

Fifty-Fourth Annual Report

1940-41

Colorado Agricultural Experiment Station

COLORADO STATE COLLEGE Fort Collins

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- E. M. Mervine, M.E., Agr. Engr., U. S. D. A.
 R. A. Bice, B.S., Field Engr., Univ. of California

‡Resigned

†On leave

Letter of Transmittal

Fifty-Fourth Annual Report Colorado Agricultural Experiment Station

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

Sir:

5 Gg 8.5 2.941

> In compliance with the law, I herewith present the Fifty-Fourth Annual Report of the Colorado Agricultural Experiment Station for the fiscal year of July 1, 1940 to June 30, 1941, inclusive.

U.E. Seewson

Acting Director

Fort Collins, Colorado July 1, 1941



In Memoriam

Dr. C. P. Gillette, director emeritus of the Colorado Agricultural Experiment Station, died at his home in Fort Collins on January 4, 1941, at the age of 81. Dr. Gillette was director of the Experiment Station from July 1, 1910, to September 1, 1932, when he retired. During the last several years of his active service he was also vicepresident of Colorado State College.

Dr. Gillette received his bachelor's degree from Michigan State College in 1886 and his master's degree the following year. The same institution conferred the honorary degree of Doctor of Science upon him in 1916. He was entomologist of the Iowa Experiment Station from 1888 to 1891, when he was called to take charge of the new department of zoology, entomology, and physiology at Colorado State College. In 1907 he became Colorado's first state entomologist, a position he held for 24 years.

Dr. Gillette was a fellow of the American Association for the Advance-



Dr. Gillette

ment of Science, an honorary fellow of the Entomological Society of America, a charter member of the American Association of Economic Entomologists and its president in 1901, an honorary member of the Iowa Academy of Science, and a member of the Colorado-Wyoming Academy of Sciences, the American Genetic Association, and the American Eugenics Society. He was chairman of the Rocky Mountain Conference of Entomologists from its organization in 1923 until 1939, when he was made honorary chairman. He was a member of the honorary societies of Sigma Xi, Phi Kappa Phi, and Alpha Zeta, and for many years was a member of Rotary International.

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Director's Annual Report

Fifty-Fourth Fiscal Year, 1940-41

Colorado Experiment Station

To the President and State Board of Agriculture:

Since this is my second and last report as acting director, it may be as well to survey the period since August 27, 1939, on which day Dr. Kick, the former director, died after less than 2 months of service.

The most serious problem to overcome during this period was the limitation in finances. Through the years the income from the mill levy had gradually decreased until in 1940 it produced more than \$30,000 less than it had in 1930. Since it had not been customary to budget certain items of operation and maintenance, such as gas, light, and water, the sections found themselves in considerable difficulty early in the year, and it became necessary to curtail all except absolutely necessary expenses. Despite this action, however, had it not been for surplus funds made available by Resident Instruction and Extension, the Station would have been compelled to defer salaries during March and April 1940. Because the budget for the 1940-41 year was made out during that financial stringency, no increases in salary whatever were approved. The sale of the Avon farm gave a surplus which allowed us to end the year in good condition and which has served as an excellent cushion since that time.

The whole matter of Station finances was placed before the Legislature with the request that the deficiency of \$30,000 annually in the mill-levy income be made up by special appropriation. The joint committee of the House and Senate was very appreciative of the situation and seemed to realize fully the need for agricultural research. This committee did recommend \$27,780 for the biennium, \$5,800 of

COLORADO EXPERIMENT STATION

which was transferred from the appropriation of the State horticulturist and marked for the Austin substation. Assuming that the Governor will sign the bill and that the appropriation will be paid, this will give the Station an added income of \$11,000 a year during the next 2 years.

A list of additional needs in agricultural research was presented to the Legislature, the estimated cost of which came to more than \$35,000 annually. The problem now is to select from that list those projects which are most urgent and which will satisfy our constituents. It is planned to increase the livestock feeding, which was necessarily curtailed; to enlarge our work on soil fertility; to give increased attention to potato diseases and to peach mosaic; to initiate a study of the nutritive quality of range grasses, beginning in Middle Park and thereby throwing some light on troubles which the stockmen have experienced there; and to give added assistance to the fur growers in the hope that their industry may be placed on a firmer foundation in the State. While it is not expected that all the agricultural needs can be fulfilled, the Station is in a better position to be of service to the agriculture of Colorado than it has been for several years. Through contact with various agricultural groups it is also in a better position to know what is desired by them, and it is hoped that this collaboration will result in an increased budget and an enlarged program.

