

THE COLORADO STATE COLLEGE

FORTY-EIGHTTH  
ANNUAL REPORT

— OF —

The  
Colorado Agricultural  
Experiment Station



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FOR THE FISCAL YEAR 1934-1935

# The Colorado State College

FORT COLLINS, COLORADO

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FINANCIAL REPORT OF THE EXPERIMENT STATION

For the Year Ending June 30, 1935

	Hatch fund	Adams fund	Purnell fund	State mill levy fund	Special fund	Total funds
<b>DR.</b>						
Balance, July 1, 1934.....				\$8,048.16	\$16,000.00	\$24,048.78
From the Treasurer of the United States as per appropriations for the fiscal year ending June 30, 1935, under acts of Congress approved March 2, 1887 (Hatch fund), March 16, 1906, (Adams fund), and February 24, 1925 (Purnell fund) .....	\$15,000.00	\$15,000.00	\$60,000.00			90,000.00
Other sources than the United States .....				82,933.26	33,045.48	115,978.74
	\$15,000.00	\$15,000.00	\$60,000.00	\$90,981.42	\$49,046.10	\$230,027.52
<b>CR.</b>						
To Salaries .....	14,944.00	15,000.00	45,853.06	3,868.94	30,800.83	110,466.83
Labor .....			6,562.85	22,054.99	519.10	29,136.94
Stationery and office supplies .....			155.26	859.76	88.37	1,103.39
Scientific supplies, consumable .....			657.08	962.67	818.78	2,439.13
Feeding stuffs .....			408.71	6,874.02	60.00	7,342.73
Sundry supplies .....			286.98	2,344.32	1,290.53	3,921.83
Fertilizers .....			17.50	33.50		51.00
Communication service .....			93.49	1,271.36	19.76	1,384.61
Travel expense .....	56.00		1,828.29	4,562.88	281.49	6,728.66
Transportation of things .....			73.24	1,380.54	73.07	1,535.85
Publications .....			821.21	2,443.21	71.42	3,335.84
Heat, light, water, power .....			376.59	4,892.03	361.86	5,630.48
Furniture, furnishings, and fixtures .....			40.75	555.24	52.27	648.26
Library .....			41.31	213.54	13.75	268.60
Scientific equipment .....			1,441.35	1,909.75	35.19	3,386.29
Livestock .....			102.00	1,178.40		1,280.40
Tools, machinery, and appliances .....			752.49	6,480.48	296.22	7,529.19
Buildings and land .....			381.96	3,102.24	1,610.53	5,094.73
Contingent expenses .....			105.28	769.10	188.57	1,062.95
	\$15,000.00	\$15,000.00	\$60,000.00	\$65,765.97	\$36,581.74	\$192,347.71
Balance on hand June 30, 1935.....				25,215.45	12,464.36	37,679.81
<b>Grand total .....</b>	<b>\$15,000.00</b>	<b>\$15,000.00</b>	<b>\$60,000.00</b>	<b>\$90,981.42</b>	<b>\$49,046.10</b>	<b>\$230,027.52</b>

LETTER OF TRANSMITTAL

To His Excellency, Edwin C. Johnson, Governor of Colorado :

In accordance with the law of Congress establishing Agricultural Experiment Stations, I have the honor to transmit the Forty-eighth Annual Report of the Colorado Experiment Station for the federal and state fiscal years July 1, 1934 to and including June 30, 1935.

E. P. SANDSTEN, Director.

Fort Collins, Colorado  
July 1, 1935

## ANNUAL REPORT OF THE DIRECTOR OF THE EXPERIMENT STATION

To the President and State Board of Agriculture:

During the past year the work of the Experiment Station has, on the whole, been satisfactory, as evidenced by the reports of the various section heads. There has been a growing realization among the workers that our agricultural problems are very complex, requiring the efforts of several departments to arrive at a correct solution. Several of the sections now have cooperative projects, and the problem involved can be approached from many sides. As a rule, research workers are individualists and prefer to work independently, and while this mental characteristic is excellent so long as the problem involves only one field of scientific work, yet when several fields are concerned it is necessary that there should be cooperation among the workers.

In the past year the call for help from farmers and stockmen has been greater than usual, especially in connection with water shortage, both for domestic and irrigation purposes. The Chemistry Section has analyzed a large number of water samples for domestic and livestock use, and Irrigation Investigations has spent much time in the field, aiding in the location of suitable ground waters for pumping. While this assistance has not been strictly investigational, we have felt that in an agricultural crisis like the present we should render every possible help to the hard-stricken farmer.

The outbreak of peach mosaic in the Palisade section added another burden to the station. There is no known remedy for this serious disease, and the destruction of the infested trees is the only known method of control. Professor E. W. Bodine of the Botany Department is supervising the work. He and his assistants are marking the diseased trees and seeing to it that they are destroyed. It will be necessary for Mr. Bodine to spend the whole summer at Palisade. Considerable success has been attained in the control of the potato psyllid, and further work on this trouble, which is very serious, is planned for the coming year.

### SUBSTATIONS

AVON: The work at this station is carried along the same lines as formerly. The livestock part of the farm program has received considerable attention in the way of improvements. With the purchase of pure-bred Herefords and with heavy culling of the old herd, we now have one of the best farm herds in the state. We had over a 90 percent calf crop last year. We did not dispose of the calves last fall because of low prices, and also because we had suffi-

cient feed to carry them over the winter. They were sold this spring at three times the price offered in the fall, thus amply repaying us for the winter keeping. Several acres of land have been broken and added to the cultivated area. Practically all of this can be irrigated from the water supply on the land purchased 2 years ago.

We have been endeavoring to straighten out the water rights of the land we now own and control. We still have to make additional filings and do a small amount of construction work. In this connection, we are asking for an increase in the water adjudicated, since land in the valley requires larger volume than land with a more impervious subsoil.

The purchase of five Ayrshire heifers for the farm will be of great value to the farmers in the mountain section, and already requests for young animals have come in. As stated in previous reports, we are continuing to operate the station along two lines: As a substation for experimental work with horticultural crops, particularly those grown in high altitudes; and as a demonstration in mountain farming. We feel we are succeeding well in this work, and that the station, under the direction of Ralph Manuel, has been a credit to the institution.

**ROCKY FORD:** This substation continued to improve, although this year was one of the most trying in the valley. Water shortage, coupled with extremely high temperatures and winds, made farming operations both difficult and expensive. The superintendent, Herman Fauber, has succeeded in practically eliminating the noxious weeds on the farm. He has done considerable grading to permit a more efficient irrigation, and is gradually building up the fertility of the soil, previously in a very low state. It is difficult to carry on a program of demonstration, as well as a program of experimentation, without provision for fertilizers. Commercial fertilizer should be used only in connection with green-manuring crops or by the addition of animal fertilizer. Since both these types involve heavy expense and the keeping of livestock, this is not advisable with the limited size of the farm. We are doing the best we can, however, under the circumstances, and the present superintendent has made an excellent showing during the short time he has been in charge. The planting of small fruits adapted to the valley, as well as cherries, has been completed this year. The experimental work, particularly with onions and pod peas, has progressed to the point where valuable information is now available to the farmers of the valley. Due to the size of the farm and condition of the land as we found it, it has not been possible to make the work self-sustaining, although the income was much better than we had reason to expect.

**CHEYENNE WELLS:** There is no change in the status of this substation. Tentative arrangements, however, have been made by the Soil Erosion Division to take the station over, using it as headquarters and nursery for the Smoky Hills erosion project. We hope this arrangement can be consummated sometime early this coming summer.

**STATION FARM:** This report covers the second year's operations under the present management, and it gives considerable satisfaction to report that this year the farm is practically self-sustaining; this in spite of the fact that we have spent considerable money for new machinery and other equipment, and have made some substantial improvements in the irrigation system by putting in cement head gates, checks, and new pipe lines. In addition, considerable grading and reseeding to pasture have been done.

The work of weed eradication, which has been a serious problem on the farm, has progressed much faster than we had anticipated, and we hope by the end of the present season noxious weeds will not interfere with the farm program or with production. It will take a much longer time before the noxious weeds are eradicated completely, if this can ever be accomplished. There has been a decided change in the personnel which was found necessary; however, the present personnel is satisfactory and the work is carried on with minimum friction and delay. The increase in production has been very noticeable, and this has been a factor in making the farm a self-sustaining unit. The horse population has been reduced and the older animals disposed of, and at present there is no draft horse on the farm over 8 years of age. This showing of the farm operations is due principally to the fine services of the farm superintendent, William P. Kintzley, who should receive due credit for his faithfulness and efficiency.

