.11		10.39	5,024.27
Heat, light, water, power.....			13.96	633.22	212.82			860.00
Furniture, etc.....			55.52	1,151.38	441.13	5.00		1,653.03
Library.....			55.60	527.79	286.00	13.00		882.39
Scientific equipment.....			711.32	3,349.89	608.76	345.25		5,015.22
Livestock.....				3,859.58				3,859.58
Tools, machinery, appliances.....			247.88	3,375.10	79.18		1.50	3,703.66
Buildings and land.....			29.35	3,857.42	3,710.29	57.76	14.85	7,669.67
Contingent expenses.....			30.00	355.66	26.25	35.00		446.91
	\$15,000.00	\$15,000.00	\$60,000.00	\$106,556.61	\$44,414.18	\$8,000.00	\$3,358.36	\$252,329.15
Balance on hand June 30, 1931.....				4,784.27	4,947.05		1,311.64	11,042.96
Grand Total.....	\$15,000.00	\$15,000.00	\$60,000.00	\$111,340.88	\$49,361.23	\$8,000.00	\$4,670.00	\$263,372.11

## LETTER OF TRANSMITTAL

To His Excellency, William H. Adams, Governor of Colorado:

In accordance with the law of Congress establishing Agricultural Experiment Stations, I have the honor to transmit to you the Forty-fourth Annual Report of the Colorado Agricultural Experiment Station for the Federal and State fiscal years, July 1, 1930, to June 30, 1931.

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, as well as a list of projects upon which work was carried during the year.

C. P. GILLETTE, Director.

Agricultural Experiment Station,  
Fort Collins, Colorado,  
July 1, 1931.

# AGRICULTURAL DIVISION

## REPORT OF THE DIRECTOR

To the President:

I am presenting herewith the forty-fourth annual report of the Colorado Agricultural Experiment Station for the fiscal year 1930-31. It consists, chiefly, of brief reports of progress upon investigations that have been under way in the several sections. The full reports are given out from time to time in station bulletins, in the Journal of Agricultural Research of the United States Department of Agriculture, in technical journals and in the agricultural press of the country.

The results of the experimental work of the year compare favorably with those of former years, both in amount and in their practical value to the agricultural and other interests of the state and nation. The unusual number of calls for station bulletins is a fair index of the growing interest that the people are taking in the results of our work. Several recent bulletins have been entirely exhausted, making it necessary to issue reprints.

It is to be regretted that, at a time like the present, when the agricultural interests of the country are in great need of investigational work that may help the farmer and the stockman to grow their products more economically, we should be faced with the necessity of curtailing the work because of a shortage of funds. It is a situation that we have to accept. While this shortage is not large, only about 10 percent of the total budget of the past year, it is keenly felt when the need of expanding the work is so urgent. It is the first time in many years that a reduction in total budget allotments has been necessary. Perhaps the most unpleasant feature in the allotment of budgets for the coming year has been the inability to recommend salary increases in many cases where increases are well deserved, and where the failure to make some increase is very likely to result in the loss of a valuable worker in the near future. We have been fortunate, however, in that we have lost but few of the more important members of our research staff during the past year. A few excellent producers were taken from us by institutions that could offer better salaries and better opportunities for advancement in their special fields of work than we could offer here.

A classified list of the projects upon which work has been done during the past year is given below:

### **Agronomy Section**

- Relation of Soil Moisture, Structural Development and Acre Yields in Small Grains. Adams and State funds.
- High-Altitude Crops. State funds.
- Plains Crops and Management. State funds.

Improved Seed. State funds.

Control of Excessive Soil Nitrates in the Arkansas Valley. Purnell and State funds. (Cooperative with Bacteriology).

Studies in the Control of Bacterial Wilt and Winter Killing. Purnell and State funds. (Cooperative with Bacteriology).

A Comparative Study of Methods of Determining Soil Fertility. Purnell fund. (Cooperative with Bacteriology).

#### **Animal Investigations Section**

Ration Experiment with Cattle. Purnell fund.

Summer Cattle-Fattening Experiments. State funds.

Range and Pasture Improvement. State funds. (Cooperative with Botany).

Ration Experiments with Lambs. State funds.

Cornfield Lamb-Feeding Experiment. State funds.

Beet By-Products for Fattening Beef Calves. Purnell fund.

Utilization of Dryland Feeds. State funds.

Hog Feeding in the San Luis Valley. State funds.

#### **Bacteriology Section**

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

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

The Natural Inoculation of Colorado Soils with Legume Bacteria. Hatch and State funds.

A Comparative Study of Methods of Determining Soil Fertility. Purnell fund. (Cooperative with Agronomy).

The Control of Excessive Soil Nitrates in the Arkansas Valley. Purnell fund. (Cooperative with Agronomy).

Studies in the Control of Bacterial Wilt and Winter Killing. Purnell and State funds. (Cooperative with Agronomy).

#### **Botany Section**

Range and Pasture Improvement. Purnell and State funds. (Cooperative with Animal Investigations).

Cereal and Field-Crop Disease Studies. Hatch and State funds.

Truck-Crop Disease Studies. Hatch and State funds.

Weed Control. Purnell and State funds.

Diseases of Greenhouse Plants. State funds.

#### **Chemistry Section**

Deterioration of Hays Resulting from Rain. Adams, Hatch and State funds.

#### **Entomology Section**

Plant-Louse Investigations. Adams fund.

Ants in Relation to Plant Lice. Hatch and State funds.



- Codling-Moth Studies. Hatch and State funds.  
 Codling-Moth Control by Means of an Egg Parasite. Purnell and State funds.  
 Grasshopper Control. State funds.  
 Potato Flea-Beetle. Hatch and State funds.  
 General Insect Investigations. State funds.  
 Rodent Poisoning. State funds.  
 Rodent Life Habits. State funds.  
 Colorado Insect Fauna. State funds.  
 Resistance of Bees to American Foulbrood. State funds.  
 Relation of the Honey Bee to the Production of Seed in Red Clover. State funds.  
 Range Insects. State funds.

### Economics and Sociology Section

- An Economic Study of the Peach Industry in Colorado. Purnell fund. In cooperation with U. S. Dept. of Agriculture.  
 An Economic Study of Farm Organization and Management in the Greeley Area in Northeastern Colorado. Purnell fund.  
 A Study of Costs and Methods of Producing Cattle and Sheep on the Range in Colorado. Purnell fund. In cooperation with U. S. Dept. of Agriculture.  
 A Study of the Social Status of the Spanish-Speaking People in Rural Colorado. Purnell fund.  
 A Study of Taxation in Colorado. Purnell fund. In cooperation with U. S. Dept. of Agriculture.  
 A Study of the Methods of Storage and Marketing Practices which Obtain in Handling Potatoes on Farms in the San Luis Valley. State funds. In cooperation with Colorado Division of Markets.  
 An Economic Study of the Apple Industry of Colorado. Purnell fund. In cooperation with U. S. Dept. of Agriculture.  
 An Economic Study of Land Utilization in Northwestern Colorado. Purnell fund. In cooperation with U. S. Dept. of Agriculture.  
 A Study of the Major Types of Cooperative Organizations of Associations in Colorado. Purnell fund. In cooperation with U. S. Dept. of Agriculture.  
 Rural Social Agencies in Colorado; Classification and Evaluation. Purnell fund (new). In cooperation with U. S. Dept. of Agriculture.

### Home Economics Section

- The Baking of Flour Mixtures at High Altitudes. Part II. Purnell fund.

### Horticultural Section

- Potato-Variety Testing and Improvement by Selection. Hatch and State funds.  
 Garden-Pea Variety and Breeding. Purnell and State funds.  
 Spanish Onion Breeding Work. Purnell and State funds.  
 Garden Pod Bean Project. State funds.  
 Development of a Tipburn-Resistant Variety of Head Lettuce. Purnell fund.  
 High-Altitude Vegetable Production. State funds.  
 Orchard Management including Cover Crops. State funds.  
 Raspberry Investigations. State funds.  
 Small Fruits. State funds.  
 Certified Seed Potatoes. State funds.

### Irrigation Investigations Section

- Measurement of Water. Hatch and State funds.  
 Evaporation. Hatch and State funds.  
     (a) From a Free Water Surface.  
     (b) From Moist Soils.  
 Meteorology. State funds.  
 Pumping for Irrigation and Drainage. State funds.

### Pathology Section

- Sheep Losses in Feedlots. Hatch fund.  
 Contagious Abortion. Hatch and State funds.  
 Coccidiosis in Cattle. Purnell fund.  
 Death Losses in Lambs on Heavy Grain Feed. Purnell and State funds.  
 General Disease Investigations. State funds.

### Veterinary Section

- Animal Diseases. State funds.

## ENGINEERING DIVISION

### Civil Engineering Section

- Frost-Heaving Investigation on Concrete Slabs. State funds.  
 Light Asphaltic Road Surfaces. State funds.  
 Road Oils. State funds.

### Mechanical Engineering Section

- A Study of Hair Cracks in Concrete. State funds.  
 A Study of the Gas Situation in Fort Collins. State funds.  
 Poultry Housing and Equipment. State funds.

Respectfully submitted,

C. P. GILLETTE, Director.

## REPORT OF THE AGRONOMIST

To the Director:

I am submitting my annual report of the activities of the Agronomy Section of the Colorado Experiment Station for the budget year ending June 30, 1931.

The staff of the Agronomy Section for the past year has consisted of: Alvin Kezer, Agronomist; D. W. Robertson, Associate; G. Warren Deming, Assistant; Roy D. Hockensmith, Associate; Warren H. Leonard, Assistant—all located at Fort Collins; Robert Gardner, Associate, located at Rocky Ford; and Dwight Koonce, Assistant, located at Fort Lewis.

Mr. G. Warren Deming, who has been with our station work for the last 8 years, resigned in March to accept a position with the Sugar Office of the United States Department of Agriculture. Mr. Deming was located by the Sugar Office at Rocky Ford in the Arkansas Valley. We are recommending Mr. Wayne Austin to succeed Mr. Deming—Mr. Austin's employment to start in June.

During the year, the work at the home station or at Fort Collins has been a continuation of the improved-seed project, under which breeding work on the various grains and forage crops is conducted. The work not only consists of technical breeding work and studies on heredity, but also includes breeding new varieties, the purification of old established varieties, and preparing purified seeds to distribute to approved farmer growers.

The critical-period project has been continued. This is a study on the effect of irrigation at different periods in the growth of the wheat plant. Certain phases of this study have been completed. The work has resulted in two publications—one on Critical Periods, appearing in the Journal of the American Society of Agronomy, the other on Residual Effects on the Crop in the Succeeding Year, which appeared also in the Journal of the American Society of Agronomy.

The present trend of the work is to attempt to discover why these residual effects continue into the next year. Studies have also been made on the effect of water at different temperatures and root development under different irrigation treatments.

