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THE STATE AGRICULTURAL COLLEGE
OF COLORADO

THE FORTY-FIRST ANNUAL REPORT

— OF —

The Colorado Agricultural Experiment Station

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FOR THE YEAR 1928

THE STATE AGRICULTURAL COLLEGE
OF COLORADO

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The Colorado Agricultural Experiment Station

FOR THE YEAR 1928

The Colorado Agricultural College

FORT COLLINS, COLORADO

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*On leave, 1928-29. **Deceased.

FINANCIAL REPORT OF THE COLORADO EXPERIMENT STATION
For the Fiscal Year Ending June 30, 1928

	Hatch Fund	Adams Fund	Purnell Fund	State Mill Levy Fund	Special Fund	Pure Seed Fund	Total Funds
DR.							
Balance, July 1, 1927	.....	.....	.....	($161.56)*	$15,692.43	$7,720.97	$ 23,251.84
From the Treasurer of the United States as per appropriations for the fiscal year ending June 30, 1928, 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	$40,000.00	.....	.....	.....	70,000.00
Other sources than the United States				$109,399.51	37,480.69		146,880.20
	$15,000.00	$15,000.00	$40,000.00	$109,237.95	$53,173.12	$7,720.97	$240,132.04
CR.							
To Salaries	14,803.01	15,000.00	31,150.74	9,324.81	42,192.95	4,137.60	116,609.11
Labor	35.18	.....	911.68	22,115.12	1,738.07	187.02	24,987.07
Stationery and Office Supplies	4.41	.....	217.15	1,306.55	169.96	62.15	1,760.22
Scientific apparatus consumable	14.35	.....	527.09	1,120.56	2,027.86	7.22	3,697.08
Feeding stuffs	33.47	.....	8.80	12,760.45	241.10	.....	13,043.82
Sundry supplies	0.45	.....	61.57	3,188.78	534.24	1.50	3,786.54
Fertilizers	.....	.....	.....	253.05	.....	.....	253.05
Communication service	1.36	.....	28.68	781.85	15.45	73.56	900.90
Travel expense	25.75	.....	3,404.66	8,513.72	830.90	42.90	12,817.93
Transportation of things	.....	.....	47.50	948.65	9.00	.....	1,005.15
Publications	.....	.....	319.15	3,232.91	127.14	.....	3,679.20
Heat, light, water, power	.....	.....	.....	658.27	1,613.20	.....	2,271.47
Furniture, etc.	8.00	.....	516.54	928.70	343.25	.....	1,796.49
Library	72.35	.....	47.10	618.20	102.20	.....	839.85
Scientific equipment	1.67	.....	436.48	1,875.15	267.74	30.73	2,611.77
Livestock	.....	.....	.....	16,222.81	3,091.00	.....	19,313.81
Tools, machinery, appliances	.....	.....	7.65	2,553.77	6.31	.....	2,567.73
Buildings and lands	.....	.....	1,975.21	2,681.83	1,450.81	.....	6,107.85
Contingent expenses	.....	.....	340.00	353.95	20.50	10.00	724.43
Total expenditures	$15,000.00	$15,000.00	$40,000.00	$ 89,439.11	$54,781.68	$4,552.68	$218,773.47
Balance on hand June 30, 1928	.....	.....	.....	19,798.84	(1,608.56)*	3,168.29	21,358.57
Grand Total	$15,000.00	$15,000.00	$40,000.00	$109,237.95	$53,173.12	$7,720.97	$240,132.04

(*) Overdraft

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 the Forty-first Annual Report of the Colorado Agricultural Experiment Station for the state fiscal year, December 1, 1927 to November 30, 1928, and the financial statement for the federal fiscal year, July 1, 1927 to June 30, 1928.

The report contains brief summaries of the work done by those in charge of the different sections of the Experiment Station, as well as a full list of projects upon which work has been done during the year.

C. P. GILLETTE, Director

Agricultural Experiment Station
Fort Collins, Colorado
December 1, 1928

AGRICULTURAL DIVISION

Report of the Director

To the President:

I am presenting herewith the forty-first annual report of the Colorado Agricultural Experiment Station. It covers the investigations of the calendar year just closing, but the financial statement is for the federal fiscal year, July 1, 1927 to June 30, 1928.

The researches of the station are being carried in 14 sections or departments by 14 employees devoting their full time to investigational work and about 35 devoting part time to their investigations and part time to teaching. This plan for part-time work appears, on the whole, to be advantageous, both to our teaching and experimental work.

During the year, 71 projects have received more or less attention. In some of the sections the entire time has been devoted to one or two lines of investigational work, while in others several projects were carried at one time. The heads of the various sections have given brief summaries of the investigational work under their direction during the past year in their annual reports which accompany this, so I am avoiding mentioning any of the outstanding pieces of work myself, preferring each section head shall speak for his own work.

I believe, on the whole, the work of the station has never been in a more satisfactory condition than at the present time, and, in no previous year have there been so many manuscripts presented as the result of investigational work as during the past year.

The work of the station, however, has been handicapped to some extent during the year by the resignation of a considerable number of employees who were offered positions in other institutions at salaries that we could not meet. Some of the work is suffering at the present time because we have not been able to find desirable men to take positions that have been made vacant by resignations.

Several projects have been started on the Purnell Fund during the year, and other new projects are being favorably considered. So far, we have spent most of our Purnell Fund in the department of Economics and Sociology.

The station funds for experimental work during the past year were as follows:

Federal funds—	
Hatch Act	$ 15,000
Adams Act	15,000
Purnell Act	40,000
State Mill Levy	109,399
	$179,399

While this total may seem large, it is really very small to cover the many lines of investigation that are needed for the betterment of agricultural conditions on 58,000 farms in Colorado, involving such a wide diversity of conditions in soil, moisture and climate. There is also a wide diversity in the insect pests and plant diseases that have to be controlled in the different sections of the state. The farmer whose property is assessed at $10,000 is taxed 71 cents per annum to support the investigational work of the station, which seems to be little enough.

The projects upon which work has been carried during the past year are given below.

AGRICULTURAL DIVISION

Agronomy Section

Relation of Soil Moisture, Structural Development and Acre Yields in Small Grains. Adams and State funds.
Correlation of Characters in Grain. Hatch and State funds.
High-Altitude Crops. State funds.
Plains Crops and Management. State funds.
Improved Seed. State funds.
Arkansas Valley Niter Control. (In cooperation with Bacteriology)

Animal Investigations Section

Ration Experiments with Cattle. State funds.
Summer Cattle-fattening Experiment. State funds.
Range Management (Cooperation with Botany). State funds.
Ration Experiments with Lambs. State funds.
Cornfield Lamb-feeding Experiment. State funds.
Summer-fallow Experiment at Akron, Colorado. State funds.
Winter Maintenance of Ewes. State funds.
Swine-feeding Experiment. State funds.
Poultry Experiment. State funds.
Beet By-Product Rations for Fattening Beef Calves. Purnell 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.

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

Arkansas Valley Niter Control. (Cooperation with Agronomy). Purnell and State funds.

Winogradsky Method of Testing Soil Deficiencies. Purnell fund.

Botany Section

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

Physiology of Seed. Purnell fund.

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

Truck-crop Disease Studies. Hatch and State funds.

Alfalfa Root-rot Disease. Adams fund.

Chemistry Section

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

Grasshopper Control. State funds.

Potato Flea-beetle. State funds.

General Insect Investigations. State funds.

Rodent Poisoning. State funds.

Rodent Life Habits. 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.

Home Economics Section

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

Horticultural Section

Potato Varieties. State funds.
Garden-pea Variety and Breeding. State funds.
Tomato Crosses at Manzanola, Colo. State funds.
Effect of Washing on Keeping Quality of Apples. State funds.
Orchard Management. State funds.
Celery Storage at Littleton. State funds.
High-altitude Vegetable Production. State funds.
Fertilizer Project. State funds.
Certified-seed Potatoes. State funds.
Development of a Tipburn Variety of Head Lettuce. Purnell fund.

Irrigation Investigations Section

Measurement of Water. State funds.
Evaporation: (a) From a Free Water Surface.
(b) From Moist Soils. Hatch and State funds.
Meteorology. State funds.
Drainage Districts in Colorado. State funds.

Pathology Section

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

Veterinary Section

Animal Diseases. State funds.

ENGINEERING DIVISION

Civil Engineering Section

Road Materials of Colorado. State funds.
Cooperative Work with State Highway Commission. State funds.
Frost Heaving Investigation on Concrete Slabs. State funds.
Capping of Concrete Cylinders. State funds.

Mechanical Engineering Section

Commercial Insulating Material for Buildings. State funds.
A Proximate Analysis of Colorado Coals. State funds.

Respectfully submitted,
C. P. GILLETTE,
Director.

REPORT OF THE AGRONOMIST

To the Director:

I am submitting my annual report for the fiscal period ending November 30, 1928. The year has presented to us a number of new problems both in personnel of staff and problems affecting the farmers in order to help in their solution.

The staff for the year has been made up of Alvin Kezer, D. W. Robertson, G. W. Deming, and for a part of the year, Rudger H Walker, located at the home plant at Fort Collins; J. W. Adams, specialist, located at Cheyenne Wells; Justus C. Ward, chemist, located at Rocky Ford; and Dwight Koonce, assistant agronomist, located at Fort Lewis. Dr. Rudger H. Walker resigned in July. Dr. Walker was assisting in soils research problems, altho his main work was teaching. His place has not yet been filled. Mr. Justus C. Ward resigned from the Rocky Ford work effective November 5. His work is in good shape and is being carried by the staff until such time as we can find a suitable successor. His resignation came at a time of year when the volume of work was the lowest of any period of the year.

During the year we have published one bulletin on Wheat of Colorado, we have manuscripts practically completed for bulletins on barley, oats, peas and corn. These manuscripts will be submitted as editing is completed. During the year covered by this report we have also published in the Journal of the American Society of Agronomy two articles on our Critical-Period work. One of these articles was on the use of water and its effect upon crop development when applied at different periods. The second publication was on the

residual effect of the application of irrigations at different seasons of the year.

