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*Fifty-second  
Annual Report  
1938-39*

# COLORADO EXPERIMENT STATION



*Colorado State College*  
FORT COLLINS

# COLORADO STATE COLLEGE

## COLORADO EXPERIMENT STATION

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James R. Miller. .... Editor

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## Letter of Transmittal

### Fifty-Second Annual Report Colorado Experiment Station

Hon. Ralph L. Carr  
Governor of Colorado  
Denver, Colorado

Sir:

In compliance with the law, I herewith present the Fifty-Second Annual Report of the Colorado Agricultural Experiment Station for the fiscal year of July 1, 1938 to June 30, 1939, inclusive.



*Director*

*Fort Collins, Colo.  
July 1, 1939*

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# Director's Annual Report

Fifty-Second Fiscal Year, 1938-39

## Colorado Experiment Station

*To the President and State Board of Agriculture :*

The past year has been the most difficult one since the present Director took office. Changes in personnel and the transfer of a department from one division to another have made certain adjustments necessary. The Station staff has been strengthened by the addition of two new members and by releasing others to do advanced work in other institutions.

With the impounding of the Station mill levy in January, the problems of paying salaries and expenses of Station workers became a serious matter, and had it not been for Federal funds the Station could not have operated. As it was, several experimental projects supported by State funds were temporarily set aside. Fortunately the mill levy funds were finally released, although valuable time was wasted and the work seriously delayed.

The Station has operated during the past fiscal year well within its budget, and the necessary balance that must be maintained from year to year to meet the low income months has been met. Further, the Station will finish this fiscal year with a balance at least equal to that of the past year. The financial support of the Station from the State has been constantly decreasing for several years and is now 35 percent less than formerly. At the same time the demands on the Station have multiplied. Many serious problems have arisen affecting agriculture in the State, and these have caused losses amounting to millions of dollars.

The serious outbreak of peach mosaic in the Grand Valley and the outbreak of a bacterial disease of potatoes have cost the farmers a loss of more than a million dollars. While a strong research program and control measures have been formulated and placed in operation to control these diseases, the limited State support is a serious handicap. The pressure for Station aid from our farmers is constantly growing, and complaints are frequently made that the Station workers are not getting into the field and becoming acquainted with State problems. This claim is undoubtedly justified from the farmers' viewpoint. No doubt the institution as well as the farmers would be greatly benefited if Station workers could be in the field to a much greater extent than is now possible. The writer well remembers

the time, before the advent of the Extension Service, when Station men were frequently in the field and the staff was well known. This service was greatly appreciated by the farmers, and the Director believes they profited by the information that the Station staff could give them. The problem, however, is not as simple as it looks to the farmers who are asking for Station men. In the first place, the Extension Service was established to carry to the farmers the information obtained by research. Members of the Station staff, in most cases, operate in a dual capacity as teachers and experimenters, and it is difficult to get away from the College campus. Real research requires constant attendance and cannot be carried on by piecemeal work. Further, funds for paying traveling expenses are a serious matter. The question is: Should investigation or research work be curtailed so as to make it possible to pay traveling expenses for these men, were it possible to release them from their duties as teachers?

It is clearly evident that farmers are less interested in investigational work than they should be. It does not appeal to them because research is slow and tedious, and the solution of a given problem may require several years of work. The farmer asks for, and demands, an immediate solution of his problem. The policy of the Station has been to strike a balance in the use of Station funds between fundamental research and demonstrational work. It may be that some of the fundamental research now carried by the Station could be curtailed and more attention given to the immediate problems. From the standpoint of support and popularity of the Station, the Director would feel inclined to make some changes in the budget assignments and devote more of the Station funds to practical research and demonstration. However, this policy should be carefully considered, since fundamental research is the foundation for all future progress of agriculture. Further, the Director must satisfy the Federal Government as to the disposition and use of the funds which it contributes. The Experiment Station is not receiving the financial aid it should from our farmer constituents.

### Substations

The work of the substations has been very popular in the State. While research is carried on along many lines, the substations are also demonstration farms conducted to show the type of farming best adapted to the sections in which the substations are located. The annual field days are largely attended,

and it is very evident that valuable information is obtained by the farmers.

AVON.—The work at the Avon Substation has been along the usual lines, particularly potato breeding under the direction of Mr. Carl Metzger. Several thousand seedlings are annually produced and tested to discover new varieties which may be better than the existing ones. Extensive field tests are carried on in connection with potato seed certification. Each grower of certified seed potatoes in the State has a test plot so that he may keep a check on his seed production. If the test plot does not come up to the required standard, the grower must obtain a new seed supply before he can apply for certification. This arrangement has been of great value to the seed-potato industry. Field tests on mountain vegetables are continued so as to furnish the necessary information to the vegetable growers, particularly in the San Luis Valley where the growing of pod peas, cauliflower, and head lettuce has developed into a large industry. Several thousand carloads of pod peas alone are shipped from the San Luis Valley and mountain sections.

A fine herd of Hereford cattle has been developed. Methods in high-altitude farming are being studied and put into practice. The value of the substation is indicated by the large number of people who visit the farm. At the last Farmers' Day in August, some 1,300 people were present. The substation is not run as a show place but as an actual demonstration of what can be done in high-altitude farming. The crop production is very high; the yields of alfalfa, grains, and potatoes are above the average of high-altitude farms. Due credit should be given to Mr. Ralph Manuel, superintendent.

ROCKY FORD.—Under the direction of Mr. Herman Fauber, the Rocky Ford Substation is doing excellent work. This year lamb-feeding tests have been carried on which have attracted considerable attention. At the Feeders' Day held recently, 85 lamb and cattle feeders were present from the eastern and southern counties. This work is to be continued because of the interest that has developed, not only in the Arkansas Valley but in the adjacent dry-land area. In the report of Animal Investigations, the result of the feeding tests at Rocky Ford showed the superior value of milo over corn in the fattening of lambs. In a conference with Mr. Fauber, Dr. C. H. Kick, Mr. H. B. Osland and Mr. A. M. Binkley, it was decided that this feeding work should be continued on the basis of feeding not only for income but for the improvement of productivity of the land. While the farm is only about 37 acres in extent, preliminary

studies would indicate that even a farm of this dimension can profitably feed from one to two carloads of lambs every year, produce the feed required with the exception of protein supplements, and at the same time devote enough acreage to cash crops like onions and vine crops. If this can be demonstrated, it would mean a great deal to the small farmers of the Valley, not only in maintaining a suitable agriculture but in an increase in the fertility of the soil. The substation is also used as a testing ground for hybrid seed corn for this part of the State. Onion production problems are studied, and new varieties of the Valencia type, originated at the home Station, are on trial.

AUSTIN.—The fruit substation at Austin which, in the past, has been supported by State Horticulturist funds, is continuing the work in orchard management, fertilizers, and new variety tests, besides furnishing service to the fruit growers on the Western Slope. During the winter months, meetings are held in the fruit-growing districts, with Visitors' Day at the substation. The substation serves the need of the fruit industry in western Colorado.

The Cheyenne Wells substation is under lease to the Bureau of Soil Conservation and considerable improvements have been made and buildings repaired by the Federal service. The farm is now in fine condition and the cooperative work may continue for a long period.

Cooperative work is also carried on with the Dry-land Field Station at Akron, particularly along agronomic lines. Extensive field tests of various crops are followed, with particular reference to their adaptability to Plains conditions.

### College Farm

With the constant encroachment on land area by different agencies and departments, crop production and income of the College Farm have necessarily become reduced. This condition will continue with the expansion of the departments and with the building program. We have already reached a point where equipment cannot be utilized to a profitable extent, and the income from sales will be less in the future.

In previous reports the Director has detailed the improvements that have been made on the Farm and its present status. The cost of operating the farm has been assumed by the Experiment Station. When the farm was taken over by the Director some years ago, he believed it was only a temporary expedient to straighten out a difficult situation. Whether this has been a success or not, the continuance of this arrangement may well



be questioned, first, because operation of the farm is not a Station function except as a side issue. The farm is not used for experimental purposes but solely for the growing of feed crops for the Animal Husbandry Department. The Director would strongly recommend that the management of the College Farm be turned over to the Animal Husbandry Department which is the logical agency to operate it, and that it be divorced from the Station entirely.

The accompanying reports of the various sections will furnish specific information on the extent and character of the work now being done. As previously stated, many of the Station projects are perforce of a fundamental nature and may seem to be unnecessary; yet from the standpoint of science and the science of agriculture, they are vitally important and cannot be neglected.

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## Agronomy Section

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The Agronomy Section staff consists of Alvin Kezer, chief agronomist; D. W. Robertson, agronomist; Dwight Koonce, Robert Gardner, and Lindsey A. Brown, associates; Ralph M. Weising and Otto H. Coleman, assistants. All these workers, except the chief agronomist, put in their full time on research. Warren H. Leonard, associate, devotes part of his time to corn research. Robert S. Whitney, assistant, devotes part of his time to soils research.

During the present year Mr. J. J. Curtis of the Cereal Office of the United States Department of Agriculture has been assigned to this location, and Mr. Horace S. Smith, who has been on a Federal fellowship, devotes half time in the school year and full time in the summer period to research problems.

### Corn Improvement

Corn improvement is carried on a two-fold basis—continued improvement of existing varieties and the study of hybrid seed. The hybrid seed program is also carried in two portions: (1) Research and study on our own selfed lines and hybrids which can be produced from various combinations of those lines, and (2) trial studies of out-of-state hybrids to ascertain their adaptation to Colorado conditions.

Trials have been run at Fort Collins, Akron, and Rocky

Ford on Experiment Station land and cooperatively on a few farms. In northern Colorado these tests indicate that certain Minnesota hybrids are probably best adapted, while in the Arkansas Valley both Iowa and Illinois hybrids are found adapted and recommendations have been made on the basis of 2 years' trial for their general farm use. Up to the present time, no hybrid has done as well on dry land as existing standard sorts.

One difficulty with this problem is the tendency of many persons to think that there is magic in the name "hybrid". Consequently they are likely to buy anything named "hybrid". The best hybrids under irrigation are better than the best standard varieties. It is our hope to do enough work along these lines to be able to advise growers, enabling them to avoid serious mistakes in the choice of hybrids.

### **Hydrocyanic Acid in Sudan Grass**

The Adams Fund project on hydrocyanic acid in sudan grass is continued, using old self-fertilized lines. Many new lines are being self-fertilized to increase the possibility of selection of favorable strains. There is abundant indication that the tendency to produce hydrocyanic acid is inherited. Growing environment seems to influence hydrocyanic acid content also. The work has gone far enough to give hope that strains valuable for forage may be produced which have a very low tendency to produce hydrocyanic acid, thus increasing the safety of this crop as a pasture.

### **Optimum Nutrient Balance in Soils**

This project is giving special emphasis to the relation of nitrogen and phosphorus and their effects on crop yield and quality. There is nothing particularly to report except progress.

### **Availability of Mineral Nutrients in Soils**

Studies are being made in an effort to find the reason for availability differences with phosphorus and the methods of laboratory determination of field availability.

### **Chlorosis of Stone Fruits**

The study of chlorosis of stone fruits is a joint project between the Soils Agronomy, Horticulture, and Botany Sections. During the past year a detailed survey of 22 square miles of territory in the Palisade orchard district was made. The most serious chlorosis areas have been located and mapped, and preliminary studies looking toward the cause of chlorosis have

been made. A preliminary report for the Station (not published) has been made to the Director.

Several leads have been obtained. Among these is the higher pH as moisture increases and the water table rises in the soil. Nitrates and phosphates were higher under chlorotic trees. This may be due to heavier fertilization and may be due to lower plant food intake by the chlorotic trees. Other inferences are possible, among which is that the high phosphate content of the chlorotic trees, whatever its cause, might lead to a precipitation of iron in the plant tissues, especially in the vascular bundles. Growth of alfalfa in some of the orchards seems to reduce the chlorosis. It is interesting to speculate on the cause of this and it furnishes interesting leads for further investigation. The preliminary work indicates several leads worthy of serious investigation in their relation to the problem.

#### **Bacterial Wilt and Winter-Killing in Alfalfa**

Alfalfa is Colorado's most valuable crop. Any information which will throw light on the control of alfalfa wilt, the most serious disease affecting the crop, will be helpful. Enough work has been done to indicate that the problem must be attacked as a breeding problem, that is, strains of alfalfa resistant to the disease must be found or bred. Self-fertilized lines are being produced. Later, crossing and segregation must be done. The most resistant strains at present seem to come from the Turkestan. What is needed is something more than the resistance of common Turkestan with the growth and yield habits of Grimm or Baltic. If real resistance can be produced in the inbred strains, crossing and backcrossing will very likely produce the desired combinations.

The Federal Government, associated with states of the Midwest, especially Wisconsin, Nebraska, and Kansas, is exchanging material with all the states and agencies. The Agronomy Section is included in this breeding program for the exchange of prospective breeding material. The Government is making a world-wide search for possibly resistant strains for breeding material. The program here is part of this program.

We could speed up the work considerably with suitable greenhouse and freezing equipment, because part of the generations could be grown in the greenhouse and freezing equipment would make possible elimination of weak strains at an earlier date. In many cases this type of work is a long time program unless one is favored by chance. It takes five or six generations of inbreeding to safely isolate homozygous strains. It takes at

least three or four generations where straight segregations may produce new forms, and it takes four to eight generations or more where backcrossing has to be used to make a desired combination. Preliminary studies are in typed form.

### **Linkage Relationships in Barley**

Barley inheritance and the mapping of genes and chromosomes into linkage groups has continued to be the main object of this project. A number of papers have been produced. Dr. Robertson, who has been directing this work, has been asked during the present year to give a special program on the progress of the work at the Agronomy Society meetings. He has also been asked to give a special paper at Edinburgh, Scotland, at the 1939 meeting of the International Genetics Congress.

A new variety of barley called Lico, which during its test period went under the designation of F. C. 1110, gives promise of a very important practical result of these studies. This barley apparently outyields Trebi and produces a barley of superior quality. It has the very great added advantage of having smooth awns or beards, which makes it possible to use the straw without danger of injuring livestock. From the present outlook, we can expect further practical production in addition to the mass of purely fundamental research data which has arisen out of these studies.

### **Soil Resources and Land Use Survey**

Semi-detailed soil resources and land use surveys have been made in Weld County, Morgan County, Logan County, and Phillips County. Cooperative surveys have been made in the Colorado Springs district and Kit Carson district. During the summer of 1938, in the chlorosis of stone fruits studies, a detailed survey was made of 22 square miles. The Washington County detailed survey has been completed. Detailed surveys were made of the Federal range management study area in Weld County. Because of inspection, a part of Morgan County will have to be rechecked to comply with Federal adjustments.