The staff was depleted during the year by the resignation of four men, all of whom had shown considerable ability but who were offered marked increases in salary by other institutions. Offers came to several other staff members, but we were able to hold them by making adjustments. Three men have been away for graduate study but will return during the summer. It is expected that our Sabbatical leave system will take several men each year, thus giving us contact with other research institutions and keeping the staff refreshed in its scientific outlook.

Steps have been taken to organize the Colorado Agricultural Research Foundation for the purpose of developing inventions, discoveries, and processes arising from the research of the staff members. The necessity of such a corporation indicates that we are becoming mature. Similar non-profit organizations in other states have been helpful in the orderly distribution of discoveries having the possibility of commercial exploitation.

No attempt is made here to summarize the work of the various lines, since that is done by the heads of sections on the following pages.

The monthly meetings of the Station Council have been helpful in bringing about a unity of purpose and the transfer of ideas, so that cooperation has been on a sounder basis. The feeling in the staff is excellent.

Substations

The purpose of the substations is to investigate problems peculiar to the agricultural districts in which they are located. The wide range of physical conditions in Colorado, such as altitude, topography, rainfall, length of growing season, temperature, irrigation water supply, and other factors, creates different agricultural districts and also many different problems. Many crops such as peaches, cantaloupes, and others cannot be grown at the main Station at Fort Collins, and it is necessary to assist growers by working directly with them on their problems in their own districts. The substations serve as an important means of bringing growers in direct contact with Station work and creating confidence in our attempts to find the answers to numerous field problems.

Arkansas Valley Substation, Rocky Ford

The Rocky Ford substation of 40 acres was established more than 50 years ago and is located in the center of the Arkansas Valley irrigated district. During the past 10 years there has been some change in crops grown, and while the general trend is toward more intensive crop production there has also been a change to the dry-land type of crops on irrigated farms with short water rights. This has been more evident in the late drought years; consequently there is more demand for information on dry-land crops grown on irrigated land in relation to feeding cattle and sheep.

WORK OF THE SUBSTATION.—The results of the research carried on this substation are reported under projects by the sections cooperating. At the present time the Agronomy Section carries tests on alfalfa varieties, sorghum varieties, and hybrid field corn. The Entomology Section is working on control of the striped cucumber beetle on cantaloupes and the corn-ear worm in canning tomatoes. The Horticulture Section carries projects on onion breeding, fertilizers for onions, strain tests, cantaloupe breeding and testing, and seed potato disease testing. The Botany and Plant Pathology Section cooperates on working out control measures for leaf-spot disease of cantaloupes and honeydew melons. Until last year lamb feeding tests were carried by the Animal Investigations Section. The substation is widely used by various sections of the Station, is fairly well supported by growers, and is worth while.

THE BUDGET.—The total budget allowed for the operation of the substation is \$4,000.

REQUESTS FOR PROJECTS.—Requests have been received to continue the lamb feeding or to start cattle feeding tests. Testing new crops, soil investigations, storage research, and additional disease and insect control work have also been requested.

COLORADO EXPERIMENT STATION

BUILDINGS AND EQUIPMENT.—The dwelling, storage house, farm tractors, and farm machinery are all in excellent condition.

Fruit Substation, Austin

The fruit substation at Austin was established in 1922 and was purchased largely from income collected from the sale of fruit. The policy then was to operate it as a demonstration farm, and the sunerintendent acted as a fieldman to carry on direct educational work with fruit growers. Income from the sale of crops was emphasized until the orchard was paid for. Until 1932 the orchard was operated by funds appropriated to the State horticulturist, and not by Experiment Station funds. Growers were responsible for the purchase of the farm and are continuing to support the program. With fruit, substations are more necessary than with field crops because of the length of time required (10 or more years) to get consistent results on trees and on damage that may occur by use of experimental sprays and by pruning practices. Strict control is required over fruit projects. Also, the work is spread over an entire year, and an untrained man cannot be employed to supervise the work. The results of the work at this substation are applicable to all the Western Slope counties, and fruit growers are anxious to see the work continued.

THE BUDGET. — Since 1932 the Station has contributed about \$2,000 annually, and the State horticulturist's office has furnished the remainder of this substation's budget. Under a split budget arrangement, administration has been very difficult. The transfer of the administration of the work and budget to the Station will completely eliminate problems. An annual budget estimate of \$5,100 is provided for the fruit substation.

BUILDINGS AND EQUIPMENT. — The dwelling and fruit storage buildings are in excellent condition, but they need painting. The orchard sprayer is 20 years old and needs a new tank at a cost of \$100. The truck is 11 years old and needs overhauling at a cost of about \$50. Some of the farm machinery needs replacement but is in fair condition.