It may be interesting to note that out of the research on the best time to apply water to the crop has come information which has been put into practical use. The suggestion has been put out that certain regions might profitably fall irrigate. Judicious use of fall irrigation in some sections has increased the yield of alfalfa hay the succeeding year more than a ton. It has increased the yield of sugar beets the succeeding year often as much as five tons. It has been conclusively shown that a soil which is dry in the late summer and fall, going into the winter dry, will produce a smaller crop the next year than if the same soil were properly moist. These researches have also thrown considerable light and have offered an explanation of some of the hitherto unexplained behavior of dryland soils. We don't know all of the reasons why a dry soil, that is a soil dry in the late summer and fall, should produce less the next year. It is associated with the water supply, but just what happens we are unable to say. Whether the reduction in yield is caused by suspension of bacteria and other organisms in the soil—because if moisture is deficient, there would be a reduction in development—or whether it is caused by colloidal changes; or whether all of these factors are involved we can not at present say. We hope to be able to answer the question.

We are carrying at Fort Collins in our crop-improvement work, around 20,000 progenies. Of these 20,000 progenies we take annually about 1,000 of the more promising dryland sorts to Akron. We also take those sorts whose hardiness we wish to test to Akron. Many winter grains perfectly hardy under Fort Collins conditions are completely killed out at Akron. As the result of this breeding work and testing we have already produced some new varieties, we have established the merit and purified some existing varieties, and have some very promising new things coming on.

At Akron we have changed and enlarged our work somewhat, adding new plats and new soil treatments to our dryland work. We are carrying forward the rate of planting, the date of planting, and varieties of wheat, barley, oats and corn for our common grains; and are carrying a considerable series of millets and grain and forage sorghums. There are some pieces of dryland work which need to be worked on a larger scale than is possible on the Akron farm. The problem of soil blowing is always staring the plains farmer in the face. Any method of soil treatment, or any rotation, has to consider the possibility of soil blowing. As the country gets older, weeds become better and more widely distributed. The problems of blowing

and of getting rid of weeds constitute a set of conditions which the farmer must face and face economically. It is not enough to control. The methods which effect such control must be performed at relatively low costs.

In order to solve some such problems, we ought to be working on fields of from 40 to 80 acres, so that the area would be large enough to show the effectiveness of the method and its economy at the same time. We ought to be comparing the plow fallow, the listed fallow, the duck-foot fallow, the chisel fallow, the one-way disc fallow. We ought to be comparing the blade weeder, the rod weeder, and other methods of destroying weeds which come up in the fallow. A tillage method must not only control weeds, but it must control those weeds cheaply and leave the ground in good shape for the crop, and at the same time prevent blowing. The combine is coming in as a generally used method of harvest. We need field-sized experiments on combining, and the care of the grain afterwards. Combine grain must of necessity, as a rule, contain more moister than headed or bound grain. How can the grain be stored or handled to reduce moisture and keep high quality? Until we have answered a series of problems associated with the newer methods of harvest we have not fulfilled our duty to the plains farmer, and the plains farmers produced approximately 17,000,000 bushels of wheat in 1928 on the dry lands.

At Cheyenne Wells during this year and this biennial period we have performed no experimental work because the appropriation being in the third class, has not been paid. We are simply trying to hold the farm in a good state of cultivation and repair under a rental basis.

At Rocky Ford our chief problem, as for several years past, has been a problem of control of soil nitrates. Two rotations are under way in the farm methods of control. These include the sequence of crop with the use of farm and green manures. We are running, in addition, under this same problem a series of plats in which a study is being made of the behavior of nitrates with different amounts of organic material. These organic materials add the same quantity of nitrates to each plat, but the percentage in the materials varies widely. We may call these materials carriers. We are using, as carriers of nitrogen, straw, corn stalks, alfalfa, dried blood and some other materials. Exactly the same quantity of nitrogen is added by each carrier. When we add a nitrogen carrier with a high percentage of nitrogen there is an increase of soil nitrates during the season. Where we add the nitrogen with a carrier having a low percentage there is a decrease of nitrates, that is, plowing under materials rich in nitrogen increases the nitrates after a time; while plowing under mate-

rials low in nitrates such as straw or corn stalks, temporarily reduces nitrates. The theory is that in the decay of the low nitrogen material more nitrogen is required for the metabolism of the decay organisms than is present in the carrier. Under these conditions the organisms concerned in the decay take their necessary nitrogen supply from the soil, and nitrates are reduced. The action is temporary and apparently does not hold over into succeeding years. This effect seems to be associated also with the use of green manures. A low-nitrogen green manure will help keep down the nitrates for a season.

We are carrying some side experiments on the rotation plats. Part of these plats must be in clover. We are using different methods of seeding. We have several regional strains and disease-resistant strains of clover. This method enables us to carry on our main project and at the same time carry several subordinate projects like variety tests of clover. These subordinate projects answer problems pertinent to the neighborhood.

Onions are becoming a very important crop in the Arkansas valley. Storage problems need investigation. In order to get the best prices, onions must be put into storage for fall and winter delivery. These onion-storage problems naturally fall into the work of the Horticultural Department. We believe that storage houses should be built so that the Horticultural Department can carry on the storage experiments on the station farm.

We need to investigate more thoroly than we are doing the use of mineral fertilizer in the soil and nitrate-control problem. This phase of the subject has been pretty largely handled by the Bureau of Chemistry and Soils. We need to carry on certain work, however, to enlarge and supplement that program.

Mr. Justus C. Ward, who has been acting superintendent for the past two years, resigned effective November 5. It will be difficult to get a man who will just fill the place—a man who can carry the technical work and meet well the people in the neighborhood.

At Fort Lewis we are carrying the Agronomy Section high-altitude crop work. This at present consists of type and variety tests of wheat, oats, barley, field peas, clovers, alfalfa, annual and perennial pasture, and storage crops. The work is going along well. There is a sufficient need and demand to enlarge the work, but the program can not be much enlarged until there is a possibility of more financial support. Mountain agriculture is developing much faster than was expected a few years ago. We need the enlarged program to meet many of the conditions of this development.

The season of 1928 has forcibly called to our attention rather new agricultural conditions. We had this season two foot rots affecting winter wheats in the dryland section. These were the helminthosporium foot rots affecting early planted winter wheat from the New Mexico line to the Wyoming line. It would seem from this year's experience that, while we need some further investigations along pathological lines, there is a considerable need of agronomic investigations on the effect of soil treatment and time of planting. Our observations in 1928 would indicate that it would be largely possible to control the disease by time of planting. The fusarium foot rot was confined to the Akron section. It also looks as if it might be controlled by time of planting. Fortunately, we were not afflicted with that pernicious foot rot known as "Take-all."

We are not able to make as extended investigations as we should on agronomic control of these foot rots. We are, of course, making some investigations and have sent out by letter to every county agent, information gained from Dr. Hurley Fellows, the U. S. Department expert on these foot rots so as to spread to the farmers as rapidly as possible all the information we have up to date. I may add that the foot rots were especially virulent in certain fields all over the country this year. This was true in Kansas, Colorado, Minnesota, Wyoming, Washington and Oregon—all of these places being foci of infection of exceptional virulence.

The other new, or relatively new, problem forced on us this year was that of alfalfa wilt. This is a bacterial disease. At present the only possibilities of control seem to be agronomic. We are attacking the problem from two points of view. Part of this work is in cooperation with the Bacteriology Section. The methods of attack on the problem are, from the agronomic standpoint, two: First, we are attempting to find resistant varieties. We are obtaining from other sources all the possibly resistant varieties that we can get. If we find a resistant variety, we will attempt to increase seed and get seed centers established so that farmers may obtain resistant stocks. The second line of attack is use of soil treatment itself if soil treatments affect the crop resistance. We haven't gone far enough in either of these lines to report definite findings. The U. S. Department of Agriculture reports that certain strains of Turkestan and Ladak have appeared resistant in Kansas and Nebraska.

Another new problem, but which is small, has been the appearance of the bacterial disease called Black Chaff. This has caused only a slight amount of damage, but it appeared in Sedgwick County this year.

Respectfully submitted,

ALVIN KEZER,

Agronomist.

REPORT OF THE ANIMAL HUSBANDMAN

To the Director:

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

Ration Experiments with Cattle.—Wet beet pulp has proved to be an excellent fattening feed for calves as well as for older cattle. Its most economical utilization with the present limited allotment to the grower is a problem confronting many feeders. The present experiment with calves has been planned to determine the value of corn silage in supplementing a protein of the wet-pulp allotment. In the first feeding test corn silage fed with wet pulp in a fattening ration reduced the amount of wet pulp necessary to fatten a calf by 42.6 percent. A comparison of siloed beet pulp and pressed beet pulp, the utilization of beet tops, and a comparison of costs and gains in fattening test involving 6 lots of 10 calves each. Steer calves outgained heifer calves 44.9 pounds or 13.8 percent in 187 days on feed and at a feed cost of 80 cents or 8.7 percent less per cwt. gain.

Summer Cattle-Fattening Experiment.—Yearling steers were taken from the range in May and fed grain on a perennial pasture grass mixture (Morton's) thru the summer. Corn and barley were compared during this period. The cattle made good gains during the summer but were not finished in time for the early fall market. This experiment has indicated that range cattle, to be summer fattened on grain and irrigated pasture for an early fall market, must be carrying considerable finish when started on pasture in the spring. This condition can be secured best by a "warming-up ration" composed of available roughages and a light grain allowance fed thru the balance of the previous winter.

Range Management.—A study has been made of the carrying capacity of low foothill range in the maintenance of a beef breeding herd. The value of protection to the forage during the early spring growing period is shown thru actual practice. Systematic rotation of cattle on the pastures as a means of increasing forage production is another phase of the investigation.

Cornfield Lamb Feeding Experiment.—Different methods of lambing down corn have been attempted in an effort to establish an economical practice that will cheapen fattening costs and at the same time eliminate the possibility of excessive death loss. Altho the pasturing of stock beets in connection with cornfield feeding has shown a tendency to reduce losses, no safe method for fattening lambs in the cornfield has yet been developed.