Dr. Brown, who is in immediate charge of this work, has qualified as a collaborating inspector for the Federal soils work and assists in inspection of Soil Conservation Service, Bureau of Agricultural Economics, and Bureau of Chemistry and Soils surveys. This is necessary and desirable because it enables keeping all surveys headed up with uniform descriptions and correlations.

### High Altitude Crops

The project on high altitude crops covers experimental work with small grains; peas; high-altitude, dry-land, and irrigated grasses; alfalfa; and a minor list of forage crops. Breeding work on peas is under way, and outlines for cultural and breeding work on several of the grasses are contemplated.

### Improved Seed

Under the heading of improved seed, variety testing and cultural practices not coming under the general Federal research field have been undertaken. Variety testing work and variety purification work will always be needed as a means of testing the value of and getting clean seed for general farm seed distribution. Reduction of State funds seems to endanger the continuance of this particular program. Such a program may be properly conducted only under State funds and is a necessary part of crop improvement.

### Plains Crops and Management

Our cooperative work with the Office of Dry Land Agriculture has been continued. Experiments are under way on rate and date to plant crops of wheat, barley, oats, and mixed forage varieties. The work at Akron on the production of Coes sorgo and Highland grain sorghum indicates that there is a large field for forage and grain sorghum improvement which might well be carried on at Akron. The sorghums are much more drought-resistant than corn. If high yielding, cold-resistant, and early-maturing types which would extend the sorghum acreage can be developed, it would materially increase the certainty of forage and grain feed in the Plains area and thus materially stabilize Plains agriculture. Enough work has been done to indicate the feasibility of such a plan. This work should be pushed but may have to be held in abeyance because of insufficient financial support.

The Akron Substation is still used as an elimination and trial ground for new strains of grain. If they will stand Akron conditions, they are adapted almost anywhere in the Plains region, and many sorts which will do well at Fort Collins will not stand Akron conditions, so Akron is used as a trial ground to see if new varieties or new creations are adapted to the more severe Plains conditions.

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## Animal Investigations Section

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The following is a statement of the status of projects carried by the Animal Investigations Section:

### Urinary Calculi With Lambs

The test of urinary calculi with lambs was cooperative among the Pathology and Bacteriology Section, Chemistry Section, and Animal Investigations. The test was started November 15, using wether lambs which were divided into seven lots of 96 each, and were fed the following rations:

- Lot 1. Yellow corn, "C" molasses, alfalfa, and salt.
- Lot 2. Yellow corn, alfalfa, and salt.
- Lot 3. Yellow corn, bran, alfalfa, and salt.
- Lot 4. Yellow corn, "C" molasses, beet tops, and salt.
- Lot 5. Yellow corn, bran, cane fodder, and salt.
- Lot 6. White corn, bran, cane fodder, and salt.
- Lot 7. Yellow corn, "C" molasses, cane fodder, and salt.

Urinary calculi were developed in lambs in lots 5, 6, and 7 where cane fodder was used as the only roughage. Lambs in lots in which alfalfa and beet tops constituted the roughage part of the ration showed no indications of urinary calculi.

A complete summary of this particular test is not available at the present time, but indications are that much further work is necessary in order to give us complete information on the subject.

### Wintering Heifer Experiment

Three lots of 12 heifers each were wintered on a ration of 1 pound of supplement, 15 pounds of silage, and alfalfa hay. One of the lots of heifers received in addition one-tenth of a pound of lime ( $\text{CaCO}_3$ ) per head per day, and the third lot received one-tenth of a pound of steamed bone meal. The addition of these mineral supplements to the basal ration gave negative results as far as rate of gain was concerned.

This test was closed May 1, and 12 heifers were sorted off to be used in the Range Management test this summer.

### Range Management Test

The range management test was run in cooperation with the Range Management Section and will be continued this year

on the same basis as last year. Its object is to show the comparative value of conservative versus deferred-and-rotated grazing.

### Rocky Ford Lamb Feeding

The results of the Rocky Ford lamb feeding test, which was completed April 14, are as follows:

1. Milo, when used as a substitute for corn in the grain, cake, and hay ration, showed 106 percent the feeding value of corn.

2. Barley used as a partial substitute for corn showed 90.5 percent the value of corn.

3. Wet beet pulp added to a ration of grain, cake, and hay showed a replacement value of \$2.29 per ton, whereas its cost was only \$1 per ton.

4. One-half sugar beet mangels fed with grain, cake, and alfalfa hay was not a very satisfactory succulent roughage because: (1) It did not produce as high a rate of gain as wet beet pulp; (2) percent waste was extremely high; (3) diseased or partially spoiled mangels caused death loss.

### Wintering Ewes

Cost and gain records are kept on three bands of ewes. One band is wintered on the Utah desert, the second is wintered at home on home-grown feeds, and the third is run on public domain part of the time and the balance of the winter is fed on home-grown feeds. This test is in cooperation with Claire Hotchkiss, Paul Swisher, and J. P. McIntire of Hotchkiss, Colo.

### Official Testing

Herds being tested are as follows (in the herd improvement test all cows in the herd are tested):

#### Holstein Herds

HERD IMPROVEMENT TEST:—C. W. Henry, Greeley; George T. Sinton, Colorado Springs; Modern Woodmen Sanatorium, Woodmen; the Denver Farm, Henderson.

ADVANCED REGISTRY.—Jewish Consumptive Relief Society, Spivak; J. K. Mullen Home, Fort Logan.

#### Guernsey Herds

ADVANCED REGISTRY.—F. C. Kay, Pueblo; J. W. Loving, Pueblo; Robert Roemer, Fort Collins; George T. Konishi, Platteville; Loyd Robertson, Rocky Ford; Velma G. Shanks, Rocky Ford; Charles Ewing, Fort Lupton; H. L. Thomas, Las Animas.

## Jersey Herds

HERD IMPROVEMENT TEST.—Boyd Sisters, Loveland.

REGISTER OF MERIT.—F. L. Eden, Pueblo.

## Summary of Testing

Following is a summary of the testing work done since May 1, 1938:

Month	Number of cows on yearly test, one day per month	Number of cows on yearly test in herd improve- ment division	Number herds	Fees
May	57	88	13	\$24.95
June	67	84	15	25.15
July	71	80	15	28.60
August	67	85	16	26.50
September	72	88	16	26.80
October	76	90	16	28.00
November	75	64	16	28.45
December	75	63	16	25.30
January	79	70	16	26.75
February	84	83	16	26.80
March	92	97	16	32.70
April	(Reports not all in at time report was written)			
	815	892	171	\$300.00

## Botany Section

### Chlorosis of Stone Fruits

The study of chlorosis of stone fruits is in cooperation with the Horticulture and Agronomy Sections. Analyses of leaf samples of chlorotic peaches have shown the following results to date:

Calcium ranged from 6 to 8 percent higher in normal leaves than in chlorotic leaves and was 50 to 100 percent higher in September than in June. The magnesium content of chlorotic leaves was significantly different from that of normal leaves. There was, however, a slightly greater quantity present in September than in June. No differences were found in phosphorus content in normal and chlorotic leaves. Potassium showed no consistent variation. The total nitrogen content ranged from 12 to 91 percent higher in chlorotic leaves than in normal ones. Both diseased and healthy leaves were significantly lower in



nitrogen in September than in June. The chlorotic leaves averaged about 28 percent dry matter while the normal leaves were about 34 percent dry matter in June. In September dry matter was in the same order but slightly higher for both normal and chlorotic leaves.

Spectroscopic analysis is being used in these studies.

### Weed Control

Tests on interval and depth of cultivation for weed control indicate that 3-inch cultivations are as effective as 6-inch and 2- or 3-week intervals between cultivations are as effective as 4- or 5-day intervals.

The effect of time of beginning clean cultivation indicates an advantage in favor of early starting from the point of view of moisture conservation.

Tests with corn planted on heavily infested bindweed land that had been clean cultivated one season indicate it is not very effective in the weed control program. Bindweed made strong growth after the corn had been laid by.

Sodium chlorate treatments along ditch laterals indicate that 3 pounds per square rod in the fall gave very good results in weed control.

Tests involving sodium chlorate, limestone chlorate, and calcium chlorate in poundages of 2, 3, 4, and 6 pounds per square rod indicate that effectiveness in weed control depends upon the amount of sodium chlorate in the mixture.

Tests with sodium thiocyanate indicate that this substance is not very effective on bindweed.

Tests of weed burners indicate that they are about as effective as shallow clean cultivation, but the cost of burning is excessive. There was no advantage in special types of weed burners tried. Tests with weed burners on tennis courts indicate that they are apparently effective, though a second year's trials will be necessary.

Treatments of lawns for control of crabgrass and plantain have been continued. Calcium chlorate, ammonium sulphate, kerosene, lead acetate, arsenical spray, and a weed burner were used. The arsenical was most detrimental to the bluegrass; lead acetate, weed burner, and ammonium sulphate were effective in control of crabgrass in about the order named.

Work on the root reserves of bindweed covering 3 years' results has been submitted for publication.

### Physiology of Poisonous Plants

The role of various nitrogen fractions in the metabolism of *Suckleya suckleyana* is being studied. Because of its high hydrocyanic acid content, suckleya is considered a desirable plant to use in nitrogen studies.

Chemical studies are being made of the newly discovered poisonous plant, oxytenia, which has been responsible for serious cattle losses in certain parts of Colorado. The active poisonous principle is a glucoside.

A new poisonous weed, bahia, has been discovered and has been found to contain hydrocyanic acid. Results of this study have been published.

### Corn Root Rot

A brief survey has been made of the root rot of corn in this State, and several test plots have been planted. Indications are that the treatment of seed with organic mercury dust increases the stand and the yield. However, where good selected seed is used, root rot is negligible and seed treatment is of little value.

### Corn Smut

Infection tests have been made in cooperation with the Agronomy Section on local inbred lines of corn for their resistance to smut. Indications are that some of these show resistance.

### Onion Diseases

The pink pigment which is frequently evident in pink root disease of onion and which gives the root its diagnostic color symptom becomes yellow brown when subjected to pH below 7. This explains in part the yellow root condition where roots are attacked by *Phoma terrestris* in acid soils.

Bulb rot caused by *Fusarium vasinfectum zonatum* is induced only by injury to the bulb. The organism will not attack the roots nor will it attack the uninjured bulb.

### Tomato Fruit Rot

Tomato fruit rot, recently prevalent in the Arkansas Valley, is caused by the fungus *Phytophthora capsici*. The same organism has been shown to cause a wilt of pepper plants. In Weld County this same organism was found responsible for a wilt of squash and watermelon.

### Potato Ring Rot

Potato ring rot has been shown to be caused by the bacterial organism *B. sepedonicum*. The organism has also been found

to cause severe wilt of tomatoes when artificially inoculated. Field plots during the past season have been planted to test different potato varieties with different isolates of the organism obtained from Germany, Canada, California, and Florida. Plantings were made from tubers showing different symptoms, and further studies have been made on the associated soft rot which frequently follows ring rot.

### Winter Killing in Raspberries

Chemical analyses and anatomical studies are being made of raspberry canes damaged by winter injury and those showing winter hardiness.

### Virus Diseases of Stone Fruits

It has been found that certain varieties of peach are symptomless carriers of peach mosaic.

### Diseases of Greenhouse Plants

Work on disease of greenhouse and ornamental plants has largely been confined to the *Fusarium* disease of carnations. Some 20 strains of *Fusaria* have been isolated. These strains seem to belong to three species tentatively identified as *Fusarium dianthi*, *F. culmorum*, and *F. avenaceum*.

These strains show different physiological reactions, type of growth, and spore measurement on different media. They also show different reactions to temperature.

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## Chemistry Section

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During the fiscal year the Chemistry Section has actively prosecuted investigations on three major projects. Since one of these is nearing completion, a fourth is being initiated. The following is a brief resume of operations:

PROJECT I. The Yield, Starch, and Mineral Content of Tubers Grown in the Principal Potato-growing Sections of Colorado as Affected by Available Nutrients of the Soil and by Moisture Conditions.—This cooperative project with the Horticulture Section was carried on for 5 years with a view to shedding some light on the causes of deterioration of Colorado potatoes, which constitute one of the State's more important crops.

For purpose of publication, the study was subdivided into three parts: (1) A study of the starch, protein, crude fiber, and

mineral ash content of tubers with reference to the soil solution; (2) a comparison of the chemical composition of plant and tuber parts as regards physiological and metabolic needs of the crop; (3) the effect upon quality and yield of tubers of added mineral fertilizers.

Parts 1 and 2 have been written up for some time and are practically ready for publication. For part 3, the final field data were collected during the 1938 growing season. The analytical and laboratory work on part 3 is nearing completion.

**PROJECT II.** A Study of the Base Exchange Capacity of Typical Native Sods and Cultivated Soil Profiles of Colorado, Together with the Effects of Saline Irrigation Waters Upon the Adsorptive Soil Complex.—This study was undertaken for the purpose of gaining concrete information on the status of available mineral nutrients in some Colorado agricultural soils and also the trends indicated by use of saline irrigation waters over a relatively long period of time.

The soils thus far studied are from the eastern Plains section. Some 40 profiles have been collected and many of the analytical data have been completed. There are still a few types of profiles not represented in this study and these will be collected during the summer. However, the volume of work connected with such a study is so great that it will require another year to complete the collection of all necessary data.

**PROJECT III.** Inorganic Constituents of the Alfalfa Plant in Relation to Available Soil Nutrients.—The lay livestock feeder, in calculating feed rations and the possible use of mineral feed supplements, probably assumes that the mineral composition of alfalfa hay is much more uniform than it really is.

This project was undertaken to study the variation in composition of alfalfas caused by their growth in different types of soil, such as long-cropped soil, irrigated soil, new irrigated soil, and mountain-valley soil.

The project was accepted too late to permit the beginning of studies during the past growing season and was initiated in the spring of 1939.

**PROJECT IV.** A Study in Urinary Calculi in Lambs. (This is a cooperative project with the Pathology and Bacteriology Section and the Animal Investigations Section.)—Owing to the feeding of concentrated rations in the feed lots, some systems of stock feeding have caused losses of wether lambs and steers, especially toward the end of a feeding season. These losses have caused some concern among livestock feeders of northeastern

Colorado and have been diagnosed as due to the formation of solid precipitates in the urinary tract.

The study is now being pursued by way of chemical investigations of the urines of seven lots of sheep throughout the feeding season. Each of these lots was maintained on a specific type of ration.