#### AGRONOMY

**CRITICAL PERIODS IN USE OF IRRIGATION WATER.**—The basic purpose of this project was to solve some of the problems of the best time to use irrigation water. The project is reaching the objective and in addition is giving considerable fundamental information on the better use of irrigation water. Seasons such as 1934, when water was short, indicated a special value of the better use of water. The work has shown that the best time to apply irrigation water to wheat, if only one irrigation is given, is between jointing and heading. Our work has brought out the development of root systems and the differences in root system developments when irrigation water is applied at different times. Cold water was found not to retard growth of wheat or other small grains. The setting back of wheat after

early irrigation was proved to be the effect of washing out of nitrates from the surface supply and not the effect of applying cold water.

**CONTROL OF EXCESSIVE SOIL NITRATES.**—Technical Bulletin 6, published in 1934, cleared many of the problems in natural nitrate formation. The work showed that permeable soils are not damaged by nitrates produced in place. Often impermeable or seepy soils were injured, but when injury did occur it was the result of an accumulation of salts. Nitrates are only one of the group of salts. Work during the year with sugar beets as a test crop has shown that nitrates may often be used in heavier dressings than was formerly considered possible without doing harm to the crop. It was also shown that in some instances the addition of phosphates gave no returns until rather high quantities of nitrates were used, after which phosphates commenced to improve both yield and quality. Nitrates could be added heavily enough to damage, but the amount necessary to damage was much higher than was formerly believed.

**STUDIES IN CONTROL OF BACTERIAL WILT AND WINTER KILLING IN ALFALFA.**—Bacterial wilt is now wide-spread over all our Eastern Slope alfalfa producing districts. Where wilt is present, alfalfa stands are short-lived. Usually such stands will not live over 3 years. In the last 5 years Hardistan, a strain of Turkestan alfalfa, has maintained a stand 2 years longer in field tests than Baltic, Grimm, or Common alfalfa. However, Hardistan yielded about one-fifth less for the first 3 years than the superior Baltic and Grimm strains. The alfalfa grower has to keep this in mind in choosing the most desirable strain of existing varieties of which there is a seed supply. Up to the present time, fertility treatments have not influenced the length of life of alfalfa where wilt was present. The most hopeful line of attack is hybridization. Genetic studies are under way. These take considerable time. Selfed lines must be produced and tested before we can hope for much progress through hybridization. A number of selfings are already started.

**GENETIC STUDIES IN LINKAGE RELATIONSHIPS.**—This project is a technical search for fundamental facts. There are seven haploid chromosomes in our domestic barley. Certain genes are carried by each chromosome. Genes occurring in the same chromosome are said to be linked. Dr. D. W. Robertson's work has now shown the full theoretical number of linkage groups, namely, seven. A number of technical papers have been published. One has recently been accepted by the *Journal of Agricultural Research*. At present the Colorado station leads in the study of locations of genes in barley. A profitable side line of the work is the production of a number of new barley varieties that are quite promising at the present time.

**SOIL PLAQUE METHOD OF DETERMINING MINERAL DEFICIENCIES IN**



**SOILS.**—A bulletin on the electro-dialysis method has been published during the year. The study shows that the method is not well adapted for use on alkaline and calcareous soils and not as reliable on such soils as the modified Das method which we have put forth. Improvements have been made in the Das method which make it more accurate. Studies are being made on water soluble methods which offer considerable promise. Robert Gardner is studying the possibilities of analyzing plant petioles or stems to get an indication of soil fertility needs. While still in the experimental stage, this method is giving considerable promise.

**HIGH ALTITUDE CROPS.**—Most of the agronomic high-altitude crop work is carried at Fort Lewis. A bulletin on field peas has been published during the year. Recent publications on wheat, barley, and oats have contained high-altitude sections showing the Fort Lewis work. At present the high-altitude crop work is limited to grains and forages.

**PLAINS CROPS AND MANAGEMENT.**—Experimental work was started at the Akron field station in 1907. In all that time the only complete crop failure was in 1934. In all other years, despite prolonged drought, some crops have been produced. The best barley and the best oats for the dry land have been produced on the Akron station. Very promising new varieties are being tested. Greeley, a grain sorghum of hybrid origin, is promising. Greeley can now be added to the list of well-adapted sorghums which includes Coes sorgo and a Colorado strain of Early Sumac.

**IMPROVED SEED.**—Hybrid corns are being tested in comparison with adapted varieties. All hybridization work is expensive in time, as it is necessary to get selfed lines and to check station results by farm plantings, since corn has a limited regional adaptability under our highly variable altitude and climatic conditions. In short seasons native corns and adapted importations show superiority. Colorado No. 13 has a wider adaptation than almost any other strain. With corn, the development of locally adapted strains is more important than with any other common farm crop. We are introducing a new oat hybrid which appears to be unusually smut resistant. If the preliminary tests hold for a longer period, this oat will replace Markton as a smut resistant oat. Markton has heretofore been the standard.

#### ANIMAL INVESTIGATIONS

**RANGE MANAGEMENT STUDIES WITH STEERS UPON NATIVE GRASS IN ENCLOSED FOOTHILL PASTURE.**—This is a long-time experiment based upon grazing by different systems, using the same number of cattle relative to acreage throughout the entire time since the begin-

ning of the experiment as a comparison of continued grazing, deferred grazing, and deferred and rotated grazing.

**WINTERING RANGE CALVES.**—North Park hay is used as the roughage for this work. Comparisons the past season involved the addition of three different supplements: Cottonseed cake; beet pulp pellets composed of dried beet pulp and molasses; and beet pulp pellets composed of dried beet pulp, molasses, and cottonseed cake.

Cottonseed cake showed decidedly the best replacement value pound for pound, one ton replacing 7,455 pounds of North Park hay.

The two kinds of beet pulp pellets were very close together in their replacement value, number 1 pellets replacing 4,512 pounds of North Park hay, and number 2 pellets replacing 4,400 pounds.

Cottonseed cake was considerably higher in price, so that the replacement values per dollar cost are much closer together than the replacement values per ton.

**MINERAL SUPPLEMENTS FOR FATTENING CATTLE AND FOR FATTENING LAMBS.**—Mineral supplements were used in connection with beet by-product rations, and these rations used as check rations contained different roughages: Alfalfa, oat straw, and cane fodder.

The chief objects of this investigation were to find the value of substitutes for alfalfa hay because of the growing scarcity of alfalfa in the beet-growing sections, and to find whether there may be benefit in the addition of lime to beet by-product rations based upon these roughages.

Both straw and cane fodder were found to be satisfactory roughages when lime was fed with them, but the addition of lime to a standard beet by-product ration, with alfalfa hay as the roughage, did not aid the fattening process.

Heavier amounts of cottonseed cake may be fed in connection with oat straw rations than with alfalfa. The same is true also of rations with cane fodder as the roughage. Two pounds or one and one-half pounds of cotton cake gave better results than one pound per day.

In studying mineral supplements for fattening lambs, the results did not show the addition of minerals to a ration of grain and alfalfa hay to be profitable. When minerals were added to a ration of grain, cottonseed cake, and cane fodder, feed costs were lower.

An attempt to find the most beneficial ratio of calcium to phosphorus in a mineral mixture, fed in a ration of grain, cottonseed cake, and cane fodder, resulted in very little difference in the relative gains produced.

For lambs, alfalfa hay proved to be a much more efficient roughage than cane fodder, whereas cane fodder showed a slightly greater feed value when fed to steers with cotton cake supplementing it. For lambs, the cane fodder supplemented by cotton cake was much better than the ration without the cake, but nevertheless the ration was lower in value than the alfalfa hay ration.

Grinding of fine-to-medium stalked cane did not prove profitable.

OFFICIAL TESTING WORK.—Official testing of dairy cows again brought out a number of high records. The Roemer herd at Fort Collins has the highest 5-year herd average of any breed in the United States, with 539 pounds of fat.

### BOTANY

TRUCK CROP DISEASES.—The mosaic of peaches is being studied and an eradication campaign carried on. Twenty thousand trees have been taken out in an attempt to stop the spread of the disease. Experiments on budding and grafting have demonstrated the virus nature of the disease and that the disease can be spread in this manner from tree to tree. Similar tests are being made on other stone fruits.

Press Bulletin 85, on the "Wilt of Peppers," has been published, also a paper on the "Blight of Canada Thistle" in phytopathology.

WEED CONTROL.—Chemical treatments and cultivation experiments have been continued on several of our noxious weeds. A bibliography of some 3,000 references on weeds has been compiled.

Analysis has been made of the weed legislation in the various states.

Bulletin 316, "Poisonous Plants," is being rewritten, as the old edition is exhausted.