Ration Experiments with Lambs.—Feeding barley in place of corn in ordinary Colorado fattening rations is the principal problem being studied in the present lamb-feeding experiment. Altho barley fed with alfalfa hay alone produced lighter gains and less finish than corn, the use of available supplementary feeds such as the beet by-products and corn silage and fodder increased gains to the point where barley compared very favorably with corn. Whole barley produced practically the same results as steam-rolled barley when fed to fattening lambs. An average of 3 years' work shows corn silage worth 38 percent the value of cut corn fodder for lambs. Light "cully" lambs fed separately made lighter but more economical gains than medium-weight lambs. The value of available supplementary roughages in reducing the amount of alfalfa necessary for fattening lambs is also being studied.

Summer Fallow Experiment at Akron, Colorado.—Sheep have been carried on two standard dryland rotations and on native sod pasture for a number of years to determine their value on dryland farms. The practice has been successful in keeping down weeds on summer fallow and the sheep have been maintained satisfactorily on home-grown feeds. Feeder lambs born in April have weighed 61.6 pounds in the fall.

Utilization of Dryland Feeds.—Extensive crops work at the Akron field station has demonstrated conclusively that the most dependable crops for eastern Colorado drylands are the forage crops. Information concerning growing and fattening rations for livestock with these forage crops is needed. Definite information concerning livestock production and fattening will do much toward stimulating a more diversified farming system for eastern Colorado.

The investigational feeding work under way at the Akron field station includes:

(a) Pasture Tests for Sheep.—A comparison of a perennial pasture grass mixture and a sweet-clover pasture for the summer pasturing of sheep.

(b) Winter Maintenance of Ewes.—The use of corn and cane fodder, corn silage, standing corn stover and other feeds in carrying breeding ewes thru the winter.

(c) Winter Hog Feeding.—The comparative value of the dryland grains, corn, barley, and hog millet with protein supplement for fattening hogs.

(d) Lamb Feeding.—The use of dryland grains and roughages for fattening lambs.

(e) Summer Hog Feeding.—The summer fattening of hogs on grains, protein concentrate and a succession of annuals for pasture.

(f) Growing Out Ewe Lambs.—Ewe lambs will be carried thru their first winter on a ration of millet hay, grain and cottonseed meal in a test to determine the value of a simple mineral mixture containing calcium, phosphorous and iodine.

Winter Maintenance of Range Ewes.—The proposed work for the winter 1928-29 starts a new 3-year series of study. The chief object of the experiment is to learn the most economical and satisfactory supplement to South Park hay in the maintenance of range ewes during the winter. The supplements used will be protein, calcium and phosphorous alone and in combinations.

Wool-Shrinkage Studies.—The value of wool in the grease is dependant largely upon its shrinkage. Wool buyers are very familiar with the shrinkage of wools by areas and territories. The average wool producer is usually ignorant of the shrinkage of his wool, is not able to accurately estimate the shrinkage, and in the past has not been able to have composite samples scoured without sending samples some distance. With the completion of the new wool laboratory, this project is now possible and it is proposed to make wool shrinkage studies of Colorado wool by areas. The area in which to start the work has not yet been selected.

Cost of Producing Winter Eggs.—In order that the poultry raisers may know the exact cost, exclusive of labor, the above experiment has been started. It includes the five winter months from October, to February, inclusive. A daily record and cost sheet is being kept of the pounds of feed consumed daily, as well as water, green feed, oyster shell and straw for litter. A daily record of the number of eggs produced is also kept. An average flock of about 249 S. C. White Leghorn pullets is being used for this experiment.

Amount of Sunshine During Winter Time in Modern Poultry House.—In order to determine the height of a poultry house front wall and the size of the openings relative to the amount of sunshine during the winter months on the floor of the poultry house, this experiment will run for 3 months, November, December and January. A new 24x60 laying house is being used. Measurements are taken every other day at the same period of time, of the width of sunshine on the floor that comes thru the openings and also the distance it extends back from the front wall.

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

Same as above with the following addition:

Storage Studies with Pressed Beet Pulp.—In several of the beet sugar factories in northern Colorado the free moisture is pressed from the wet beet pulp by rollers. This pulp is sold directly to the feeder to be stored and fed on the farm. Methods for storing this pulp with the least loss are being tested.

I wish to recommend development of the investigations concerning dryland feeds and feeding. We have been carrying on work for irrigated sections for a considerable length of time, and there is a serious lack of definite information concerning the use of feeding stuffs in dryland sections.

Respectfully submitted,

GEO. E. MORTON,
Animal Husbandman.

REPORT OF BACTERIOLOGIST

To the Director:

I have the honor to submit herewith the annual report of the Bacteriologist Section of the Experiment Station for the state fiscal year, December 1, 1927 to November 30, 1928.

Four of our projects have been continuations from 1927 and one new line of investigation has been begun. Two of these are supported by the Purnell Fund and three by Adams, Hatch and State Funds, jointly.

The personnel of the section has been changed somewhat by the resignation of Mr. Justus C. Ward, soil chemist at Rocky Ford and by the addition of Miss Laura C. Stewart as fellow in bacteriology. Miss Ann Roberts succeeds Miss Esther Elliot as student laboratory assistant.

Projects

1. **Winogradsky Method of Testing Soil Deficiencies. Purnell Fund.**—A comparative study is being made of the Winogradsky Azotobacter method, the Neubauer method and Hoffer method of determining soil deficiencies in the Fort Collins and Campion series of soil in Larimer County. Each of these three procedures is designed to help the farmer in his fertilizer practices and our object is to determine the relative value of each in forecasting the fertilizer needs of a soil. If the Winogradsky method proves to be as reliable as the others, much time can be saved in making the soil tests. This investigation will be continued in 1929.

2. **Vegetable Spoilage. Adams and Hatch Funds.**—That phase of this project which dealt with the length of exposure and degree of temperature necessary to kill the spores of Bacillus botulinus has been practically completed. In this work we have confined our determinations to such temperatures as might be used in home canning. Before the investigation is completed we wish to carry on further work on the canning lag, an aspect of the question on which we have reported previously. This project will be continued in 1929.

3. **Azotobacter Energy Studies. Adams Fund.**—It is of great importance in controlling the production of excessive soil nitrates to know the part which organic matter plays in furnishing energy for the nitrogen-fixing bacteria, chiefly Azotobacter. It is the opinion of some investigators that green manures and crop residues are not available sources of energy for Azotobacter and hence the addition of these materials to a soil does not stimulate nitrogen fixation; others believe the contrary. Our experiments have attempted to shed further light on this point. We have employed seven strains of Azotobacter with such insoluble carbonaceous material for a source of energy as sawdust, alfalfa meal, corn fodder and barley straw. The investigation is still in progress and will be continued the coming year.

5. **The Natural Inoculation of Colorado Soils with Legume Bacteria. State Funds.**—As time would permit we have added a few new soils to our list, but the demands by other work have prevented active pursuance of this question.

5. **Soil Nitrates in the Arkansas Valley. Purnell Fund.**—This is a cooperative project between the sections of Bacteriology and Agronomy. Severe hail storms early in the growing season with periodic repetition thru the summer and just before the harvest of the vine crops interfered very seriously with our experimental field work for 1928. In spite of this, however, we have secured rather satisfactory results on our crop residue and cucumber failure experiments.

The results of the former have shown quite conclusively that excessive soil nitrates can be and are depressed by the use of green manures and some crop residues. This furnishes an additional argument for their use when soil nitrates threaten to become excessive.

Our cucumber experiments have demonstrated three facts beyond reasonable doubt: First, that bright sunshine is not a factor in poor vine growth and early maturity; second, cucumber failures are due to some form of disease which is transmitted by insects; third,

a strip of fallow ground 50 feet wide around the cucumber plantings offers no barrier or protection against disease-carrying insects.

A brief report upon the progress of this project, by Mr. Justus C. Ward, chemist in charge of the Rocky Ford Laboratory and Experimental Farm, follows:

"The work of the Colorado Experiment Station laboratory at Rocky Ford, Colorado, has been continued under the joint supervision of Dr. W. G. Sackett and Professor Alvin Kezer during the 1928 season.

"Essentially the same types of work have been under way as in former years. The task of testing rotations, green manuring practices, fallow fertilizer plots and crop residue effects has been the major part of the investigation, while the re-checking of the valley survey results of the two former years was considered the minor phase of the work.

"Due to the curtailing of the personnel in the American Beet Sugar Company's research department, it was found to be impossible to continue their cooperation, so the projects under way were carried forward to be re-checked during the coming season should that prove feasible.

"A rather closer correlation between the Colorado Experiment Station farm and the laboratory was attempted during the past season with results beneficial to both.

"Findings in the various lines of experimental work corroborated those of previous years; namely, rotation of crops seems the most logical method for the control of excessive soil nitrates, while the judicious use of commercial fertilizers offers some chance of control. The work on commercial fertilizers in fallow plots has proved of such interest that if possible a rather elaborate test of them in connection with crop growth should be made. The tests on the effects of crop residues on soil nitrates indicate the advantages and disadvantages of the various residues used for nitrate control. The valley survey has corroborated the findings of earlier years in that in general the type of soil is related to the nitric-nitrogen content. And it was again found that the nitrogen values increased as the soils became heavier, which favored a gradual increasing nitrogen value as the curve followed the Arkansas Valley from Pueblo to Lamar.

"The work on this latter project, that of the valley survey, should be closed until natural conditions change to the extent of making the acquired results inaccurate. Or, until the neccessity of applying the results obtained in the Rocky Ford area to other sections of the valley makes further investigation desirable.

"Following thru the complete rotations now under way on the experimental farm should be continued. The problems of the relationship of crop growth and the application of commercial fertilizers to the nitrogen content of the soils should be studied further. A study of the nitrogen requirements of some of the newer crops in the valley, such as onions, red clover, celery, and like crops might well be made. Further work on green manures might well be carried on. These projects and such others as may suggest themselves during the analysis of this season's findings on the Colorado Experiment Station farm are contemplated for the 1929 investigations of the Colorado Experiment Station laboratory."

The repeated hailstorms thruout the season completely destroyed our bean plantings of old seed for the control of bean blight or bacteriosis. If satisfactory diseased seed can be secured, this work will be continued in 1929.