The actual feeding experiment started November 15, 1938, and the animals were taken off feed on March 17, 1939. The Animal Investigations Section furnished the lambs and feed and carried on the actual feeding operations. The Pathology and Bacteriology Section and the Chemistry Section arranged facilities to confine the experimental animals and conducted daily urine samplings periodically over 120 days from 49 test animals. The Pathology and Bacteriology Section observed the health of the animals on feed, posting any dead animals and diagnosing causes.

Seventy sheep (10 from each lot) were bled at the beginning and at the termination of the experiment to determine any fluctuations in their blood content of calcium, phosphorus, and magnesium.

Some 840 daily (24-hour) samples of urinary excrements were collected, and 280 consecutive composites from these were subjected to a rather complete chemical analysis.

As the data accumulate and are tabulated, it becomes increasingly evident that much valuable information has been gained in this study. The work with collaboration of the other cooperating sections should be ready for publication probably by September 1939.

### Service Projects

The Chemistry Section has been giving assistance of chemical nature to the Horticulture Section in the "Study of Greenhouse Soils," in an effort to solve some of the difficulties of Colorado florists.

The Section has been giving chemical assistance to the Pathology and Bacteriology Section in matters relating to forage poisoning, toxic plants and stock waters, etc.

The Section has been rendering assistance to the Range Management Section in matters relating to the nutritive values of range plants.

To the farmers and lay citizens of the State, the Section has given assistance of advisory and informative nature, as well

as testing waters for household, stock-watering, and irrigation purposes.

In cooperation with the Colorado Director of Markets and Food Inspection, this Section has continued as in the past to make tests for spray residues on fruits and vegetables. Some 290 samples were so tested during September, October, and November.

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## Civil Engineering Section

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### Organization Changes

On December 14, 1938, the State Board of Agriculture took the following action:

“On motion of Mr. Rockwell, seconded by Dr. Webb and unanimously carried, the Civil Engineering and Irrigation Investigations Sections of the Experiment Station and the Department of Civil Engineering were combined to be administered by the Head of the Department.” It was understood that this motion was to take effect at the end of the fiscal year.

### Personnel

Mr. Adrian R. Legault, testing engineer, was on leave during the 1938-39 fiscal year. However, a bulletin by Mr. Legault—Colorado Experiment Station Bulletin 452, “Looped Wire for Concrete Reinforcement”—was published in January 1939.

Arrangements have been made with the Mathematics Department for Dr. D. F. Gunder to spend one-quarter of his time doing research work in the field of hydraulics during the fiscal year 1939-40.

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## Mechanical Engineering Section

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Work in the Mechanical Engineering Section has been conducted in cooperation with the Bureau of Agricultural Engineering, United States Department of Agriculture. Support from the United States Sugar Beet Association has made it possible to expand the work in the Section during the past year.

## Sugar-Beet Machinery

### Mechanical Thinning

The partial elimination of hand labor in the thinning of beets is a goal that is apparently much nearer attainment. An important step leading up to this goal has been the development of improved planting. It seemed desirable to approach more nearly to single seed ball planting and more regular spacing of these seed balls in the row. A normal expectation is that a large portion of these seed balls will sprout single plants. With a more even distribution of these single plants in the row it becomes more nearly feasible to mechanically cut portions of the row, leaving a desired number of single plants.

A "single seed ball" planter developed at the Station yielded 22 percent more singles than were obtained when the standard commercial planter was used. The disk furrow-opener tests indicated a very significantly greater initial germination was obtained than when the shoe furrow-opener was used. This substantiates previous findings.

A multiple disk press wheel developed at the Station showed significantly greater initial germination stands (1 year's results) than those obtained with the standard commercial press wheels.

One proposed scheme for eliminating the stoop labor involved in thinning has been to use a long-handled hoe. The speed and effectiveness of this method is dependent on having plenty of singles in the row. Three comparisons where the harvest yield was not significantly different are shown in the following table:

	Time of labor involved (man hours)
Customary hand block and thin	22.0
Long-handled hoe on standard plantings	16.5
Long-handled hoe on single seed ball plantings	10.9

Progress has been made in the development of mechanical tools to replace the long-handled hoe method.

## Entomology Section

The largest insect pest problem presenting itself in the past year was the continuance of the grasshopper plague. This was divided into two phases, the migratory grasshopper and the

crop-land 'hopper. By using all available agencies and financial aid from various agencies, the 'hopper situation was coped with ably

The Experiment Station Entomologist assumed the duties of a representative on the State Grasshopper Control Committee. From data collected by the Experiment Station and the Department of Entomology, necessary technical information on bait formulas, methods of application, and life history records was furnished to make control most effective. All the swarms of migratory 'hoppers contacted were well controlled, as was the crop-land 'hopper.

At a meeting held in Denver on March 5 and 6, at the office of the State Bureau of Plant and Insect Control, at which there were representatives from the United States Bureau of Entomology and Plant Quarantine, State Department of Agriculture, Colorado Extension Service, Colorado Experiment Station, and the Colorado State College Department of Entomology and Zoology, plans were drawn and tentatively agreed upon as to organization and methods of procedure in so far as Federal aid was concerned.

Operations for control of Mormon crickets in Moffat County in 1938 were so effective that this pest was practically eradicated. Because of this efficient work, no control work is necessary this season. Colorado is the only previously infested state that is now virtually free from Mormon crickets.

Insects in general, except for a few severe outbreaks, were about the same as last season. The outbreak of psyllids on potatoes and tomatoes was very severe, and a tremendous amount of damage was done to the potato crop of Colorado. We have a new problem with the tomato psyllid. It appears that tomatoes given the recommended sulphur treatment for psyllid control are unfit for canning. Apparently the sulphur cannot be removed from the tomatoes, and shortly after canning the cans swell and burst. This undoubtedly will necessitate further experimentation for a substance other than sulphur, or further work on the time of its applications, that will control tomato psyllids and still leave the fruit in a condition suitable for canning.

The old pest of corn, cotton, and tomatoes, commonly known as the cotton boll worm or corn earworm, has recently come into importance in the Arkansas Valley where tomatoes are grown for canneries. The insect bores into and develops within the tomato, making the fruit unfit for canning. The Government has placed a tolerance on worm particles in canned tomatoes, the same as it has on the percent of poison on various fruits.



During the past year hundreds of cases of tomatoes were condemned because too many worm fragments were found in them. Mr. John L. Hoerner did some work on this insect the past season while he was studying cucurbit insects in the Arkansas Valley. Some life history studies along with control measures were made.

Because of the heavy rains last September, another insect pest, which under normal conditions is not prevalent, appeared. This was the mosquito. Water collected in all low places on the Colorado State College campus and remained long enough to give ideal conditions for mosquito development. This pest was coped with by applying a 2-percent kerosene emulsion where the adults had collected, by draining stagnant pools of water, and by applying kerosene on places that could not be drained. A very satisfactory control was effected.

Work on ant control was continued at opportune times.

Mr. L. B. Daniels returned from his leave about the middle of June and immediately took up his regular duties on Station projects. The principal part of his time was spent on the potato insect project, and some time was spent on the Western Slope on peach mosaic vectors. Up to the time of Mr. Daniels' return, the latter project was handled by Dr. Charles R. Jones. Mr. Hoerner spent most of the summer in the Arkansas Valley, working on his regular project, control of cucurbit insects. Attention was also given to the corn earworm and other insect pests. Miss Miriam A. Palmer was in Fort Collins rearing Syrphidae, delineating, and working on the plant louse projects.

### Three New Insect Pests of Colorado

Along with the numerous insect pests that are yearly sent to this Section for identification and control recommendations, three insects were received that are new to this state: *Prinus fur* L.; *Rhopalosiphum splendens* Theo.; and *Rhopalosiphum prunifoliae* Fitch. The last, a brown variety, may be a new insect to science.

*Prinus fur* L. is a small reddish beetle and is a household, stored-grains, museum, and "what-not" kind of pest. This insect is a native of the Old Country and has in the past few years become widely disseminated in all European countries where, because of its habit of living in dwellings, store houses, and museums, it has become a very serious pest. It has been reported infesting every type of organic material from dried fish to opossum skins, even feeding upon woolen clothing.

This pest was introduced into Maine in 1888. It has spread

slowly to a few states in the Union. Lately it has been reported from the West Coast and various parts of Canada. The record this year is the only one from Colorado. Should the insect become established, it will present another serious problem. The specimen was sent in by Mrs. F. E. Smith of Wray, Colo. All possible chances of the insect's entry into Colorado were checked, and it is believed that it came from Oregon with a shipment of home-canned goods which Mrs. Smith received from that state.

*Rhopalosiphum splendens* Theo. and *R. prunifoliae* Fitch were discovered in wheat fields in northeastern Colorado; some specimens were sent in for identification from southern Nebraska and parts of Kansas. These insects are at present fairly well established in these three states. The pests were injuring fall wheat and taking a very heavy toll. Neither of these two aphids seem to have been previously reported in this country. This genus is a serious pest in Egypt. Miss Palmer has prepared a paper on these pests for publication in the Journal of Economic Entomology.

### Potato Psyllid

The psyllids this season have been a real menace to potato growers because of the favorable winter and early spring conditions. This serious epidemic demonstrated clearly that extensive educational work was necessary. Consequently, upon returning to Colorado in June, Mr. Daniels began educational work on this serious problem. Thirteen meetings were held as follows: Monte Vista, two; Alamosa, two; Del Norte, one; La Jara, one; Greeley, two; Eaton, two; Windsor, one; Julesburg, one; and Carbondale, one.

In October, psyllids were taken in numbers on cedars at Gypsum and Buena Vista. The frost had killed the potato vines in those vicinities a week or 10 days before, and the psyllids were moving onto the cedars along the river. Hibernation cages containing adult psyllids were placed on cedars and other evergreens at Gypsum, Lake George, and Fort Collins.

### Psyllid Resistance

This Section has tentatively drawn up a new project, in cooperation with the Greeley Potato Experiment Station and the Bureau of Plant Industry, United States Department of Agriculture, to study potatoes in respect to psyllid resistance. Work has been in progress during the late fall and winter. This project is being supported publicly by Nebraska and Wyoming.

A virus-free strain of psyllids is being propagated on

Erlain and Chippewa varieties of potatoes. Two generations have been produced and a few preliminary tests made on potato seedlings.

### Spray Efficiency

The data obtained from experiments in the spray efficiency project will materially aid farmers in the control of potato insect pests. Treated plots this year yielded 450 bushels per acre, while untreated fields, in many cases, remained undug.

Actual delivery capacities were determined on a number of machines spraying for psyllids in Weld County. The milk-can gauge and stop-watch method was found very satisfactory. It was found that the delivery capacities on the better machines were about as the manufacturers had stated them; however, some of the cheaper competitive machines were overrated 10 to 30 percent. The worst fault that was evident was the use of low-capacity machines in spraying four and six rows. It is believed, as more detailed data are accumulated on coverage values as related to pump capacities and pressure, that these low-capacity machines can be recommended only for 2 or 3 rows.

A very important relationship has appeared in regard to coverage and the speed of machines. Under epidemic conditions such as existed in 1938, many machines, particularly the larger, tractor-powered, take-off outfits, attempted to cover large acreages in the minimum time. In such cases control was reduced 30 to 40 percent. Where time and care were used to obtain maximum coverage, yields were normal or above.

The importance of carrying this project actively for the next 2 or 3 years is evident. As has been pointed out repeatedly, the effectiveness of an insecticide is definitely related to the thoroughness with which application is made.

Experimental work on potato psyllid and flea beetle was carried on in connection with the spray efficiency project. The results of commercial spray tests at the Greeley Experiment Station in 1938 have shown convincingly the value of the combination spray on psyllids and flea beetles. The unsprayed plots averaged only 53.04 percent of the yield of the sprayed plots. The quality of the sprayed plots, however, was only 8.5 percent better than the unsprayed. That is, the tubers entirely free of worm track in the sprayed plots were only 12.5 percent more than in the unsprayed, or the U. S. No. 1 amounted to 50.2 percent for the sprayed and 32.8 percent for the unsprayed.

### Peach Mosaic

Work on the peach mosaic project was conducted by feeding

experiments on numerous sucking insects taken in infested peach orchards at Palisade. The report on "Progressive Discoloration as a Symptom in Peach Mosaic," was prepared in the light of the work done in the Long orchard in 1937. It was shown in this report that there is a possible association between aphids and progressive discoloration which may be a symptom of mosaic. To obtain further evidence, 110 trees were carefully studied, charted, and tagged in October 1938 in the Hart orchard, a "hot spot" the past season for mosaic. The Levi Clark orchard, another serious spot, was charted twice during the summer for further study in 1939. From the above studies peach mosaic can be spotted readily in very early stages, even before the general symptoms appear on the trees.

A spray program was contemplated to control aphids effectively and thus control the mosaic disease, but because of lack of funds it did not materialize.

#### **Syrphidae in Relation to Plant Lice Control**

This project has received minor attention by Miss Palmer and Dr. Jones. Records have been kept on the type and number of plant lice destroyed by each specimen.

#### **Aphidae of Colorado**

This project has been continued by Miss Palmer, 18 slides from Colorado being added to the collection, comprising 11 species. Twenty-two additional slides were added from Wyoming. Miss Palmer has published another paper on "Additional Aphids of Colorado."

#### **Cucurbit Insects**

Mr. Hoerner carried on the cucurbit insects project at Rocky Ford and at Fort Collins on the squash bug, striped cucumber beetle, melon aphid, and spotted cucumber beetle. Because insect injury caused the loss of tomatoes in the Rocky Ford district, he also carried on limited experiments with the corn earworm and the tomato psyllid.

In July Mr. Hoerner published a press bulletin, No. 93, "Controlling the Squash Bug." This bulletin is the first authentic publication that gives a specific control for the squash bug, and it has been distributed generally through the United States.

The work on the striped cucumber beetle shows that cantaloupes and honeydew melons can be protected with four dust applications. In years when insect infestations are not so severe, two applications afford good protection. Two applications of nicotine dusts will protect the crops from the melon aphid.

Experiments on the corn earworm, using stomach poisons, gave promise of an effective control. This is very encouraging because this insect has practically put the tomato canning industry out of business in the Arkansas Valley, but more work is necessary to perfect the control methods.

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## Home Economics Section

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### Personnel

The position left vacant in February 1938 by the resignation of Dr. Mark A. Barmore was filled by the appointment of Mr. W. E. Pyke. Mr. Pyke assumed his duties with this section July 1. Mr. Gestur Johnson, who began his appointment as research assistant under Dr. Barmore, has continued his work in that capacity.