The project on the control of alfalfa disease is under way. This is a joint project in cooperation with the Bacteriology Section. Our portion of the work consists in the trial of alfalfa varieties in the attempt to find varieties or strains which will resist the attacks of the wilt disease (*Aphanobacter insidiosum*). The alfalfa disease-control work is in two phases—the first phase consists in the trial of varieties under diseased conditions in the attempt to find resistant varieties. When such are found, if any,

they will be used either directly to start a new seed industry or will be used in breeding work to produce new sorts. If resistant varieties of good hay and yield-producing qualities are discovered, these will be propagated and seed centers will be established, if possible. If, however, we find resistant sorts that do not have good hay qualities, they may be used in hybridization experiments to attempt to produce new sorts having resistant qualities and favorable hay production. Many phases of this work could be very greatly expedited by greenhouses with suitable cold equipment, because such greenhouses would enable us to eliminate quickly many of the strains which, under field conditions, take several years to eliminate. We appreciate that the field is the final answer, but we could take to the field only the more promising sorts—those which resist cold and the disease, because in our climate both types of resistance are necessary.

There has been a prevailing opinion that the disease was associated with methods of irrigation. We have tested this out with carefully diked plats and have found no connection with methods of irrigation and the wilt disease other than considerable evidence that irrigation water spreads the disease. There was apparently no difference in the disease percentage on lightly irrigated, unirrigated and very heavily irrigated plats.

Another phase of this problem has been an investigation into soil treatments which might have the effect of building up physiological resistance. It will take some years to determine this feature of the work. This phase could also be expedited somewhat with greenhouse equipment. In the field, it takes 2 or 3 years, at least, for the alfalfa wilt to develop to killing proportions on susceptible varieties.

The studies on laboratory methods of measuring soil fertility are also in cooperation with the Bacteriology Section. These studies are being conducted in the laboratory and checked in the field with actual treatments in accordance with laboratory findings. So far, our field results have checked almost 100 percent with the laboratory findings when measured by the Winogradsky method of test. We have been particularly fortunate in being able to check our own tests with tests of the Great Western Sugar Company, covering much of the sugar-beet area of Colorado.

In addition to the biological methods such as the Winogradsky and Neubauer, we have also been attempting to develop a chemical method which would give comparable results. We can report promising results. Much work needs to be done, but we have considerable promise that a chemical method may be worked out which will be even quicker than the biological methods.

Our work at Akron in dryland agriculture is carried on under three projects, which may be summarized under the general heading of Plains, Crops and Management. This work is in cooperation with the Office of Dry Land Agriculture and the Cereal Office of the United States Department of Agriculture. It consists of experiments on the time of planting crops for best returns. Studies on wheat, barley, oats and corn are used for these experiments. Studies are also being made on the rate of planting different crops to make the best use of a limited rainfall.

A series of studies on methods of soil preparation and another series of studies on dryland rotations are also under way. In addition to these studies, we carry to Akron each year, a considerable number of progenies of our breeding work, because we have found that climatic conditions at Akron, especially with our winter-grain breeding, are sufficiently severe to eliminate most of the weaklings. Thus, we send our hybrids and selection work on our winter grains to Akron each year in order that we may eliminate the non-hardy types before going to the expense of increasing many sorts for field trial. In other words, we require our winter-grain selections and hybrids to meet the severe climatic conditions found at Akron before we finish our field trials for yield and quality.

At Cheyenne Wells, Mr. Adams, who had been with the station for over 20 years, resigned to enter business for himself in Western Kansas. Since we had no appropriation for the Cheyenne Wells farm, it was necessary to find a man who could supply the place on a modified rental contract. After interviewing a great many applicants for the place and also after interviewing Senator Nelson and some members of the Board of County Commissioners, Mr. Scott H. Alexander was placed on the Cheyenne Wells farm.

At Rocky Ford, the studies in the control of excessive soil nitrates is still under way. This work has been carried on in two phases. The first phase was a study of the effect of crop sequence and soil cover and tillage in the production of nitrates. This phase was carried from 1920 to 1926. In 1926, a system of rotations was laid out based on the crop-sequence studies. Two sets of rotations—one of 5 and one of 8 years—have been conducted since that time. These give considerable promise of controlling the nitrate problem if rotations and crop sequence are given due and proper attention.

We have spent some time the past winter in checking up the results in an attempt to find out where our experimental data were deficient. We are spending the present summer in continu-

ance of the regular work and an attempt to get additional data on those points where data seem to be a little deficient.

We are studying not only the laws governing the production of nitrates in the soil but also the movement of nitrates from the soil to the sub-soil. Under fallow conditions, there is a steady downward movement at predictable rates of nitrates from the surface into the sub-soil. We have traced this movement rather accurately to depths of 6 feet and have some borings to a depth of 9 feet. We are attempting also to find the length of time required for crops to remove sub-soil nitrates and the depth to which different crops will remove nitrates because these are very vital points in practical land management.

In addition to the nitrate control work, we are carrying on cooperative experiments in clover growth and clover-seed production. These studies include methods of irrigation, methods of tillage, a test of varieties and cultural practices.

At Fort Lewis, our work is primarily a study of high-altitude crop culture and adaptation.

In addition to these lines of work during the past year we have conducted cooperative experiments with the Sugar Office of the United States Department of Agriculture. The cooperative experiments include a large number of cultural and irrigation practices, such as row spacing, methods of blocking, methods of cultivation—all described roughly under the brief heading of Agronomic Practices.

A list of the projects under way and which we hope to continue the coming year is given below:

Relationship of Soil Moisture, Structural Development and Acreage Yield of Small Grains. Adams, Purnell and State funds.

High-Altitude Crops. State funds.

Plains Crops and Management. State funds.

Improved Seed. State funds.

Control of Excessive Soil Nitrates in the Arkansas Valley. (Cooperation with Bacteriology). Purnell and State funds.

Cooperative Clover Experiments. (Cooperation with the United States Department of Agriculture). State funds.

Studies in the Control of Bacterial Wilt and Winter Killing. (Cooperation with Bacteriology). Purnell and State funds.

Laboratory Methods of Measuring Soil Fertility. (Cooperation with Bacteriology). Purnell and State funds.

Cooperative Experiments in Sugar-Beet Culture. (Cooperation with the United States Department of Agriculture). State funds.

It is proposed for the coming year to take up studies in soils in Western Colorado. Since budgets have not been allowed as yet for this work, an exact project title is not offered.

A list of bulletins and periodical articles published during the year is given below:

Bulletin 369—"The Date to Plant Corn in Colorado" by D. W. Robertson, Alvin Kezer and G. W. Deming.

Bulletin 370—"Oat Varieties in Colorado" by D. W. Robertson, Alvin Kezer, F. A. Coffman, J. F. Brandon, Dwight Koonce and G. W. Deming.

Bulletin 371—"Barley in Colorado" by D. W. Robertson, Alvin Kezer, F. A. Coffman, J. F. Brandon, Dwight Koonce and G. W. Deming.

"Genetic Studies in Barley" by D. W. Robertson and G. W. Deming, published in the Journal of Heredity.

"Natural Crossing in Barley" by D. W. Robertson and G. W. Deming, published in the Journal of American Society of Agronomy.

The work of the section has two phases—scientific results which must be applied indirectly and results which have immediate and practical bearing. The Critical-Period studies have given both scientific results and results which can be put to more or less immediate use both in irrigated regions and on dryland. The finding that water at certain periods in the growth of wheat, especially at jointing and blooming time, had a much greater effect on yield than when applied at other times has enabled many to make better use of a limited irrigation-water supply. The finding that soils dried out by crops in the fall which go into the winter dry will produce a lower yield the next year has been made use of especially by farmers in the lower Platte Valley. These farmers have irrigated in the fall of the year and have considerably increased crop returns.

On the dryland, these studies have enabled us to interpret many facts connected with the fallow. They have brought out the necessity of collecting moisture in the soil before putting in a crop like winter wheat. This is especially true in those regions where the rainfall is limited. Starting with a moist soil is a big factor in the success of the crop whether rains come or fail to come.

Our studies in the control of soil nitrates have shown very conclusively that many soil factors are under the control of the farmers. Nitrates rise in the soils when frequently stirred by cultivation. Thus, they are always higher under tilled crops than under untilled crops. Our studies with the effect of crop residues

also indicate that plowing under residues high in nitrogen increases the soil nitrates, while plowing under residues low in nitrogen will temporarily decrease nitrates. Certain crops favor the production of nitrates. Others diminish the production and consume nitrates already produced in the growth of those crops. These factors indicate that they must be taken into consideration in the crop sequence followed in order to prevent nitrates becoming unduly abundant in the soil. They suggest, where high nitrates are a trouble, the more desirable crop sequence. They also suggest the limited use of farmyard manures rich in nitrogen. Such manures can be utilized, but the amount supplied at any one application should necessarily be limited rather than unlimited.

Enough is now known to enable a very much better farm practice where nitrates are a problem. There is much yet to be learned, but we can, at present, give very many helpful suggestions.

Our studies in laboratory methods of determining fertilizer needs have given us a practical way of assisting farmers. In something over 7,000 tests made, 93 percent of the cases showing a phosphorus need responded favorably to phosphorus applications and 81 percent out of the total gave profitable returns. These findings, while they do not constitute a basis for absolute practice, are accurate in a sufficient percentage of the cases to constitute a very helpful service to farmers. Used intelligently, the laboratory test will give very material aid to the farmer in the field.

Our variety test work at Akron has brought new and superior varieties of grains to the crops adapted to the dryland regions. These new and superior varieties, coupled with new tillage methods that have been worked out at the dryland station, constitute a distinct contribution to the stability of our dryland agriculture.

Our high-altitude work has enlarged the cropping possibilities of those regions. Recent work which is especially promising is the test of pea varieties, indicating that the yield of field peas for the higher altitudes can be very materially increased by the adoption of some of the newer varieties which have shown superiority in the tests.

There has been a feeling that beardless barley could never be as plump as the bearded types. This point is not completely settled, but we have found that with Colsess, a beardless type bred up at this station especially for the high altitudes, can be increased in plumpness by early planting. This increase in plumpness takes place both on the plains and in the higher altitudes.



This knowledge alone is of very material value in raising the yield and quality of this valuable variety which the Agronomy Section produced by breeding.

The studies in the control of bacterial wilt have not gone far enough to make any positive statements, but the work so far has very clearly shown that common alfalfa and Argentine strains are very inferior in winter hardiness and in resistance to a number of other sorts. Grimm, one of our hardiest varieties and one of the best cold-resistant varieties, is susceptible to the wilt. Certain strains of Turkestan, Ladak and Provance appear to be resistant to the disease. If these appearances prove true in further studies, we can proceed to build up centers of seed production of the resistant strains.

Respectfully submitted,

ALVIN KEZER, Chief Agronomist.