RANGE IMPROVEMENT. — Further studies on deferred rotation grazing continue to show that this method is the most desirable in maintaining forage and producing more forage over a longer period.

Studies are being continued in North Park on the improvement of forage in native hay meadows. Reseeding has not yet been found successful in these meadows.

Range reseeding studies have been carried on in several counties of the state, and the grass nursery of foreign grasses is being enlarged and improved.

Press Bulletin 84, "Crested Wheatgrass for Dryland Pastures," and an article "Deferred and Rotation Grazing" in the "Producer" have been published.

A large and accurate vegetation map of Colorado has been made.

## SEED LABORATORY

## SAMPLES TESTED:

Farmers and dealers .....	1,545
Seed registration service .....	213
Longevity investigations .....	260
Range ecology .....	12
Sugar beet investigations .....	8
 Total samples received .....	 2,047

## TESTS MADE:

Purity .....	1,607
Germination .....	2,547
Identification .....	7
Examination .....	11
 Total tests made .....	 3,750

The greatest need in the interest of good seeds in Colorado is funds for enforcement of the pure seed law. Since no funds for that purpose have been available, no general inspection has been carried on during the biennium just closing. Recently 9 samples were collected in Fort Collins, only 2 of which complied entirely with the labelling provisions of the law. One of these was a lot of seed held over from last year.

Three lots flagrantly mislabelled have been turned over to the Division of Seed Investigations, United States Department of Agriculture, for prosecution under the interstate act.

In general, only the best seeds on the market reach the seed laboratory for test. The following facts, therefore, would indicate that there is a large amount of poor seed on the market at the present time: The average germination for all millets received this year is less than 70 percent, varying from 0 percent to 90 percent; the average of all canes and sorghums is 65 percent, varying from 0 percent to 98 percent.

Comparatively few samples have been received from dealers. The reliable dealer is seriously handicapped, since an inaccurate label resulting from lack of law enforcement makes the seed of an unscrupulous competitor appear to be as good as his truthfully labelled seed.

Free tests offered to farmers during the month of November brought in 609 samples and requests to have the free work continued.

## CHEMISTRY

During the fiscal year ending July 1, 1935, the Chemistry Section has devoted most of its time to the three projects cooperative with other sections on the campus. However, as in former years, some chemical service was also rendered to other departments as well as to individual farmers out over the state.

Progress to date on major projects is as follows:

1. RELATION OF READILY SOLUBLE SOIL MINERALS TO COMPOSITION AND QUALITY OF POTATOES (Chemistry, Horticulture, and Home Economics Sections cooperating).—This project was initiated late in 1933, and we were able to gather only about 22 samples of potatoes of uniform source, which were chemically investigated.

In 1934 our operations were extended to 6 varieties of potatoes of common source, planted at 10 locations over the state. This was perhaps the driest year of many years in Colorado, and one of our varieties gave practically no yield at 3 locations due to drought, leaving about 57 samples of potatoes. All these were chemically investigated.

Soluble mineral constituents were determined in soils of the 10 locations.

In 1935 we have repeated our plantings as in 1934, but we have extended to 12 locations. The prospects are much better for a potato crop this year than in 1934. The soil samples from these locations have been collected, and analyses are in progress.

While potatoes have been grown in Colorado for many years, there has existed a dearth of chemical data on Colorado-grown potatoes relative to the composition of the more suitable varieties, and also relative to the effect of abundant soluble salts (alkali) in the soil and of other factors upon the character of the tubers.

With the completion of the work on our 1935 crop, this need should be at least partly satisfied, and the results should point the way to further more specific and more completely controlled investigations of Colorado potatoes.

2. A STUDY OF THE MINERAL CONTENT OF SOME COLORADO RANGE FORAGES AND RANGE SOILS IN THEIR RELATION TO CERTAIN NUTRITIONAL DEFICIENCY DISEASES OF LIVESTOCK (Chemistry, Pathology-Bacteriology, and Botany Sections cooperating).—This project was begun in the early spring of 1934, when staff members of the cooperating sections observed the ranges of the Douglass Mountain and Blue Mountain areas in western Moffat County.

Reports of losses of stock from these ranges had repeatedly come in to the Veterinary Department over a period of years. With the drought years since 1930, the problem became more acute, and a

study of conditions was undertaken. Several investigations in the United States, as well as in foreign countries, under apparently similar conditions, indicated that the trouble might be a nutritional deficiency disease and more particularly  $P_2O_5$  or CaO deficiency or both.

Accordingly, frequent visits to the area from early spring to late fall 1934 were made. Blood samples of the animals, as well as soil and forage samples, were collected and tested, and the symptoms of the ailing animals were observed. Our findings up to the fall of 1934, yielded a careful recording of the symptoms of diseased animals, together with chemical data relative to the calcium and phosphorus status of soils, vegetation, and the blood of affected and non-affected animals. Further, the Pathology Division imported six badly affected animals in October 1934 from the Blue Mountain area, and these were under observation and treatment for several months.

Tentative conclusions were that, if this were a phosphorus or lime deficiency disease, and there were some affirmative indications, that deficiency must be considered only as secondary because of the depleted condition of the range (starvation).

Timber Vetch (*Astragalus campestris*) had been reported previously to be the cause of heavy stock losses in other states and Canada, with symptoms strikingly similar to those observed here. Accordingly, in the early summer (1935), because timber vetch was quite common in the aspen thickets of this range, it was decided to feed this intensively to some isolated animals. The very symptoms were produced in abundance. The Chemistry and Pathology Sections are now attempting to isolate the toxic principle in order to determine its nature and the dosage necessary for harmful effects.

Further on this project, the Botany Section has collected and submitted to us some 28 samples of weeds growing on this range. These have been tested for Selenium content, with the finding that in no case was there more than a trace, i. e., less than 0.5 part per million. It appears that Selenium content of the forage does not enter into our problem.

3. NUTRITIONAL CHARACTERISTICS OF MOUNTAIN MEADOW HAY PLANTS OF COLORADO (Chemistry and Botany Sections cooperating).—The chemical analytical work on this project is now completed. The work of our section consisted of critical chemical analysis of some 10 individual species of grasses growing in the North Park area, as well as several meadow mixtures. The crops of 1933 and 1934 were observed. The Botany Section collected the samples and the Chemistry Section did the analytical work.

Fodder analyses and ash analyses were made on plants of both crops, while biological assays for vitamins A, B, and G were conducted on the 1933 crop. The chemical work has been completed during this summer (1935).

The vitamin content of these plants, while somewhat lower than that of alfalfa, appears relatively high, considering the type of grasses, viz.,

Vitamin A—25 to 38 units per gram hay.

Vitamin B—2.5 to 3.5 units per gram hay.

Vitamin G—4.0 to 6.0 units per gram hay.

No small degree of the excellence of these mountain meadow hays lies in their energy value (N free extracts) and in their high mineral-ash content.

4. ADDITIONAL WORK. — Besides these projects, the Chemical Section has conducted some major chemical service work for the Animal Investigations Section in the form of fodder and blood analyses. This work is to continue during the forthcoming feeding season.

#### AGRICULTURAL ECONOMICS

TYPES OF FARMING IN COLORADO.—The term "type of farming" refers to the kind and proportion of the productive enterprises found on individual farms. Thus, farms which produce the same kind of crops and under similar methods and conditions may be said to follow the same type of farming. Likewise, the term "type-of-farming area" refers to a section or region on which there is a fairly high degree of uniformity in the systems of farming and in the physical and economic conditions which prevail.

As a result of this study, Colorado has been divided into 17 major type-of-farming areas. This analysis provides background material which may be used in dealing with the agricultural problems of the state; it also may be applied in teaching agriculture and related subjects in public schools, high schools, and colleges; and it should serve a useful purpose in making recommendations to farmers, also in placing a limit on the application of such suggestions, and in formulating land-use policies.

AN ECONOMIC STUDY OF FARM ORGANIZATION AND MANAGEMENT IN THE GREELEY AREA IN NORTHEASTERN COLORADO.—The preliminary report issued for 1933, which included crop production data for that year and for the winter feeding for 1933-34, showed the effect of better returns in lamb and cattle feeding and in the higher potato prices received that year. One interesting feature of the work with lamb feeders was the increasing attention which was being given to this study by the men who have cooperated in the development of this project. The methods used in summarizing and presenting the results are now followed by many operators in studying the problems of their own feedlots. A continuous record of costs and returns on these farms provides valuable source data for further analysis of the problems associated with irrigation farming in this region.