### Baking of Flour Mixtures at High Altitudes

Work upon the whole-egg foundation, butter-type cake has continued, and work on the whole-egg sponge cake is rapidly nearing completion. An outline of the progress of this project follows:

#### Whole-egg, Butter-type Cake

The effect of altitude upon the tenderness of the butter-type cake in relation to variation of the ingredients (sugar, shortening, fresh or dry egg, and water content) has been completed.

Heat penetration into cake batters at various altitudes has been studied. When 800 grams of batter were baked in an 8.25-inch by 8.25-inch layer pan in an oven at 185-188° C., an internal temperature of 90° C. was reached in 31 minutes at sea level, 34 minutes at 5,000 feet altitude, and 38 minutes at 10,000 feet. The maximum internal temperature at 10,000 feet is 90° C.

Through the cooperation of Dr. H. S. Wilgus, Jr., of the Poultry Section, it has been possible to include studies of the effect of egg quality upon the properties of the various cakes studied. The effect of egg content and quality, as well as the type of commercial egg product used, has been followed. When the height of the firm albumen was used as a criterion of egg quality, a coefficient of correlation of + 0.82 was found between this measure and the volume of butter-type cake produced from these eggs. Poor quality eggs gave crumbly cakes of undesir-

able texture. The possibility of correcting the cake formula to allow the use of poor quality eggs is being investigated.

The liquid requirement of a balanced cake batter varies with altitude. As the altitude increases the liquid requirement increases for any fixed amount of sugar and flour.

### **Whole-egg Sponge Cake**

The preliminary work of Barmore on the whole-egg sponge cake has been very largely repeated and considerably extended. One of the objectives in the work has been to develop a technique which could be applied to the various commercially available egg products with a minimum of variation. The conventional method of mixing did not lend itself readily to this adaptation.

After an extensive investigation, a method has been developed by which an exceedingly stable whole-egg meringue can be obtained. The cakes produced through the use of this meringue and the new mixing technique have many more and smaller air cells than cakes prepared by the conventional method. They have a far superior texture. Cell walls are much thinner when the new method of mixing is used. The principal advantage of this method is that it may be employed where large mechanical equipment is used. It is as readily adaptable to small mixing equipment or mixing by hand.

The altitude-tenderness relationship for the sponge cake has been evaluated. The effect of the variation of ingredients upon this relationship has been studied.

### **Gelatinization of Starch**

Heat penetration and tensile strength studies suggest that much more information regarding starch gelatinization rates at various temperatures must be available before the problem of baking comparable cakes at the various altitudes habitable by man can be solved. For this reason preliminary studies have been initiated to follow and attempt to evaluate the variables that influence the rate and degree of set of the starch gel. Some methods have been found which both tend to speed up the rate and increase the degree of set of wheat starch.

### **Culinary Quality of Potatoes**

The effect of the calcium ion upon the sloughing and fracturing of pared potatoes during the boiling process has been followed. It was established that when the calcium content of the water in which the potatoes were immersed for boiling was sufficient to maintain or slightly increase the calcium content of the tissues, satisfactory control of sloughing could be obtained. Control of sloughing is attributed to the fact that

the cell-cementing pectins are kept insoluble in the presence of relatively small concentrations of the calcium ion. Concentrations of calcium chloride of 0.1 percent in the water in which the potatoes were boiled were adequate to control sloughing. In this study solutions of calcium sulfate and calcium sulfamate were found to give equally good results when compared with calcium chloride.

A method has been devised by which the variation in sloughing and tendency for hydration of the potato during boiling could be followed by measuring the amount of power required to beat the boiled potatoes for determined intervals of time. Other phases of the potato project, which is carried on in cooperation with the Horticulture and Chemistry Sections, are being continued.

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## Horticulture Section

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The results reported on Station projects in horticulture indicate that good progress has been made during the past fiscal year. The report on projects is given here to furnish information of use to growers before the projects are completed, and should not be considered final. Several projects were reorganized last year on a broader and more positive basis, and results are not yet far enough along to report.

The field of horticulture in Colorado is becoming better organized each year, and each group demands more assistance on problems affecting its specialized and intensified production. The department actually has the equivalent of about 1.8 men on Station work, and the funds being limited make it impossible to properly cover the problems of the field.

### Projects in Progress

Cooperative projects are carried with Agronomy (Soils Section); Botany (Plant Diseases and Plant Physiology); Chemistry; and Soil Bacteriology.

### Vegetable Crops Projects

TESTING NEW VARIETIES AND SEEDLINGS OF POTATOES (in collaboration with the U. S. Department of Agriculture).—Three new varieties of potatoes have already been released to growers in the State as a result of this project. These are Red McClure, Katahdin, and Chippewa. Many other varieties and seedlings have been tested and discarded.

Promising varieties in the 1938 tests include Houma which has performed especially well in the San Luis Valley. CS 106, CS 229, and CS 125 all appeared promising in 1938 tests. Seba-go, while tested for only 1 year, is very promising. CS 125 showed no bacterial wilt in three different tests.

There are now 62 seedlings under test in cooperation with the United States Department of Agriculture, the University of Minnesota, and the University of Michigan. Many seedlings are discarded and new lots added each year in this project.

**TESTING FOR SCAB RESISTANCE.**—In 1938, 78 seedlings were tested at the Mountain Substation for scab resistance in cooperation with the United States Department of Agriculture. Of these, 24 were highly resistant and 2 showed no scab whatever. All but eight of the varieties and seedlings in the test showed more resistance to scab than Bliss Triumph, which was used in the check. Seedling M-110, carried by this Station since 1928, proved as resistant as any in the official plot.

**POTATO BREEDING.**—Parent stocks have been reduced from 53 to 29 varieties, seedlings and inbreds. Of the 800 seedlings grown in 1938, a total of 275 from 11 different families are being carried on for further selection. Several of these seedlings show excellent commercial possibilities. During the winter, approximately 1,000 new seedlings were grown in the greenhouse. During the summer of 1938, seed was obtained from 29 crosses. This seed will not be planted in the greenhouse, however, until the winter of 1939-40.

**COMMERCIAL FERTILIZERS FOR POTATOES.**—During the season of 1938, commercial fertilizers were tested in six localities in the State. As in previous years, ammoniated phosphate and complete (4-12-4) gave the largest and most consistent increases in yield where any increases at all were obtained, the largest increases amounting to 30 percent. The sandy soils in the San Luis Valley and in the Gilcrest area in Weld County have shown consistent and substantial increases, but the heavier soils, particularly when properly rotated with alfalfa and which have received barnyard manure, do not show a profitable increase in yield. This project will be continued for at least 2 more years.

**DATES OF PLANTING RUSSET BURBANK.**—In 1938, as in the previous 2 years, the best yield and the best quality of Russet Burbank potatoes were produced by planting on May 18.

**BACTERIAL WILT OF POTATOES.**—The project on bacterial wilt of potatoes is in cooperation with the Botany Section. This disease was first observed in 1937 in the early potatoes around Olathe in Montrose County, where the damage in 1938 was also



the greatest in the State. During the summer of 1938, plants and tubers appearing to have symptoms were gathered and sent to the Botany Section for culture. Gram-positive bacteria were obtained from samples from all parts of the State.

**CHEMICAL COMPOSITION AND COOKING QUALITY OF POTATOES.**—This project is in cooperation with the Chemistry and the Home Economics Sections. The major portion of the work on this project has been completed and the volumes of data are being analyzed as time permits. The work is so extensive that it will probably be published in three parts. Part 1 should be ready for publication soon.

**SWEET SPANISH ONION BREEDING.**—The work on this project has been reorganized for closer coordination with the United States Department of Agriculture onion breeding program, and several stocks have been secured that are to be used for breeding work. The purpose of this project is to develop varieties resistant to onion thrips and to purple blotch disease. Lines resistant to these troubles are available, but do not carry desirable market characteristics. Resistant lines will be crossed to Sweet Spanish strains and inbreds, and then followed by back-crossing to the Sweet Spanish parent.

Sufficient seed of Sweet Spanish is produced each year to carry a small supply of seed on strains released to growers. Work on early maturing Sweet Spanish lines and white types is being continued.

**FOOT ROTS OF POD PEAS.**—Field tests to determine means of reducing losses from foot rot diseases on pod peas were carried in the San Luis Valley. Comparison of seed sources, varieties, seed treatments, chemical soil treatments, and commercial fertilizers were made on the sandy soils and on the heavier clay loams.

The work to date indicates that foot rot losses on pod peas can be reduced by following these practices: (1) Long rotations; 8 years between plantings of pod peas on the same soil; (2) use of disease-free seed for planting; (3) treatment of pea seed before planting, preferably with an organic mercury dust; (4) following practices that will maintain soil fertility, and addition of animal manures supplemented by commercial fertilizer applications.

The problem is a very complex one, and more thorough investigation should be carried over several seasons. Plans are being made to continue the field work this year, if funds permit.

**VEGETABLE VARIETIES TESTED.**—There is a continual string of letters each year requesting information on new varieties of

vegetables for Colorado. With many of our commercial vegetables, there are not satisfactory types available. As new varieties are introduced by the seed trade and experiment stations, as many as possible are tested for adaptability to our climatic conditions. Only a few new varieties on some of the main crops are reported here.

**CANTALOUPE.**—The new Hales Best No. 45 is the outstanding recent introduction. It is a good yielder and shipper, and it is fairly early. It needs some inbreeding for uniformity of fruit and better quality. This work is being carried at Rocky Ford.

**POD PEAS FOR MARKET.**—Gilbo is a new early-maturing variety of the large-podded types of peas and is finding a place for early shipping. G. O. P. shows promise as a main crop shipping variety. No. 40 and No. 95 are still important main crop varieties.

**TOMATOES.**—There is not a variety of tomato entirely satisfactory for our conditions. The new ones tested last year included Red Cap, Valiant, Rutgers, Penn State, Marbon, and others. Most of them sunscald badly here. Red Cap and Marbon are worthy of trial.

**WATERMELON.**—Early Kansas is worthy of trial.

**HEAD LETTUCE BREEDING.**—The 1938 season was a favorable one for the production of lettuce seed on hybrids and inbreds, and this will permit wider testing of various lines this coming season. In the past, seed production was low and sufficient seed was not produced for field trials in the mountain head lettuce districts. More extensive plantings have been made this spring, and better comparisons should be possible.

### **Fruit Production Projects**

**TREE FRUIT TESTING.**—Ninety-nine apple varieties and several seedling apples are now growing in the variety test planting. Fire blight occurred during the season of 1938 on 11 varieties, very severely on 6. This disease accounted for all tree losses in the apple varieties.

**ORCHARD MANAGEMENT** (cooperative with Soils Laboratory).—The fertilizer plots in the Harvey cherry orchard had a yield in 1938 slightly above that of 1937. Yield records for 3 years (1935, 1937, and 1938) showed that nitrogen alone, as  $(\text{NH}_4)_2\text{SO}_4$ , and manure alone both gave fruit yields significantly greater than were obtained from any other treatment used.

The use of heavy mulch in cherry orchard management

was started in 1938 as a part of the orchard management program. Some of the factors being investigated are soil temperature, soil moisture, nitrogen ( $\text{NO}_3$ ), ammonia, soil organic matter, yield and tree growth under mulch as compared with clean cultivation.

**CHLOROSIS OF STONE FRUITS** [cooperative with Agronomy (Soils) and Botany].—Sand culture work as a phase of this project is being carried on with peach trees (and strawberries) in the greenhouse.

**STRAWBERRIES.**—Yield records in 1938 at Fort Collins have shown no significant yield differences with plants on level planting or on raised beds. The use of raised beds under irrigation and mulch has definite cultural objections.

**RASPBERRIES** (cooperative with Botany).—The Latham raspberry planting set out in 1938 wintered in good shape. Samples of material for analysis have been collected, but the project, initiated in 1938, has not developed far enough to make any report of progress possible.

#### **Effect of Soil Treatments on Carnations**

During the past 3 years the carnation experiment, dealing with the response of this plant to various soil treatments, has been carried under the floriculture project. The treatments were as follows:

1. Virgin prairie soil.
2. Virgin prairie soil plus manure.
3. Virgin prairie soil, steam-sterilized.
4. Virgin prairie soil plus manure and steam-sterilized.

Treatments 2, 3, and 4 resulted in marked nutritional changes over and above those occurring in treatment 1.

Well-branched carnation plants ready for permanent benching at standard distances (7 by 9 inches) in June did not exhibit any reduction in yield or quality of flowers, or loss of plants, when planted in freshly sterilized soil. Rooted carnation cuttings, however, when planted during December, January, February, and March in freshly sterilized old carnation soils at growing-on distances of  $3\frac{1}{2}$  by 4 inches showed a high mortality rate. The condition is serious, and if the practice of soil sterilization is to be of any economic value to greenhouse operators of this State, the handling of rooted cuttings in steamed soils will need more thorough investigation.

#### **Personnel**

Prof. George Beach, who has been on leave of absence this past fiscal year, is to return and be ready for work by Septem-

ber 1. Mr. W. E. Gunesch has been taking care of his work during his absence.

### **Budget**

The budget during the past fiscal year has been far too small to satisfactorily cover the work that should be done. The difficulty comes from the fact that we have a rather complete physical plant to maintain, the maintenance of which requires considerable expenditure of funds, and this must be taken care of before the funds are available for Station work.

The sales in the greenhouse and garden this year have made it possible to end the fiscal year with a balanced budget. However, it is impossible to estimate accurately what the sales will be from year to year; consequently, sales money cannot be depended upon as a source of revenue for permanent project set-ups. It is used to help maintain the physical plant and for labor and supplies on instruction and Station work.

### **Greenhouse**

The greenhouse is used for Station work, for instructional purposes, and for production of plant materials for campus use. There is no separate budget on which to maintain the greenhouse, and all this cost is carried from sales of products.

### **Seed Potato Certification**

The amount of certified seed potatoes planted in Colorado in 1939 will again show a substantial increase. In addition to the 489,185 bushels produced in Colorado in 1938, at least eight cars, mostly foundation stock, were shipped in from Michigan, Montana, New York, North Dakota, and Wisconsin. Several lots were also trucked in from Nebraska and Wyoming. The entire State is now seed-conscious, with some improvement still possible in the Carbondale district.