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## REPORT OF THE ANIMAL HUSBANDMAN

To the Director:

Following is a report of the various projects carried on by the Animal Investigations Section:

**Ration Experiment With Cattle (Purnell).**—Six lots of steer calves fattened during the past winter on various rations are almost ready for market. Feeders' day will be held May 28 and we expect to ship the cattle the first week in June. In this experiment, a duplicate of last year's work, a study is being made of the comparative feeding value of wet beet pulp, corn silage, cull potatoes, and a silage composed of potatoes and dry corn fodder cut together into the silo. A basal ration consisting of ground barley, cottonseed cake and alfalfa hay has been used in this experiment. This year's test will conclude the current series.

**Summer-Fattening Experiment With Cattle.**—Beef calves which had been carried thru the previous winter on cheap available roughages to get them in a fleshy condition when the pasture season opened were carried thru the summer on alfalfa and Morton's pasture grass mixture with and without protein supplements. A heavy feed of protein was used to determine if such feeding practice would prevent the yellow color of fat found in grass-fed cattle. Linseed oilmeal and cottonseed meal were used as protein feeds. Two lots of cattle were fed in drylot with and without protein supplement. The cattle were shipped the latter part of September. Results of the test indicated that the heavy

feeding of protein had no effect on color of fat. The highest net returns for cattle on pasture were secured from those pastured on alfalfa with the next highest from those pastured on Morton's mixture without protein supplement. This experiment will be duplicated this year with reduced amounts of protein supplements.

**Winter-Maintenance Experiment With Pasture Cattle.**—The third year's work on this experiment comparing stacked beet tops and corn silage has been completed. These rations were considered as "warming up" rations for beef calves carried thru the winter to be fattened on grain on irrigated pastures during the following summer. The stacked beet tops, altho furnishing a satisfactory cheap roughage, were not as efficient as corn silage, but the test clearly indicated that the stacked tops can be utilized and fed after going thru the fermentation process without any harmful effects whatsoever.

**Wintering Experiment With Heifer Calves.**—Eighteen head of home-grown heifers were carried thru the past winter on North Park hay and in addition nine of the heifers were fed one-half pound of cottonseed cake. The cake-fed heifers gained 96 pounds more than the non-cake-feds, more than paying for the small addition of cottonseed cake. These heifers will be followed thru the summer to determine if their stunted condition can be overcome.

**Wintering Experiment With Two-Year-Old Heifers.**—Twenty-two head of yearling heifers were bred to calve at 2 years of age. They were fed North Park hay in both lots, one lot receiving 2 pounds rolled oats and the other 2 pounds cottonseed cake in addition to the hay. The rolled oats seemed to give more favorable returns.

**Range Management.**—The study made of the carrying capacity of the low foothill range in the maintenance of a beef-breeding herd is being continued. In connection with this a creep-feeding experiment has been started with the calves produced on this range. Demonstrations indicate a decided advantage to creep feeding in producing calves for market. Colorado is the first experiment station doing this type of work. One lot of calves has access to a self-feeder containing rolled oats, the others have only their mothers' milk.

**Peafield Hog-Feeding Experiment.**—The second year's work was completed with hogs on peafields. The experiment confirmed last year's results in all phases of the study. Peafield pasture alone proved unsatisfactory. It required 931 pounds of peas to produce 100 pounds of pork when peas were fed alone. Barley

proved a valuable supplement to peafield pasture. Protein supplement was essential with a peafield ration. Alfalfa meal proved itself the most desirable protein supplement at existing prices.

**Summer Pig-Feeding Experiment at Akron.**—Forty pigs were fed 140 days on a succession of annual pastures including fall-sown rye, spring-sown barley and sudan grass with a self-fed grain supplement. These pigs compared very favorably both in gain and cost of gain with a similar lot fed the same ration in drylot. A duplicate of this test has been started this spring.

**Winter Pig-Feeding Experiment at Akron.**—The second test of this series was completed this spring. It included comparisons of corn, barley, millet and hay millet seed and mixtures of these grains. Millet did not show quite as high a feed-replacement value because of the better grade of corn used in this year's test and also because the millet was not ground as completely as last year. A mixture of the grains again showed an increased palatability of the ration. A comparison of rations containing protein supplements and no protein supplements indicated the need for protein to balance the available grains. Triple mixture did not prove as valuable as tankage with these small pigs. Indications are that triple mixture, altho just as efficient as tankage with older pigs, was somewhat bulky for small pigs. More work should be done along this line.

**Winter Lamb-Feeding Experiment at Akron.**—Under non-irrigated conditions there has been no dependable source of home-grown protein developed. Sudan meal, grown in Eastern Colorado, showed very satisfactory results this year and should by all means be included in a lamb-fattening ration. Under existing price conditions it proved itself very valuable when used in connection with cottonseed meal in half-and-half proportions. Hog millet again showed 83 percent the value of corn. There was little difference between "natives" and "westerns." The rate and cost of gain was about the same. A comparison between wethers and ewes showed that the wethers made greater daily gain, required less feed per cwt. gain and the feed cost was lower to produce a unit of gain.

**Rations for Fattening Lambs.**—A comparison was made between cull potatoes, cull potato and corn fodder silage, and siloed beet pulp fed as carbonaceous supplements to a basal ration of whole barley and alfalfa hay. A study was also made of adding cottonseed meal to a basal ration of whole barley and alfalfa hay and also adding cottonseed meal to rations containing the carbonaceous supplements as mentioned above. Alfalfa meal (13 percent protein) and alfalfa stem meal (9 percent protein) were

compared in a self-fed mixture of ground barley, cottonseed meal, molasses and alfalfa.

Final discard molasses from the barium-process factory at Johnstown, discard molasses from the Steffen's house and foreign molasses and can molasses were fed as supplements to a basal ration of shelled corn and alfalfa hay.

**Field Lamb Feeding.**—One lot of lambs was pastured on stock beets and alfalfa hay for 45 days. The second lot was pastured on stock beets and alfalfa hay, receiving barley in addition for 54 days. A third lot was fed barley and alfalfa hay in the drylot. After the preliminary feeding period all three lots were put on a ration of barley, cottonseed meal, wet beet pulp and alfalfa hay.

A study of comparative yields of blocked and unblocked stock beets is being made in cooperation with the Agronomy Section. The unblocked beets yielded 23.13 tons of beets and 25.12 tons of tops. The blocked beets yielded 24.6 tons of beets and 18.09 tons of tops. The cheapest feed cost per 100 pounds of gain was lower for the lambs fattened entirely in the drylot.

**Advanced Registry Testing.**—Following is a summary of the work done since May 1, 1930:

Month	1-Day	2-Day	3-Day	Herd Imp.	Fees
May	62	2			\$16.00
June	58	3			15.25
July	52	3		29	16.65
August	49	3		10	14.00
September	55			10	14.75
October	51	2	2	11	14.85
November	56	6		17	17.20
December	62			13	16.80
January	63			15	17.25
February	63			14	17.15
March	50			24	14.90
April	44			21	13.10
	<hr/> 665	<hr/> 19	<hr/> 2	<hr/> 164	<hr/> \$187.90

Following is a list of the projects upon which we desire to prosecute work during the coming year:

1. Ration Experiments with Cattle (Purnell).
2. Summer Fattening Experiment, Cattle.
3. Range Management, Cattle.
4. Creep Feeding, Calves.
5. Field Lamb Feeding.

6. Ration Experiment, Lambs.
7. Nitrogenous Concentrate Studies with Lambs.
8. Utilization of Dryland Feeds.
  - a. Winter Pig Feeding.
  - b. Winter Lamb Feeding.
  - c. Summer Pig Feeding.
  - d. Winter Maintenance of Ewes.
  - e. Summer Pasturing Ewes.
9. Hog Feeding, San Luis Valley.

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

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### REPORT OF BACTERIOLOGIST

To the Director:

I have the honor to submit herewith the report of the Bacteriological Section of the Experiment Station for the year July 1, 1930, to June 30, 1931.

Four lines of investigation, supported by both government and state funds, have been conducted as follows:

1. Alfalfa Wilt Resistance Tests.
2. Winogradsky Soil Deficiency Tests.
3. Botulism Poisoning.
4. Niter Studies at Rocky Ford.

The personnel of the staff has remained the same except that Miss Sarah E. Stewart has replaced Mrs. Mildred Brown Carpenter, resigned.

#### Projects

**Bacterial Wilt of Alfalfa.**—We now have the results of 2 years' observations on our alfalfa variety-test plots in Larimer, Boulder and Weld counties. These plantings have been made for the purpose of obtaining one or more varieties which will show outstanding resistance to winter injury and bacterial wilt. There have been added to the list this year four northern-grown Nebraska strains which are said to possess the qualities we are seeking. The Canadian Variegated, Cossack and Grimm appear to be the most promising varieties; counts made in the spring of 1931 showed considerable mortality in the Common and Argentine, and as the season progresses we shall probably find more of the plants succumbing to the wilt since the stands are now in their third year, at which age our observations have shown the disease becomes of economic importance.

This investigation is being carried on in cooperation with the Agronomy Section.

**Soil Deficiency Tests.**—Further improvements on the soil-plaque method of determining soil deficiencies have been made. A total of 545 samples have been examined with the following results: 77.24 percent are deficient in phosphate; of these 56 percent are very deficient, 30 percent are moderately deficient and 14 percent are slightly deficient. For soils that are very deficient we have recommended the use of 125 to 150 pounds of treble superphosphate per acre, and for those that are moderately so, 100 to 125 pounds; when the test indicates only a slight deficiency we have recommended an experimental trial before a general application is made to the whole field. Twenty-eight percent of samples examined were also deficient in available nitrogen.

Our experimental work on this project has consisted of a comparative study of the soil plaque, the Neubauer method and the Hoffer corn-stalk method as means of determining soil deficiencies. A close correlation has been obtained between the results of the soil-plaque and Neubauer methods in relation to phosphate, but the work on potash correlation has not yet been completed. In the majority of cases the nitrate tests by the corn-stalk method have confirmed the chemical determinations; the potash tests indicate an abundance of this material in practically all soils, but the correlation studies with the Neubauer and soil-plaque methods have not been completed. A very close agreement in calcium carbonate deficiency has been secured between the soil-plaque determination, hydrogen ion concentration and chemical test. The results obtained with these various methods of determining soil deficiencies have been checked with fertilizer field plots planted to sugar beets. In every case where the laboratory tests showed the need for fertilizer, increased yields have been obtained. The most profitable returns, amounting to from 1 to 5 tons per acre, were secured with applications of "Ammono-phos." Neither raw nor steamed bonemeal gave as good yields as the mineral phosphate. The field tests were made in cooperation with the Agronomy Section, with Dr. D. W. Robertson in charge.

This investigation presents an outstanding case of the great practical value which a technical department of the Experiment Station can be to the agriculture of the state. The soil-plaque method of testing for soil deficiencies was developed in the Bacteriological Laboratory, and is being used now by the five sugar companies in Colorado, the Utah-Idaho Sugar Co., the Hawaiian Sugar Planters Association, and a number of fertilizer com-

panies and experiment stations in the United States, Canada, Alaska and New Zealand.