Miscellaneous Investigations—State Funds

a. Alfalfa Wilt.—The wholesale destruction of our alfalfa stands which we have been experiencing the past two years appears to be due to two principal causes:—Alfalfa wilt, a bacterial disease of the root, and winter injury resulting from planting unhardy varieties. The prevalence of the wilt appears to be closely related to winter injury for it is thru the winter-injured roots and crowns that the disease organism, which causes the wilt, gains entrance to the plant. The most practicable method for the control of this very serious condition seems to be the planting of varieties which will withstand our winter conditions without injury. To this end the Bacteriology Section and the Agronomy Section last spring began a cooperative experiment for the eradication of this heavy alfalfa loss by planting variety test plots in Boulder, Larimer and Weld Counties. The varieties used were such as are reputed to be hardy under our winter conditions and included Grimm, Cossack, Hardigan, Turkestan, Canadian Varigater and Utah Common as a check. Dr. D. W. Robertson of the Agronomy Section has assisted in this part of the work.

b. Crystallization of Honey.—In cooperation with Mr. Richmond of the Entomology Section we have made a preliminary study of the relation of yeasts in honey to its crystallization.

c. Black Chaff and Basal Glume Rot of Wheat.—Mention should be made, as a matter of record, of the occurrence during the summer of 1928 of two diseases of wheat, black chaff and basal glume rot, which were investigated by us. The diseases were reported from the eastern and northeastern parts of the state.

d. **District School Wells.**—As a part of the health program of the Larimer County school nurse, we have made sanitary water anlyses of 21 district school wells and cisterns.

e. **Soil Deficiency Tests.**—Many of the County Extension Agents have availed themselves of the service offered by the Bacteriological laboratory to make soil deficiency tests for their constituents. The soil from 61 farms has been examined and fertilizer recommenadtions have been made, based upon the Winogradsky test.

f. **Sanitary Examination of Swimming Pools.**—Bacteriological tests of the water in the swimming pools of Ammon's Hall and the Men's Gymnasium have been made at regular intervals thruout the year, as a check on the sanitary condition of the water and the efficiency of the purifying mechanism.

At the invitation of the Extension Department I gave five talks over Radio Station KOA, Denver, on the following subjects: Botulism Poisoning; The Cause and Prevention of Typhoid Fever; The Preparation and Use of Vaccines; Vinegar Making and Tularemia.

Each year the number of routine examinations of diseased plants, soil, milk and water increases. This has been particularly true in the case of water. While we are glad to perform this service for the citizens of the state, due recognition should be given to the time it requires, which in turn is reflected on the progress of our research work.

It is with much regret that I have to report the resignation of Mr. Justus C. Ward, who leaves us to accept a position as chemist in the Denver office of the United States Biological Survey, at a very substantial increase in salary.

In the various phases of the work described above, I have been ably assisted by Miss Ida W. Ferguson, Mr. Justus C. Ward, Miss Laura C. Stewart, Mrs. Alpha Powell Head and Miss Ann Roberts, whose efficient services I take pleasure in acknowledging.

In conclusion, I desire to express to the Director of the Experiment Station my sincere appreciation of the congenial relations which have existed during the past year and for his interest in the welfare of the Bacteriological Section.

Respectfully submitted,

WALTER G. SACKETT,
Bacteriologist.

REPORT OF THE BOTANIST

To the Director:

The following is a report of the projects carried by the Botanical Section, December 1, 1927 to November 30, 1928:

Projects.—1. Range Improvement—Purnell.
2. Physiology of Seed—Purnell.
3. Cereal Diseases—State and Hatch.
4. Truck-Crop Diseases—State and Hatch.
5. Alfalfa Root-rot—Adams.

As these projects have been carried during the past 4 years and some of the work as originally outlined was completed, the projects were redrawn and approved October, 1928. The Adams project, alfalfa root-rot, was discontinued, the others rewritten and now stand as follows:

Range and Pasture Improvement—Purnell.
Identification of Seedlings of Species of Beta and Brassica—Purnell.
Weed Control—State.
Truck-Crop Disease Studies—State and Hatch.
Cereal Diseases—State and Hatch.

Physiology of Seed.—The work on hard seed of alfalfa has been completed and published in Experiment Station Bulletin 326.

The study of the germination of wild-oat seed has been continued; it has been found that not all the wild-oat seed is dormant the first year.

Studies have also been made on the germination of various weed seeds to test their possible dormancy and the effect of heating on their germination. Weed seeds fallen to the ground are little affected by burning off the dead weeds over the ground or even by the burning of distillate sprayed on the ground.

Our grasses are generally thought to have a dormant period; seed studies have been made of several species of **Stipa** which have been found to exhibit such dormancy. **Koeleria cristata,** however, has been found not to have dormant seed.

Further studies have been made, in cooperation with the Association of Official Seed Analysts, on the significance of broken sprouts in certain legumes. Cooperatively with the Agronomy Section, longevity studies of seed of cereals have been continued; also, further studies have been made on persistance of hard seed in soja beans. Studies on the germination and respiration of broken cereal seeds have been further carried on and are being published in the Proceed-

ings of A. O. S. A. Investigations were also made of embryoless seed of wheat, barley and rye. This later work has been published in Science 67 and in the Journal of Agricultural Research 36.

The physiology-of-seed project has been revised, specific study of identification of species of Beta and Brassica are to be undertaken and the projects renamed accordingly.

Cereal Diseases.—Tests of a number of commercial dusts for treatment of stinking smut have been continued. Work to date on these tests has been published in Experiment Station bulletin 333. Study has also been made of the physiology of the smut organism which work is being prepared for publication.

The work on furfural derivities as treating agents for stinking smut, done in cooperation with the Crop Protection Institute, was completed and a second project on seed treatment for corn was undertaken with the Institute.

During the past year a root rot of wheat has been quite prevalent in certain sections of the state. Investigations of the cause of this diseases and the conditions influencing it have been started. Work on the black stem rust and the eradication of the barberry has been continued in cooperation with the United States Department of Agriculture.

Truck Crop Diseases.—Spraying and dusting experiments on mildew of onions have been continued. A pink root of onions caused by a fusarium has been found this last year in some of the onion-growing sections and is being given some study.

Tests of treatments for gladiola bulb rots are being continued.

Range Improvement.—Work on this project has been continued during the past year at the following locations by use of transects and 250 quadrats:

1. Lower foothill range (5000 ft. Ft. Collins)
   A study of the composition, succession and factor relations of vegetation of this type of region. Detailed studies have been made on 40 quadrats, and on isolation transects to guage the effects of different grazing systems (cattle) on vegetation. Data are ready for publication.

2. Short-Grass plains (Akron)
   Studies of the effect of sheep grazing on native vegetation. Data on isolation transects and on 35 quadrats, including notes on succession and palatability of the forage, are being prepared for publication.

3. Upper foothill range (7000 ft. Virginia Dale)
   Data have been collected on the composition, succession and factor relation of vegetation in this region and their relation to grazing. Studies have been made here of artificial reseeding. Various tame species as smooth brome grass, slender wheat grass, crested wheat grass, yellow sweet clover, as well as native species are being tested on these foothill ranges.

4. Sagebrush studies (Laramie River Valley)
   Fenced enclosures in this region have afforded means of study of the effect of rodents on range forage and also of the effect of deferred grazing. Studies have been made in this locality on composition of vegetation, succession and factor relations. The effect of the destruction of sagebrush by burning, grubbing and scraping has been very striking. Marked natural revegetation has followed destruction of the sage.

5. Irrigated pastures (Ft. Collins and vicinity)
   Valuable data have been collected on the analysis of seed mixtures, rates of seeding and seedling stands. Competition between species has been studied and the succession of the species planted has been noted during the past year by exact studies on 75 quadrats.

Weed Work.—The weed work formerly done in cooperation with the office of the State Entomologist, has become of increasing importance and has been made a definite project, "Weed Control."

Certain phases of the weed work as heretofore carried have been published in scientific journals and as Experiment Station bulletins (see list of publications). Regeneration studies are being conducted and tests on poison sprays continued under the new project.

State Seed Laboratory.—The state seed laboratory, due to reclassification of appropriation, has been without funds the past year and has been supported by the Experiment Station budget.

Under this arrangement notices were sent out advising seed dealers, county agents and all those sending in seed for testing that a charge would be made after October 1, 1928.

The following is a record of the work done during the past fiscal year:

Inspection samples.

Purity tests	195
Germination tests	195

Current samples.

Purity tests	1486
Germination tests	1823
Examinations	84
Identifications	19
Total	3802

These figures are lower than in former years due to some extent to the charges made for tests.

Emphasis in inspection work was placed on preventing (1) the sale of southern-grown alfalfa seed as northern grown and (2) the introduction of a serious weed pest with imported Turkestan alfalfa seed.

L. W. Durrell—Root rot of alfalfa. Colo. Agr. Exp. Sta. Press. 1928. Bul. 66.

_____—Smuts of Colorado Grains. Colo. Agr. Exp. Sta. 1928. Bul. 334. 1-25.

_____—Root rot of alfalfa. Through the Leaves. March 1928. P. 119.

E. L. LeClerg and F. B. Smith—Fungi in Some Colorado Soils. 1928. Soil Science 25: 433-441.

E. A. Lungren and L. W. Durrell—Seed Treatment for Stinking 1928. Smut. Colo. Agr. Exp. Sta. Bul. 333.

Anna M. Lute—Impermeable Seeds of Alfalfa. Agr. Exp. Sta. Bul. 1928. 326.

Mildred E. Lyon—Embryoless seed in cereals. Science 67. P. 652. 1928.

_____—The Occurrence and behavior of embryoless wheat 1928. seeds. Jour. Agr. Res. 631-637.

E. L. LeClerg and L. W. Durrell—Vascular plugging of alfalfa 1928. roots. Colo. Agr. Exp. Sta. Bul. 339. 1-24.

H. C. Hanson—Reclamation of waste range lands. The Producer. 1928. 10-3-6.

_____ and Walter S. Ball—An application of Raunkraer's 1928. law of Frequence to Grazing Studies. Ecology 9, 467-473.

_____ and Frederick B. Smith—Some types of vegetation in 1928. relation to soil profile in northern Colorado. Jour. Am. Soc. Agron. 20: 142-151.