ORCHARD MANAGEMENT PROBLEMS.—Work carried on at the Austin substation is largely on orchard management problems. These include (1) cover crop tests; (2) fruit variety tests on apples, peaches, pears, apricots, and plums; (3) commercial fertilizer tests on apples and peaches; (4) pruning methods; (5) root stocks; and (6) spray tests of fungicides and insecticides. The results have already been reported in detail in the State horticulturist's report.

Under the change in management of the fruit substation it is going to be possible to work out a better program by closer coordination, and more effective work can be accomplished.

San Luis Valley Substation, Monte Vista

Because of drought conditions and the effect of soil spots on yield records, the first year's results on the potato experimental work at the San Luis Valley substation were not as satisfactory as it is possible to obtain there. It is believed that more accurate results can be obtained after this past year's experience. The 20 acres in operation on the farm for potato research are under the Station's supervision, but the farm is in charge of the Extension Service.

This year more work is being initiated on problems pertaining to soil fertility and the loss of color in potatoes.

A mimeographed report on last year's results has been issued and distributed to growers.

Agricultural Division

Agronomy Section

Since the beginning of the fiscal year, the cooperation formerly enjoyed with the Division of Cereal Crops and Diseases, U. S. D. A., has been discontinued because Congress failed to appropriate funds for the Cereal Office. This meant the loss of Mr. J. J. Curtis, with his budget, and the loss of a fellowship, supported by the same Federal funds. This, of course, was a severe blow to the wheat improvement program because it means the program will have to be dropped or adjusted with meager state funds.

Corn Improvement

The corn improvement work has been carried on State funds and has consisted of yield tests of corn hybrids at Fort Collins, Rocky Ford, Akron, and Fort Lewis to test the adaptability of outside hybrids in order to be able to advise farmers. In addition to these tests of immediate benefit to farmers we have conducted a corn breeding program, attempting to create inbred lines which would give highyielding single or double crosses. The hybrid yield tests have resulted in definite recommendations to farmers, enabling them to know the adapted varieties for sections below 5,000 feet and above that altitude where corn is adapted. So far no hybrid corn has been found superior to the best adapted open-pollinated varieties on the dry land. Hybrid corns under irrigation frequently outyielded the best openpollinated sorts. The corn acreage in Colorado is increasing because of an increased trend toward livestock feeding and also because of relatively low prices for sugar beets. The tendency probably has been augmented by lower irrigation water supplies in recent years.

Improved Seed

New varieties of field crops are constantly being created by this and other stations. The Agronomy Section tests these varieties, ascertains which are the better sorts, purifies mixed strains, and gets these improved seeds into the hands of farmers. Reward, a new spring wheat originating in Canada, is showing yields nearly 30 percent higher than other varieties. Since its quality is high, it is being distributed on its merits. Before distribution it had to meet the competitive variety tests under irrigation and on the dry land. A new strain of Black Amber sorghum was distributed during the year. A new barley, bred at the Experiment Station and put through the competitive tests, is called "Beecher." This is being put into the hands of a number of farmers this year. Beecher originated as the result of a cross and gives promise of being superior to any previous barleys.

High-Altitude Crops

Most of the Agronomy Section's high-altitude work is conducted at Fort Lewis. Tests are being made with grains, peas, dry and irrigated grasses, alfalfa, and minor forage crops. This work has resulted in establishing the best pea varieties, confirming work at other points, and the best alfalfa, oat, and barley varieties, and may indicate a new choice of variety for high-altitude spring wheat.

Plains Crops and Management

The plains crops and management project is carried on in cooperation with the United States Dry Land Field Station at Akron. It includes cultural methods and tillage methods for all ordinary farm crops. Special results have come out of the project on the rate and date of planting wheat. These results will safeguard stands of wheat because it has been found to be possible to dodge certain disease conditions by planting on the proper date.

Breeding work with sorghums is going forward. The two adapted grain sorghums, Improved Coes and Highland, are being extensively grown. These varieties have given higher yields in pounds of grain per acre than corn; in fact, almost double that of corn through the same period. When these varieties get a larger distribution it will increase feeding possibilities on the dry lands and increase the stability of dry-land agriculture. The dry lands produce normally more than 50 percent of the wheat, oats, corn, barley, and sorghums. In some seasons they produce more than 70 percent. At present the Office of Dry Land Agriculture is supporting most of the work. The Station's contribution consists largely of consultation on programs and at critical times during the progress of the crop work. The burden has been increased and some work has had to be dropped because of the curtailment of work in the Division of Cereal Crops and Diseases.

Chlorosis of Stone Fruits

The study on chlorosis of stone fruits is carried jointly by the Agronomy (Soils), the Horticulture, and the Botany and Plant Pathology Sections. The agronomy studies have been mainly in furnishing information on plant nutrients and their availability in soils and advising on greenhouse nutrient studies which are under way.