Three hundred thousand acres of sugar beets were grown for the Great Western Sugar Company last year in Colorado, Wyoming, Nebraska and Montana. Twenty-six percent of this acreage, or 78,000 acres, were given applications of phosphate fertilizer after laboratory tests had shown the need of this plant food. Increased yields resulting from the use of the phosphate conservatively averaged  $2\frac{1}{4}$  tons per acre, according to company officials. The increased yield on this area totaled 175,500 tons of sugar beets; at \$7.00 per ton, this meant an additional return to the beet growers of \$1,228,000.00, the direct result of the development of the bacteriological soil-plaque method of soil testing by the bacteriological laboratory of the Colorado Experiment station.

**Botulism Poisoning.**—The numerous outbreaks of botulism poisoning thruout the country indicate the need of further study of the distribution of *Clostridium botulinum*, the organism responsible for this poisoning in the soil. Various workers have demonstrated the presence of this germ in the soil, showing that fields and gardens are its common habitat.

The usual procedure used for testing soils consists of inoculating the soil to be examined in a suitable medium and of feeding or inoculating the culture filtrate into guinea pigs.

A method has been developed in this laboratory for determining the presence of *Clostridium botulinum*, which consists of testing the filtrates from the soil cultures by a complement fixation reaction. This is very specific for botulinus toxin. By employing this technique, minute quantities of poison can be detected immediately, while if the same quantity of toxin is fed to a guinea pig, the results are delayed, in many cases taking as long as 2 weeks. This method makes possible the examination of a large number of soils in a short time and does not involve the mortality of a large number of guinea pigs.

The investigation has brought out a very serious objection to the methods previously employed by other workers for detecting *Clostridium botulinum* in soil. We have been able to show repeatedly that there is a very strong antagonistic action in a culture medium between the germs of botulism poisoning and other soil anaerobes. Many soils, even tho artificially inoculated with *Clostridium botulinum*, give negative results both with the complement-fixation reaction and when fed to guinea pigs. This suggests that with the methods now in vogue, negative results may have been obtained when the soils may actually have had

*Clostridium botulinum* present. Either the growth of the organism may be inhibited or the toxin produced may be destroyed. The method has not been completely perfected yet, but the preliminary work looks rather promising. Soils for this study have been collected from the vicinity of Eaton, Ault, Greeley, Fort Morgan, Brush, Sterling, Akron, Wray, Holyoke and Julesburg.

**Niter Studies.**—Our investigations of the origin and control of excessive nitrates in the soil of the Arkansas Valley, carried on in conjunction with the Agronomy Section, now have an added interest and value, due to the recent appearance of high nitrates in the eastern part of the state. The results of some 5 years of experimental work are now available for the use of this section and with this information at their disposal, which they are putting into practice, it is reasonable to predict that their nitrate problem will not become as serious as in other parts of Colorado in earlier years. We have continued our studies of the effect of crops, crop sequences and crop residues on nitrate production and accumulation in soil, and shall include this in our 1931 program. The additional information which we have secured strengthens further our evidence that the high soil nitrates are being produced in the surface layers and are of bacterial origin.

Two new phases of the nitrate question are being initiated in 1931:

The first of these pertains to the effect of the addition of different carbonaceous materials, phosphates and available nitrogen on the amount and rate of accumulation of nitrogen by azotobacter. This will include a study of the influence of varying amounts of nitrate on the fixation of atmospheric nitrogen by bacterial agencies.

The second is concerned with determining the rate of nitrogen transformation in green manures from protein nitrogen to nitrate nitrogen and with the effect of plowing under green manures on the initial nitrate content of the soil.

A brief report of the laboratory work at Rocky Ford by Mr. Robert Gardner, chemist, follows:

“The effect of crops and crop sequences, and the effect of various added soil components on the amount of nitrate in the soil continue to be the two principal lines of study. No material changes were made in the 1930 work, but emphasis was given the aspects less completely solved by the preceding work—the three of these aspects of principal importance being: The movement of nitrates with the water in the soil; the time required for nitrogen reduced by adding green manure to return to nitrates, and the effect of crop residues on cropped as well as uncropped soil.



"The first of these aspects has offered so many difficulties to study that no adequate evaluation of its importance on nitrate accumulation has been made. Because of the difficulty in measuring the nitrate lost by leaching, the field studies in the past have had to be carried on by the unsatisfactory procedure of measuring the residual amount of nitrate left after an indeterminate amount had been removed in the water. Since this amount would vary with the type of soil and drainage conditions, it is obviously vital to the problem. During 1930, an attempt was made, principally by a more intensive analysis of the subsoil, to make some kind of an evaluation of this loss. The results of this attempt indicate the importance of continuing the effort. No quantitative results are obtainable from the data secured, but they clearly indicate an enormous leaching loss on the particularly well-drained soil under investigation. It would appear that under these particular soil conditions the rate of leaching would preclude the possibility of more than temporary excessive surface nitrate accumulations."

### Miscellaneous

For several years we have been testing out at Rocky Ford the value of aging bean seed for the control of bacterial blight. The results last season with 2 and 3-year-old seed failed to show any advantage over 1-year-old stock, so far as prevalence of the disease was concerned. The attack was very severe all over the state and everything seems to have suffered alike.

In addition to the aged seed work, we also tested out six strains of beans obtained from Wisconsin and said to have been selected because of some degree of resistance. These were furnished us by Dr. Zaumeyer, of the U. S. Department of Agriculture. I regret to state that all of these succumbed to the disease as badly as home-grown commercial seed. Among these, there were a few scattering plants that seemed to have escaped, but they were such shy producers that I doubt their commercial value. Seed has been saved from all of these, and this year we shall increase our plantings of so-called resistant varieties. However, I have very feeble hopes of securing anything with marked resistance, for this has been attempted for years and years without success.

In cooperation with Mr. R. G. Richmond, of the Entomology Section, I investigated the cause of troublesome fermentation in crystallized honey. This was found to be due to a yeast.

At the invitation of the Department of Botany, I gave five lectures on bacterial plant diseases; a similar lecture on "Methods of Determining Soil Deficiencies" was given before the class in industrial chemistry.

At the invitation of the Extension Service I spoke before the fruit growers of Palisade and Clifton on "Yellow Peach Trees, Pear Blight and Sulphur;" before a farmers' meeting at Hudson and the cherry growers at Loveland on "Soil Testing."

Radio talks were given over Station KOA as follows:

"The Preparation and Preservation of Fruit Juices."

"Testing Soil for Fertilizer Needs."

"Spare the Soil Microbe."

"Camp Sanitation."

At the invitation of the American Society of Agronomy and Section O of the American Association for the Advancement of Science, I presented a paper on "The Use of the Bacteriological Soil-Plaque in Determining Soil Deficiencies," at Cleveland, Ohio, December 30, 1930. This was one of six papers given at a symposium on methods of testing soil deficiencies.

### Publications

"Spare the Soil Microbe." Farm Messenger, April, 1930.

"A Bacteriological Method for Determining Soil Deficiencies by Use of the Soil-Plaque." Proceedings Sixth Annual Convention, National Fertilizer Association, 1930, p. 47.

"Mud Pies That Mean Something." Fertilizer Review, July, 1930.

"Testing Soil for Fertilizer Needs." Through the Leaves, Nov., 1930.

"A Bacteriological Method for Determining Soil Deficiencies." Proceedings 87th Annual Meeting, Am. Assoc. Adv. Science, 1930 (submitted).

### Projects to Be Carried in 1931-1932

1. Heat-Resisting Bacteria in Fresh and Canned Vegetables. Adams fund.
2. The Value of Certain Carbon Compounds as Sources of Energy for Azotobacter. Adams fund.
3. The Natural Inoculation of Colorado Soils with Legume Bacteria. Hatch and State funds.
4. The Winogradsky Method of Testing Soil Deficiencies. Purnell fund. (Cooperative with Agronomy).
5. The Control of Excessive Soil Nitrates in the Arkansas Valley. Purnell fund. (Cooperative with Agronomy).
6. Studies in the Control of Bacterial Wilt of Alfalfa and Winter Killing. Purnell fund. (Cooperative with Agronomy).

In the various phases of the work reported here, I have been assisted by Miss Laura C. Stewart, Mr. Robert Gardner, Dr. D. W. Robertson, Miss Sarah E. Stewart and Miss Esther Elliott, whose efficient services I am pleased to acknowledge.

Respectfully submitted,

WALTER G. SACKETT, Bacteriologist.

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## REPORT OF THE BOTANIST

To the Director:

I beg to submit the following report of the work carried by the Botanical Section for the past fiscal year.

**Diseases of Greenhouse Plants.**—The work on diseases of greenhouse plants was started July, 1930, at the request of the Colorado Growers Association and partly financed by that organization.

The purpose was first to make a survey of the diseases affecting the greenhouse crops of the members of the association and second, to make a study of these diseases in order to remedy them.

The following work has been done on this project by Mr. E. J. Starkey:

Fifty-two distinct diseases have been found in the greenhouses of Denver and vicinity. Micro-organisms have been isolated from many of these and Koch's laws of proof have been completed on three of them.

The most important diseases, economically, in the Denver houses are those on carnations.

The following chemicals have been tested for prevention of spread of root rot of carnations,  $\text{CaCO}_3$ ,  $\text{HgCl}_2$ , Corona dust, Semesan, Ceresan and DuPont mixtures.

It has been proved that the carnation root rot organism may be transmitted by cuttings from infected stock. This of itself is sufficient to enable the grower to control the disease.

It has been found that stem rot of carnation is due largely to faulty cultural methods. The disease is caused by a soil-borne organism, *Rhizoctonia*, that is spattered from the soil to the leaf sheaths in watering.

Ammonical copper carbonate spray has been tested with success on delicate foliage and flowers. This spray destroys organisms on leaves, prevents infection and does not corrode or discolor the flowers. Copper carbonate dust has been found to be

more satisfactory than sulfur for control of mildew of sweet peas under glass.

The Sidawitz variety of chrysanthemum has been proved susceptible to black leg (*Cylindrosporium*) and other varieties are immune.

Study has been made of black spot of roses and satisfactory recommendations given.

With diseases of vegetables under glass the following work has been done.

Demonstration has been made of the cause of failure in steam sterilization for control of tomato wilt in several greenhouses where tomatoes are used as intermediate crop.

A serious disease of cucumber was studied, and in cooperation with Mr. Hockensmith of the Agronomy Section, the cause was found to be high nitrate content of the soil. The corrective measure, however, did not consist in lowering the nitrate content, but in raising the available phosphate. Over \$6,000.00 was saved one grower by this study.

**Cereal Disease Studies.**—Work on this project has been carried on part time by Mr. Bodine. Study of the physiology of *Tilletia levis*, the fungus causing stinking smut of wheat, has been continued and acid relations of that organism have been determined. The temperature of infection of resistant and susceptible wheat has been studied and also the temperature relations of different strains of smut collected in different states. The life history of the smut organism has been completed on artificial media.