A STUDY OF COSTS AND METHODS OF PRODUCING CATTLE AND SHEEP ON THE RANGE.—The following summary will indicate a few of the points that have been considered in this study. Of all income received by farmers in Jackson County, according to the census in 1930, 73 percent came from livestock sales, 7.3 percent from livestock products, 16.2 percent from crop sales, and 3.4 percent from family living or board. This indicates the predominance of the livestock business in Jackson County. The crop sales were of native hay, which is an essential part of the stock ranch organization. Few ranches produce hay exclusively for sale. Practically all have cattle or sheep as their major enterprises, or in addition, hay, where these sales are a major source of income. The general trend in North Park is to increase the size of the business, rent more land, buy land if possible, and build up a larger unit operated on a more efficient basis.

A STUDY OF TAXATION IN COLORADO.—During the year direct attention was given to the study of tax delinquency in several selected areas within the state. Maps have been prepared showing the results of this analysis in 20 counties. The publication of a preliminary report dealing with delinquency and farm tax sales has received much favorable comment. The department also has cooperated with the Bureau of Public Roads in a study of highway finance. Financial reports have been assembled from some 45 counties, but our tabulation work has not proceeded far enough to permit us to summarize the results of this investigation. Highway finance constitutes an important part of governmental activity in the state, and this study no doubt will contribute many constructive suggestions which will be available for those who are engaged in this special field.

AN ECONOMIC STUDY OF LAND UTILIZATION IN NORTHWESTERN COLORADO.—The following excerpt, taken from our ranch study and applicable to Jackson County, illustrates something of the problem of land utilization in Northwestern Colorado: "There are 1,044,480 acres in the entire county. The 1930 census reports 321,277 acres in farms. The 1932 yearbook of the Colorado State Board of Immigration reports 403,903 acres in national forest and 51,309 acres in state land. The United States Department of Interior reports 170,060 acres of public domain as of June 30, 1931, leaving 97,231 acres unclassified. These lands include state and homestead lands not completely paid for or patented, and lands withdrawn from entry. Only 30.8 percent of the land area of Jackson County was in private hands in 1930. The men who operate the 321,277 acres of land in farms are directly affected by the method of control of the remaining area. Ranch management in the North Park area is influenced by national forest grazing policies, changes in the public domain and unclassified areas, state leasing policies, and finally public domain policies."



A STUDY OF THE MAJOR TYPES OF COOPERATIVE ORGANIZATIONS IN COLORADO.—Owing to unfavorable business conditions as a result of the drought and no grain crop in eastern Colorado, our cooperative elevator study is practically at a standstill. Information has been received to the effect that some of the managers have found it necessary to close their elevators because of a lack of business. In other cases the business has kept going by handling side lines. In many cases this side line business is largely credit, and a part of it has been the result of government relief spending. At the present time we have data available for 4 complete years. Originally it was our purpose to continue this study for 5 consecutive years. However, in the development of the work we have been compelled to take records during 2 years in which the elevator business was extremely light, largely on account of the prolonged drought in this area.

#### CIVIL ENGINEERING

Improvement of driveways on the campus took the full time of the Civil Engineering Section from the middle of June until the first week in October. The construction of concrete curbs and gutters, grading the roadways, and the mixing and placing of 2½-inch oil-gravel surfacing on all approaches to the campus oval constituted this work.

The portion of the driveway running west from the road on the east side of the Administration Building consisted of 35 experimental sections, the mixtures of which differ from each other in the following ways:

1. The percentage of asphaltic road oil to the dry weight of the aggregate.
2. The grading of the aggregate.
3. The amount of moisture in the aggregate at the time of mixing with the oil.

The purpose of this construction is to observe the joint effect of traffic and weathering upon the 35 different mixtures. From the results of these observations and the results of laboratory tests of these same mixtures, it is hoped that some conclusions can be drawn with respect to the following questions:

1. Which formula of those most commonly used is best adapted to oiled roads of this character?
2. What part does the aggregate that passes a 200-mesh sieve play in oiled-gravel mixtures?
3. What is the effect upon oiled-gravel mixtures of moisture contained in the aggregate at time of mixing with the oil?

The oil used in each of the 35 sections is MC2, a medium-curing

cut-back asphalt. To have the laboratory mixtures comparable with the field mixtures, this type of oil is to be used. A supply of SC3 oil, which is a slow-curing petroleum residue, will also be used in identical mixtures. A comparison of the results of tests on mixtures made with the two types of oil will be helpful in drawing general conclusions.

Mechanical analyses of aggregate samples taken at the time of construction have been run, and from these the gradings to be used in the laboratory mixtures have been computed.

During the last month an effort has been made to devise a test that will indicate to what degree water affects different mixtures. So far this attempt has been only partially successful, and a test has been devised that shows different reactions of mixtures made with wet and with dry aggregate. We hope to develop this test to a degree that slight differences in reactions of oiled-gravel mixtures and water may be detected.

In December the moisture content of the road was again determined and found to be the same throughout, although it had been very different when the materials were laid.

Regular inspections of the experimental road have been made during the winter to observe changes that might be occurring. There has been no marked deterioration except in two sections. All the other sections are holding up well under traffic. Several of the sections richest in oil have become black and glossy. These, no doubt, will "roll" as soon as the weather becomes warm.

No report can be made as yet upon the loss of oil from the cylinders exposed to the weather, but observations have been made by studying the present condition of each cylinder in relation to the group and sub-group to which it belongs. These observations, it should be understood, are not conclusive, for they cannot be applied to all mixtures nor to all oils and aggregates. These cylinders were in every instance considered satisfactory for use in an oiled road. All cylinders have been in the test lot from 15 to 18 months. From these observations it appears that:

1. Cylinders that contained certain types of fines were, in general, not satisfactory.
2. Cylinders that contained either silica or unburned cement as fines were usually good.
3. The condition of a cylinder could not be predicted from the type of oil or the quantity of oil used.
4. The condition of a cylinder could not be predicted from the quantity of moisture contained in the original aggregate.

The fines mentioned in no. 1 were the fines occurring in some of the aggregate secured locally. Cylinders made with this aggregate

showed decided deterioration within 15 months in nearly every instance, unless the fines had been replaced with either silica or unburned cement, in which event the cylinders were usually good.

Cylinders made with silica or unburned cement that contained water in the aggregate at the time of mixing with the oil were not noticeably affected, even though the water content had been as much as 4 percent; whereas cylinders containing the objectionable fines, were usually poor if the water content had been more than 1 percent. However, a low moisture content in the latter did not insure a durable mixture.

Tests for oil content and calculation of evaporation losses will be made this summer. It will be interesting to note whether there is a relationship between evaporation and the physical condition of the cylinders.

#### MECHANICAL ENGINEERING

The live project in this section is cooperative with the United States Department of Agriculture, Bureau of Agricultural Engineering, under the immediate supervision of E. M. Mervine, and deals with the development of sugar beet machinery. Notable progress has been made on this project.

Studies of costs of raising sugar beets show a cost of about \$65 per acre, that about 42 percent of this cost is for labor, and that at least two thirds of this labor cost is for strictly hand labor.

The mechanical harvester is giving definite evidence of being practical; its adoption will permit 2 men to replace a crew of 14, thus smoothing out one of the two peak labor loads.

Studies of beet-lifting devices show the possibility of using considerably less power than is now used in the same areas.

There is some evidence that mechanical thinning might be practical, and its adoption would take care of the second of the two peak labor loads.

The development of the hill planter and its adoption may represent a saving of more than one-half the seed bill, which in the past has been \$3 per acre, and which was \$4 per acre in 1935.

Experimental study and development of other beet tools, such as crust breakers, subsoilers, and fertilizer placement drill, have demonstrated the possibility of their bringing significantly increased yields.

#### ENTOMOLOGY

PLANT LICE INVESTIGATIONS.—The work of this project is toward the preparation of papers for the use of the general entomologist,

county agents, and other field workers. Keys will deal largely with the species on a single host or a group of hosts, using only the structural characters that can be readily seen, and depending largely upon color, size, effect of the feeding upon host appearance, and such other characters and symptoms as can be observed in the field.

Tentative keys have been prepared for the species found upon box elder, ash, prunus, crataegus, pyrus, Ribes, rubus, and elm, and are in the hands of field workers for use and criticism. Life habits and host relationships of many species are being studied.

NON-POISONOUS INSECTICIDES INVESTIGATIONS.—This work to date has been limited largely to tests of dusts for the control of cabbage and cauliflower insects. Pyrethrum- and rotenone-bearing materials are more effective on cabbage worms as dust than as sprays. Dusts of these materials that are effective against cabbage worms do not give satisfactory control of plant lice. The imported cabbage worm is controlled with pyrethrin- and rotenone-bearing dusts of lower strengths than will control the cabbage looper and diamond-back moth. Calcium arsenate dusts gave very poor control of the imported cabbage worm. Paris green dust gave a satisfactory control. Derris and Cube dusts were equally effective when used at the same rotenone content, although the Cube appeared somewhat more erratic when used during cool weather in the fall.