Optimum Nutrient Balance in Soils

The work during the year on the Federal fund project on optimum nutrient balance in soils has been a study of variations in available phosphorus and variations in nitrate nitrogen, as shown by soil and crop samples. The effects of these variations on crop yield and quality have been studied in four sets of experimental plots. It has become apparent that if the nitrates are high there may remain in a crop like sugar beets an unutilized amount of nitrate. Such unutilized nitrate in the sugar beet tends to reduce sugar content at the rate of about 1 percent sugar content for every .025 percent nitrate nitrogen in the beets. Sugar beets need a high nitrate level early and a low nitrate level late in the production of the crop. Very high applications of calcium nitrate to the soil did not injure sugar beets in any way, except to lower sugar content, but it was very uneconomical to make such high applications.

Availability of Mineral Nutrients

It has long been known that phosphates on some soils, although present in considerable quantities, were low in availability. In other soils, availability was relatively high. During the year, studies have been completed which show that subsoils in Colorado in a high number of cases are low in availability as compared with surface soils. This has shown that one of the reasons for low productivity where "top soils" are lost is low availability and low nitrates in the subsoil. These findings indicate a possible correction in many cases by applying available phosphate and nitrogen. Since low availability in subsoils was found in more than 90 percent of the cases studied, these general findings become economically important. Special studies were also made on the effects of pH change on phosphate solubility on typical Colorado soils. The results have been published in a bulletin.

Bacterial Winter-Killing in Alfalfa

Since 1924 alfalfa wilt has been a vital Colorado problem. Prior to that date hardy alfalfa would live indefinitely. Since that date, in most sections, alfalfa will produce about three crop seasons but then must be broken up because wilt has reduced the stands to the point where they are no longer profitable. Baltic and Grimm are hardy, produce good desirable hay, and are desirable in every respect except

resistance. Certain strains of Turkestan show considerable resistance. Accordingly, breeding programs are under way to attempt to create both hardy and disease-resistant strains. These studies have gone far enough to indicate that hardiness and disease resistance are inherited and that creation of more-resistant varieties is only a question of time and the choice of parents. There are genetic reasons for good seed setting and poor seed setting, so those factors enter the problem, for if a new variety is created it must be reproduced by seed to be of commercial and farm importance. Work could be expedited by suitable greenhouse and freezing equipment. It takes 4 or 5 years of inbreeding to create true-breeding inbred strains; then when crosses are made it takes 3 or more years before their worth can be established. Accordingly, these breeding programs, although very promising, require time. Improvements will come out of the present work, but not enough time has elapsed to get commercial strains on the market.

Linkage Relationships in Barley

During the year two additional genes and their behavior with linkage relationships to seven other characters have been worked out. New final information has been gleaned on the question of plumpness in barley. Among the gene relationships worked out this year has been an understanding of the fertility and uniformity of size. Uniformity of size is essential in the trade wherever barley is malted because uniformly fertile and uniformly sized seeds handle commercially very much better. A subsidiary accomplishment of this project, and arising primarily out of it, is the creation of the new hybrid, Beecher, which tests show to be superior to the other barleys.

Inheritance of Disease Resistance in Small Grains

The project on inheritance of disease resistance in small grains is new this year. Crosses have been made with eight resistant varieties and the best of the high-yielding barley sorts to try to get new barleys resistant to loose smut. Similar studies are being made with winter- and spring-wheat hybrids for loose smut, bunt, and rust resistance. These hybrids are being subjected to artificial epidemics in order to isolate the resistant sorts. Barley in 1939 showed a farm value of \$3,813,956; oats, \$1,556,843; wheat, \$8,757,627; and sorghum, \$2,533,425, a total of more than \$16,600,000. All of these crops are reduced in yield in some instances by disease. The production of disease-resistant sorts would increase present yields, under the same climatic conditions, without any material cost to the farmer.

Soil Resources and Land-Use Survey

Physical surveys by the Agronomy Section and by cooperating agencies in the Federal Government, namely, Bureau of Plant Indus-

try, Bureau of Agricultural Economics, Farm Security Administration, and Soil Conservation Service, have been completed for the major Plains areas and, to some extent, for the Western Slope. Work has progressed far enough so that now a publication is proposed which will show the necessary physical data for land-use planning in these regions. The published material and maps can be used by county agents, by the Bureau of Agricultural Economics, and by the Farm Security Administration and will be helpful in land-planning operations for the soil conservation districts and for the State Planning Commission.

Animal Investigations Section

Cattle Experiments

Wintering Range Cows

Thirty purebred Hereford and Shorthorn cows were used in a wintering trial designed to show the value of cottonseed cake as a partial substitute for alfalfa hay and to show the effect of these feeds on calf crop and milk production. This trial is a continuation of last year's work in which a comparison of weights of cows and weights of calves will be used as measures of the values of the two wintering rations.