**Truck-Crops Disease Studies.**—The work on truck-crops diseases has chiefly centered in the Arkansas Valley in a study of the onion purple blotch. Mr. Cation was stationed in the valley last summer, located in the laboratory of the sugar company of which we have use thru the courtesy of Dr. Coons. Mr. Cation's chief work was in answering calls of farmers in the valley. Three hundred growers called for assistance and as many visits were made. Diagnoses and recommendations were made for a number of diseases of crops. The diseases of most importance noted in the valley were purple blotch of onions and bacterial canker of tomato. The latter disease may be confused with tomato wilt and seriously threatens tomato growing in the valley.

Following Mr. Cation's resignation to go to Michigan, Mr. Bodine has been put on this project and has planted 2 acres of onions on beet company ground where various treatments will be tested this season. Greenhouse studies are being made of sporulation of *Macrosporium porii* that causes purple blotch and infection experiments are being run.

**Range and Pasture Improvement.**—The following is a list of the activities on this project:

1. Completion of Akron native-pasture studies. Data presented for publication.
  2. Completion of irrigated pasture studies. Data presented for publication.
  3. Completion of 10-year study on deferred and rotation grazing versus continuous grazing on native pasture. Data accepted for publication.
  4. Construction and testing of portable recording at-mometer to measure evaporation in field.
  5. Extension circular written on deferred-rotation grazing and an article on range preservation written for *Western Farm Life*.
  6. Continuation of meteorological and ecological records for foothill pasture and Virginia Dale to determine proper forage condition for opening of grazing season.
  7. Continuation of range improvement studies in the Laramie River Valley and sagebrush range. Grazing capacity and forage production have been increased on this range 200 to 400 percent.
  8. Study of methods of meadow analysis.
  9. Hay and meadow analysis made in North Park and Laramie River Valley.
  10. Competition studies in dryland pasture mixtures. Virginia Dale and Willard, Colorado. Assisting extension agronomist and county agents in establishing pastures at Wray and Hugo, Colorado.
  11. Ecological studies on native and tame pasture grasses to determine possibility of reseeding, the survival of species and the season of pasturage.
  12. Study of palatability of shrubs determining the food content and utilization. Mountain mahogany has been found high in food value and forms considerable forage of foothills for fall and winter pasture.
  13. Answering correspondence and requests regarding range plants and range management.
  14. Establishment of a forage plant nursery at Ft. Collins for selection of introduced forage plants for range reseeding.
- Forty-six rare species of grasses are being tested, collected from China, Manchuria, Spain, Russia, Korea, South Africa and Canada.

**Weed Control.**—The work on weed control has been confined to experimental tests in four localities—Larimer county, Arkansas Valley, San Luis Valley and the Western Slope. These localities offer a wide range of climatic and soil conditions. The weeds treated on these plots are the poverty weeds, bindweed, Canada thistle, Russian knapweed and white weed.

All the commercial weed killers on the market have been tested out, tho the chief experimental work has been with chlorates. The chlorates have been found the most effective and promising materials for killing weeds and, moreover, they are now obtainable at a low price in large quantities.

In our experimental tests, which consist of over a thousand rod-square plots at the above-mentioned locations, sodium chlorate has been found the most effective, tho the value is lessened because of risk from fire. The newer calcium chlorate, sold under the commercial name "Atlacide," is nearly as effective, tho it contains but 60 percent chlorate. Three applications of these substances have been found effective in killing perennial weeds, tho in some cases one application has been sufficient. The costs of these treatments is within reason.

The mouse-ear poverty weed and bindweed are easiest to kill. Canada thistle and Russian knapweed are next, but white weed so far has resisted treatment.

Several factors have been found to influence the efficiency of chlorates. The acidity of the soil or acidifying of the water used in making the spray increase the effectiveness of the chemical. The use of nozzles giving a very fine spray also favors the efficiency. On the other hand, irrigation or the removal of the tops after treatment materially lowers the efficiency of the spray or even prevents its action.

During the past year, in cooperation with the Chipman Chemical Company, a book of instructions on the use of chemical sprays for weeds has been furnished to the county agents and Smith-Hughes men. Numerous newspaper articles on weed control have been published. The culmination of the work has been the adoption by Weld county and some of the counties in the Arkansas Valley of a program of weed eradication thru the agency of the county agents and county commissioners.

**Seed Laboratory.**—Samples tested have been:

	Number of Samples Tested
Field Crops	
Cereals .....	658
Forage crops	
Legumes .....	631
Grasses .....	347
Lawn and pasture grasses.....	73
Vegetables .....	525
Vines .....	295
	<hr/>
Total.....	2,529

**Samples Taken by Inspector**

Field crops .....	513
Total tests made	
Purity .....	2,275
Germination .....	5,558
Identifications .....	31
	<hr/>
Total.....	7,864

Approximately 45 percent of all samples of field seeds were submitted by seed dealers.

103 samples were tested for the Agronomy Section of the Experiment Station.

255 samples were tested for Seed Registration Service.

**1930-1931 Publications of the Botanical Section**

Bodine, Edward W. Double plate method used for culturing *Tilletia levis*. Science, May, 1931.

\_\_\_\_\_ and Durrell, L. W. Inoculation of wheat with *Tilletia levis*. Phytopathology, Vol. 20, 1930.

Durrell, L. W. The Pathology of Maize.

Torrey Botanical Club, Vol. 57, January, 1931.

\_\_\_\_\_ Diseases of Corn. Symposium Botanical Society of America, A. A. A. S.

Howe, Mary F. Germination and infection with *Sclerospora graminicola*. Abstract, Mycologia.

Hanson, Herbert C. Grazing of sheep on short grass sod at Akron, Colorado. Journal of Agricultural Research.

\_\_\_\_\_ Factors influencing the establishment of irrigated pastures in Northern Colorado. Colorado Experiment Station Bulletin.

- The effect of different systems of grazing by cattle on western wheat-grass type of range. Colo. Agr. Exp. Sta. Bulletin.
- The root systems of strawberry varieties. (Ecology —submitted).
- Pastures for spring and fall grazing in mountains of Colorado. Colo. Agr. Exp. Sta. Bul. 360.
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**Papers Read Before Colorado-Wyoming Academy of Science,  
November, 1930**

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- Howe, Mary F.—Resume of the life cycle of *Sclerospora graminicola*.
- Smith, E. C.—Current observations on Myxomycetes.



- Starkey, E. J.—Effect of ultra-violet light on sporulation of fungi.
- Thornton, Bruce J.—The status of weed control experiments in Colorado.
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## REPORT OF THE CHEMIST

To the Director:

The chemical section of the station has but one approved project,—“The Deterioration of Alfalfa Hay Due to Exposure and Rain.” This has been prosecuted during the past year to the exclusion of all other work. The composition of the samples has been determined in all cases before and after wetting.

In addition to the chemical work, biological experiments have been made by feeding the prepared samples to rats. A series of samples was prepared from each growth, cutting the plants at different stages of maturity. The whole series will be finished as far as vitamins A and B are concerned, probably by October or November.

No other line of investigation has been prosecuted except as follows: An acre of land was rented and planted to beets with the application of a variety of fertilizers, used singly. Only two were used in conjunction. The results were not in conformity with the general views or experience. The results obtained are on record, but the subject has not as yet been followed up and extended sufficiently to justify any further conclusion than that a further study would be justified. No plan has been worked out for its prosecution.

There have been no publications in journals this year.

Respectfully submitted,

WM. P. HEADDEN, Chemist.

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## REPORT OF THE AGRICULTURAL ECONOMIST

To the Director:

During the year ending June 30, 1931, the Section of Agricultural Economics and Rural Sociology has continued its research activities on nine projects, eight of which have been approved for development with Purnell funds.

**Project 1.—An Economic Study of the Peach Industry in Colorado.**—This study was initiated in 1926-27 in cooperation with the Division of Farm Management and Costs, Bureau of Agricultural Economics, U. S. Department of Agriculture, and it

has been continued during the past 3 years in cooperation with the Extension Service of the Colorado Agricultural College. The original records which were assembled dealt with labor and material costs in producing peaches. Within the past 3 years much more emphasis has been given to an analysis of the farm business as a whole.

As the work has developed it has been apparent that farm operators who are located under favorable conditions are finding the production of peaches a profitable business. New lands adjacent to old districts are being set to new orchards. It is altogether probable that some of these new areas have not been tested thoroly and future experience may demonstrate that all of these lands are not adapted to this particular crop. New projects may therefore face uncertain years in so far as the returns from this crop are concerned.

**Project No. 2.—An Economic Study of Farm Organization and Management in the Greeley Area and in Northeastern Colorado.**—This analysis was undertaken in 1922 in cooperation with the Division of Farm Management and Costs, Bureau of Agricultural Economics, U. S. Department of Agriculture. This relationship was continued for 4 years and at the end of this period the entire responsibility for the project was taken over by this department. Detailed farm accounting records have therefore been continued in this region for a period of 9 years.

Detailed farm accounting records have been maintained on a few of the same farms for 9 consecutive years. Financial records have been assembled for representative types of farming in this area for several years in succession. These two groups of records have provided a wealth of material showing changes in Northern Colorado irrigated farming since 1922 and they have furnished direct information on the methods and practices which have been followed in this area. Our analyses indicate the increasing severity of competition in farming and they furnish suggestions with respect to the need for a revision in the methods of handling crops to meet competition. In spite of disastrous reverses the feeding of livestock persists as the most profitable type of farming in this irrigated area.

**Project No. 3.—A Study of Costs and Methods of Producing Cattle and Sheep on the Range in Colorado.**—Four departments are represented in the study and analysis of this project and two distinct but closely related regions are involved. The cooperating agencies are: The Bureaus of Animal Industry and Agricultural Economics in the U. S. Department of Agriculture, the Wyoming Experiment Station and this department. Approximately 20 rec-

ords are being maintained for the North Park area in Colorado and the records of 22 ranches are being assembled in the Saratoga Valley in Wyoming.

Fine weather prevailed quite generally in this region during the past winter. It has been counted as one of the best winter seasons in the memory of operators who have spent practically a lifetime in this section. While the temperatures were fairly low, the winter was remarkably free from high winds and blizzards and as a result winter losses have been light and feed requirements somewhat less than usual. There will be some hay left over, but the surplus is not nearly so large as last year. The decrease in supply has been due to the lighter crop which was harvested in 1930.

**Project No. 4.—Rural Social Agencies in Colorado, Classification and Evaluation.**—The project relating to "The Social Status of the Spanish in Rural Colorado" has been completed, and a new project under Rural Social Agencies has been approved. The latter is being developed in cooperation with the Division of Farm Population and Rural Life, Bureau of Agricultural Economics, U. S. Department of Agriculture.

Thru questionnaires made up for the different social agencies in the state much material has been received concerning the location, activities and favorable and unfavorable conditions. Some personal conferences have been held. In all phases of the project there are many loose ends that must be gathered by personal conferences. The project is a big one, setting out as it does to classify and evaluate the educational, religious, health and other social agencies. There is a general interest in the project by the people of the state and their cooperation is very helpful.