The program, as it is now carried on, is far from ideal, due to the practice of using students as inspectors and to the lack of adequate facilities for tuber indexing at least 20,000 tubers a year. Another increase in acreage is anticipated in 1939. As more growers purchase certified seed, purchase it oftener than they formerly did, and learn more about diseases, it is imperative that certified seed be of the highest possible quality. While quality in Colorado has steadily improved and many lots are equal in quality to those of other states, Colorado still has too many poor lots of certified seed. Since potatoes are one of the major crops of the State and successful production depends, first, on insect control, particularly psyllids, and, second, on good seed, it is imperative that this seed program be made as nearly ideal as possible.

The major problem facing the certification officials at the present time is bacterial wilt. Practically one-third of the acreage entered in 1938 was rejected because of bacterial wilt or psyllids. The following table shows the amount of seed which met the requirements:

Varieties	Acres	Number of Lots	Bushels
Red McClure	527	23	163,600
Perfect Peachblow	425	16	131,450
Bliss Triumph	548	44	88,470
Irish Cobbler	406	29	63,540
Katahdin	85	18	17,760
Chippewa	26	7	7,350
Russet Rural	29	7	6,980
Russet Burbank	14	4	4,275
Brown Beauty	24	5	3,930
White Rose	6	1	1,250
Rural New Yorker	3	2	580
	2,093	156	489,185

## Irrigation Investigations Section

Work of the Irrigation Investigation Section is in cooperation with the Division of Irrigation, Bureau of Agricultural Engineering, United States Department of Agriculture. During this fiscal year, active work has been done on the following projects: Design, invention, and testing of irrigation apparatus; snow surveys and irrigation water supply forecasts; pumping for irrigation and drainage in Colorado; and meteorology.

### Design and Invention of Apparatus

**ADJUSTABLE TUBE ORIFICE METER.**—Preliminary tests made on this type of measuring device with a buoyant turbine velocity indicator show that for differences in pressure heads from 0.003 foot to more than 1 foot there was a definite relation between rotation and the square root of the value of the effective pressure head. Previous studies made on the adjustable tube meter show the rate of discharge to be equal to the square root of the difference in head multiplied by a constant, which depends upon the opening through which the water passes. The use of the buoyant turbine would require observing the time in seconds for 10 revolutions of the turbine. From a simple table the corresponding value of the square root of the difference in head is obtained which, when multiplied by the constant for any set-

ting of the opening, will give the rate of flow in cubic feet per second.

Tests were made at the laboratory on a large buoyant turbine geared to a counting mechanism for the purpose of exploring the possibilities of integrating the flow in acre-feet through the Parshall measuring flume for either free or submerged flow. Dependable rotation of the turbine was observed for effective heads of 0.003 to 0.005 foot. This study has not yet been completed.

**INTEGRATING INSTRUMENT.**—An experimental instrument has been completed and given preliminary tests in the laboratory. Field tests are expected to be made to determine the practicability of this design of meter in conjunction with a 1-foot Parshall measuring flume operating under free-flow conditions.

**VORTEX TUBE SAND TRAP.**—For the purpose of demonstration and further study of this type of sand trap, there has been constructed in the Jackson Ditch, at the Bellvue laboratory, a concrete vortex tube, in cooperation with the ditch company. This sand trap replaces a temporary structure which has been operated in this ditch over the past 4 years. The new trap will permit further study of this type of sand trap when operated under practical field conditions.

**RIFFLE DEFLECTOR-VORTEX TUBE SAND TRAP.**—There has been built and tested at the Bellvue laboratory a model of a riffle deflector-vortex tube sand trap for the New York Canal at Boise, Idaho, which has a capacity of 2,800 second-feet. The trap in this canal is to serve two purposes: First, to rid the canal of its bed load and, second, to determine the quantity and nature of the material carried. This second consideration is a matter of vital interest in connection with the study of erosion in the Boise Valley now being conducted by the Forest and Range Experiment Station, United States Forest Service, at Ogden, Utah. The riffle deflector is an obstruction of such a design that when placed on the bed of the canal the bed load is moved laterally to one side and then removed through a short length of vortex tube. Because of the bottom width of the New York Canal (40 feet) the present plan is to move the bed load to the center of the channel and discharge into a narrow compartment which is outletted through a suitable conduit under the bank of the canal.

The problem of sampling the effluent from this large sand trap is now under consideration. An automatic electrically controlled sampling apparatus has been designed and built to determine by laboratory tests the ratio of discharge, both sand

and water, that will be extracted from the issuing stream from the sand trap.

A riffle deflector sand trap has been in operation during the past year in the C. F. and I., Arkansas Valley Canal, near Pueblo. This trap is not provided with vortex tubes; however, it is reported that this structure has been very effective in relieving the canal of its excessive bed load. The capacity of this canal is about 250 second-feet.

In western Nebraska, near Mitchell, there has been built one of these sand traps, equipped with vortex tubes. At this time nothing is known as to its efficiency.

**SIPHON TYPE OF SAND TRAP.**—A suggested design of sand trap, utilizing the principle of the siphon, has been prepared and a model is being built to enable a study of the possibilities of this device. In the Arkansas Valley in Colorado, and elsewhere, conditions are found where the bed of the canal is at or below the elevation of the river bed and because of this condition it is difficult, if not impossible, to sluice the deposit from the canal back into the river channel. It is the intention to lift the bed load in the canal by siphonic action and deposit it in the river. The water elevations then become the criterion rather than the relation between the beds of the channels.

**FARM LATERAL LINING.**—A 90-foot section of a small lateral near Wellington was lined with cotton fabric and tar in October 1938. Since placing this lining there has been no water in the lateral, and at this time nothing can be said as to its efficiency or lasting qualities other than that frost action during the winter did not damage the work. Further experimental linings of the cotton fabric and asphaltum are expected to be placed in one or more small laterals on the College Farm.

**THE PARSHALL MEASURING FLUME.**—This type of measuring device continues in the replacement of other methods of measuring discharge, especially in irrigation canals and ditches. Several large flumes have recently been installed and are in use on a number of irrigation projects in western Nebraska.

**CURRENT METERS.**—The current meter rating station at the hydraulic laboratory over the past year has served in providing for the calibration of meters sent in from Nebraska, Utah, and the International Boundary Commission, as well as for the state engineers of Colorado and Wyoming and Colorado state institutions.

**HYDRAULIC LABORATORY.**—The hydraulic laboratory is being used by the Bureau of Reclamation this year, but only to a limited extent; most of their work is now being carried on in

Denver. Since January the civil engineering students of the College have also been using the facilities of the laboratory.

### Snow Survey and Irrigation Forecasts

The snow survey project is carried on in cooperation with various Federal and state agencies, irrigation companies, and municipalities. These organizations, in addition to assisting in the work, in many instances made substantial contributions of funds for the project. During the year several courses were abandoned, some were relocated, and a few new courses were established. Snow measurements were made on 68 courses in Colorado, 34 in Wyoming, 13 in New Mexico, and 7 in Arizona. The results of the observations on the snow courses in Utah and Montana on the drainages of the Colorado and Missouri rivers are also reported to our office.

Stream flow forecasts based on the snow survey measurements were issued monthly, from February to May inclusive, for the Colorado, Missouri-Arkansas, and Rio Grande watersheds. In addition, a weekly report based on information telegraphed to us each Friday, concerning snow cover in Colorado and portions of Wyoming and New Mexico, was issued each Saturday from January 14 to May 27. Each issue of the monthly forecasts consisted of about 2,000 copies, and each issue of the weekly report, of about 375 copies. The reports were mailed to individuals and organizations interested in the prospective water supply.

The work of correlating the snow course measurements and the stream flow records was started this season. Although the snow course observations have not been carried on long enough to draw definite conclusions, the results indicate that there is considerable variation in the correlation between snow cover and runoff for different streams. However, where records have been kept for a period of years, as shown by investigations in other states, a close relation has usually been found.

The importance of the safety of the men who make the monthly snow surveys in the high mountain country cannot be stressed too much. As a protection to the men, shelter cabins are planned for those areas in which the survey work is particularly hazardous. Such a shelter has been designed, known as the Colorado type of cabin, which is about 14 by 16 feet in plan and is large enough to accommodate four men. The cabins are to be stocked with provisions and supplies in the late fall for use by the snow surveyors during the following winter months. Funds have been solicited from irrigation companies in Nebraska to build such a shelter cabin near Encampment, Wyo.



### **Pumping for Irrigation**

Less pumping from wells was done in 1938 than in the previous year, according to records of the electric utilities companies serving pumping areas. This was due to the heavy rainfall in early September. New irrigation wells were being drilled at a fair rate until September when the demand fell off sharply. Little field work was done during the season on pump and well testing.

The semi-annual observation of the water table in pumping areas was continued.

The third season of study on the effect on potatoes of cool ground water as compared to warm surface supplies still showed no significant difference in yield. This study is being carried on in cooperation with the Agronomy Section of the Station and the Bureau of Plant Industry of the United States Department of Agriculture.

The manuscript for a farmers' bulletin on "Small Irrigation Pumping Plants" was prepared in collaboration with Mr. M. R. Lewis of the Bureau of Agricultural Engineering.

### **Meteorology**

The usual record of weather observations continues to be taken twice daily. A text and tables have been prepared for a bulletin summarizing, and in some cases analyzing, weather data taken at this station over the period 1887-1936. The evaporation equipment has been overhauled and old records are being recalculated and summarized. Data concerning the weather are released daily to the local newspaper and frequently to many organizations and individuals.

### **Miscellaneous Activities**

**WOODWARD DAM.**—During the period from July to November, inclusive, Mr. Carl Rohwer was temporarily transferred to Woodward, Okla., to build an irrigation system for the Southern Great Plains Field Station of the Bureau of Plant Industry. This project consists of a storage reservoir and a pipe distribution system with pumps for providing pressure to operate sprinklers by means of which the land is to be irrigated.

**FALL CREEK DAM.**—Engineering assistance was given the Forestry Section in the building of an earth dam located on Fall Creek above Pingree Park. The lake created will be used for recreational purposes.

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## Pathology and Bacteriology Section

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### Animal Pathology

#### Poisonous Plants

**SILKY SOPHORA.**—Work with silky sophora, which has been under suspicion for a number of years, has been continued. Two mature cattle did not eat the weed readily when placed in a restricted pasture where the weed was prevalent. A mature animal was force-fed the ground plant without evidence of toxicity. Combining the work of last year with this, it seems that the plant may now be said not to be toxic for either sheep or cattle.

**BAHIA OPPOSITIFOLIA.**—This plant, which by routine tests conducted by the Botany Section had been found to contain hydrocyanic acid, showed toxic effects when force-fed to a steer, a ewe, and a guinea pig. It was not fatal, however, in the amounts fed to any of these animals.

**KOCHIA SCOPARIA**, (fireweed).—This common plant has frequently been suspected of causing death of cattle. A 3-year-old heifer and a mature sheep were fed this material for varying lengths of time without evidence of toxicity.

**OXYTENIA ACEROSA** (Nutt).—This plant, suspected by ranchers in the western part of the State as being poisonous to cattle, was identified by the Botany Section. When this weed was force-fed to two lambs, both died within 12 hours. When it was fed to two starved rabbits, death followed. Confirming previous suspicions, this plant can now be listed as being poisonous to sheep and rabbits.

#### Bang's Disease

The station herd at Avon contained 23 positive and 17 suspicious animals when tested for Bang's disease in November 1936. By repeated testing the disease had been reduced to one reactor and four suspicious animals in January 1939.

Routine testing of blood samples in cooperation with the Federal Bureau of Animal Industry has continued during the past year. Since the previous report, 58,709 blood samples have been tested, 1,831 (3.2 percent) of which were positive.

#### Sheep Losses

**PARASITES.**—Routine examination of feces and of the carcasses of dead lambs has been continued for the purpose of de-

termining the prevalence of coccidia and parasite eggs. Coccidia have been found in lambs as young as 1 month of age and are generally present in both feeder and range animals. In a series of 199 lambs and 5 ewes autopsied this year, 41 showed fringed tapeworms in the liver, 39 in the intestines, and 19 in both intestines and liver, making a total of 61 (29.9 percent) of the animals parasitized. Of the 191 lambs whose feces were examined microscopically, 165 showed coccidia; 24, stomach worms; 3, *Nematodirus filicollis*; and 3, whip worms. In the 104 lambs dead from overeating, 33 (31.7 percent) showed fringed tapeworms in the liver; 30 (28.8 percent), in the intestines; and 17 (16.3 percent), in both intestines and liver, making a total of 46 (45.1 percent) animals harboring this parasite.

COCCIDIOSIS.—In connection with another experiment, 49 lambs were available for individual fecal examinations. A microscopic examination and coccidial count were made on the feces of each lamb every 3 weeks for a period of 120 days. Corroborating previous observation, a rather rapid rise in numbers of coccidia was noted during the first month. During the second month a rather rapid decline was observed which became more gradual until in the fourth month very few or no coccidia were found.

HYDROGEN-ION DETERMINATIONS.—Since it was thought that the hydrogen-ion concentration in the intestinal tracts of feeder lambs might be a factor in the development of *Cl. welchii*, thus precipitating outbreaks of what has previously been styled overeating, pH determinations have been made on a series of 85 lambs dead of various diseases:

Disease	Number	Duodenum	Jejunum	Ileum
Overeating	46	6.17	6.50	6.69
Pneumonia	6	6.10	6.95	6.67
Coccidiosis	8	6.79	7.57	7.79
Other diseases	24	6.45	6.80	7.08
Slaughter	1	6.10	6.38	6.92

INTESTINAL FILTRATES.—The intestinal filtrates from 54 cases of overeating were studied for their toxicity, using rabbits and white rats. Forty-four were toxic, one slightly toxic, and nine non-toxic. The filtrates from 33 lambs dead of other diseases showed 1 toxic, 1 slightly toxic, and 31 non-toxic.

One hundred and twelve bacterial cultures, physiologically resembling *Cl. welchii*, have been isolated from the intestinal tract of lambs dying in the feedlots. At this time, 46 of 80 cultures from overeating cases have been tested and found path-

ogenic for mice, and 14 of 32 cultures isolated from lambs dead of other diseases so tested killed mice.

**URINARY CALCULI.**—An outbreak of coccidiosis was observed among feeder lambs on seven different rations in the calculi experiment. The results were as follows:

Lot	Diet	Scouring	Deaths	Culls (coccidiosis)	Calculi
1	Alfalfa, yellow corn, molasses	14	1	4	0
2	Alfalfa, yellow corn	10	3	2	0
3	Alfalfa, yellow corn, bran	14	6	1	0
4	Beet tops, yellow corn, molasses, straw	23	3	3	0
5	Cane, yellow corn, bran	9	0	2	1
6	Cane, white corn, bran	13	1	0	5
7	Cane, yellow corn, molasses	14	2	0	0

There were from 93 to 95 lambs in each lot. Seven lambs were selected from each lot and the urine was collected from each lamb for a period of 3 days. One case of calculi occurred in lot 5 and five cases occurred in lot 6.