Winter pasture was used last year, but because of climatic and range conditions last summer pasture was not available for this year's work. The test is still in progress.

Feeding Trial of Middle Park Hay versus North Park Hay to Cattle

A joint experiment of the Animal Investigations, Pathology and Bacteriology, and Chemistry Sections was set up to ascertain the effect of feeding to cattle certain hay raised near Kremmling, Colo. This hay was suspected of being a factor in causing an unthrifty condition associated with a diarrhea in the cattle to which it was fed. The results of this study have been reported in a mimeographed report issued by the cooperating sections.

Conservative versus Deferred and Rotated Grazing for Breeding Cows

An experiment is being run in cooperation with the Range and Pasture Management Section to ascertain the relative values of conservative and deferred-rotated grazing; to record seasonal gains of the cattle; to ascertain the effects of varying rates of stocking on range capacity; to ascertain the effect of seasonal growth of the important forage species; and to ascertain the degree to which each important forage species and each major forage type may be grazed without permanent injury to the range. The experiment was begun in 1936, this being the fifth year of its progress. Because of drought, the experiment was temporarily discontinued August 7 at the 50-day period.

Limited versus Unlimited Pasture for Dairy Cows

A preliminary report on the 90-day pasture experiment shows that each cow in the lot receiving pasture and grain produced daily an average of 32.3 pounds of milk containing 1.36 pounds of butterfat. Each cow in the lot receiving pasture, hay, and grain produced daily 32.5 pounds of milk containing 1.27 pounds of butterfat. Using the Morrison feeding standard as a basis of calculation, it was found that each cow receiving pasture and grain obtained a daily average of 11.8 pounds of total digestible nutrients from the pasture. Each cow receiving pasture, hay, and grain obtained daily 5.24 pounds of total digestible nutrients from the pasture.

Sheep Experiments

Crossbreeding, Fattening Crossbred Lambs, Wintering Range Ewes, and Studying Grading and Shrinkage

The large sheep experiment includes five phases which are conducted as a series, and the experiment is set up on a long-time basis. Initial work was begun in the fall of 1939. The following report covers the second year's work.

FATTENING CROSSBRED LAMBS.—The fattening of crossbred lambs produced during the 1939-40 crossbreeding study was a trial set up to give information on, first, the rate of gains of crossbred lambs and, second, the value of corn versus milo in the fattening ration. The rations fed were corn and alfalfa versus milo and alfalfa. The Pathology and Bacteriology Section made a study regarding fringed tapeworms in the lambs which were marketed. The ewe lambs were kept for replacements.

CROSSBREEDING STUDIES WITH RANGE EWES.—The following is a summary of the 1940-41 crossbreeding studies: One hundred and eighty head of native western ewes, those used in the 1939-40 study, were divided into four lots and were bred to Hampshire, Corriedale, Targhee, and Rambouillet rams. The results of this breeding trial will be based upon percent lamb crop, birth weight of lambs, weaning weight of lambs, type of lambs at weaning time, and wool factors such as face and body coverage as well as density and staple of fleece. The lambs produced will be used in fattening studies, and the ewe lambs will be kept for continuation of breeding studies.

WINTERING RANGE EWES.—Following the breeding season the ewes were placed on a wintering test to compare the value of two mineral supplements added to ground alfalfa hay. Simple mineral mixtures were used. Results will be evaluated upon the basis of body weight of ewes, fleece weight, and birth weight of lambs.

GRADING AND SHRINKAGE STUDIES.—Following shearing of the range ewes and ewe lambs, grading and shrinkage studies are being conducted. The new wool laboratory is used for these studies as well as for other research and educational wool work.

Breeding Study with Hampshire Ewes

A Hampshire ram purchased for a herd sire in 1938 sired 33 percent "parrot-mouthed" lambs for the 1939 lambing season. "Parrotmouth" is apparently a result of a heritable genetic factor, and this experiment was designed to study the transmission of this factor. The "parrot-mouth" condition is a serious problem for the range sheepmen and, therefore, for the breeder of purebred sheep. It is a very elusive and difficult factor to study from a genetic standpoint. This year's study completes a series of 2 years' work during which time a high rate of inbreeding was reached, along with the breeding of ewes from the Station's flock and ewes from an entirely unrelated flock. The result of this year's matings showed only one "parrot-mouthed" lamb, although almost all the weak lambs and death loss for the lambing season were encountered in the inbred stock.