**Project No. 5.—A Study of Taxation in Colorado, Particularly in Its Relation to the Agricultural Industry.**—This enterprise was initiated in 1927 as a joint study with the Division of Finance, Bureau of Agricultural Economics, U. S. Department of Agriculture. During the past 3 years the study has been carried mainly by this department. Two phases of work have received special consideration. In the first place an analysis has been made of the cost of local government in Larimer County, and in the second place a study has been completed with reference to the cost of public schools in the local county.

As a result of the latter study it was suggested that educational costs may be reduced: (1) By the adoption of a simple and uniform system of cost accounting; (2) thru a study of comparative unit costs in education which should serve as the basis for evaluating the expenditures for any school; (3) thru the

adoption of a business-like procedure of budget making in order to eliminate wasteful methods of spending money; and (4) thru the development of a sound debt policy.

**Project No. 6.—A Study of Methods of Storage and Marketing Practices in Handling Onions on Farms in the Arkansas Valley.**—This project was developed originally for the purpose of making a detailed analysis of marketing practices and storage costs in handling potatoes in the San Luis Valley. After assembling records for approximately 4 years in the latter region, our attention was then directed to an analysis of similar problems in handling the onion crop. Both of these projects have been carried in cooperation with the Colorado Division of Markets, State House, Denver.

**Project No. 7.—An Economic Study of the Apple Industry in Colorado.**—Originally this project was conducted in cooperation with the Division of Farm Management and Costs, Bureau of Agricultural Economics, U. S. Department of Agriculture. Within the past 3 years the field work has been conducted in cooperation with the Extension Service of this institution. Our work on this project now includes financial records for 4 years on several types of farming in the region.

The apple producers of Colorado have been thru trying times within the past few years. Our field records appear to show that few operators relying entirely upon fruit for their incomes are making a profit. Farms ranging in size from 80 to 160 acres and selling both fruit and livestock are more profitable than those using the single-crop system. The feeding of livestock in connection with fruit and crop production appears to offer the best opportunity for profit. The latter type will require larger farms and some adjustments in the existing method of farming.

**Project No. 8.—An Economic Study of Land Utilization in Northwestern Colorado.**—This enterprise was undertaken in 1927 in cooperation with the Division of Land Economics, U. S. Department of Agriculture, and it includes a study of land utilization in Moffat, Routt and Grand counties. For 3 years in succession preliminary reports have been prepared and returned to cooperating farmers. In addition to the farm-organization analysis which has been handled by this department, a representative of the Division of Land Economics spent several months in Northwestern Colorado compiling a set of maps and records showing the present land utilization of this area. The combination of continuous financial records on a few farms, together with a few maps on land utilization, will give a very complete picture of existing conditions in this region. Our field party of 1930 ob-

served a widespread belief in the efficacy of summer fallow for winter-wheat production in Moffat County and a much more general use of tractors. Both of these items represent decided changes in the attitude of these men during the progress of the study.

Farm-business analysis records are now available for the years 1926 to 1930, inclusive. This has been a period of adjustment in this area. Much of the early settlement of this region was by men who were not familiar with dryland methods. The principles of sound dryland farming practice are rapidly being adapted to this area. Power machinery is coming into use. Farms are being cleared and increased in size. Men who are making these changes are finding a combination of feed crops and livestock the basis for profitable results.

**Project No. 9.—A Study of the Major Types of Cooperative Organizations or Associations in Colorado.**—During the summer months a representative of the department visited some 20 or more cooperative grain elevator men in Eastern Colorado and obtained partial records covering the business of these elevators during the past year. In addition, data have been obtained on grain shipments from stations on the Chicago, Burlington and Quincy, the Rock Island, the Union Pacific and the Great Western railways. This information was obtained primarily for the purpose of determining whether additional storage facilities should be provided in order to care for the storage of our wheat crop in Eastern Colorado. This phase of the situation is also under consideration by the states of Nebraska, Kansas and Oklahoma.

Respectfully submitted,

L. A. MOORHOUSE, Agricultural Economist.

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## REPORT OF THE ENTOMOLOGIST

To the Director:

Following is a brief summary of the work of the Entomology section of the Experiment Station for the year just closing:

There has been no important change in the personnel of the section during the year. The budget was not increased over that of the preceding year. The work has been carried in coordination with the work of the office of the State Entomologist, which, by state statute, is attached to this department of the Experiment Station. In this way the duties of the State Entomologist and the head of the Entomology Section of the Experiment Sta-

tion are cared for more efficiently and economically than would otherwise be possible.

The special appropriation of the federal government made 2 years ago for the purpose of exterminating the Mormon cricket in Northwestern Colorado, was continued for the past fiscal year, also, the work being in charge of Mr. F. T. Cowan. This work has been completed over the area formerly known to be infested. A new area of infestation, however, extending over several square miles of mountain territory was discovered during the past year in Moffat County. It is believed this area can be taken care of during the coming season, but, as there are two or three prominent stockmen who are strenuously opposed to having poison put upon the range occupied by their stock, it will probably be necessary to organize a pest district in order to carry on the work.

Grasshoppers and cutworms were especially destructive to crops in the state over rather large areas during the past year and from present indications will be equally destructive during the present season.

Far more poison for the preparation of arsenic-bran-mash was sent out to farming communities last year than in any previous year, enough, in fact, to treat 366 tons of bran.

The call for poisoned oats for the destruction of prairie dogs and the Wyoming ground squirrel has also been unusually heavy, enough, according to our estimate as ordinarily put out, to destroy a million of these rodents. If to this we should add the strychnine that has been furnished thru this section to farming communities for the preparation of poisoned oats, the estimate of rodents destroyed thru our cooperation with the farmers and the Extension Service would reach two millions.

The projects carried in this section during the past year are listed in the report of the Director of the Experiment Station. Progress was made in all of these. I am asking that all of them be kept active during the coming year except the one dealing with the relation of the honeybee to the fertilization of red clover in the Arkansas Valley. This investigation has been completed and a manuscript has been written, giving the important results, for early publication.

We plan to stress during the coming fiscal year, our work with the egg parasite (*Trichogramma minutum*) which is being experimented with for the control of the codling moth; the work for the control of the potato flea beetle in the Greeley district; the plant-louse investigation; the work for grasshopper and cutworm control; the experiments for the control of the onion thrip; and do as much on other projects as time and funds will permit.

### Publications

Only one bulletin, "Life-History Studies of the Wyoming Ground Squirrel (*Citellus elegans elegans*) in Colorado," has been published for this section during the year.

The manuscript for Part I of the "Aphidae of Colorado" by Miss Palmer and the writer, is to be published in Annals of the Entomological Society of America.

Two other manuscripts, giving results of important investigations, are practically completed for publication. One of these, by Dr. George M. List, is the paper presented by him to Iowa State College as part requirement for the degree of doctor of philosophy. The other one is the manuscript by Mr. R. G. Richmond, recently presented to the graduate committee of this institution, on the importance of the honeybee in the fertilization of red clover blossoms in the Arkansas Valley, as part requirement for the master of science degree. Both of these papers will be presented for publication in the very near future.

A technical paper entitled "Three New Aphids from Colorado," by Miss Palmer and the writer, appeared in Annals of the Entomological Society of America for September, 1930.

I am suggesting a cut in the budget for this section for the coming year so we may take our share of the necessary reduction in the total station budget which you state will be necessary for the 1931-32 fiscal period.

Respectfully submitted,

C. P. GILLETTE, Entomologist.

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### REPORT OF THE HOME ECONOMIST

To the Director:

The one project carried by the Home Economics Section of the station—Baking of Flour Mixtures at High Altitudes—has been under way since 1926.

A study of the influence of change in barometric pressure on the quality of flour mixture products is fully reported in Bulletin 365 under the title of the project, and published in January of this year.

The supplement of that publication, with explanatory introduction and suitable cuts, appeared also as Bulletin 366, Baking Quick Breads and Cakes at High Altitudes, a guide to housewives, in February of this year.

So great has been the demand for these publications that the 3,000 issue of the popular bulletin has already been practically exhausted. There are still available less than a third of the 3,000 issue of the technical bulletin.

In the technical report there were presented: Definition of ingredients, measurements and technic employed; the working out of formulae for representative products at pressures corresponding to the range of elevations from sea level to about 12,000 feet; confirmatory tests at actual locations; description by curves of necessary changes in proportions of ingredients and in temperatures for the different pressures; the formulation of rules for the successful guidance of housewives, and description of the altitude laboratory providing accurate pressure and vacuum control.

In the work now under way and designated as Part II of the project it is the purpose to study the function of each variable from a physico-chemical standpoint. The first of such investigations, a study of the functions of cream of tartar in angel cakes, has been made. That type of cake was chosen because from the standpoint of colloid chemistry it is the simplest of all types.

For investigations to be next undertaken it is necessary to have temperature and relative humidity control as well as pressure and vacuum control.

To that end Professor J. H. Scofield of the Department of Mechanical Engineering has been engaged in making a study of the installation necessary.

The design of the conditioner and the selection of the refrigerator, blower, water pump, electric re-heater and automatic controls have been studied and tested for our very unusual application. It is anticipated that the installation—tested, adjusted and with instruction for operator—will be completed by July 1, 1931.

The one special piece of equipment added during the year is a Despatch oven, designed for the altitude laboratory. In such an especially constructed oven, and equipped with a Bristol controller, a temperature constant for all points within about 2 degrees is maintained.

Miss Florence Schott, associate in Home Economics Investigations from July, 1929—March, 1931, resigned to be married. Her resignation makes again necessary the search for one sufficiently qualified from physical chemistry and technical training standpoints to carry on.

Respectfully submitted,

INGA M. K. ALLISON, Home Economist.



**REPORT OF THE HORTICULTURIST**

To the Director:

I submit herewith a brief report of the work on the different horticultural projects. The report will necessarily be short since not much has been done on the projects since the last report. However, a brief statement on each project will give you an idea of what is being done.

**Spanish-Onion Breeding and Selection.**—Considerable progress has been made on this project. We now have a number of crosses and selfed plants planted from last season's work. The most promising crosses appear from crosses between the Valencia and the Brown Australian. In this cross the character of dark brown thick skin of the Brown Australian is dominant. The hybrids, therefore, should have better storage and shipping qualities.

The strain test and sources of seed tests indicate that seed grown locally are not only more productive, but also of higher grade, showing fewer doubles and scallions. The breeding and selection work is being done at the home station, and the testing and selection work is duplicated at the Rocky Ford substation.

**Onion Storage Project.**—This project has been in progress for the past 2 years and the results were published during the winter. The significant facts in this work may be summarized as follows:

Topping of onions after pulling should be delayed for 4 to 5 days. In topping, remove the top to about one-half inch of the bulb. Field cure the onions for 7 to 12 days. Remove all cut, bruised and diseased bulbs as well as scallions and immature bulbs. Store in crates in a well-ventilated storage.