### Thyroid Gland in Feeder Lambs

A histo-pathological examination of the thyroid gland of about 150 lambs has been made during the past feeding season. Many of these glands are showing changes indicating iodine deficiency at the time the lambs enter the feedlot. This study is not yet completed.

### Equine Encephalomyelitis

For the sixth time in 7 years equine encephalomyelitis ravaged the horse population of the State. Veterinarians reported 4,384 cases with a mortality of 639 or approximately 15 percent. Wide use of chick vaccine resulted in a very satisfactory control of the malady, very few animals taking the disease after vaccination.

**MOSQUITO TRANSMISSION.**—Using *Culex tarsalis* (5 cages, each containing 100 to 176 females), the virus of equine encephalomyelitis was not transmitted from infected guinea pigs to normal guinea pigs. Three species of mosquitoes, *A. vexans*, *A. dorsalis*, and *A. nigromaculus*, whose ability to transmit the virus has been proved by other investigators, were identified in the vicinity of Fort Collins, Colo.

### Poultry Diseases

**IODINE REQUIREMENTS OF CHICKENS.**—The study of the iodine requirements of chickens, in cooperation with the Poultry Section, has been continued during the past year. Goiter, characterized by hyperplasia of the thyroid, was produced on low

iodine rations. The study in the second generation of chickens includes experiments to determine the minimum requirements for iodine to prevent the development of goiter.

Cooperation with the National Poultry Improvement Plan has continued, resulting in 32 examinations being given to quality agents for pullorum testing. Tests were also made of all antigens to be used in this work.

**VITAMIN A DEFICIENCY IN TURKEYS.**—This project is carried on in cooperation with the Poultry Section. Young poults on a vitamin A deficient diet exhibit symptoms of a nervous disorder but show no gross lesions. After the birds are older, a few, but by no means all, show eye and throat lesions. This is in marked contrast to the pathological picture shown by chickens.

### **Diagnostic Work**

Approximately 865 diagnostic examinations have been made by the Section. During this period, 3,743 blood samples were tested for Bang's disease.

## **Soil Microbiology**

### **Decomposition of Organic Matter**

Work on this project with special reference to cellulose has continued to deal with the decomposition of cellulose by aerobic bacteria. Studies on factors influencing the rapidity of decomposition have been made by measuring the residual cellulose following decomposition and by determining the amount of carbon dioxide evolved by the organisms. For a single organism, determinations have been made of the mineral nutrients required and of the effect of oxygen concentration.

A study has been completed on the effect of moisture content upon the rate of decomposition of various forms of organic matter in the soil. Changes in the number of soil micro-organisms, the rate of carbon dioxide evolution, and nitrification as influenced by soil moisture have been studied. It is hoped that results of this work and its extension will indicate desirable practices for maintaining soil organic matter under Colorado conditions. An analysis of the Russian thistle plant, which contributes a large amount of organic matter to Colorado soils, has been completed.

### **Studies on *Azotobacter***

Ecological and physiological studies on *Azotobacter* arose from the isolation of a strain of *Azotobacter* which appears to have been seldom described from American soils. Investigations concerning its distribution and its physiological characteristics are in progress.

### Miscellaneous Activities

Some preliminary work has been done on the production of organic acids from farm wastes such as the cantaloupe residue left from seed production.

In cooperation with the Botany Section, investigations have been made concerning the hydrocyanic acid content of *Suckleya suckleyana* as influenced by season of year, stage of plant growth, and soil conditions. Determinations for 1 year have been accumulated. It is thought that investigations for another season will make possible definite conclusions regarding conditions under which greatest toxicity of the plant may be expected.

Help has been given the Horticulture Section on soil micro-biological problems arising from the steaming of greenhouse and nursery soils. The effect of partial sterilization on Colorado soils should receive further investigation because of its importance to the vegetable and flower industries.

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## Special Research Fund

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The titles of the following papers indicate the general scope of the work so far completed and of the projects in progress under the special research fund for the Department of Physiology, Division of Veterinary Medicine.

1. F. X. Gassner. Coccidiosis in Dogs. Accepted by the research section of the National Convention of the American Veterinary Medical Association and to be presented in August 1939 at Memphis, Tenn.

2. E. Hays, F. X. Gassner, and R. G. Gustavson. The Effect of 2-4 Dinitrophenol on the Thyroid Gland of the Rat and the Fowl.

3. E. Hays, F. X. Gassner, and R. G. Gustavson. Microdetermination of Iodine in the Thyroid Gland of the Rat. The Influence of Estrin upon the Relationship of the Ovary to the Thyroid.

4. F. X. Gassner, E. Hays, and R. G. Gustavson. Histology of the Thyroid, Ovary, and Uterus of the Rat Fed on an Iodine-deficient Diet.

5. F. X. Gassner, H. S. Wilgus, Jr., and R. G. Gustavson. The Goitrogenic Property of Soybeans. (Preliminary report of the work completed on the rat and the fowl, including histology of the thyroids, ovaries, and adrenals).

6. F. X. Gassner. A New Staining Technic in the Study of Endocrine Glands with Special Reference to the Thyroid of the Rat and Fowl.

7. F. X. Gassner. An Improved Torch for the Microdetermination of Iodine in Biological Material.

8. F. X. Gassner. Endometrial Biopsy in Domesticated Animals. A new instrument developed.

9. F. X. Gassner. Quantitative Determination of Estrogenic Substances in the Urine of the Cow.

10. F. X. Gassner. Histological Study of the Genital Tract of the Cow During the Normal Oestrus Cycle and Early Pregnancy.

The work on projects 1 to 8 has been finished and the papers are in preparation. Projects 2, 4, 5, 8, 9, and 10 are being continued.

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## Poultry Section

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On July 1, 1938, Dr. A. R. Patton, formerly assistant professor of animal nutrition at the University of Arkansas, assumed duties in the Poultry Section as research assistant, his training being in chemistry, biochemistry, and animal genetics. Most of Dr. Patton's time is being devoted to the investigatorship started here at that time by the Iodine Educational Bureau, Inc., of New York.

### Vitamin G Requirements of Turkey Breeders

Vitamin G assays of the experimental diets used in the 2 previous years of this study indicate that the vitamin G requirement of turkeys for hatchability is about the same as that of chickens. The results for the spring of 1937 showed that the requirement is over 200 units and approaches a satisfactory level at 245 units of vitamin G per 100 grams of ration. The data for the spring of 1938 showed that a level of 435 units was no better than one of 310 units and that 210 units would give fair results.

During the spring of 1939, 6 lots of 25 turkey hens each are being fed rations ranging from 210 to 310 units of vitamin G per 100 grams of ration. Owing to improved hatching conditions, good results are being obtained on the lowest level, but the best hatches are coming from the hens receiving the 250-unit ration. A study of poult growth and mortality during the first 6 weeks from the various pens will serve as important criteria in evaluating these results.

During the first 12 weeks, the six lots of turkeys were divided, one pen of each lot being housed in close confinement and the other in an open shed with a small, bare yard. Electric lights to make a 14-hour day were started January 1. Egg production started during the fourth week in the confined pens and at the end of the fifth week in the open-shed pens. The confined

pens reached peak production much more rapidly, but fertility and hatchability tend to favor the outdoor pens as they did last year.

### Sources of Green Feed for Poultry

A basal diet for the assay of vitamin G has been evolved which consists essentially of corn, oatmeal (20 percent), soybean oil meal (15 percent), casein, and mineral and vitamin supplements. A special molasses has been used at the 5 percent level to assure sufficient "filtrate factor." This has been supplied by a commercial feed manufacturer and was found to be free of flavin. Nicotinic acid would not replace the molasses. This diet is capable of supporting excellent growth when supplemented with pure crystalline flavin. Growth was not increased by replacement of part of the flavin with an equivalent number of units of flavin from dried pork liver.

With this diet successfully evolved, it has been possible to assay diets and samples used in the previous 2 years in the turkey studies as reported above. A sample of dried buttermilk was found to contain 28 units of vitamin G per gram.

The comparative vitamin G requirements of various strains and breeds were studied. While marked differences were noted, the numbers of chicks used were too small to permit high significance. The results do indicate the necessity for confining experimental work of certain types to a single source of stock. On the other hand, the application of experimental findings should be made on different breeds of chickens to assure general application.

In another phase of this project, the vitamin A requirement of turkey poults was investigated in order to attempt verification of similar work reported from another station. This problem is of pressing importance in Colorado, owing to the widespread prevalence of vitamin A deficiency in poultry.

Poults on the basal diet were all dead early in the fourth week. To prevent mortality, 400 units were required. Growth was closely correlated with vitamin A intake up to 600 units per 100 grams of diet. Necrosis of the beak and nasal inflammation and congestion, owing to the use of considerable finely-divided yeast and oat groats, interfered with growth in this experiment.

Further observations were made on the experimental grass range, this work being in cooperation with the Range and Pasture Management Section. These substantiated earlier observation showing that Kentucky bluegrass and crested wheatgrass are better utilized and more persistent for a heavily grazed poultry range than buffalo grass, blue grama, mountain brome, or smooth brome.



### Trace Elements in Poultry Nutrition

The fact that calcium and phosphorus salts in excess quantities in chick rations produce the common disease known as slipped tendon or perosis is universally recognized. The belief has been that this effect was due to excess phosphorus. Work at this Station has shown that phosphorus alone added to a ration moderately low in calcium is not causative and may be slightly beneficial. However, when calcium is added to rations already fairly high in phosphorus, perosis is aggravated.

This led to the hypothesis that possibly the excess calcium and phosphorus, when reprecipitated in the intestines, renders manganese less available. Manganese has been shown to be specifically required to prevent perosis. Laboratory tests showed that freshly precipitated calcium phosphate does adsorb or combine with manganese, rendering it insoluble. These results were substantiated by *in vivo* experiments and have been published.

The addition of 100 parts per million of zinc, aluminum, boron, or barium, or of 50 parts per million each of molybdenum, lead, or cobalt to the simple basal diet used in perosis studies had no marked effect on growth except in the case of cobalt. The salt of this element caused the feed to become rancid in about 2 to 3 weeks after mixing.

### Iodine Requirements of Poultry

In the first year on the iodine requirements of poultry project, goiter in chickens has been produced experimentally. This finding has established a basis on which to proceed successfully to determine the iodine requirements of poultry throughout life. This work takes on added significance by the fact that the Fort Collins water supply has been found to be free of iodine and grains grown locally and in eastern Colorado were found to be very deficient.

In the first experiment, the birds are now in their second year of life. Moderately pronounced goiter has resulted in no difference in body weight until time of sexual maturity, when birds on the deficient ration failed to gain normally. They have remained consistently smaller. Thyroid glands have been enlarged. Histological examinations showed marked hyperplasia and absence of colloid until after sexual maturity, when the type of goiter appears to be colloid in nature.

Some trouble has been experienced with the rations for chicks in subsequent work, growth being very unsatisfactory. Much time has been spent in attempting to improve the diet. The type of ration used in the vitamin G studies here has been found to give superior growth.

Even with unsatisfactory rations, the low iodine contents obtained by analysis and selection of ingredients has produced thyroid enlargement exceeding 25 times normal weight for pen means, and about 50 times normal for several individual glands. Normals have been arbitrarily designated as those glands produced by the use of 5,000 parts per billion of iodine in the diet. Glands approaching normal weight were produced on an iodine level of 300 to 400 p. p. b., but the glands were not normal histologically.

Preliminary results show that raw soybeans are "goitrogenic" when compared to casein, that autoclaving soybeans for 2 hours at 15 pounds destroys part of the goitrogenic effect, and that the effect is in the extracted residue rather than in the oil. Work on this phase is being pushed energetically in cooperation with the Pathology and Bacteriology Section here.

The project is supported largely by funds from the Iodine Educational Bureau, Inc.

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## Range and Pasture Management Section

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The proper utilization and continued productivity of the native range resource is of vital importance to the welfare of Colorado. The program of range research is outlined to obtain more adequate knowledge of the natural revegetation of Colorado's native range plants; the variation in annual forage production as affected by climate; the use of different forage plants at various seasons of the year as affecting seasonal gains in livestock; comparison of methods of grazing in terms of annual grazing capacity; chemical analyses of range forage at various seasons of the year; the effects of different methods of irrigation upon native hay production and vegetation composition in mountain meadows; range forage surveys in various parts of the State; testing forage species and methods in artificial re-seeding; and the comparison of various methods of eradication of sage brush.

### Natural Revegetation of Native Ranges

Studies to determine the effects of various methods of grazing upon the shortgrasses (blue grama and buffalo grass) and western wheatgrass were continued. A gradual improvement of the grasses has taken place the past 2 years in the experimental pastures. The number of cattle grazed in the pastures the past 2 years was reduced to the actual grazing capacity,

and grazing in the spring was deferred until the grasses had made substantial growth. The spring precipitation in April, May, and June during the past 2 years was about normal while the summer precipitation in July and August was 47.0 percent below normal. Studies show, however, that western wheatgrass and green needlegrass are more dependent upon spring precipitation for their growth, while blue grama and buffalo grass, because of their higher temperature requirement, make their maximum growth in July and August. Because of the deficient precipitation during the past 2 years in July and August, these shortgrasses have not recovered as rapidly in plant area and vigor as have western wheatgrass and green needlegrass. Furthermore, the deficient precipitation in the summer both reduced the forage growth of the shortgrasses and seriously affected seed production. In spite of the droughty summers, there was sufficient range forage for the livestock to make satisfactory gains.

Seasonal gains of livestock in pastures were closely correlated with utilization of the various range grasses; in the spring months, western wheatgrass was the principal forage but its feed value and palatability declined as the grass became coarser and drier; in the summer months, blue grama and buffalo grass, in spite of their poor growth, constituted the main feed. Chemical analyses of forage samples collected in the late August dry period showed that blue grama had one-third more protein than western wheatgrass.

In some years, climatic conditions in the fall are favorable for aftermath growth of certain range grasses. Utilization studies showed that cattle grazed about 50 percent of the western wheatgrass and green needlegrass aftermath growth. Chemical analyses showed that both grasses were extremely high in protein.

The pasture project is in cooperation with the Animal Investigations Section.