_____—Revegetation of waste range land. Colo. Agr. Exp 1928. Sta. Bul. 332.

_____ Walter S. Ball and Anna M. Lute—Ecological stu-
1928. dies in grazing at Colorado Agricultural Experiment Station. Carnegie Inst. of Washington, Year Book.

_____—Early grazing ruins ranges. The Cattleman. 15:
1928. 31-32.

Respectfully submitted,

L. W. DURRELL,
Botanist.

REPORT OF THE CHEMIST

To the Director:

The Chemical Section of the Station has nearly completed the Adams project entitled, "The Part Played by Carbon Dioxide in Crop Rotation." This project was extended to include a study of the deportment of such soils after the clover and alfalfa had been plowed under. This work was divided into two parts, namely. The deportment of wheat when grown on the different plots or parts of them, and a study of the variations of the total and nitric nitrogen in them, the amount and variation of water-soluble potassium combined with an independent series of nitric nitrogen determinations and of the amount and variations of the carbon dioxid in the various plots for one year after the crops had been plowed under. All plots were treated alike during this year of study. We expect this work will be finished soon after the close of the fiscal year.

Reports have already been made on this work in the form of three bulletins, and a fourth one covering the deportment of the plots cultivated fallow, as set forth in the closing portion of the preceding paragraph, is in the course of preparation.

We have presented the manuscript of a bulletin on some digestion experiments made some years ago and not heretofore published to complete our account of the work.

Future work, as now planned, will be a study of the changes in and the value of rain-damaged hay. This project is now under consideration by the Office of Experiment Stations which will determine the status of the project, so far as funds are concerned, if approved.

Respectfully submitted,

WM. P. HEADDEN,
Chemist.

REPORT OF THE ENTOMOLOGIST

To the Director:

In this section the work has been carried in 8 projects which are given below. Much of the work has been done in connection with the Office of State Entomologist, whose funds have borne a considerable proportion of the expense entailed.

The only changes in personnel have been due to the absence of Mr. John L. Hoerner to carry on investigations under the direction of the Crop Protection Institute, and at the same time to accumuate credits leading to the doctor's degree; and of Mr. George S. Langford to carry on work at the University of Ohio for credits leading to his doctorate. Mr. Langford resigned some time ago and his place was filled by Mr. F. T. Cowan, who is devoting most of his time to work in the Office of the State Entomologist as deputy, tho he will give some time also to Experiment Station projects. Dr. W. C. O'Kane, under whose immediate direction Mr. Hoerner is carrying on his work, has made an urgent request that Mr. Hoerner be allowed to continue with the Crop Protection Institute for another year in order to complete the project which he has undertaken. Mr. Hoerner also naturally desires to complete the investigation upon which he has been engaged, and requests that his leave be extended for another year, provided that will not jeopardize his return to the department here. Since Mr. Hoerner's work is being quite satisfactorily taken care of by Mr. Leslie B. Daniels, who is willing to continue his services with the department, I am glad to recommend that Mr. Hoerner's leave of absence be continued until the end of December of next year.

The insects that have been given the most attention during the past year have been grasshoppers, the Morman cricket, plant lice, alfalfa weevil, oyster-shell scale, Mexican bean-beetle and ants. A bulletin, (337) has been published covering the work that has been done on the potato flea beetle. One technical paper on plant lice studies has been published and another paper written and put into the hands of the printer for publication. A paper on ants is in the hands of the Experiment Station editor, a manuscript on the Mormon crickets is about ready for publication, and four technical articles have been presented to scientific societies as a result of investigations in this department.

The alfalfa weevil has been found in the counties of Mesa and Garfield where it had not been discovered before. This wider spread makes more difficult the work of inspection and quarantine.

No new pests of a serious nature have been apprehended in the state during the year.

It will be noted that two new projects, both dealing with rodent control, have been added to the investigational work of the department during the year.

Projects

Plant Lice Investigations.—This has been a continuing project for a number of years borne on the Adams fund, the workers being Miss M. A. Palmer and the writer. Fair progress has been made in the work during the past year. Twenty-five species of plant lice entirely new to science have been described and named, and life histories worked out and food plants given. One paper dealing with 12 of these species has been published in the Annals of the Entomological Society of America, and a second manuscript has been accepted for publication.

Ants in Relation to Plant Lice.—This project is being carried by Dr. C. R. Jones. Considerable additional information concerning the habits of species of ants in Colorado and their relationship to the plant lice has been accumulated during the year, and Dr. Jones' paper, upon which he received his degree of doctor of science at Iowa State College, has been condensed and offered for publication as a bulletin from this station. This manuscript is in the hands of the station editor at the present time.

Codling-Moth Studies.—This project is being carried under the direction of Mr. George M. List, the investigations being for the most part, in the orchards of the western slope in the vicinity of Grand Junction and Delta. The object of this project is to determine more fully the life habits of this insect and to do whatever is possible to work out better means of control. Mr. W. P. Yetter reports very good results at Grand Junction in the use of vinegar traps for the collection of the moths in the trees, and a specially prepared and treated band for the destruction of the larvae as they accumulate beneath this band on the trunks of the trees. It seems almost certain that the codling moths in the vicinity of Grand Junction at least have been bred up quite largely to resist poisoning from arsenical sprays. To test this matter out, several hundred of the larvae were collected by Mr. Yetter at Grand Junction and sent to Dr. Walter S. Hough, Associate Entomologist of the Field Laboratory at Winchester, Virginia, who was carrying on the investigation to determine whether or not insects may build up an immunity to arsenical poisons. The results of this investigation indicate that this is

what has taken place with the codling moth in the orchards about Grand Junction.

Mr. J. H. Newton, who is in charge of the field work with this insect in Delta County, reports excellent results in codling-moth control the past summer where his directions were carefully followed.

Codling Moth Control by Means of an Egg Parasite.—This project, which is under the direction of Mr. List and Mr. Yetter, was making excellent progress up to about the middle of April of this year, and several thousand parasites were actually sent to the western slope and released in the orchards to assist in the control of the codling moth. However, at about that time, it was found that two mites, one **Pediculoides ventricosus,** and the other a species of Gamasid were infesting the parasite laboratory and destroying the eggs and larvae of the Angoumois grain moth, whose eggs were being used for the production of the egg parasite. As a result, it was found necessary to renovate the insectary and start the whole infestation anew in order to get rid of the mites, which seems to have been very successfully done. If no new trouble arises, it seems probable that we should be able to ship these parasites to the orchards of the western slope during the coming summer in very large numbers to assist in the control of the codling moth.

Grasshopper Control.—Work on this project was being carried under the direction of Mr. George S. Langford, who resigned to take a position in the Ohio Experiment Station. The work has been transferred to Mr. Frank T. Cowan, who devoted most of his attention this year to the control of the Mormon cricket (which is a grasshopper) in the northwestern counties of the state. I am glad to report that where the directions of Mr. Cowan were followed very little damage was done to crops by the Mormon cricket during the past summer. We believe we have worked out a very satisfactory control for this pest, as probably less than $1000 of injury was sustained to crops by the Mormon cricket in Moffat and Routt counties during the past summer.

Mr. Langford has a manuscript nearly completed giving the results of his grasshopper work during the past two or three years, which has brought out many new facts in grasshopper habits. This paper will be ready for publication in the near future.

Potato Flea Beetle.—This project was being carried by Mr. John L. Hoerner, who worked out a method of control that succeeded well in the control of this pest in the Greeley section during 1927. The control method worked out by Mr. Hoerner did not give satisfactory

results the past summer, so that we are planning to extend the experimental work on this insect another year. Its life habits in the Greeley district are fully worked out by Mr. Hoerner, which gives a better basis for controlling this pest than we have ever had before.

General Insect Investigations.—This project is a continuing one, having for its object the accumulation of as much data as possible in a general way concerning the insects occurring in Colorado, including all species that can be taken either upon cultivated crops or upon native vegetation. Considerable work is done each year and many data concerning the habits of Colorado insects studied under this project have been accumulated and placed on file in the department for the future information of workers in entomology.

Rodent Poisoning.—This is a new project upon which work was started during the past summer, and is under the direction of Mr. W. L. Burnett. There is much that we need to know concerning the effect of strychnine and other poisons for rodent control. It is to obtain this information that Mr. Burnett has carried on his investigations. Good progress seems to have been made this year.

Rodent Life Habits.—There is a great lack of information concerning the life habits of many of our destructive rodents in Colorado. A knowledge of these habits will greatly facilitate methods of control. Mr. Burnett is carrying on investigations on this project in order that we may have a better knowledge of the habits of our destructive rodents thruout the year.

Respectfully submitted,

C. P. GILLETTE,
Entomologist.

REPORT OF THE AGRICULTURAL ECONOMIST

To the Director:

During the year ending November 30, 1928, nine projects have received active consideration by the members of the staff of the Section of Economics and Sociology. Eight of these projects have been approved for development with Purnell funds.

Project No. 1: An economic study of the peach industry in Colorado; in cooperation with the Division of Farm Management and Costs, Bureau of Agricultural Economics, U. S. D. A.

Project No. 2: An economic study of farm organization and management in the Greeley area and in northeastern Colorado.

Project No. 3: A study of costs and methods of producing cattle and sheep on the range in Colorado; in cooperation with the Division of Farm Management and Costs, Bureau of Agricultural Economics and the Bureau of Animal Industry, U. S. D. A.

Project No. 4: A study of the social status of the Spanish-speaking people in rural Colorado.

Project No. 5: A study of taxation in Colorado, particularly in its relationship to the agricultural industry; in cooperation with the Division of Finance, Bureau of Agricultural Economics, U. S. D. A.

Project No. 6: A study of the methods of storage and marketing practice which obtain in handling potatoes on farms in the San Luis Valley; in cooperation with the Division of Markets, State House, Denver, Colorado.

Project No. 7: An economic study of the apple industry in Colorado; in cooperation with the Division of Farm Management and Costs, Bureau of Agricultural Economics, U. S. D. A.