Rotenone and pyrethrins are known to break down more rapidly in direct sunlight; however, there were no significant differences in the results from morning and evening applications. Sulfur and tobacco dusts have been reported to activate pyrethrins, but neither showed this effect in tests made. All tests were made on plots upon which the worm population was counted before and after treatment. Data thus secured can be analyzed statistically by "Student's" method of paired comparison, thus enabling chance errors to be eliminated and small differences, due to treatments, detected. This appears to be the first use of this method of analysis in this type of tests.

TOMATO PSYLLID PROJECT.—There have been two phases to this project: (1) as it relates to the potato and the psyllid yellows of potatoes; (2) as it relates to the tomato.

The symptomatology, as expressed in more than 200 infected potato plants, has been carefully studied. Portions of the psyllid yellows infected plants were preserved and are being studied. Histological comparisons are being made with the diseases known as leaf roll, Western yellow blight, and Phizaetonia. Anatomical studies of the psyllid were made especially with the view of studying the salivary glands and other glands that might be responsible for secre-

tions bringing about the psyllid poisoning of plants. Host plant studies were made with special reference to the native hosts. The areas where native hosts exist were carefully mapped and their existence correlated with the outbreaks of psyllids. The plants belonging to the *Physalis* and *Quinquala* groups seem to be the most important wild hosts.

In the control work attention was given to combination sprays to control the psyllid and also the potato flea beetle, and where necessary, the Colorado potato beetle. Lime-sulfur and zinc arsenite combination is the most promising.

Lime-sulfur was used quite generally in all the more important early potato sections. In Mesa County the early potatoes were almost 100 percent sprayed. A very high percentage was treated in Fort Morgan and Greeley sections, with outstanding results. Spraying was not so general in the late potato growing areas, as the infestation did not prove to be serious in all cases.

A new development was made in the control of the psyllid on tomatoes that promises to be as important as the discovery of control by the use of lime-sulfur. This is control through the use of dusting and wettable sulfurs. Lime-sulfur was first used for psyllid control on tomatoes but has often caused more or less injury to the plants. The sulfurs seem to promise equal control and have shown no injury to the plants. The sulfurs, in common with lime-sulfur, have a repellent effect upon adult psyllids. Their lethal effect upon the nymphs is very marked.

Sulfur and lime-sulfur were used in 8 commercial tomato plantings in the Fort Collins area. The effect upon the yield in all cases was very marked. In one case the increased yield due to treatment was 24,171 pounds, and in the other 14,726 pounds per acre, with a very definite improvement in quality. The sulfurs were as effective as the lime-sulfur without visible injury to the plants.

GENERAL INSECT INVESTIGATIONS.—Important Insects of the Year: The alfalfa weevil caused considerable loss to the first crop of alfalfa in Mesa County and in a few fields of Delta and Montrose Counties. No new counties were found infested. The asparagus beetle was somewhat more numerous in Eastern Colorado than usual. The beet webworm was only moderately abundant. More than the usual number of inquiries were received in regard to the carpet beetle. Drought conditions favored the clover mite and the common red spider. They were especially bad on raspberries and peaches.

The corn ear worm was probably more numerous than ever before recorded. Most of the early sweet corn in the eastern half of the state was unfit for the market. Many tomatoes were seriously

damaged. In some fields of the Arkansas Valley as much as 20 percent of the fruit was worm eaten.

The mild winter of 1933-34 favored the European elm scale, with the result that there is a serious infestation in most cities of the state. The forest tent caterpillar was not so serious in Northern Colorado as a year ago, but some spraying was necessary. The fruit tree leaf roller has been increasing in numbers during the last two seasons, especially in the Denver and Littleton sections. The box elder leaf roller seriously defoliated many trees in Greeley and Denver.

The gladiolus thrips was first found in Colorado in 1933. During the past season most commercial and amateur plantings were seriously damaged. The grape leaf hopper was especially numerous on grapes and woodbine.

The Mormon cricket is again on the increase in Moffat County. Grasshopper control work was carried on in 40 counties of the state. The long-winged locust occurred in large numbers in Lincoln County. The long, dry, and warm season favored the codling moth. One and two more cover sprays than usual were required in most sections. The peach borer has been more numerous than usual for two seasons on peaches and cherries.

The potato flea beetle caused noticeable tuber injury in several sections where it has not been considered a problem. Say's stink bug was numerous in many grain fields and did some damage to garden crops. In one garden near Denver several acres of cabbage and beets were almost a complete loss on account of their feeding. The squash bug and the bacterial wilt spread by it make squash growing very difficult. The strawberry root aphid was quite injurious in several plantings. The pea aphid seriously checked the early alfalfa growth in a number of localities. It also damaged the pea crop in Northern Colorado. The grain aphid was quite injurious in eastern counties. The appearance of the peach mosaic disease in Mesa County presents an important problem as to the insect vector.

**GRASSHOPPER CONTROL.**—This was carried under the general insect pest project. In cooperation with the Departments of Animal Husbandry and Botany, the three college pastures in the foothills west of Fort Collins were poisoned to determine if it is practical to poison grasshoppers on native pasture land. The infestation was so heavy that it did not seem advisable to leave one of the pastures unpoisoned as a check, but one received only a single application, while the others received two of the poison bran. Each pasture is normally considered to have the same carrying capacity, and each had the same

“load.” The cattle on the pasture receiving only one application of poison bran gained 45 and a fraction pounds per head less than those on the pastures receiving two applications.

Bran baits prepared with oil, in the hope they would retain their attractiveness longer than the standard wet baits, failed to give as good initial kill as the standard, but the final kill appeared to be quite as good. The oil baits, on account of their “flaky” nature, do not spread as well by hand as the wet baits. They are almost ideal for spreading from an airplane. Airplane tests were made in cooperation with Major V. D. Stone of the Colorado National Guard. The airplane has possibilities for this work in areas of this type.

### HOME ECONOMICS

From the reports of Dr. Mark A. Barmore, associate in research, there are quoted the brief reviews of the work completed on the two projects approved for the Home Economics Section of the station for the current year; viz., the making of flour mixtures and the culinary quality of potatoes.

BAKING OF FLOUR MIXTURES AT HIGH ALTITUDES.—“A bulletin, bearing the title ‘The Influence of Physical and Chemical Factors on Egg White Foam’, or Technical Bulletin 9, has now been published, reporting the results of the investigations on that phase of the project.

“The second phase, the study of the baking of angel food cake, has now been definitely completed. A report including and summarizing all the worth-while data has also been submitted. Two bulletins have been prepared giving the findings of this phase: One a brief practical bulletin, now in press, bearing the title ‘The Baking of Angel Food Cake at Any Altitude’; the other a more detailed compilation of the findings, now ready for the press, bearing the title ‘The Influence of Various Factors, Including Altitude, on the Production of Angel Food Cake’. A summary of this study appeared in the 1934 annual report.”

CULINARY QUALITY OF POTATOES.—“This project, undertaken this fiscal year and carried out in cooperation with the Chemistry and Horticulture Sections, is an effort to determine the factors which contribute to culinary quality.

“These first results from the study of the 1934 crop have, as a whole, been very unsatisfactory. A thorough literature review revealed only two tests which proved to be of any value in estimating culinary quality. The first was the amount of sloughing which was found by other laboratories and by this one to be a fair index of mealiness. The degree of ‘doneness’ as determined by means of a

penetrometer seems to be of little value. In the first place, tubers vary tremendously from one to another and from point to point within medullary or cortical areas. In the second place the 'doneness,' once determined, seems to be of minor value. The degree of 'doneness' was found to be of no value in evaluating mealiness by sloughing.

"Several tests of our own have been devised and tested, but none seem to give entirely satisfactory results. Some tests tried were the penetration of mashed tubers; the strength, under compression, of cylinders of cooked potato; and the behavior of mashed tubers on stirring. Some of these tests may, on further development, be of some value.

"By means of a score card set up by us, and the sloughing test for mealiness, it has been possible to show that certain locations produce better potatoes than others, the same variety being mealy when grown at one place and soggy when grown at another. Just why this is true is not known at present but should come to light when more of the factors are understood."