The work thus far shows conclusively that the quality of the onions at the time of storage is the main factor. The average farm storage in use in the Valencia onion-growing district is very good, and with greater care in preparing the crop for storage, the present losses from storage can be reduced to a minimum.

The experimental storage now in use has been in operation for the past two seasons and is fully equipped. The storage work will be continued for more complete data and checking.

**Development of Tipburn—Resistant Varieties of Head Lettuce.**—This work has been in progress for three seasons. Numerous crosses and selections are under trial and observation both at Fort Collins and at Avon. The progress is slow, due to the fact that while tipburn resistance is the end sought, the quality is equally important, so that while many of the crosses show resist-

ance to tipburn, they are not of sufficient size or firmness to make them of value. The work will be continued.

**Variety Testing of Tree Fruits.**—This general project is carried on at Austin, and additions of new varieties are made from year to year. Some of the new varieties are sports picked up in Colorado. One of these should be mentioned. A sport of the Delicious variety was found at Cedaredge. This sport gives promise of being an improvement over the old Delicious, being darker red, firmer and a better keeper. This work is very important to the fruit industry.

**European Grapes for Western Colorado.**—The growing of the European grape in some sections of Western Colorado may develop into commercial proportions. The experimental planting at Austin is now 6 years old. Many California varieties have been tested for hardiness and for production. The work thus far indicates that many of the varieties can be grown when due attention is given to soil and sites for the vineyard, and when proper cultural methods are used.

**Orchard Management.**—The importance of proper orchard management in Colorado is well recognized. Apart from a proper site and soil for tree fruits, the management of the soil in the matter of fertilizers, cover crops, tillage, irrigation, pruning and spraying determines the failure or success of the business. High quality as well as yields depend largely upon the growers.

At the fruit farm at Austin, problems in connection with orchard management are in progress. The greatest progress has been made in the use of cover crops and tillage, and gradually the growers are adopting better practices in the care of their orchards.

**Potato Variety Testing, Breeding and Selections.**—Over 1500 potato seedlings are being grown. These were started in the greenhouse and transferred to Avon. The seedlings were grown from seed obtained in England and Scotland as well as from Avon. Many of the seedlings produced flowers the first year and relatively large tubers.

Work on improving the standard potato varieties grown in the state is also in progress, both by selection and tuber indexing.

**Raspberry Investigations.**—This project has been carried for the past 2 years and one bulletin has been published. The following lines of investigations have been pursued:

1. A study of the fruiting habits of standard commercial varieties grown in the state.
2. The fruiting response to different methods of pruning.

3. Character and efficiency of different methods of winter protection.

4. Fruiting and branching habits of different varieties in relation to pruning.

**Snap Bean Investigations.**—Work with snap beans started 2 years ago. The general complaint of growers, particularly in the South, against the poor seed sold and the demand for Colorado seed that was reasonably free from disease, led to the adoption of a general program of bean-seed improvement and seed certification. Bacterial blight being the worst bean disease in the state, and seed stock in general being badly infested with this disease, three general lines of bean-seed improvement have been followed: (1) Selection for blight resistance. (2) Selection and purification of existing commercial varieties. (3) Crossing some of the better varieties with the best of European varieties to obtain longer and darker green pods, to increase the meatiness of the pod, and to eliminate stringiness.

This project is vitally important to Colorado seed growers. The work already done is attracting considerable attention in the Southern States, and these are looking to Colorado for their seed supply.

In addition to the above enumerated projects, attention is being paid to the testing of new varieties of vegetables and to the improvement of sweet corn for canning.

Respectfully submitted,

E. P. SANDSTEN, Horticulturist.

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## REPORT OF THE IRRIGATION ENGINEER

To the Director:

I am presenting a brief report of the work in the section of Irrigation Investigations for the fiscal year 1930-31.

**Measurement of Water.**—The practicability of the Parshall measuring flume as a means of meeting conditions which heretofore have been inadequately served, is rapidly becoming recognized. At the present time there are more than 500 of these flumes being used as official measuring devices, being recognized by the State Engineer in the administration of the waters of this state. Also, many individual irrigation companies are using the smaller-sized flumes in distributing the water to the user. Throughout the irrigated West these flumes are being used, and recently information has reached us that in South Africa they are expect-

ing to install several large flumes as a means of meeting their measuring conditions. A number of manufacturing concerns in the West are interested in the construction of metal flumes in the smaller sizes to be used by the farmer so that he may determine his rightful share of the common water supply. As reported some time ago, the double-head indicating registering instruments, designed for the large flumes, are proving to be entirely satisfactory, and it is with considerable gratification that we compare our present and up-to-date installations with those which are replaced.

Attention is being given to the development of a new type of measuring device known as the adjustable tube meter, which is intended to meet conditions where the grade in the channel is very flat. Deposits of sand and silt, or interference to flow due to temporary checks, have little or no effect upon the accuracy of this device. One of these meters has been installed in the Arkansas Valley on the Fort Lyon Canal on a lateral of adverse conditions, and it has been found to be entirely satisfactory as a means of meeting them. In its present form this meter is more expensive than the Parshall measuring flume; however, because of its automatic operation, and, too, where accurate measurement of water is essential, this meter would be entirely warranted.

**Pumping Project.**—Since the inception of this project on Pumping, practically our entire attention has been given to that of costs of irrigation by pumping and that supplied by ditch or reservoir. Studies have been made in Weld and Otero counties, and the results of these findings prepared as progress reports. In Northern Colorado it was found under favorable conditions for pumping, that the water could be supplied at approximately the same cost as that of ditch or reservoir water. It was found in the Arkansas Valley that because of the apparent lesser cost of surface supplies, the cost of pumping there was somewhat greater.

The matter of underground water supplies in the state is one of importance. Apparatus has been provided for a preliminary study of the determination of the depth to water table by electrical methods which may prove to be a quick and dependable means of making a rapid survey of areas where the depth to water is uncertain.

**Evaporation From a Free Water Surface.**—This project has now been closed and the official report, prepared by Mr. Carl Rohwer, is to be published in bulletin form by the United States Department of Agriculture in the near future. Incidental data are being collected relative to the rate of evaporation from salt solutions, and also studies are being made of the relative losses

in transpiration from grasses and fallow surfaces, where the water table is being held at a definite depth below the ground surface. This evapo-transpiration work is being conducted in a series of tanks on the college campus.

**Meteorology.**—This project has been carried for a great number of years, and the data collected have been presented in bulletin form at various times. Perhaps one of the popular uses of this information is in the publication in the local papers of the maximum and minimum temperatures, wind velocity, or excessive precipitation.

**Projects for the Coming Year.**—Perhaps one of the most outstanding features of our work to be studied this coming year is that having to do with the development of the vortex tube and riffle deflector sandtrap. In the fall of 1930, preliminary apparatus was studied at the Bellvue hydraulic laboratory, and it was there determined that this new idea of trapping sand or heavy materials carried in channels can be trapped out. If this can be developed along practical lines to meet field conditions, it will prove to have a tremendous economic value. The cost involved in conducting the experiments on this new sand trap will be relatively small, and the laboratory is favorably designed for this particular work. It is our ambition to have installed in the near future in a small channel in the field, one of these traps so that we may obtain more practical information concerning it.

Respectfully submitted,

R. L. PARSHALL, Irrigation Engineer.

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## REPORT OF THE VETERINARY PATHOLOGIST

To the Director:

We must again report only a slight opportunity to do work on coccidiosis in cattle and none whatever on the project on icterohematuria in sheep.

### Sheep Losses in the Feedlots

Coccidiosis was again prevalent last fall in feeder lambs to such an extent that we were able to collect information from several outbreaks. This work was published, reference to which will be made in the list of publications. In a general way it was found that placing the lambs on native hay, cutting off all grain entirely and treating them daily resulted in a lowered mortality. The disease, when properly handled, is not as serious as it appears to be, altho in some outbreaks the losses ran to 10 or 12 percent.

More cultures were isolated from cases of pneumonia and a bacteriological study was made of this disease along with similar organisms from other animals. This work will be prepared for publication during the summer. The more important finding is that pneumonia in feeder lambs is commonly associated with organisms of the bipolar species which easily fall into two general groups and which can be differentiated culturally and immunologically. Since one does not immunize against the other, it is apparent that biological products made for this disease could be valuable only against the homologous organism.

### Death Losses in Lambs on Heavy Grain Feed

We fed 50 lambs during the last season in an attempt to reproduce the disease which we have described as overeating and which has caused such serious losses in previous years. Only three of the lambs died. One showed the presence of sugar in the urine and in the other two the bladders were empty. In no case was an excess of sugar found either in the blood or in the urine before death, altho weekly examinations were made. Feeling that this experiment was not conclusive, we should like to repeat it next year.

### Contagious Abortion

The work on the Veterans Bureau herd being now practically complete, we are preparing material for publication. We are now taking on other herds in the state for purposes of similar study. We are continuing to examine all blood samples sent us, but propose to confine our detail work to herds belonging to state or federal institutions.

### General

The diagnostic work in poultry has continued, with fowl paralysis, leukemia and white diarrhea playing the major part. Infectious bronchitis which was so prevalent in baby chicks last year has not been seen this spring.

The tabulation of our diagnostic work in the laboratory follows:

Avian .....	351	Ovine .....	40
Bovine .....	330	Suis .....	26
Canine .....	20	Feline.....	1
Equine .....	7	Homo .....	261
Miscellaneous .....	67		
Baby chicks examined for white diarrhea.....			59

**Blood Tests**

Contagious Abortion	2,425 samples	435 positive	17.0 percent
White Diarrhea	1,506	106	7.0
Undulant Fever	26	4	15.3
Kahn	39	13	33.3
Widal	14	1	7.1

**Publications**

- “An Outbreak of Coccidiosis in Lambs.”  
I. E. Newsom and Floyd Cross  
American Veterinary Medical Association, Vol. 77, p. 232, 1930.
  - “The Toxicity of Thallium Sulphate for Sheep.”  
I. E. Newsom, Jule B. Loftus and Justus C. Ward  
American Veterinary Medical Association, Vol. 76, p. 826, 1930.
  - “Diagnosis and Treatment of Some Common Diseases of Sheep.”  
I. E. Newsom  
The Veterinary Alumni Quarterly—Ohio, Sept., 1930, p. 69.
  - “Dietetic Diseases in Feedlot Lambs.”  
I. E. Newsom  
Veterinary Medicine, Vol. 25, p. 368, 1930.
  - “Coccidial Dysentery in Colorado Feeder Lambs in 1930.”  
I. E. Newsom and Floyd Cross  
Veterinary Medicine, Vol. 26, p. 140, 1931.
  - “A Survey of Icterohematuria in Sheep in Colorado.”  
Floyd Cross and I. E. Newsom  
Veterinary Medicine, Vol. 26, p. 75, 1931.
  - “Some Complications of Sore Mouth in Lambs.”  
I. E. Newsom and Floyd Cross  
A. V. M. A., Vol. 78, pp. 539-544, April, 1931.
- Respectfully submitted,  
I. E. NEWSOM, Veterinary Pathologist.