Project No. 8: An economic study of land utilization in northwestern Colorado; in cooperation with the Division of Land Economics, Bureau of Agricultural Economics, U. S. D. A.

Project No. 9: A study of the major types of cooperative organizations or associations in Colorado, in cooperation with Division of Cooperation, Bureau of Agricultural Ecnomics, U. S. D. A.

Project No. 1.—The early work on this project was carried in cooperation with the Bureau of Agricultural Economics, U. S. D. A. At that time special attention was given to an analysis of costs involved in developing peach orchards and a study of the costs of producing peaches. For the year 1927 records have been assembled showing the returns for the farm as a whole on the few representative units in the area. On many farms in this particular district the chief source of income is from the sale of peaches. The prosperity of the farmer varies widely from year to year according to the yield and prices received for peaches. The year 1927 was somewhat better than normal while the prospects for 1928 were not quite so favorable.

Project No. 2.—Detailed farm accounting records have been obtained from several farms in the Greeley area. For some of these units this study has been continued for the seventh year. Financial records have been secured from several farms in the same general region. For the northeast section of Colorado the work is in its

second year and it is presumably too early to submit conclusions for this portion of the project. In so far as the detailed farm accounting records are concerned, progress has been made in the development of two manuscripts which will appear shortly as station bulletins. One of these papers deals with a financial study of sheep and cattle feeding on irrigated farms in northern Colorado. This analysis is based upon records for six feeding periods. A second paper includes a study of costs and returns for the more important crops which are produced on irrigated farms in Weld County.

Project No. 3.—Ranch-organization studies which were begun in 1922 and carried thru the year 1925 have been completed and the results have been published in Colorado Station Bulletin Number 327 entitled "Cattle Ranch Organization in Eastern Colorado," and Colorado Station Bulletin Number 342 entitled "Cattle Ranch Organization in the Mountains of Colorado". Some of the results which have been secured from the analysis deal directly with the abnormal conditions in the cattle industry during the years of acute depression following the world war.

During the summer months the Department of Economics and Sociology cooperated with the Bureau of Animal Industry and the Bureau of Agricultural Economics, U. S. D. A., in bringing together statistics with respect to the supply of feeder cattle which will be available for sale this autumn. A comprehensive report was prepared on the basis of this field study and copies of this outline were mailed to a large number of prospective buyers in the cornbelt. This study was very much appreciated by producer and feeder alike.

It is our purpose to continue the ranch-organization study in the North Park area. The cooperative features of this projcet so far as they involve the Bureau of Agricultural Economics and the Bureau of Animal Industry, U. S. D. A., have been approved and we are now ready to proceed with the inventory work on ranches in the North Park region. The Wyoming Experiment Station has agreed to participate in this study and will assemble ranch-organization data in the Saratoga Valley.

Project No. 4.—The development of this project has involved a study of the Spanish speaking people in rural Colorado. It was thought that any satisfactory analysis of conditions in Colorado would necessarily include the economic, religious, social and educational conditions under which the Spanish have lived in previous years. It should also include a study of their habits and life practices; their citizenship ideals and ideas and the present situation in old Mexico which has decided immigration to the United States. An

intensive study of these features has furnished an excellent foundation for an analysis of problems along similar lines among the Spanish in the United States and Colorado. In the development of this project the following topics have been considered:

(a) Social Theory
(b) Social Theory and Mexican Origin
(c) Spanish Movement to the United States and Mexico
(d) Background of Religion
(e) Background of Education
(f) Background of Occupation and Economic Success
(g) Economic Aspect of Background of Mexican Civilization
(h) Background of Living Conditions
(i) Spanish in the United States and Coming In
(j) Education and Health in Colorado
(k) Citizenship and Crime in Colorado
(l) Winter and Unemployment
(m) How They Live
(n) Income
(o) Present Status and Problems
(p) Conclusions

Project No. 5.—A manuscript dealing with farm taxation in Colorado has been completed and has been submitted for publication. This will appear as Colorado Station Bulletin Number 346, "Some Tax Problems in Colorado," with special attention to their effect on agriculture. A tentative outline has also been prepared with respect to the revenues and expenditure of the county government in our local area. This outline will be submitted for publication in the near future. An analysis of Colorado tax laws as they affect farms in this state has also been completed. This paper will be available for publication at a later date.

Project No. 6.—In April and May some 35 farm-organization records were obtained from potato growers in the San Luis Valley. Practically all of these operators had provided information with respect to the storage and marketing of the potato crop on their farms. Substantially 2 years' work have been completed in our study of storage and marketing as related to the potato crop. The results of this investigation are being compiled for publication.

Project No. 7.—A farm-organization survey was conducted in the apple districts on the western slope during the months of June and July and some 75 or more records were obtained from farm operators who had cooperated with us during the preceding season. Our objective in this study was to compare the results on farms where

major attention was being given to apple production with other types of farming in which enterprises other than the apple constituted an important part of the system.

A general conclusion based upon our investigations to date appears to indicate that farmers who rely upon apples as their chief source of income are not making as good incomes as farmers who are producing general crops and livestock.

Project No. 8.—In August a farm-organization and land-utilization survey was made in northeastern Colorado. Approximately 75 records were secured during the 2-week period which was set apart for this study. This survey constituted a repetition of the work which was carried last year in cooperation with the Division of Land Economics, Bureau of Agricultural Economics, U. S. D. A. It seemed to be desirable to obtain records for an additional season so that we might have a somewhat better basis for our final consideration and report on the economic situation in Moffat, Routt and Grand Counties. Our study thus far has served to indicate the types of farming which appear to be best adapted to conditions in northwestern Colorado.

Project No. 9.—Active cooperative organizations are being studied in the hope of determining the causes for success and failure. Obviously any business organization must be built upon the successes and failures developed in the past. At the present we are undertaking a cooperative study with the Division of Cooperation, Bureau of Agricultural Economics, U. S. D. A. This project will include an analysis of approximately 120 elevators in the winter-wheat area including Kansas, Nebraska and Oklahoma. Colorado will furnish approximately 20 elevators for this study. A preliminary survey has been made this autumn of 20 typical farmers' cooperative elevators. The object of the study is to help the elevator manager to analyze the various items of expense and returns; then to give him an opportunity to compare his business with other plants which are similar in size and character. The results of the study will provide the cooperating agencies with the information which will enable us to teach and advise with respect to cooperative organizations and marketing.

Respectfully submitted,

L. A. MOORHOUSE,

Agricultural Economist.

REPORT OF THE CHAIRMAN, DIVISION OF HOME ECONOMICS

To the Director:

The work on Part I of the project—The Baking of Flour Mixtures at High Altitudes, has been completed and the findings are now being put in form for publication. The accomplishment to date includes:

Definition of ingredients, measurements and technique to be employed;

The working out, at 500 foot elevation of recipes for the representative products to be baked;

The repetition of routine work with foundation recipes at each 1000 feet of the range of pressures corresponding to elevations, from sea level to 12,000 feet, this routine being carried out under controlled conditions;

Many repetitions at each 1000 feet, of formulae modified to meet the requirements for a satisfactory recipe for each of the pressures chosen for a test;

Confirmatory tests at locations with barometric pressures corresponding to those chosen for tests, in the altitude laboratory;

The further description by curves, of necessary changes in proportion of ingredients and of temperatures for the different pressures.

Mrs. Marjorie Peterson performed the major part of the work of Part I of the project.

In the subsequent work on the project, to be designated as Part II, the purpose is to interpret from a physical-chemistry standpoint the results obtained in Part I.

Appointment of a physical chemist to continue the experimental work in the direction indicated, has not yet been made.

Respectfully submitted,

INGA M. K. ALLISON.

REPORT OF THE HORTICULTURIST

To the Director:

The following is a brief report on the work of the Horticultural Section for the past season. Practically all of the projects have been active and considerable progress has been made.

1. **Potato-Variety Project.**—This project has now been running for 2 years. Out of the original 300 varieties and strains, eliminations have been made, that is, worthless and duplicate varieties have been discarded, and we now have about 150 varieties under observation. The work has been carried on at Avon. Beginning next year it is the intention to do a part of this work in the San Luis Valley as well as at Avon in order that we may test out the different varieties under different soil and climatic conditions. This is necessary before any varieties are recommended for the various sections of the state. At present we have several promising varieties but it is necessary to carry on the test under varied conditions before they are recommended for commercial planting.

2. **Garden-Pea Variety and Breeding Project.**—This is the second year for this project. The original 800 varieties assembled and planted in 1927 were reduced at the end of the first year to 300 and at the end of last season all were eliminated except 50 varieties that we expect to use for breeding work next year. There are several promising varieties of pod peas as well as canning peas among this number. Selections from the Dwarf Telephone pea have been in progress for the past 5 years and we now have an excellent strain of this variety. Distributions have been made of this strain to growers for the past 2 years. It seems to be especially well adapted to the high altitudes.

3. **Tomato Project at Manzanola.**—The tomato project at Manzanola was completed last year and we expect to publish the results early next year.

4. **Effect of Washing on Keeping Quality of Apples.**—This work was undertaken at the request of growers and shippers of apples. It was the opinion of many people that the washing of apples lowered the keeping qualities. The work on this project was completed last spring and the results published in Bulletin 343. In connection with the above project considerable work was done in designing a practical home-made washing machine. As a result of this work a washing machine was designed and complete data on construction and cost were worked out and embodied in Bulletin 343.

5. **Orchard Management.**—The Orchard-Management project has been active for a number of years and carried out in cooperation with the State Horticulturist, using the demonstration orchard at Austin for the field work. Various kinds of cover crops, such as sweet clover, vetch, annual sweet clover, red clover and rye have been used. The results indicate that the different cover crops used have different effects, not only on soil conditions, but upon the fruit production and wood growth. For peaches the rye as a winter cover crop has been uniformly beneficial, both as regards to growth of the tree and the fruit. In the apple orchard, the sweet clover has thus far been most beneficial. This work will be continued for several years, but we have sufficient data to publish a preliminary report.

6. **Celery Storage at Littleton.**—This work has been in progress for 3 years. We expect to complete the project with the end of this season and the results will be published in a bulletin.