A study was started last year in cooperation with Mr. Charles Lilley, a livestock operator near Virginia Dale, to determine: (1) The rate of decline in nutritive values of important range grasses throughout the growing season and the following winter and early spring, and (2) the loss of forage volume throughout the winter and early spring. The need for such information is to ascertain the value of reserving range forage for winter grazing as compared to feeding native hay.

#### Artificial Revegetation

Pertinent problems that demand considerable attention are : (1) The restoration of abandoned croplands to a produc-

tive cover of grass, and (2) the improvement of deteriorated native range where artificial means are necessary. Results obtained in the experimental grass nursery, while not exactly comparable with field conditions, are in a measure indicative of what may be expected.

**ADAPTABILITY OF INTRODUCED GRASSES.**—Four years' results of testing various introduced grasses (other than smooth brome and crested wheatgrass) show that 6 out of 19 are promising under our climatic and soil conditions.

**SOURCE OF NATIVE GRASS SEED.**—Plants grown from blue grama seed obtained from various sources show characteristic differences in habit of growth. The Montana source of blue grama produces smaller plants and shorter basal leafage and matures its seed from 9 to 21 days earlier than Colorado blue grama. The Amarillo, Tex., seed produces more vigorous basal leafage and immature seed.

**DATE OF SOWING RANGE GRASSES.**—Tests show that spring sowings of blue grama, sideoats grama, green needlegrass, and western wheatgrass are more successful than fall sowings under Colorado conditions. Crested wheatgrass and smooth brome may be sown successfully either in the late fall before the soil is frozen or early in the spring.

**RATES OF SOWING.**—Successful stands of blue grama were established by sowing seed of 40-percent germination at a rate of 4 pounds per acre in 36-inch rows, 8 pounds in 24-inch rows, and 12 pounds in 12-inch rows.

**SEASONAL FORAGE YIELDS.**—Commercial crested wheatgrass in 1938 outyielded smooth brome in forage production in both spring and fall. However, smooth brome produced more forage in the summer and a greater total annual yield than the commercial crested wheatgrass.

**TRANSPLANTING SOD CUBES.**—Transplanting sod cubes of grasses that revegetate rapidly either by surface runners or underground rootstocks may be the ultimate solution of artificially restoring abandoned croplands in many areas where seeding is not practicable. The results of a 3-year study show the value of the method. Western wheatgrass sod cubes spaced 4 feet apart covered the bare ground in 2 years. Buffalo grass did not spread as rapidly as western wheatgrass but formed a more complete cover. Crested wheatgrass, a bunch grass, spaced at 4-foot intervals, increased rapidly by reseeding naturally the intervening spaces.

### Native Hay Meadows

The mountain meadows of Colorado are of importance to

many livestock operators because they are needed either for hay production or livestock grazing. Most mountain hay meadows are continuously irrigated throughout the growing season year after year. It is believed that this irrigation practice has been responsible for the gradual increase in sedges and rushes and the decline in hay grasses. Studies were started in 1932 in North Park to ascertain how continuous irrigation influenced annual hay production and the vegetation composition of the meadows. Two other practices were tried out, namely, an early intermittent system in which irrigation starts on or about May 15, is continued for 3 days, then is discontinued for 3 days. The practice was continued until about July 15. The third practice was similar to the second one, except that the irrigation was started 15 days later, or on June 1 each year.

The 6 years' record shows that the yield of hay was primarily influenced by the manner of irrigation. Better yields were obtained every year under the continuous plan except in 1933. In this period, the average yield in hay under continuous irrigation was 10.8 percent greater than under early intermittent and 27.7 percent greater than under late intermittent.

A consistently better stand of timothy was maintained where the late intermittent irrigation practice was followed. The stand of sedges and rushes increased under continuous irrigation. Alsike clover, however, increased very slowly.

### **Improvement of Sagebrush Lands**

Studies conducted in North Park on dense sagebrush lands since 1932 show the value of certain methods in eradicating sagebrush. In 1938, the highest density of grasses occurred on the burned plots. However, only 36.0 percent of the grasses were ranked as very good to excellent forage, as contrasted to 64.7 percent on the scraped plots and 84.1 percent on the railed plots.

A significant increase in grazing capacity is noted on the burned, scraped, and railed areas as compared to the present grazed sagebrush area. Where heavy sagebrush is removed by burning, scraping, or railing, it is estimated that the grazing capacity may be increased from 30 to 40 percent for cattle. Burning is not recommended as a general practice, especially on sloping lands where there is a possibility of erosion.

### **Range Resource Surveys**

Agricultural resource surveys were conducted during the past 3 years in Washington and Elbert Counties to determine the extent and location of the native range areas, farmed croplands, and abandoned croplands. The information is essential

to develop future agricultural programs in the Great Plains region of the State.

Washington County is in the "heart" of the dry-land farming area of the State. At the present time, native range lands comprise 52.1 percent and dry farming lands 47.0 percent of the county area. A small area of irrigated land is located in the northwest corner of the county. In the better hard-land soil areas, most of the land is farmed by dry-land agriculturists. The native range in these areas consists chiefly of small, scattering, overgrazed 40- or 80-acre pastures.

Constant overutilization by livestock and recurring droughts are responsible for the greatly reduced productivity of the native ranges throughout the county. Blue grama and buffalo grass still remain the dominant palatable grasses but are greatly reduced in density and vigor. Better climatic conditions and better management practices are necessary to restore them to their former productivity.

Elbert county lies southwest of Washington county. It is an important range and agricultural county. The western part of the county extends into the Black Forest region where range livestock and dry-land farming are important. Because of recurring droughts and type of farming in the southeastern part of the county, wind erosion is severe, while in the western part, an area of rolling topography, water erosion is active on agricultural and depleted range lands. Serious floods in 1935 ruined many valuable meadow lands.

There are extensive areas of splendid blue grama ranges throughout the county. Many conservative livestock men have large ranch holdings through the county.

Satisfactory progress has been made during the past fall and winter on compilation of field data and drafting maps.

### Cooperative Projects

Cooperative projects are to be continued: (1) With the Poultry Section to determine the sources of green feed for poultry, (2) with the Animal Investigations Section on summer and winter range feed problems, (3) with the Chemistry Section on chemical analyses of native range plants, and (4) with several reliable livestock operators on different phases of artificial reseeding.

### Personnel

Mr. Conrad Brown, graduate assistant, resigned on October 1, 1938 to accept a graduate assistantship with the Department of Botany at the University of Wyoming.

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## Rural Economics and Sociology Section

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### Type of Farming Areas in Colorado

In studies of type-of-farming areas, assembling financial records in the Greeley area has been continued. The cash available for investment and family living on these farms indicates that these men had net cash incomes in 1938 that were only 49 percent of the 1931-32 average and less than 16 percent of the 1937 average, thus pointing to the fact that 1938 was one of the most unfavorable years. A disastrous sheep feeding season in the winter of 1937-38 and low crop prices during 1938 were the chief causes for this low income.

### Landlord and Tenant Income in Colorado

An analysis of landlord and tenant relationships was completed in October 1938. The chief objectives of this study were to show the division of receipts and expenses and income under actual farm conditions; to point out the effect of changing conditions upon incomes; and to suggest flexible terms in leases which should result in a reasonably fair division of income under a wide variety of conditions. This study emphasizes the need for frequent inspection of leasing arrangements and a cooperative desire on the part of both landlord and tenant to work out a lease that will be fair to both parties.

### Dry Farming in Northeastern Colorado

Thirty-one farmers in northeastern Colorado cooperated in keeping a set of farm account records of their farm business in 1938. Most of these farms are located in type-of-farming area No. 12 in Phillips, Sedgwick, Washington, and Yuma Counties. The purpose of this study is to provide additional means by which farmers may solve, in some degree, their own economic problems. A careful analysis of the farm account records from year to year suggests ways in which desirable adjustments may be made, thereby increasing the farm income.

### Range Livestock Industry

Thirty ranches were visited in northwestern Colorado during the year, and valuable data and interpretations were secured which will aid in the analysis of the causes of variations in lamb and calf production and the effect of these variations upon income. It is hoped that data from a wider area can be obtained in 1939-40 to check up findings to date and to make the observations and conclusions serve a wider area. Ranch profits are

modified and controlled by (a) the size of the ranch business, (b) efficiency in the use of labor, (c) proper care of herds in order to maintain good condition during the winter, (d) taking the necessary precautions to insure a high percentage of calf or lamb crop, (e) a proper appraisal of market trends and conditions, and (f) the managerial ability of the ranch operator.

### **Farm Tax Delinquency in Colorado**

A study of farm tax delinquency was made in 26 representative agricultural counties in cooperation with the Works Progress Administration. This analysis covers a period of 9 years, beginning in 1928 and continuing through 1936. The report which was prepared during the past winter shows that there has been a perceptible decrease in the amount of farm taxes going delinquent in Colorado during the past few years; however, the amount of farm tax delinquency that existed in 1937 still indicated an unhealthy situation for agriculture.

### **Restoration Land Program**

A member of our staff was assigned for a few weeks during the summer months to cooperate with the Bureau of Agricultural Economics, United States Department of Agriculture. The analysis pointed out that the restoration land program of 1938 was received in nearly all sections of the southern Great Plains area as a means of adjusting land use and of retiring from cultivation land not suited to crop production. While the principle of restoring land to permanent cover was accepted by all except a few county committees, certain elements in the restoration land phase or in other phases of the Agricultural Conservation Program led to dissatisfaction and hampered the successful assignment of acreage for restoration. Certain provisions in the restoration land program or local interpretation of these provisions made it possible for some individuals to participate in the proceeds without making a contribution to the objective of the restoration program. In accordance with this objective, some adjustments in the program can be made which would (a) increase participation by farmers, (b) reduce that portion of the acreage which will be designated for restoration but which is not likely to remain out of cultivation, (c) speed up the process of restoring permanent cover to the point where the land will have some productive value, and (d) make payments only on tracts which will be used in developing a stable, self-sustaining agriculture.

### **Rural Sociology**

In the semi-annual report submitted in November 1938, it was pointed out that the first aspect of a dual program of



research in this field will give consideration to a long-time research program in a study of population and delimitation of social sub-regions in the State. Such information should serve as a foundation for future sociological research. The second phase may be designated as service research in cooperation with such agencies as the Extension Service, the State Conference of Social Workers, and other agencies which are interested in obtaining answers to certain current problems.

### Research in Sociology

Throughout the year an attempt has been made to further the long-time and the service research which was outlined earlier. Following are the specific developments in the long-time research program:

1. Completed one bulletin dealing with educational achievements of members of rural relief households.

2. Prepared a paper which will be submitted to the Rural Sociology Magazine on research methodology. This is entitled "Some Factors Thought to be Associated with Reporting of Population Changes in Colorado."

3. Worked out and submitted to the Work Projects Administration a project dealing with population trends in Colorado as it is related to agriculture, industry, and some social problems.

4. Cooperative relationships with the Division of Social Research of the Work Projects Administration have been continued. In this program the field work has been completed in Kit Carson County on a project dealing with unmet needs in rural areas. Schedules were filled out for 150 families.

5. A continued cooperative relationship with the Bureau of Agricultural Economics has been in effect. We are repeating the study which was made a year ago that deals with changes in Colorado farm and ranch population. A new method of sampling and some other minor procedures have been used this year which it is hoped will give a more accurate picture of changes that may have taken place within the State.

Another cooperative project with the Bureau of Agricultural Economics has dealt with a study of population changes in selected Colorado counties with special emphasis upon such changes since 1930.

In the service research program the following progress has been made:

1. Worked out a series of eight community score cards for the Extension Division. These are being used by the Ex-

tension Division at the present time in their program planning.

2. Worked out and submitted a WPA project which will enable analyzing of 1,000 schedules dealing with certain aspects of the youth problem in selected areas of Colorado.

3. Work is being done on a project dealing with the housing conditions of beet laborers in Colorado. This study will be in cooperation with the Farm Security Administration and the National Youth Administration.

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## Seed Laboratory

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The amount of work the seed laboratory does each year is based entirely on the income.

With a constantly decreasing income, the seed laboratory has a constantly increasing demand from farmers, dealers, and investigators for seed testing. The appropriation for the seed laboratory for the 1937-1939 biennium was \$10,000. For the second year of this biennium, only \$2,400 has been paid. Fees for seed testing for the same period are approximately \$1,200. It has been found that if fees are increased to cover the entire cost of seed testing the number of samples decreases so that the total amount received is less than with the moderate fee.

No inspection work has been possible with this small income; hence the pure seed law, which the seed laboratory is charged with enforcing, is entirely unenforced.

On April 1, 1939, the seed laboratory was closed for lack of funds. Hundreds of samples have been received and remain untested. The assistant seed analyst and student assistant have been dismissed. The seed analyst has been transferred to the Experiment Station payroll, and is continuing various experimental studies with seeds which have been in progress since 1920. Samples have been tested as follows:

Current field and lawn seeds.....	1,327
Current vegetable seeds .....	531
Survey samples .....	172
Investigational samples .....	574
Total samples .....	2,604

Source of current samples: 40 percent direct from farmers; 15 percent from Seed Registration Service; 45 percent from dealers.

Survey samples were taken from the drill as farmers were planting in several communities. They indicate that farmers plant a great many of the weeds which they later spend money to control.

Investigational samples were tested to ascertain: (1) Germination of crabgrass in connection with crabgrass control experiments; (2) longevity of stored seeds; (3) frost injury to immature oats; (4) hard seeds in alfalfa and sweet clover; (5) germination of weed seeds.

The following papers are in preparation: (1) "Germination of Crab Grass Seed;" (2) "Persistence of Hard Seeds in Alfalfa and Sweet Clover," and (3) "Vitality Tests—Hard Seeds of Alfalfa."

A paper in the process of being published is: "Effect of Relative Humidity, Viability, and Moisture Content on Respiration of Wheat." (Joint publication, Robertson, Lute, and Gardner in Journal of Agricultural Research.)

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## Editorial Service

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The Station Editorial Service during the year 1938-39 has issued the following publications:

### Popular Bulletins

No.

- 447—"Black Stem Rust Control in Colorado," by E. A. Lungren and L. W. Durrell.
- 448—"Lamb Diseases in Colorado Feedlots," by I. E. Newsom and Frank Thorp, Jr.
- 449—"Sorghums in Colorado," by J. F. Brandon, J. J. Curtis, and D. W. Robertson.
- 450—"Alfalfa in Colorado," by D. W. Robertson, R. M. Weihing, and O. H. Coleman.
- 451—"Landlord and Tenant Income," by R. T. Burdick.
- 452—"Looped Wire for Concrete Reinforcement," by Adrian R. Legault.
- 453—"Economics of Sugar Beet Production in Colorado," by R. T. Burdick.