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**REPORT OF THE VETERINARIAN**

To the Director:

But one project is carried in the Veterinary Section, that of animal diseases. This project is supported by state funds, is general in nature, and contemplates incidental investigations of animal-disease outbreaks, and cooperation with the pathology section in other animal-disease projects.

We wish to continue with the one project, animal diseases, for another year.

Articles have been published on the following subjects: Hog Cholera Control, Bang's Disease and Means of Control, Larkspur Poisoning, Water Hemlock, and many short articles for News Notes. Problems pertaining to animal diseases are answered thru the Western Farm Life, Capper's Farmer and The Kansas City Star.

Correspondence with farmers and stockmen respecting animal diseases has grown larger from year to year. New disease conditions are constantly arising and must be met by adequate prophylactic and therapeutic measures.

Respectfully submitted,

GEO. H. GLOVER, Veterinarian.



## ENGINEERING DIVISION

To the Director:

I am transmitting herewith the reports from the Civil Engineering and the Mechanical Engineering sections of the Engineering Division of the Experiment Station.

Respectfully submitted,

L D CRAIN, Vice-Director

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### REPORT OF THE CIVIL ENGINEER

To the Vice-Director:

This report covers the investigational work done in the Road Materials Laboratory during the year from July 1, 1930, to May 31, 1931. Mr. C. A. Carpenter furnished a report of the work completed from July 1, 1930, to December 31, 1930, before he left to assume his duties with the United States Bureau of Public Roads at Washington, D. C. Mr. D. A. Wigle was appointed Testing Engineer and it has been his effort to continue the work where Mr. Carpenter left it. The routine testing work has been done as it was sent in by the State Highway Department and the work on the experimental projects was continued. The projects that we have been engaged on since Mr. Wigle took up the work are as follows:

1. The study of frost action on road subgrades and its relation to a concrete slab.
2. The swell and emulsification tests on various aggregates using a 60-70 asphaltic road oil.
3. Drafting the specifications and laying plans for the building of an experimental oiled gravel road.

(1) The study of frost action on subgrades and its relation to a concrete slab was started by Mr. Tripp in December, 1927, and was completed February 28, 1931. The data that have been collected are at the present time being worked up with the intent of publishing a bulletin later on.

(2) The swell and emulsification tests were devised by the state of California and later studied by the Bureau of Public Roads. Some very startling results were discovered. Mr. W. D. Ross of the Bureau of Public Roads became interested in these tests, secured some samples of aggregate and wished some information concerning these samples concerning the amount of swell and emulsification when mixed with a road oil. These tests were

carried on by our department and were paid for from the funds of the Bureau of Public Roads. The results of these corroborated, to a certain degree, the tests made by the state of California. We have been working on these tests at various periods in order to secure added information. If there can be found any relation between the finished road surface and the swell and emulsification tests, the publication of a bulletin would be in order.

(3) The experimental oiled road project was started by Mr. Carpenter. The original plan was to locate this project on the Denver-Cheyenne highway between the towns of Ault and Nunn, Colorado. This was an ideal location, but due to a rainstorm that was of cloudburst proportions, considerable time was spent in rebuilding the roadway. At the time the road was ready for the oil surface, winter had set in and the project was abandoned. A new location was necessary and was secured on the Fort Collins-Laramie highway about 10 miles north of Fort Collins. This project was to have been oiled in the same manner as the original during the late spring or early summer of 1931. Mr. W. D. Ross of the U. S. B. P. R. was to be in charge of the project with the idea of helping this laboratory secure information as well as for the bureau at Washington, D. C. It was found that he was needed in Washington to help with the construction of the super-highway that is being built there and could not help us with our project. This transfer is to be only for a period of 6 months, but it made the project impractical for the reasons that (1) the U. S. B. P. R. was financing a greater portion of the total cost of the construction; and (2) it was inconvenient for them because they had no one on the project who could take charge of their interests. As a result, they recommended to the state highway department that the project be postponed until another year. It is my opinion that the state highway department will accept the recommendations of the bureau. The specifications are drawn so that the project can go forward at a moment's notice. Should the project be continued as planned, an abundance of information will be on hand and a bulletin should be published concerning this information. It is understood that no fund from the college or Experiment Station will be used in constructing this experimental road. The only expense will be that of the time of the Testing Engineer and the funds necessary to publish the bulletin.

The projects upon which we desire to pursue work during the coming year are those pertaining to surfacing the roadway with an oil and the investigations pertaining thereto. The pending acceptance of the postponement of the experimental project north of Fort Collins has handicapped us in securing information on an oil when exposed to actual conditions in Colorado. When

this project is concluded there will be a wealth of material at hand. There is still considerable experimental work to be done and as yet we have not gone into this matter thoroly enough to state a definite project at this time, but such a report will be made in the near future. Suffice it to say, that the experimental work done by this laboratory will be upon some phase of oil surfacing for roads.

By way of explanation regarding the situation between the Colorado State Highway Department and the Road Materials Laboratory, it will be noted that the State Highway Department of Colorado has in the past had all the road materials tested here at the Road Materials Laboratory. The cost of this testing work was paid for by the State Highway Department and no labor whatsoever was charged to the Experiment Station. State Engineer Blauvelt died recently and a Mr. Vail was appointed State Engineer of Highway Construction. It was his idea to concentrate all testing work in Denver and relieve us of the responsibility. It was thus ordered and executed. Many of our students who were receiving remuneration for labor and helping themselves thru school are now looking for other means of support. Mr. O. V. Adams was able to secure an agreement with the State Highway Department whereby this laboratory was designated as the "Official Testing Laboratory of the State Highway Department." At first this agreement was in writing and later it was renewed by a verbal understanding. This agreement was filed away so well that it has been impossible to find. A new State Highway Engineer was appointed and by a word from him the agreement was destroyed and we are at the exact place we were in 1917. In no way does this act of the State Highway Engineer affect the experimental work or the budget of our Road Materials Laboratory.

Respectfully submitted,

E. B. HOUSE, Civil Engineer.

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## REPORT OF THE MECHANICAL ENGINEER

To the Vice-Director:

Following is the annual report from the Mechanical Engineering Section of the Experiment Station for the year ending June 1, 1931:

Three projects have occupied the time of this section of the Experiment Station during the past year. Of these three projects, one has been completed and two are still in progress.

**No. 1.—A Study of Hair Cracks in Concrete.**—A number of concrete slabs and steps on the campus and elsewhere have developed hair cracks since their construction, which show signs of ultimately destroying the concrete as well as being very unsightly. The cause of these cracks has been fairly well determined by other stations, but it is the purpose of this project to determine what, if anything, can be done after the cracks have formed to prevent or delay ultimate destruction. Specimen slabs have been constructed and hair cracks have formed on a number of these. Efforts are being made to determine the depth of the original crack and the process it undergoes in weathering. Progress is therefore necessarily very slow and no definite conclusions have yet been reached.

**No. 2.—A Study of the Gas Situation in the City of Fort Collins.**—Considerable complaint was made by users of natural gas for fuel in the city of Fort Collins during the past winter. Lack of pressure and high cost of fuel were the chief complaints made. A study was therefore made to determine the causes for the complaints. The demand orifice system used in the city of Fort Collins was found responsible for the lack of pressure at certain times. Inefficient heating appliances and the abnormally warm, dry winter season were responsible for the other complaints. A report covering the results of this study has been prepared, approved and released.

**No. 3.—Poultry House and Equipment Plan Project.**—This project is a cooperative one with the Extension Division and consists of the preparation of plans of a number of poultry houses and the necessary equipment for handling poultry successfully. This project is continuing and will be finished in the course of the summer.

Tentative projects for the coming year are:

1. Farm water systems
2. Dairy-barn plan
3. Onion storage
4. Sugar-beet machinery investigations in cooperation with the Bureau of Agricultural Engineering of the United States Department of Agriculture.

Respectfully submitted,

F. E. GOETZ, Associate Mechanical Engineer

## REPORT OF THE EDITOR

To the Director:

Of the 1,832 bulletin pages published by the editorial service during the past year, 855 were for the experiment station. The total edition was 61,200 copies.

Approximately 30 percent of the 637 news and information stories sent out from this office were about experiment station work and workers. From the number of clippings we have received, we estimate that over 90 percent of the weeklies and dailies in Colorado are using at least part of our material. That the 187 farm and home papers in the United States and Canada, to which we send the weekly release, are using many of the stories is evident by letters from all parts of the country. Requests for more information, for special stories and photographs are always coming to the office from different sources out of as well as in the state, and in practically every instance we can trace their lead to one of our stories.

Only recently Western Newspaper Union asked special permission to distribute some of our stories in plate form, which will undoubtedly add greatly to their usage.

Following are the publications issued by this office for the Experiment Station during the past fiscal year:

- Bul. 229—Brisket Disease. 8 pages. 1,500 copies. Reprint.
- Bul. 358—Hog Cholera. 10 pages. 4,000 copies.
- Bul. 362—Effects of Clover and Alfalfa in Rotation. Part II. 132 pages. 1,500 copies.
- Bul. 363—Effects of Clover and Alfalfa in Rotation. Part III. 44 pages. 1,200 copies.
- Bul. 364—Effects of Clover and Alfalfa in Rotation. Part IV. 77 pages. 1,500 copies.
- Bul. 365—Baking Flour Mixtures at High Altitudes. 180 pages. 3,000 copies.
- Bul. 366—Baking Quick Breads and Cakes at High Altitudes. 48 pages. 3,000 copies.
- Bul. 367—Raspberry Investigations. 41 pages. 3,000 copies.
- Bul. 368—Cost of Public Education from the Viewpoint of Agriculture, in Larimer County, Colorado. 66 pages. 3,000 copies.
- Bul. 369—The Date to Plant Corn. 8 pages. 3,000 copies.
- Bul. 370—Oat Varieties in Colorado. 34 pages. 3,000 copies.
- Bul. 371—Barley in Colorado. 37 pages. 3,000 copies.
- Bul. 372—Diseases of Poultry. 42 pages. 6,000 copies.

- Bul. 373—Wyoming Ground Squirrel. 23 pages. 2,000 copies.  
Press Bul. 73—Feedlot Fattening Rations for Lambs. 12 pages.  
2,000 copies.  
Press Bul. 74—Feedlot Fattening Rations for Cattle. 12 pages.  
2,000 copies.  
Press Bul. 75—Onion Investigations in the Arkansas Valley. 12  
pages. 2,500 copies.  
Forty-Third Annual Report. 44 pages. 1,500 copies.  
Colorado Seed Law (Booklet). 16 pages. 3,000 copies.  
Lamb Feeders' Day Program (card). 5,500 copies.  
Feeders' Days (Booklet in cooperation with Extension Service).  
8 pages. 6,000 copies.

Respectfully submitted,

I. G. KINGHORN, Editor.