7. **High-Altitude Vegetable Production.**—This is a general project dealing with commercial vegetable production in our mountain section. With the development of vegetable growing in the mountains it was found that the land could not be utilized for continuous cropping with vegetable crops without the use of manures or fertilizers of some kind.

It was believed that vegetable growing in high altitude should be combined with a system of farming so as to permit a rotation of crops and also a system that would maintain the soil fertility thru rotation and the use of livestock. Under this scheme the vegetable production assumes the major part, that is, the cash crops of production, while the livestock are used to consume hay and roughage produced, and also for fertilizers.

The farm at Avon contains a little over 100 acres of tillable and irrigable land. Forty acres are constantly in alfalfa and the other 60 in crops. The period of rotation is figured on the basis of 4 years. The main vegetable crops are head lettuce, peas and potatoes. A small acreage is devoted to secondary crops like spinach and cauliflower. Potatoes follow the alfalfa and the vegetables follow potatoes. About 100 head of livestock are kept. Under this system of animal production and rotation there has been a noticeable increase in the yield of the various crops and we believe that if this system is continued a high state of fertility and high crop production will be obtained.

8. **Fertilizer Project.**—For the past 5 years, especially since the development of the vegetable-growing industry, there has been a considerable demand for information on the use and value of com-

mercial fertilizers. Trial plots, using fertilizer in combination and separate have been carried on at the farm at Avon. The results have been negative. The largest yields have been obtained from the land where barnyard manure has been applied. From the work thus far, it is apparent that the use of commercial fertilizers in the production of vegetables in the mountain sections is not profitable nor econmical.

9. **The Development of a Tipburn-Resistant Variety of Head Lettuce.**—This project has been carried on for several years past. The work to begin with was mainly along the line of cultural problems. As a result of this work Bulletin 311 was published. It was later decided to approach the problem of tipburn resistance from the breeding or crossing side. The work was started on crossing different varieties of lettuce 2 years ago and we now have a number of promising hybrids. Two or three of these have thus far shown complete disease resistence to the tipburn. Further crossing was done last season and the work will be continued.

10. **Certified Seed-Potato Project.**—In connection with the certification of seed potatoes, it was found necessary to carry on selection work in order to maintain yield and quality. This work has been carried on at Avon for the past 2 years. In connection with this work it has been found advisable to request all growers of certified seed to send to the Experiment Station a peck of potatoes each year from the certified fields. These samples are planted at Avon and a record kept. It has been found that a given source of seed, when used by a farmer for 3 or more seasons, deteriorates and it becomes necessary for the farmer to obtain a new seed stock. This work is of great importance for the maintenance of high-grade seed.

Respectfully submitted,

E. P. SANDSTEN,
Horticulturist.

REPORT OF THE IRRIGATION ENGINEER

To the Director:

During the past state fiscal year, the following projects have been under consideration:

Measurement of Water, Hatch and State Funds
Evaporation from Free Water Surface
Evaporation from Moist Soils
Meteorology
Pumping for Irrigation and Drainage

In my last report to you reference was made of the possibility of proposing a new project on the subject of "Conservation of the Irri-

gation Supply in the South Platte Valley in Colorado." Considerable thought has been given to this subject and a preliminary report prepared covering the general features of such a study. At this time, however, it can only be reported that much interest is shown by the irrigation men of this valley, in the hope that later some cooperation could be set up in which a rather extensive survey may be made to determine the economic limits of the storage of flood waters for supplementary irrigation.

During the past year work has been continued in the development of the improved Venturi flume in the study of the larger sizes. There has been in operation on the Holbrook Canal near Rocky Ford, a 20-foot reinforced concrete flume which replaced the customary rating flume. After a year's study of this large device, where 17 current-meter check gagings have been made, it is found that the mean error between the computed and actual observed discharges showed a deviation of less than 2 percent. Because of the success of this large flume, the construction of a 40-foot reinforced concrete improved Venturi flume has been started on the Fort Lyon Canal near La Junta. It is expected that this new large flume will have a capacity of about 2,000 second-feet and that it will be the means of more accurately measuring the water than has been previously experienced. The several smaller flumes now in operation on canals in the Arkansas Valley appear to be operating satisfactorily, and this fall marks the installation of a number of other flumes, replacing the ordinary rating flume which in the past has proved to be inadequate to meet conditions. It is confidently expected that within a very short time practically all canals in the Arkansas Valley in Colorado will be equipped with the improved Venturi flume. A comprehensive bulletin on this subject is now with the printer. This bulletin covers the results of some years of study, and judging from the advance requests received it will fill a much needed place in the measurement of water.

In September, preliminary tests were conducted at the Bellvue laboratory on a new type of measuring device which is essentially an adjustable tube. These tests indicate that this new design will operate under the most adverse conditions now imposed upon present measuring devices, namely, that it will operate under small loss in head and also where sand and silt deposits interfere with other means of measurement. The results of our observations so far are highly gratifying.

During the past year studies on evaporation from a free water surface have been largely confined to Fort Collins. However, during May and June, Mr. Rohwer made an extended field trip during which observations were carried on at Imperial, Calif., at 68 feet below

sea level; at Lake Tahoe, at an elevation of 6,300 feet above sea level; at Logan, Utah, at an elevation of 4, 780 feet, and lastly at the summit of Pike's Peak at an elevation of 14,000 feet. These field observations were necessary to determine the effect of altitude upon the rate of evaporation as indicated by the former study, based on observations at Fort Collins. This study in evaporation is looked upon as a real scientific attainment. Because of the minuteness in which the records are taken, it has been possible to compute the rate of evaporation over a period of time where the computed value agrees remarkably well with the actual measured loss.

The studies made on evaporation loss from moist soils have been conducted this past season. However, at this time our records have not yet been compiled in sufficient detail to warrant conclusions.

The work in meteorology has been conducted as in the past. A manuscript has been prepared by Mr. R. E. Trimble, summarizing meteorological records up to January, 1928, covering a period of 41 years, which is one of the longest continuous records to be found in Colorado.

For a number of years the subject of pumping for irrigation in Colorado has been one of more than passing interest. In order to get direct information concerning this problem, a project has been undertaken on Pumping for Irrigation and Drainage in our state. Mr. W. E. Code was assigned as an associate in this study, reporting for duty early in June. A large number of tests have been made on existing pumping plants with the idea of determining the cost of operation; also to secure data concerning types of installation best suited to Colorado conditions; cost data, and other information bearing upon the subject. At this time it is expected the project will continue for 2 or 3 years which will permit sufficient time to determine whether or not the depreciation in efficiency of pumps is an item of serious consideration. In connection with this study, no definite steps have yet been taken applying the problem to drainage. This phase of the subject, however, will be considered within a short time.

An article has been prepared for publication in the Proceedings of the American Society of Civil Engineers entitled "Evaporation Loss from Moist Soils." Also, I prepared a paper, "Irrigation in Colorado," for the western meeting of the American Association for the Advancement of Science. Besides these, I have written various short articles for News Notes and the local papers.

Respectfully submitted,

R. L. PARSHALL,
Irrigation Engineer.

REPORT OF THE VETERINARY PATHOLOGIST

To the Director:

List of Projects:

1. Sheep Losses in the Feedlots
2. Death Losses in Lambs on Heavy Grain Feed
3. Contagious Abortion
4. Coccidiosis in Cattle
5. General

Sheep Losses in the Feedlots

Two outbreaks of icterohematuria in mountain ewes came under our observation. Altho considerable attention was given to blood study and inoculation of presumably susceptible animals, nothing further was learned as to its etiology. Judging from reports coming from the mountainous districts, this disease is causing increasing losses in breeding sheep. It has now been reported from practically every large area in our mountainous territory. It looks as tho the time were not far off when we would need a project on this one disease.

Tetanus and arthritis must be added to the list of diseases which have been observed. Tetanus came as a result of ear tagging and the arthritis with unknown cause was quite widespread in one feedlot comprising nearly 2500 lambs.

Pneumonia, necrobacillosis and dysentery continue to take their toll but over-eating seems to eclipse them all.

Death Losses in Lambs on Heavy Grain Feed

This phase of the work has been largely concerned with the determination of the spore-bearing anaerobes which might be found in the spleens of animals dead of disease. The first season's work is now ready for tabulation and indicates that pathogenic spore-bearing anaerobes are quite common in the spleens of dead sheep regardless of the cause of death. This finding casts some doubt upon the etiological significance which has formerly been given to these organisms in connection with certain investigations. We are hoping to have a portion of this work ready for publication shortly.

Contagious Abortion

The college herd has continued to remain free from the disease altho there is still an occasional aborter among these animals. Our work with the other large herd previously spoken of indicates two definite waves of reinfection and shows the difficulty of maintaining

an infected and a non-infected herd on the same premises. Both lapses have apparently been traced to careless disposition of the manure from the infected animals.

Coccidiosis in Cattle

The study on this subject was largely in the hands of a graduate student who has not yet finished his thesis. However, many preliminary observations were made which ought to be of value in future work. We were fortunate in having material at hand in the animals being fed by the Animal Investigations Section.

General

Our diagnostic work has been largely concerned with poultry problems as will be seen by the appended table. Fowl paralysis is causing increasing concern and comprises a large percentage of the specimens sent us.

Diagnostic Work (Exclusive of blood tests) (789-2073)

Avian	551	Rodent	18
Bovine	235	Swine	38
Canine and Feline	87	Miscellaneous	292
Equine	19		
Ovine	44	Total	1284

Blood Tests

	Number	Positive	Percent Positive
Contagious Abortion (Bovine)	1417	323	22.79
Contagious Abortion (Swine)	40	6	15.00
White Diarrhoea	10312	1042	10.10

Lots of baby chicks examined for white diarrhoea	116	84 positive
Examinations for rabies	49	26 "

Our new quarters in the old library, which were prepared for us during the summer and the new equipment which went with them have been very stimulating and should result in increased production.

Miss Helen Margaret Perry was added to the staff September 1, 1928.

Publications

"On the Accuracy of the Agglutination Test for Bacterium Pullorum Infection as Shown by Repeated Tests on the Same Birds," by I. E. Newsom, Floyd Cross and O. C. Ufford. Jl. of Am. Vet. Med. Assn., Vol. LXXII, N. S. 25, No. 5, February, 1928, pp. 611-617.