Since inbreeding has not fixed nor intensified this condition, and since it is such a difficult factor to fix, it seems advisable to discontinue this breeding work after this year. "Under-shot jaw" is the reverse condition of "parrot-mouth" and is also one of the difficult problems encountered in sheep breeding. Extremely high cost of breeding work, both in time and funds, makes it advisable for the individual breeder to practice severe culling as the best method of controlling these conditions.

Control of Coccidiosis in Feeder Lambs through Management

A cooperative experiment with the Sections of Animal Investigations and Pathology and Bacteriology was set up to ascertain the value of various methods of managing feeder lambs to prevent coccidiosis. Two sets of lambs were purchased and started on feed, but no coccidiosis outbreak occurred. Data regarding feedlot gains, marketing, and slaughtering were obtained from this experiment.

Drenching Lambs versus No Drenching

The Animal Investigations Section and Pathology and Bacteriology Section cooperated in conducting a feeding trial to ascertain

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the effects on feedlot gains of a single drenching of copper sulphatenicotine sulphate solution versus phenothiazine solution versus no drenching in the check lot. In this year's work drenching showed no advantage in feedlot gains.

Iodine Study with Pregnant Ewes

Investigation of the effect of iodine on pregnant ewes continues the iodine study begun in 1939 in which varying amounts of iodine are fed. The birth weight of lambs, fleece weight of ewes, weight of ewes during the experiment, and pathological conditions occurring in the lambs will be factors used in summarizing the data of the experiment.

Tapeworm Study with Lambs

The Animal Investigations Section cooperated with the Pathology and Bacteriology Section in an attempt to ascertain the extent of infestation of fringed tapeworms in newborn lambs. This study was completed, and the lambs were killed in the College slaughter room. This concludes 2 years' study with new-born lambs, and the intermediate host phase is now being studied.

Urinary Calculi in Lambs

The study of urinary calculi in lambs is cooperative among the Animal Investigations, Chemistry, and Pathology and Bacteriology Sections. The 1940-41 work follows 2 years' experimental work in which large numbers of lambs were fed in several lots to get indications as to type of ration and kind of feed most likely to cause urinary calculi. This year's experiment is set up on an individual lamb basis and will be continued for an indefinite period of time. Feeds suspected in the previous work and different types of water are being studied.

Wintering Pregnant Ewes on Beet Tops Alone

As a preliminary study, three ewes were taken from the range ewe flock and started on a feed of beet tops alone. They were bred and have been fed only beet tops during the breeding and gestation periods. The feeding of beet tops will continue until after lambing time. Chemical studies of beet tops have been made along with this preliminary trial.

Hogs

Fattening Hogs with Grain Sorghums

A preliminary study with fattening pigs was started this year. Pigs from the Animal Husbandry hog herd were divided into 5 lots of 10 pigs each to compare the feeding value of Coes sorgo grain versus milo grain when fed alone, and also in a mixture of corn versus corn alone.

Miscellaneous Experiments

Nutritional Control of Mastitis

The project on nutritional control of mastitis has been continued. Almost no trouble with mastitis has occurred in the dairy herd during the past year. One case, apparently developing at this time, may yield some additional information.

Sperm Longevity

The sperm longevity study includes a preliminary study of metabolism of sperm. It is to include a critical review of the present status of storage methods and of the longevity of sperm life, motility, and fertilization potentialities. Nutrition of both male and female as it affects life of sperm in storage, motility, and impregnation potential also is being investigated as are nutrition of sperm in storage and temperature effects.

Official Testing

Following is a summary of the official testing work done since April 1, 1940:

Month	Number of cows on yearly test in advanced registry division	Number of cows on yearly test in herd improvement division	Number of Herds	Fees
April	39	94	15	\$17.65
May	40	95	14	18.55
June	49	103	16	22.25
July	53	114	17	22.20
August	44 *	105	15	21.35
September	47	104	17	14.90
October	45	94	15	15.30
November	47	102	16	16.80
December	43	117	17	15.90
January	48	101	16	16.25
February	53	110	16	17.60
March	50	105	15	17.05
	558	1,244	189	\$215.80

Personnel

Mr. V. C. Askew has been employed and will assist in wool studies.

Botany and Plant Pathology Section

Weed Control

During Mr. B. J. Thornton's absence in California the weed control project was inactive. Since his return, however, the cultivation tests on the Reed place near Fort Collins have been finished and the extensive experiments on cultivation are being assembled for publication. These show that we can cut cost of weed control two-thirds. The data on chlorate, which demonstrated the limits of that chemical, are being assembled for publication.

Ring Rot of Potatoes

A searching study has been made of the symptoms of ring rot of potatoes in cooperation with the Horticulture Section. Aerial symptoms are obviously severe on Bliss and Cobbler varieties. They are not easy to see on varieties such as Rurals and Russet Burbank; however, there apparently is no definite resistance, since varieties producing slight symptoms may on cultural study show 90-percent ring rot infection.