### Technical Bulletins

No.

- 25—"A Basis for Rating the Productivity of Soils on the Plains of Eastern Colorado," by Lindsey A. Brown.

### Quarterly Bulletins

Vol. I, No. 1, Colorado Farm Bulletin, January-March 1939.

Vol. I, No. 2, Colorado Farm Bulletin, April-June 1939.

## Annual Report

Fifty-First Annual Report, Colorado Experiment Station.

Fewer publications were issued during the latter part of the year because of budget limitations, due in part to the fact that a number of bulletins dated in the preceding year were not delivered until the first half of this year, necessitating payment for them from this year's budget.

The office has on hand, awaiting publication, the following manuscripts:

"Colorado's Poisonous and Injurious Plants," by L. W. Durrell and I. E. Newsom.

"Controlling the Tomato Psyllid," by George M. List.

### "Colorado Farm Bulletin"

In January 1939 the Station Editorial Service, under instructions by the Director, began publication of a quarterly bulletin entitled "Colorado Farm Bulletin." This bulletin, consisting of 20 pages, is devoted to "presenting in popular form and with seasonal timeliness the findings of scientific research, with resultant recommendations." This information is presented in brief, readable articles prepared by the various members of the Station staff. It is mailed each quarter to a mailing list of 4,000 persons carefully selected with the assistance of various farm leaders and staff members.

The letters of appreciation for the quarterly publication which have come from farmers throughout the state make it appear that this is one of the most valuable forms of publications issued by the Station.

### Miscellaneous Activities

During the year the Station Editorial Service has continued its policy of assistance to Station staff members and to other groups at the College in editing manuscripts for publication in scientific and popular publications. Assistance has also been given in many instances to Staff members preparing public addresses.

Other miscellaneous activities of the Station Editor during the year have included the following:

Monthly editing of "Timely Poultry Tips," a mimeographed poultry news bulletin issued monthly by the Poultry Section, in cooperation with the Extension Service.

Preparation of a newspaper article regarding the work of the Station.

Delivering two addresses before farm community meetings upon the work of the Station.

Compiling of material, with the cooperation of section heads, regarding the work of the various sections of the Station. This material was presented in an address delivered at a dinner meeting in Fort Collins on December 13, 1938 at which members of the State Board of Agriculture were guests of the Experiment Station Staff Association. Later this material was made available for distribution in mimeographed form.

### Personnel

By action of the State Board of Agriculture on February 15, 1939, the Station Editor was transferred, effective on April 12, 1939, to become Secretary-Treasurer of the Board. Since the transfer, the Editor has continued at night and on Saturday afternoons and Sundays to do the work of the Editorial Service. This work has been a voluntary contribution to the work of the Station.

The retiring Editor feels that in this report acknowledgment should be made of valuable services rendered his office during the past 2 college terms by Miss Josephine P. Lambe, a student assigned to the office by the National Youth Administration. The volume of work handled by the office could not have been carried without the assistance of Miss Lambe in editing, typing, proof-reading, and general office work.

The retiring Editor further acknowledges the kindly interest, encouragement, and cooperation of the Director to the success of the work of the Station Editorial Service since its establishment in December 1935. His gratitude is also due the President and the Board for similar consideration.

### Staff Contributions

For the period from July 1, 1938 to June 30, 1939, the following articles by Station staff members have been published other than as Station bulletins:


- Barmore, Mark A. Altitude vs. Baking Powder Using Tentative A.A.C.C. Cake Formula. *Cereal Chem.* 16:145-47. Jan. 1939
- Barr, C. Guinn. Applications of the Ceric Sulfate Method in the Analysis of Carbohydrates in the Roots of *Lepidium* and *Convolvulus*. *Plant Physiol.* 14:285-96. April 1939
- Barr, C. Guinn. Organic Reserves in Field Bindweed as Affected by Cultivation (abstract). *Jour. Colo.-Wyo. Acad. Sci.* 2(5):31. April 1939
- Burdick, R. T. Fur Farm Accounting: Analyzing the Records. *National Fur News.* Dec. 1938. p. 10ff.
- Burdick, R. T. The Effect of Yield upon Tenant and Landlord Costs of Producing Irrigated Crops. *Colo. Exp. Sta. mimeo.* Nov. 1938
- Coleman, O. H. and Gardner, Robert. Comparison of Methods of Determining Small Quantities of HCN. *Soil Sci.* 47:409-13. May 1939
- Deem, A. W. and Thorp, Frank, Jr. Variations in *Coccidia* in Lambs During the Feeding Season. *Vet. Med.* 34:46-47. Jan. 1939

- Deem, A. W., Thorp, Frank, Jr., and Durrell, L. W. Range Plant Newly Found to be Poisonous. *Science* 89:435. May 12, 1939
- Gunesch, William E. Denver Carnation Culture. *The Florists' Review* 83(2147):16. Jan. 19, 1939
- Gunesch, William E. Effect of Pasteurization and Manure Treatments on the Production of the Carnation. M. S. thesis. Colo. State Col. May 1939
- Jones, Charles R. The Effect of HCN Gas, Methyl Bromide, and Methyl Bromide and Carbon Dioxide on Tomato Fruits and Greenhouse Plants (abstract). *Jour. Colo.-Wyo. Acad. Sci.* 2(5):39. April 1939
- Kreutzer, W. A. Further Studies on the Pink Root Disease of Onions (abstract). *Jour. Colo.-Wyo. Acad. Sci.* 2(5):33. April 1939
- Kreutzer, W. A. and Durrell, L. W. Rot of Mature Taproot of Sugar Beet Caused by *Pythium butleri*. *Phytopathology* 28(7):512-15. July 1938
- Kreutzer, W. A. and Durrell, L. W. Rot of Taproot of Sugar Beet Caused by *Pythium butleri* (abstract). *Jour. Colo.-Wyo. Acad. Sci.* 2(5):32. April 1939
- Larson, Olaf F. Colorado Farm and Ranch Population Changes in 1937. *Colo. Exp. Sta. mimeo.* Aug. 1938
- Larson, Olaf F. Cultural Patterns in Relation to Economic Welfare. *Proc. Western Farm Econ. Assoc., 12th Annual Meeting.* p. 108-19. June 1939
- Lee, J. K. Farm Tax Delinquency, 1928 to 1936, *Colo. Exp. Sta. mimeo.* Jan. 1939
- (Leonard, Warren H.) Clark, Andrew and Leonard, Warren H. The Analysis of Variance with Special Reference to Data Expressed as Percentages. *Jour. Amer. Soc. Agron.* 31(1):55-66. Jan. 1939
- Lute, A. M. New Facts About Old Seeds (abstract). *Jour. Colo.-Wyo. Acad. Sci.* 2(5):30. April 1939
- Mervine, E. M. and McBirney, S. W. (U.S.D.A.). Developments in Mechanical Equipment and Methods in Sugar Beet Production. *U.S.D.A. Circular* 488. Oct. 1938
- Metzger, C. H. Commercial Fertilizers in Colorado in 1937. *Amer. Potato Jour.* 15(9):252-61. Sept. 1938
- Metzger, C. H. A New Potato Disease in Colorado. *Amer. Potato Jour.* 15(8):225-30. Aug. 1938
- Metzger, C. H. Soil Moisture in Relation to Potato Production. *Market Growers Jour.* 64(6):146-48. Mar. 15, 1939
- Nelson, E. W. The Source of Blue Grama Seed and Its Variability (abstract). *Jour. Colo.-Wyo. Acad. Sci.* 2(5):36. April 1939
- Newsom, I. E. A Bacteriologic Study of Liver Abscesses in Cattle. *Jour. Infectious Diseases* 63:232. Nov.-Dec. 1938
- Newsom, I. E. and Thorp, Frank, Jr. The Toxicity of Intestinal Filtrates from Lambs Dead of Overeating. *Jour. Amer. Vet. Med. Assoc.* 93:165-67. Sept. 1938
- Palmer, M. A. Additional Aphids from Colorado. *Ann. Ent. Soc. Amer.* 31(3):353-57. Sept. 1938
- Palmer, M. A. Aphid Studies with Descriptions of a Few New Species. *Rept. of 14th Rocky Mtn. Conf. of Entomologists.* p. 14. Aug. 1938
- Palmer, M. A. Observations on Vagabond Gall Aphids on Cottonwood (abstract). *Jour. Colo.-Wyo. Acad. Sci.* 2(5):37. April 1939
- Palmer, M. A. Two Unusual Species of Aphids Infesting Wheat (note). *Jour. Econ. Ent.* 32(2):345-46. April 1939

- (Parshall, R. L.) Work, R. A. and Parshall R. L. Construction of Snow-Survey Shelter Cabins. (Presented at the Western Interstate Snow-Survey Conference held at Spokane, Wash., Dec. 28, 1938.) Trans. Amer. Geophys. Union, 1939.
- Patton, A. R., Wilgus, H. S., Jr., and Harshfield, G. S. The Production of Goiter in Chickens. Science 89:162. Feb. 17, 1939
- Reuszer, H. W. Some Effects of Benzoic Acid Compounds in *Azotobacter* Organisms (abstract). Jour. Bact. 36:309. Sept. 1938
- Reuszer, H. W. The Utilization of Low Grade Forage for Production of Artificial Manure. Publication of papers presented at Forage School and Conference, Colo. State College, Feb. 1939. p. 105.
- Reuszer, H. W. and Monk, R. W. (Colo. State College of A. and M.). A Note on the Composition of Russian Thistle (abstract). Jour. Colo.-Wyo. Acad. Sci. 2(5):31. April 1939
- Robertson, D. W. Genetics of Barley. Jour. Amer. Soc. Agron. 31:273-83. April 1939
- Simonds, A. O. The Anatomical Development of *Lepidium draba*. Jour. Agr. Res. 57:917-28. Dec. 15, 1938
- Thornton, B. J. Control of Field Bindweed by Cultivation (abstract). Jour. Colo.-Wyo. Acad. Sci. 2(5):30-31. April 1939
- Thornton, B. J. Recent Developments in the Use of Sodium Chlorate in Bindweed Control (abstract). Jour. Colo.-Wyo. Acad. Sci. 2(5):33. April 1939
- Thorp, Frank, Jr. Recent Discoveries of Poisonous Plants in Colorado Pastures in Ranges. Publication of papers presented at the Forage School and Conference, Colo. State College, Feb. 1939. p. 46.
- Thorp, Frank, Jr. Some Feedlot Diseases of Lambs. Vet. Med. 33:442-45. Oct. 1938
- Thorp, Frank, Jr. Training for Field Testing Work in the Control and Eradication of Pullorum Disease. Rept. of Conference on the National Poultry Improvement Plan in Chicago, Ill., U.S.D.A., Bureau of Animal Industry. pp. 104-19. May 1938
- Thorp, Frank, Jr. and Deem, A. W. Suckleya suckleyana, a Poisonous Plant. Jour. Amer. Vet. Med. Assoc. 94:192-97. March 1939
- Thorp, Frank, Jr. and Harshfield, G. S. Onion Poisoning in Horses. Jour. Amer. Vet. Med. Assoc. 94:52. Jan. 1939
- Wilgus, H. S., Jr. and Patton, A. R. The Availability of Manganese in Avian Digestion. Science 89:393. April 28, 1939

Since this is his last report, the Director of the Experiment Station wishes to express his appreciation to the Board for the fine support given him, and to the Station staff he is especially grateful for its wholehearted cooperation.

Respectfully submitted,



Director

FINANCIAL REPORT, COLORADO EXPERIMENT STATION

For the Year Ending June 30, 1939

DR.	Hatch fund	Adams fund	Purnell fund	Bankhead-Jones fund	State mill levy fund	Special fund	Pure-seed fund	Total funds
Balance, July 1, 1938.....					\$12,372.25	\$ 39.24	\$ 358.50	\$12,770.00
From the treasurer of the United States as per appropriations for the fiscal year ending June 30, 1939, under acts of Congress approved March 2, 1887, (Hatch fund), March 16, 1906, (Adams fund), February 24, 1925, (Purnell fund), and June 29, 1935, (Bankhead-Jones fund.) .....	\$15,000.00	\$15,000.00	\$60,000.00	\$19,627.09				109,627.09
Other sources than the United States.....					83,222.06	35,809.70	2,589.52	121,621.28
	\$15,000.00	\$15,000.00	\$60,000.00	\$19,627.09	\$95,594.41	\$35,848.94	\$ 2,948.02	\$244,018.46
CR.								
To salaries .....	15,000.00	15,000.00	48,524.51	6,516.60	36,642.50	15,168.54	2,753.30	139,605.45
Labor .....			5,334.37	7,210.61	11,369.44	8,978.52	149.15	33,042.09
Stationery and office supplies .....			307.17	426.38	471.80	126.05	8.17	1,339.57
Scientific supplies, consumable .....			706.17	680.40	1,098.78	727.48		3,212.83
Feeding stuffs .....			711.79	1,586.00	2,865.28	608.67		5,771.74
Fertilizers .....			11.75		102.70	5.00		119.45
Sundry supplies .....			442.26	142.61	1,604.95	1,289.79	0.10	3,479.71
Communication service .....			135.93	21.82	1,128.55	234.67	7.86	1,528.83
Travel expense .....			1,742.18	1,533.18	3,319.84	1,615.15		8,210.35
Transportation of things .....			59.10	147.70	1,179.71	315.08		1,701.59
Publications .....			34.86		3,347.33	144.65		3,526.84
Heat, light, water, power .....			90.35		5,418.85	938.34		6,447.54
Furniture, furnishings, and fixtures.....			53.11	16.86	33.63	101.15		204.75
Library .....			40.12		26.35	8.00		74.47
Scientific equipment .....			1,174.33	540.27	2,185.02	1,357.48	29.44	5,286.54
Tools, machinery, and appliances .....			459.86	704.76	1,368.27	2,098.44		4,631.33
Livestock .....			25.48		6,084.53	2,620.97		8,730.98
Buildings and land .....			137.59	99.90	2,199.06	493.13		2,929.68
Contingent expenses .....			9.07		86.82	28.77		124.66
	\$15,000.00	\$15,000.00	\$60,000.00	\$19,627.09	\$80,533.41	\$36,859.88	\$ 2,948.02	\$229,968.40
Balance on hand, June 30, 1939.....					15,061.00	1,010.94*		14,050.06
	\$15,000.00	\$15,000.00	\$60,000.00	\$19,627.09	\$95,594.41	\$35,848.94	\$ 2,948.02	\$244,018.46

\*Overdraft