"Fowl Paralysis," by I. E. Newsom. Veterinary Medicine Volume 23, No. 5, May, 1928, pp. 227-229.

Respectfully submitted,

I. E. NEWSOM,
Veterinary Pathologist.

REPORT OF THE VETERINARIAN

To the Director:

In the Veterinary Section we have but one project, which is that of Animal Diseases. We wish to continue with the same for the ensuing year.

Specific projects relating to animal diseases that require protracted investigation are assigned to the Section of Veterinary Pathology, under the direction of Dr. I. E. Newsom.

The one general project which is carried on in the Veterinary Section from year to year is very helpful in emergency outbreaks of disease where immediate assistance is required. It enables us to keep in touch with livestock conditions and to cooperate with state and national authorities.

We are cooperating with the section of Veterinary Pathology by supplying material for both clinical and laboratory diagnosis. The nature of this work is constantly changing. Twenty years ago our time was devoted largely to the investigation and control of such diseases as anthrax, glanders, blackleg and rabies. Now we have in the foreground the Bang abortion disease, hemorrhagic septicemia, coccidiosis, white diarrhoea of chicks and poisonous plants.

New disease conditions are constantly appearing among our animals and eternal vigilence is necessary to combat them successfully.

Many short articles pertaining to animal losses from disease have been published. Papers were read at a meeting of our State Veterinary Medical Association and at the annual meeting of the American Veterinary Medical Association at Minneapolis. The latter will be published in the Journal of the American Veterinary Medical Association in the near future.

Respectfully submitted,

GEO. H. GLOVER,
Veterinarian.

ENGINEERING DIVISION

To the Director:

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

Respectfully submitted,

L D CRAIN,

Chairman and Vice-Director

REPORT OF CIVIL ENGINEERING SECTION

Chairman of Engineering Division:

Following is the annual report of the Civil Engineering Section of the Experiment Station of the Colorado Agricultural College. During the past year this section of the Experiment Station has devoted its time to the following projects:

No. 1—Road Materials of Colorado,

No. 2.—Cooperative work with the State Highway Department of Colorado,

No. 3.—Frost Heaving Investigation on Concrete Slabs (A continuation of the Sub-grade Project),

No. 4.—Capping of Concrete Cylinders.

The projects suggested for future work are as follows: A continuation of Projects 1, 2 and 3, and we suggest the following two new projects:

No. 5.—A Study of the Effect of Hauling Mixed Concrete.

No. 6.—A Study of the Effect of Wire Mesh Reinforcing upon Concrete exposed to Moisture and Frost Action.

The progress of the work on our projects is as follows:

Project No. 1.—At different times during the year the State Highway Department has sent in samples of sand and gravel to be tested for their qualifications as to concrete aggregates. This undoubtedly will continue for many years to come, and as it is a part of our cooperative agreement with them I recommend that the work be continued.

Project No. 2.—This consists of testing concrete cylinders sent in by the Highway Department from the different stretches of concrete paving under construction in Colorado. This paving will continue for years to come and I recommend that this cooperative work be continued as long as the State Highway Department desires these tests.

Project No. 3 will have at least a year to run and perhaps two. The slabs were not completed last year at the time freezing weather began and altho we have data on the rise and fall of the slabs as the frosts penetrated deeper and deeper during the winter; and the thawing out of the soil during the spring, yet the results are so different from those expected that we desire another year or two to check these movements. At the present time it would seem that no heaving was obtained due to frost action. A vertical displacement of from ½ to ¾ inch was caused by changes of temperature and moisture content of the subgrade, but the penetration of the frost seemed to make no difference whatever.

Project No. 4 has been completed and will be written up in bulletin form in the very near future. This experiment shows that the strength of concrete cylinders varies as much as 30 percent when capped with different materials. The Lummite cement cap as used in our laboratory gives approximately the same strength as the standard cap. It gives a slightly higher strength on the low-strength cylinders and a lower strength on the high-strength cylinders. The plaster of paris cap, which is often used, gives a strength 30 percent lower than the standard cap.

The two new projects suggested are, in a way, new to the road construction work and seem to be important lines for investigation.

The work of the Road Materials laboratory has gone very well thruout the year, with one less man employed than we had formerly. At times the testing has kept them very busy, but at other times the materials sent in for testing were few enough to allow them to catch up on the work so that we have always been able to report the results of these tests within a reasonable time. I think that the work for the coming year should continue and can be taken care of by the present force.

A new line of work has been asked for by the State Highway Department as a part of our cooperative work, namely: Testing of oil, asphalt and brick for road construction purposes. It was necessary to purchase a little additional apparatus for this new work but it is under way at the present time and I think the results will be satisfactory to all concerned.

Respectfully submitted,

E. B. HOUSE,

Civil Engineer.

REPORT OF THE MECHANICAL ENGINEERING SECTION

To the Chairman, Engineering Division:

Following is the annual report of the Mechanical Engineering Division of the Experiment Station of the Colorado State Agricultural College.

During the past year this section of the Experiment Station has devoted its time to the following projects:

No. 1.—Commercial Insulating Material for Buildings.
No. 2.—Humidity of Air in Buildings.
No. 3.—A Proximate Analysis of Colorado Coals.
No. 4.—Ventilation of Onion Cellars.

Project No. 1 has been finished so far as our original plans were concerned. A report was made upon the results obtained, but no publication has been issued to date.

Some very interesting results were obtained, especially in the comparison of the cost of the different materials per degree of insulation. There is no doubt about the economy of insulation for the dwelling house, the main problem being that of selecting the insulating material best suited for the individual conditions. Many of the various materials have about the same insulating value but vary in their original cost, cost of application, structural strength and appearance. It is also quite evident that a much greater efficiency is obtained by using 2 half-inch thicknesses separated by an air space in place of a one-inch thickness of the material.

The nature of this project is such that it could be carried on indefinitely, due to the fact that new insulating materials are constantly appearing upon the market.

Project No. 2.—A month's test was made upon a new type of humidifier, but the results obtained, an increase of about 3 percent in the humidity of the air, proved that it is practically impossible to change the humidity of our classrooms appreciably, by means of radiator humidifiers.

Project No. 3 was started in October of this year and will be carried thru the winter.

Project No. 4 was dropped by this department after considerable preliminary work, due to the lack of building at Rocky Ford in which we could install a ventilating system.

Work other than the regular projects included the testing of various materials. A large number of oil samples have been tested for various individuals thruout the state.

In addition to our coal-analysis project to be carried on this winter, a preliminary survey is being made regarding a project on "The Efficiency of Stock Tank Heaters."

Respectfully submitted,

CHARLES A. LOGAN,
Assistant Engineer.

REPORT OF THE EDITOR

To the Director:

Seventeen bulletins, 3 press bulletins, 1 reprint and the annual report have been edited and published by the editorial section of the station during the past year. There was a total of 752 pages as compared with 454 last year. There are also 9 more bulletins in the hands of the editor, 5 of which have been started on the way to publication.

With the consolidation of the news and information services on the campus has come the opportunity to get more widely distributed publicity for the experiment station work and workers. The distribution of mats to the weekly as well as the daily papers, for illustrating stories, was tried out this fall with very good success.

The experiment station exhibit at the Stock Show was again in charge of the editor. The rush with which the exhibit had to be prepared prevented as careful planning as desired but results seemed to be very satisfactory.

Following are the publications issued during the past year:

No. 324—The effect of green manures and crop residues on soil reaction. Walter G. Sackett, Alvin Kezer, Ida W. Ferguson, Justus C. Ward. 3,000 copies. 31 pages.

No. 325—Effects of nitrates on composition of the potato. Wm. P. Headden. 1,500 copies. 96 pages.

No. 326—Impermeable seed of alfalfa. Anna M. Lute. 2,000 copies. 36 pages.

No. 327—A Study of ranch organization in eastern Colorado. R. T. Burdick, Martin Reinholt, G. S. Klemmedson. 2,000 copies. 61 pages.

No. 328—Hotbeds and coldframes. Richard V. Lott. 4,000 copies. 24 pages.

No. 329—Colorado wheat varieties. Alvin Kezer, D. W. Robertson, F. A. Coffman, Dwight Koonce, G. W. Deming. 3,000 copies. 55 pages.

No. 330—Colorado pavement and subgrade studies. O. V. Adams, J. G. Rose. 2,500 copies. 69 pages.

No. 331—Some edible and poisonous mushrooms of Colorado. B. O. Longyear. 3,500 copies. 48 pages.

No. 332—Revegetation of waste range land. Herbert C. Hanson. 4,000 copies. 9 pages.

No. 333—Seed treatments for stinking smut of wheat. E. A. Lungren, L. W. Durrell. 3,000 copies. 12 pages.

No. 334—Smuts of Colorado grains. L. W. Durrell. 5,000 copies. 24 pages.

No. 336—Improved Venturi flume. R. L. Parshall. 3,500 copies. 84 pages.

No. 337—The potato flea beetle. John L. Hoerner and C. P. Gillette. 2,500 copies. 20 pages.

No. 339—Vascular structure and plugging of alfalfa roots. E. L. LeClerg, L. W. Durrell. 1,500 copies. 20 pages.

No. 342—Cattle ranch organization in mountains of Colorado. R. T. Burdick, Martin Reinholt, G. S. Klemmedson. 3,000 copies. 63 pages.

No. 343—Effect of acid wash on the keeping qualities of apples. Ferris M. Green. 1,500 copies. 18 pages.

Press Bulletin 64—Feedlot fattening rations for lambs. E. J. Maynard. 2,000 copies. 7 pages.

Press Bulletin 65—Feedlot rations for fattening calves. E. J. Maynard. 2,000 copies. 7 pages.

Press Bulletin 66—Root rot of alfalfa. L. W. Durrell. 3,500 copies. 4 pages.

Fortieth Annual Report. 1,500 copies. 53 pages.

Reprint of Bulletin 293. Bacillary white diarrhoea of chicks. I. E. Newsom. 4,000 copies. 12 pages.

Respectfully submitted,

I. G. KINGHORN,
Editor.