#### HORTICULTURE

DEVELOPMENT OF TIPBURN RESISTANT VARIETY OF HEAD LETTUCE.—Last year was a very favorable one for the production of lettuce seed at Fort Collins. Sufficient seed of the selections is available to run a test on them at the Mountain Substation, and sufficient seed is available from the crosses to duplicate the planting for seed increase at Rocky Ford, where it is believed that conditions for seed production are more favorable. These plantings at three stations should materially hasten progress on this project.

RASPBERRY CULTURE FOR COLORADO.—First-year results on hill vs. hedgerow systems of planting will be obtained this year. The variety test and fruiting habit studies should be started again because of the large number of new varieties being introduced, and because the Latham now recommended for Colorado is too dark in color for discriminating markets. Some varieties are now being tested at Rocky Ford and at the Mountain Substation.

SPANISH ONION BREEDING.—Twenty-five inbred lines of Sweet Spanish onions are now practically homozygous. Outcrosses and top crosses are now being made to test the value of these lines as parents in the production of a superior commercial strain. Two selections, No. 6 and Heavy-skin, are being tested at Rocky Ford and Fort Collins. No. 6 so far has proved superior to any other strain in yield and quality. The seed supply for this strain is being increased as rapidly as possible for release to growers. Several crosses between the Sweet



Spanish and American types show promise, especially one between Sweet Spanish and Ohio Yellow Globe. The Grano onion shows considerable promise as an early companion for the Sweet Spanish. It has been sent to several growers and has been especially well received in the Greeley district. A large number of foreign plant introductions and importations from Russia are being studied as breeding material.

**PYRETHRUM INVESTIGATIONS.**—The selections for high pyrethrin content maintained the same relative positions as in 1932, despite temperatures above normal, drought, and a considerably reduced pyrethrin content in all the plantings. The progenies of selected plants were quite uniform in pyrethrin content and maintained practically the same relative positions in pyrethrin content as the parents, indicating that *Chrysanthemum cinerariaefolium* is quite homozygous, and that pyrethrin content is an inherited character. All strains showing a content above average field plantings are being increased as rapidly as possible.

Seventy-five acres of test plantings are being made this spring, in cooperation with farmers scattered over the entire state, to determine the sections best adapted to the production of high-content flowers. These tests are being seeded directly in the field, while all plantings in the past have been transplanted from the hotbeds or greenhouses.

**POD PEA VARIETY AND SELECTION.**—Over 200 crosses were made in 1933, both at Fort Collins and at the Mountain Substation. The  $F_2$  generation will be observed this summer. Tests of new introductions are constantly in progress to determine whether any of them are superior to the standard varieties—Stratagem for the mountain districts and Little Marvel for the early districts.

**GENERAL VEGETABLE CROP INVESTIGATIONS.**—The testing of new introductions has resulted in several which are very promising. Among these might be mentioned the Grano onion, the Stride group of peas, the U. S. No. 1 and Tendergreen beans, and the new U. S. D. A. baby lima bean.

Crosses have been made between the English forcing type of tomato and American types, with the object of producing superior forcing types that are smooth, heavy yielders, and not too large in size. Fruits that run four or five to the pound are preferred. Two generations per year are produced, one in the greenhouse and one in the field. These hybrids are now in the  $F_3$  generation and show promise of producing both a pink and a red forcing variety.

A source of seed test for the Henderson Bush Lima bean at

Rocky Ford indicates that local seed is badly diseased, and that Idaho or California seed will give considerably larger yields.

The department is also cooperating with the Horticultural Field Station of the United States Department of Agriculture at Cheyenne, Wyo., in testing 25 tomato varieties.

**POTATO VARIETY TESTING AND IMPROVEMENT.**—The Katahdin potato has been under test at the Mountain Substation for 3 years and has been tried by growers in various parts of the state for 1 year. It has been recommended to replace Rural and Peoples in the mountain districts. The Chippewa has been tested for 2 years, and limited quantities are being released to growers. The Golden is not recommended because of its yellow flesh. The Warba, introduced by the University of Minnesota, has been tested only 1 year. About 50 seedlings produced at the Mountain Substation remain. Several of these are promising, and the others are good breeding material.

The Dark Red Peachblow has been tuber indexed. This indexed stock will be increased at the Mountain Substation and distributed to seed growers, as present stocks contain considerable disease.

The department is cooperating with the United States Department of Agriculture Potato Station at Greeley in testing about 60 of their promising seedlings.

The department is also cooperating with the Chemistry and Home Economics Sections in a study of the quality of Colorado potatoes.

The study on certain abnormalities of unknown origin will soon be completed and ready for publication.

Crosses between the Russett Burbank and other varieties have been made in an attempt to produce scab-resistant varieties.

**STRAWBERRY CULTURE IN COLORADO.**—About 40 varieties are now under test at Fort Collins, Rocky Ford, and Avon. Variety recommendations for most of the state can be made from these plantings.

**VARIETY TESTS ON APPLES, CHERRIES, ETC.** — New introductions are being studied and compared with standard varieties at the Austin Substation.

**GRAPE GROWING.**—Among the European grapes, Flame Tokay, Thompson Seedless, and Muscat of Alexandria have done well at Austin. Similar plantings at Rocky Ford should bear next year. A variety test of 42 American varieties is under way at Rocky Ford and Fort Collins.

**SOUR CHERRIES IN NORTHEASTERN COLORADO.**—A study of cherry orchards is being made in an attempt to increase the size of fruit by cultural treatments, mainly fertilizers and cover crops. This project is in cooperation with Agronomy.

## IRRIGATION INVESTIGATIONS

DESIGN AND INVENTION OF APPARATUS.—Under this project attention has been given largely to the subject of the grating type of sand trap. During October and November a detailed study of the efficiency of different types of grating vanes was made by W. B. Leaf at the Bellvue hydraulic laboratory, under the direction of R. L. Parshall and in cooperation with the Harza Engineering Company of Chicago. This engineering firm paid Mr. Leaf's salary and furnished material for building apparatus at the laboratory.

As has been previously reported, this type of sand trap possesses a high efficiency in catching and retaining the bed load. These recent observations at Bellvue, as well as limited tests at the silt laboratory in the Imperial Valley in California, show that the grating vanes are capable of trapping not only the bed load but also a fair proportion of the fine material held in suspension.

Because of the extreme drought conditions prevailing in the Colorado River drainage area, the river's supply was insufficient to provide extra water for the operation of the Imperial Valley laboratory, and the work there has been temporarily suspended since June 12, 1934. The studies there included about 50 tests on a battery of 3 vortex tubes, and only 5 tests on the experimental setting of the grating type of trap, before the river supply failed. This work in California was supported by federal funds supplied by the Public Works Administration and the Bureau of Reclamation.

At this time there are no field installations of the grating sand trap. It is expected, however, to have such a device in operation soon in the Cheyenne lateral at Wellington. This channel is a part of the North Poudre Irrigation Company's distributing system.

Favorable reports have been received concerning the successful operation of the vortex-tube sand trap, especially the Baca Ditch installation at Trinidad. It is also expected that a vortex-tube sand trap will be installed near Wellington on the North Poudre Irrigation system in the near future. Because of the depression, the irrigation interests have found it very necessary to curtail expenses, and for this reason no improvements have been made.

A design for a proposed vortex-tube sand trap installation for the All-American Canal has been prepared and reviewed by the Bureau of Reclamation, and possibly vortex tubes will be used partly in the final design of this desilting works. There has also been prepared a suggestion for the use of the grating sand trap in connection with the aqueduct for the Metropolitan Water District of Los Angeles. This device will probably be used at various points along this 240-mile channel, which carries water from the Colorado River to the metropolitan area.

The Parshall measuring flume is becoming generally accepted as a means of successfully meeting the requirements of better and more accurate distribution of irrigation supplies. Information is at hand that all the main diversions from the Big Thompson River have now been provided with this type of measuring device. Many ditch systems are now using the flume in properly distributing the water to the individual user. The North Poudre Irrigation Company is now measuring about 95 percent of its total deliveries through these flumes. This last fall several Parshall measuring flumes were built in North Park. The scarcity of water in this area last season made evident the necessity of better management of the water supply.

Since August 1, 1930 the Bureau of Reclamation has occupied our hydraulic laboratory and during this time has made extensive investigations, principally on models of spillways, penstocks, gate towers, valves, and other hydraulic structures arising from the design of projects of unprecedented magnitude being developed by the bureau. Because of the great expansion in the construction program of the bureau, due to the government's public works activities, more space at the laboratory was necessary, and to meet this need a substantial brick addition to the building has been made, which increased the floor space about 800 square feet.

Last December, at the hydraulic laboratory, there was exhibited the vortex tube and the grating type of sand trap, the adjustable tube orifice meter, the 6-inch Parshall measuring flume, and also model apparatus demonstrating the percolation of water through a sand medium into an irrigation well; all were in actual operation. This exhibit was prepared for the general interest of a group of about 100 farmers visiting the college at that time.