A study is being made of the migration and distribution of the causal organism in infected plants, accompanied by a histological study of the tissues.

Investigation of tuber symptoms such as net necrosis, woody vascular rings, firm yellow ring, and lead-colored spots show that none of these can be correlated with ring rot. No external symptoms except the presence of the soft yellow ring in the tuber are of certain value in diagnosis of ring rot.

Several methods of diagnosis have been tried in addition to ocular examination. Selection of cut tubers under ultraviolet light reduced ring rot but did not eliminate it. The so-called "California Method" of diagnosis was good but not sufficient to eliminate the disease. Treating cut potatoes with ferric chloride seemed quite effective under laboratory-greenhouse conditions but in the field did not eliminate the disease. Eighty-three chemicals were tested in an effort to distinguish unhealthy from healthy tissue.

A careful study has been made of soft-rot organisms that follow ring rot and it has been demonstrated that tubers affected with ring rot are more readily destroyed by secondary soft rot than are unaffected tubers.

Chlorosis of Stone Fruits

The project on chlorosis of stone fruits was interrupted by the resignation of Dr. C. G. Barr. His analysis of healthy and chlorotic peach trees showed healthy trees to be higher in calcium; chlorotic trees higher in nitrogen.

On his arrival, Dr. M. E. Paddick made a survey of the Palisade region and developed micro tests aimed at the more precise study of chlorotic peach trees this coming year. This project is in cooperation with the Agronomy and Horticulture Sections.

Diseases of Greenhouse Plants

An extensive study of the resistance of a number of carnation varieties has been made. In temperature-controlled soil it has been found that three varieties show slight resistance to root rot; none are resistant.

Of the large number of Dianthus varieties other than *D. caryophyllus*, some are quite resistant to some of the known strains of the root rot fungus.

Peach Mosaic

The peach mosaic project is being extended, and the Station is to receive some assistance from the Bureau of Plant Industry this coming year. A careful study is being made of the so-called "hairy break" symptom and a large number of cross inoculations through graftings and buddings are in progress. The number of trees affected by severe strain of peach mosaic has been reduced from 28,934 trees in 1935 to approximately 350 in 1940. Studies are being conducted on strains of peach mosaic in different commercial peach varieties. Several viruses have been found in other stone fruits; these have been found to be distinct from peach mosaic. The infection and host range of these have been worked out.

Miscellaneous Work

A new macrosporium rot of potatoes has been found and studied. The histology of winter injury on raspberry canes has been studied. It is found that two types of winter injury occur—the freezing type, in which the cambial cells become broken, and the desiccation type, in which the phloem cells are plasmolyzed and the outer tissues of the stem are filled with tannin. Alternate freezing and thawing result in necrosis or death of the phloem. A histological study of *Hymenophysa pubescens*, one of the so-called "whiteweeds", is also in progress.

Chemistry Section

During this year the Chemistry Section has been actively pursuing investigations under the following projects:

Urinary Calculi in Feeder Lambs

Investigation of urinary calculi in feeder lambs is cooperative with the Pathology and Bacteriology and Animal Investigations Sections.

On the basis of 2 years of previous investigations with larger numbers and several feeding regimes, during the past year we have concentrated on five lots of three lambs each, on rations most likely to produce urinary calculi. The work is still in progress and the salient facts to date appear to warrant the following tentative conclusions:

1. In published literature on urinary calculi, calcium phosphate is cited as one of the ingredients usually present. Three-year findings here indicate that neither sheep urine nor calculi, in the few instances where these have been found, contain more than insignificant traces of calcium. This indicates that calcium in the lamb is voided practically entirely through the feces. We attribute this inconsistency to the inaccurate methods by which urine samples were formerly taken.

2. The urine of herbivorous animals is considered to be quite alkaline. Feeder lambs here showed alkaline urine (approximately 8.4 pH) for 36 days, then a rather sudden drop into the acid register (below 7.0 pH) for about 36 days, and then a levelling off to slightly alkaline condition during the remainder of the feeding season.

3. The incidence of large quantities of precipitates in the urine of lambs does not of itself predicate formation of calculi. The nature of these salts is more important. Feeding of beet molasses and beet tops causes voluminous inorganic precipitates, yet no calculi were found as a result of such feeding.

4. The feeding of cane and corn roughage as well as prairie hay gives rise to elimination of rather large quantities of silica through the urine.