**METEOROLOGY.**—This work has continued without interruption in the taking of observations twice daily and the compiling and recording of these data. The extreme shortage of precipitation during this fiscal year has caused much concern. The rainfall at Fort Collins, Colo., for the calendar year 1934 was 8.86 inches, or 40 percent deficient when based on the 50-year normal of 14.85 inches. This marks the next lowest for this extended period, the minimum rainfall of 7.11 inches having occurred in 1893.

For the period of August 1, 1934 to April 15, 1935, 8½ months, there occurred only 2.34 inches of precipitation, which is the least ever recorded for any similar period during the last half century.

The rainfall for the first 6 months of 1935 is practically normal. The mean monthly temperatures have been in excess of the normal, the accumulation by days amounting to 1,000 degrees for the period of July 1934 to May 15, 1935.

The water supply for both municipal and irrigation demands has been critical. On May 1 it was estimated that the storage in reservoirs for irrigation in the Poudre River Valley was about 20 percent of normal. The high snow in practically all the mountain area, however, is reported to be above the normal for May 15, except for the Arkansas River drainage.

**PUMPING FOR IRRIGATION**—Experiments were made in a 6- by 11-foot tank at the hydraulic laboratory to determine the characteristics of flow into 4-, 8-, and 12-inch well casings having  $\frac{1}{8}$ - and  $\frac{1}{4}$ -inch perforations. Two sands of different character were used in this study. The principal information sought was the relation of well diameter to capacity; however, additional information was obtained as to the conformation of the water table near the well while being pumped. This project has not been completed, largely because of lack of funds, and it is estimated that about a month's laboratory work yet remains to be done.

In the territory considerably removed from the main streams of the Arkansas and the South Platte Rivers and their tributaries, the ground-water table, particularly in the irrigated sections, has continued to recede over wide areas. The depression of the water table has been observed to be as much as 8 feet in places, and is due largely to the shortage of irrigation water supplies during the past 3 or 4 years, as well as to depletion by extensive pumping. Areas adjacent to the main rivers were much less affected. Special reference is given to a limited area about 6 miles east of Keenesburg, where extensive pumping has been in progress for the last 3 years, with practically no replenishment from canal irrigation. This continuous pumping, with insufficient recharge, may seriously affect this community because of the constant lowering of the water table, which has now receded from 4 to 6 feet.

Because of the extreme shortage of river water during 1934, there was an unusual activity in the development of wells for irrigation. No less than 350 such wells were put down, equaling nearly one third of the total number then in use. The same rate of increase has continued into the present year. Many requests for advice have been received, both by mail and through personal calls by farmers. Well and pump testing has been continued in a limited way, part of the expense being borne by the persons requesting such assistance.

**SPECIAL ASSIGNMENTS.**—Assisting in the design of a reinforced concrete tank of 650,000 gallons capacity as an auxiliary water supply for irrigation and fire protection at the Northern Great Plains Dry Land Field Station, Bureau of Plant Industry, United States Department of Agriculture at Mandan, N. Dak.

Study of storage reservoir sites on the La Plata River, near Fort Lewis School, Hesperus, Colo., including test borings on dam sites. This work was done under the supervision of Carl Rohwer.

Study of the irrigation supply for the proposed Subsistence Homestead F. E. R. A. Project, on the May farm, 3 miles west of Littleton, Colo.

Investigation of control of flood flow and irrigation storage on the upper Purgatoire River at Trinidad, Colo.

Conferences relative to the proposed Grand Lake Trans-Mountain Water Diversion Project.

REPORTS.—The following special reports have been prepared:

Report concerning the plans and specifications for the main and auxiliary reservoirs, pipe lines, pump and fire protection equipment at the Northern Great Plains Dry Land Field Station, Mandan, N. Dak.

Report and map concerning irrigation water rights, storage reservoir supply, and distribution system, covering an area of about 800 acres for the proposed subsistence homestead project at Littleton.

Report concerning the matter of storage reservoirs for irrigation on the La Plata River at Hesperus, Colo.

Report concerning flood flow and storage reservoirs on the Purgatoire River at Trinidad, Colo.

Assisting in the preparation of a progress report covering the work done at Bellvue on the grating type of sand trap by W. B. Leaf.

Report on the modified form of the Parshall measuring flume, covering a series of tests made at Bellvue Laboratory in 1932.

Report on a laboratory investigation of the adjustable tube orifice meter.

The following reports were prepared for publication:

“Irrigation Wells in Colorado,” by W. E. Code, Experiment Station Bulletin 415.

Revision of Experiment Station Bulletin 336, “The Improved Venturi Flume,” by R. L. Parshall.

“Irrigation Wells,” by Carl Rohwer, to be issued as a United States Department of Agriculture bulletin.

“Pumping from Wells for Irrigation,” by P. A. Ewing, United States Department of Agriculture, Farmers’ Bulletin 1404, revised by Carl Rohwer and reissued by United States Department of Agriculture.

Three broadcasts on pertinent irrigation subjects have been made over radio station KOA.

## PATHOLOGY AND BACTERIOLOGY

**PHOSPHORUS DEFICIENCY.**—During all last summer monthly trips were made to the area in northwestern Moffat County where the presumed phosphorus deficiency existed in cattle. Bleedings were made in three different herds, and samples of forage and soil were taken. On the return, phosphorus and calcium content of the blood, the soil, and the forage were determined by the Chemistry Section. In October, six of the sick animals were brought to Fort Collins from that area and kept under observation for something like 3 months. Three of them were fed bonemeal and three were not. Weekly bleedings were made and the phosphorus and calcium determined.

The net result of the experiment to date is that, while sick animals in some instances show a low phosphorus content in the blood, control animals differed so slightly that the findings did not seem to be significant. The animals on the bonemeal improved no more rapidly than those without. It would seem, therefore, that we must look for some other explanation for the condition in the cattle. This despite the fact that a phosphorus deficiency seemed to be the only adequate means of accounting for the conditions that existed.

In view of these findings, we have asked the Botany Section of the Experiment Station to make a poison plant survey in the area, both in relation to the number of the various types of plants present and to their consumption by the livestock.

**DEATH LOSSES IN LAMBS.**—We continued our examination of the intestinal filtrates from lambs dead of overeating. A good deal of time was spent on improvement of technic. The filtration done last year was very time-consuming, but a new method has been worked out that will allow us to handle a large number of filtrates next fall.

Also, trials were made with three types of laboratory animals in determining the toxicity; namely, mice, guinea pigs, and rabbits. Of these, the rabbit was found to be much more satisfactory than the other two. Out of 41 filtrates tested, 6 were found to be toxic. These toxic filtrates were mixed with antitoxins made from the four types of *Clostridium welchii*. The antitoxins were received from the Burroughs-Wellcome Laboratories of London, England. It was found that the toxicity in the filtrate was neutralized by antitoxin made from types B and D but not by that made from A and C. The toxicity was destroyed by heating, as was found last year. The filtrate was non-toxic when given by the mouth.

**SHEEP LOSSES.**—Several outbreaks of coccidiosis were studied, but in general the disease did not have as high mortality as in the previous year. Studies made on the longevity of *Eimeria faurei* (coccidium of sheep) indicated that it was rapidly destroyed when

exposed to drying in sunlight, but with moisture, and especially at low temperatures, it survived for many months. This work was done to determine the probability of the coccidium living over in the feedlots from one year to another. While it seems probable that they live over, especially under the feedracks, there is no necessity of explaining new outbreaks on this basis, because nearly all the lambs come in carrying coccidia, anyway. We have not yet discovered what it is that precipitates an outbreak in animals which appear to be normal carriers.

For some time it has seemed to us that intestinal parasites in feeder lambs were increasing in frequency. For that reason, during the past winter Dr. A. H. Groth has systematically studied individual carcasses to determine the presence and relative numbers of the various parasites present. It is expected that these examinations will be continued until we have a fair cross-section of the parasitic infestation of feeder lambs in Colorado

**CONTAGIOUS ABORTION.**—Our work with the range herds in Middle Park is continuing, and the evidence thus far gathered indicates that by bleeding range animals twice a year and shipping the reactors it is possible not only to hold in check but actually to eradicate the disease.

Last fall there was much interest in a campaign to eradicate Bang's disease from the state under a federal emergency program. Now, with the increase in the price of cattle and the relative inadequacy of the indemnity paid for the reactors, the work seems to be lagging. The federal men expect to finish the tuberculosis testing by July 1 and could then give a great deal of attention to the Bang's disease work, but already they are finding our cattlemen rather lukewarm on the question. We have, however, run far more blood samples for contagious abortion than in any previous year.

**ANAPLASMOSIS.**—As stated in the semi-annual report, animals susceptible to anaplasmosis were kept in the same corral with carriers of the disease from August 10 to October 10, during which time biting flies were numerous. There was no evidence of transmission. Susceptibility of the animals was determined later by direct inoculation.

**ICTEROHEMATURIA.**—Since the Texas Experiment Station discovered that a disease simulating icterohematuria could be produced by feeding medicated salt containing from 5 to 9 percent of copper sulfate, it seemed that we should check our information on this disease in the light of the new findings. Accordingly, a questionnaire was sent to all men in the state who had reported outbreaks of icterohematuria. Not in a single instance did we find that medicated salt had been fed, nor that there was the slightest suspicion of the disease having followed the administration of copper sulfate.



A few years ago we did some work at the request of the Biological Survey to determine the effect of the thallium sulfate upon sheep. More recently we have used our anaplasmosis carriers in determining the toxicity of the same substance for cattle. This work has been carried on under the supervision of Dr. Bryce R. McCrory and will soon be ready for tabulation and publication. In general, cattle were poisoned by approximately the same doses as sheep, but the hair did not seem so readily shed as was true of the wool in sheep. The necessity for this work arose because thallium sulfate now is commonly used as a prairie dog poison, and cattle and sheep grazing over these areas have the possibility of being poisoned by the substance.

**PERSONNEL.**—Due to the resignation of Dr. H. E. Kingman, Dr. Floyd Cross was promoted from the position of associate pathologist in the Experiment Station to professor of veterinary medicine in the teaching department. Dr. McCrory has been advanced to Dr. Cross' position, and Dr. McCrory's place filled by the appointment of Dr. C. W. Baber, who for the past 3 years has been a graduate student at Cornell University. All these changes have been made without any serious interruptions of the work.

**DIAGNOSTIC WORK**—Avian, 173; bovine, 405; canine, 14; equine, 23; ovine, 31; feline, 2; suis, 8; miscellaneous, 76; water, 86.

**BLOOD SAMPLES.**—Contagious abortion, 4,818 samples, 552 positive, 11.4 percent positive; white diarrhea, 40 samples, 4 positive, 10.0 percent positive.

**MICROBIOLOGICAL TESTS FOR AVAILABLE PLANT NUTRIENTS.**—The effect of calcium chloride and sodium nitrate upon numbers of microorganisms in the soil of field plots has been studied. Both treatments depressed the total number of bacteria and fungi, the calcium chloride bringing about the greatest decrease. The number of *Azotobacter* cells, however, was decreased to a greater extent by sodium nitrate than by calcium chloride. Small applications of sodium nitrate, which caused an increased abundance of total bacteria and fungi in incubated soils in the laboratory, were sufficiently large to cause a decrease in the number of *Azotobacter* cells present.

**DECOMPOSITION OF ORGANIC MATTER AND NATURE OF MICROBIOLOGICAL ACTIVITIES IN SLICK SPOT SOILS.**—Because of the nature of the particular phases of the problems attacked, work on these two projects has been combined during the last year. Samples of soil from 10 slick spots and the corresponding normal soils were collected in the vicinities of Montrose, Delta, and Grand Junction. Nitrogen transformations in four of these soils, both slick and normal, with and without the addition of 1 percent cellulose, were followed in the laboratory. For comparison a group of five field soils from near Fort

Collins were included. The slick soils had uniformly a slightly lower total nitrogen content than did the corresponding normal soils.

The original nitrate content of the slick soils was somewhat higher than that of the normal soils, due partly at least to less utilization by higher plants on the slick spots. With one exception, the soil nitrogen in slick soils was nitrified more rapidly than that in the normal soil.

As much as 10 percent of the soil nitrogen was changed to nitrate in the course of 30 days. The maximum nitrate accumulation in all soils was reached within 30 days and did not exceed 427 pounds of nitrogen as nitrate per 2,000,000 pounds of soil. Less nitrate appeared in the soils from Fort Collins than in those from the Western Slope. Only small increases of total nitrogen due to fixation by non-symbiotic microorganisms were noted.

The addition of 1 percent of cellulose brought about the complete disappearance of nitrates in all soils within 60 days, with the exception of two slick soils. In one of these the nitrification rate was sufficient not only to supply the demands of the cellulose decomposing microorganisms but also to maintain the original nitrate content of the soil. The addition of cellulose did not bring about an increase in nitrogen fixation.

PUBLICATIONS.—“Third Outbreak of Paratyphoid Dysentery in Lambs,” I. E. Newsom and Floyd Cross, *Journal of A. V. M. A.* Vol. 86, page 534. April 1935.

#### EDITORIAL SERVICE

Since July 1, 1934 the editorial service has prepared and distributed news stories regarding experiment station work and workers as follows:

To 26 daily papers in Colorado, 5 out-of-state, and to the United Press and Associated Press in Denver—48 regular issues and 8 special stories.

To the 167 weekly newspapers in Colorado, to 72 farm magazines and other agricultural papers throughout the United States and Canada, and to 217 libraries, state agricultural college workers, and others interested in agricultural information—59 stories.

Continuing at the same rate during the next 7 weeks of this fiscal year, our totals should be 54 regular stories and 10 specials to the daily papers, and 67 stories to the weeklies and farm magazines.

In addition to those stories, the weekly pink sheet—“What’s Doing on Colorado Farms”—which includes numerous short items regarding Experiment Station work and workers, has also gone to the entire list.

Our budget the past 2 years has prevented us from buying the press clipping service which we formerly used, and consequently we have no general summary of how our stories have been used.

Every non-technical bulletin which has been published by the experiment station during the past year has had one or more press releases regarding it. The two or three extremely technical bulletins which were of no value for general distribution were not publicized, although the gist of them was used whenever it could be made of value to the average farmer.

We usually enter samples of our work at the annual National Editorial Convention contest. At last year's convention at the University of Minnesota, our story regarding the amount of certified potato seed produced in the state in 1933, which we secured from Carl Metzger, was awarded third prize among stories from 28 other state institutions. Only Cornell and Wisconsin Universities submitted stories superior to the one from this institution, according to three nationally known judges.

Professor Binkley's bulletin on "The Home Vegetable Garden" was awarded fourth place or honorable mention in the contest, against a field of popular bulletins from 28 different institutions. Also, our pink sheet was awarded first place in a field of 26 from all over the United States. This award was particularly gratifying to us because we won over such institutions as Cornell University, Ohio University, Wisconsin University, and Texas A. & M. College, which have been winning both of these awards year after year for the past 15 or 20 years.

One interesting thing about last year's contest was the fact that there were 28 stacks of news stories, representing the yearly output from as many institutions. After the judges had worked about a day and a half to judge that phase of the contest, they gave up the task and announced that it was too great for them to complete in one week. We had made a special effort throughout the year to have our production of such quality that we could stand high in that contest and were somewhat disappointed when the judges refused to place the entry. Despite that, however, we tied for fifth place with Texas for sweepstakes award in total entries, there being 16 classes.

We have given personal assistance to several experiment station workers in the preparation and final brushing up of radio talks.

#### PUBLICATIONS

Bul. 328—(Revised) Hotbeds and Coldframes.

Bul. 410—The Tomato Psyllid and the Control of Psyllid Yellows.

Bul. 411—Lime Sulfur for Tomato Psyllid Control

- Bul. 412—Growing Potatoes in Colorado.  
Bul. 413—County Government in Colorado.  
Bul. 414—Codling Moth Studies.  
Bul. 415—Construction of Irrigation Wells in Colorado.  
Bul. 416—Field Peas in Colorado.  
Bul. 417—Rate of Planting Corn.  
Technical Bul. 9—The Influence of Chemical and Physical Factors on Egg-White Foams.  
Technical Bul. 10—Statistical Methods of Analysis Applied to Feedlot Gains.  
Technical Bul. 11—Critical Period for Irrigating Wheat.  
Technical Bul. 12—The Use of Electro dialysis for Estimating Phosphate Availability in Calcareous Soils.  
Technical Bul. 13—Baking Angel Food Cake at Any Altitude.  
Press Bul. 82—Mineral Supplements for Fattening Steers  
Press Bul. 83—Mineral Supplements for Fattening Lambs.  
Press Bul. 84—Crested Wheat Grass for Dryland Pastures.  
Press Bul. 85—Blight of Peppers.  
Press Bul. 86—Strawberry Growing in Colorado.  
Press Bul. 87—Creep Feeding Calves.  
Forty-Seventh Annual Report.  
Feeders' Day Program.