Mineral Composition of Alfalfa Hay

In the study of mineral composition of alfalfa hay as affected by the soil nutrient solution, data have now been collected for 2 years on six (natural) field plots of Colorado alfalfas, as well as such other alfalfa hays and soils as it was possible to obtain through the cooperation of county agents in different parts of the State. Tentative conclusions on the work to date appear to warrant the following statements:

1. Total mineral ash based on air-dry hay can vary between 7.6 percent and 11.6 percent.

2. Individual ingredients have varied in different samples from a ratio of 1 to 3 to as high as 1 to 10, that is, a given mineral can be as much as 3 to 10 times as abundant in one sample as in another.

3. While the composition of the ash of alfalfa grown in good soil is controlled in a large measure by the plant itself, yet the nature of the available minerals and particularly the moisture supply during the growing season influence the quantity and quality of the ash content in greater measure than is supposed.

Effects of Irrigation Waters on Soil

In the study of the effects of mineralized irrigation waters on the colloidal soil complex of some Colorado soil types, no new samples were taken during the past year, but the completion of all analytical work on soils previously taken was stressed. The chemical work is now complete and the data assembled. The manuscript for publication still remains to be prepared. Briefly, the more important findings were as follows:

1. Where the salinizing minerals in the waters consist chiefly of sulfates and bicarbonates of calcium and magnesium, they give rise to calcium and magnesium Solonchak soils which will likely remain highly productive for years to come if they have adequate drainage.

a. There is no apparent tendency to form mineral "hard pan" at any horizon so long as the total natural and artificial moisture exceeds 24 inches annually. The calcium and magnesium are adsorbed into the complex, and the excesses sometimes form "white eye" concretions but no horizontal layer. The downward percolation of water apparently has not been impaired.

2. Most of the Colorado Plains soils investigated are very young from the viewpoint of the soil-forming processes and their total replaceable cations range between 11 and 25 milli-equivalents, as compared with 25 and 42 milli-equivalents for a few Minnesota podzolic soils, or soils from the prairie region (see Dr. Marbut's classification). Despite this lower replacement capacity they are often supersaturated with calcium and magnesium salts in the A and B horizons.

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3. There is an apparent greater tendency to form "hard pan" in the native grass sods and also in dry-land cultivated soils, which are restricted in annual moisture.

4. The native grass lands were in some cases acid in reaction, but only in the first few inches (1 to 3), indicating a faint podzolizing process.

5. Organic matter in the soils tested ranged from less than 1 percent to about 2 percent as compared with about 4 percent for some prairie soils.

6. In the profiles studied, sodium salts (Na Cl, Na₂ SO₄, and NaHCO₃) did not appear to be present in sufficient amounts to affect the complex or the texture of the soil.

Effects of Mineralized Drinking Waters on Livestock

The Pathology and Bacteriology Section has cooperated in an advising capacity with the Chemistry Section on the study of longtime effects and tolerance limits of mineralized drinking water on livestock.

The preliminary and important part of this experiment must for many reasons be confined to large numbers of small animals, namely, white rats.

A study of the literature on this subject reveals the conclusion of several authors—that it requires a mineralization of 1 percent to 1.5 percent in livestock drinking waters to produce acute injury.

From years of experience in Colorado, it appears that heavy mineralization in livestock drinking waters retards and hampers the expected gains in feedlots long before the degree of 1 to 1.5 percent mineralization is reached. This experiment, by study of weight gains over a relatively long period of time, is expected to establish more definitely the mineralization limits of drinking waters which livestock can tolerate without harm.

We now have animals on experiment with the two salts suspected of being the principal offenders, namely, magnesium sulphate and sodium nitrate. These minerals are being supplied in the drinking waters at four levels. The effects are being compared with those of the relatively pure water of the Fort Collins city supply.

This work is not yet far enough progressed to warrant conclusions and must be continued for some time before results are available.

Service Work

In addition to the major projects our section has continued the usual amount of chemical service to farmers and citizens of the State as well as the testing of fruit spray residues in cooperation with the State Fruit Inspector, and some service work for the State Game and Fish Commission.

Entomology Section

General Insect Problems

Except for a few severe outbreaks the insect problem during the year was about as usual. The grasshopper again constituted the dominant problem, but a successful eradicating campaign was carried out.

Among those insects most frequently reported, and for which control recommendations were made, were termites in the Denver district, army worms, the spruce gall louse, clover mites, the granary weevil, cutworms in the Fruita district, and fall webworms on the Western Slope from Ridgway north to Grand Junction and westward to the State line.

A cactus-destroying insect was reported in the vicinity of Colorado Springs and was identified as one of the longhorn beetles, *Moncilema annulata* Say. In abundant numbers the insect kills many cactus plants, thus aiding range improvement.

There are many more problems that have come to the attention of the Entomology Section, but only a few of the more pronounced and important types have been cited.

Station Projects

Ant Control

Work on ant control was carried on in the area adjacent to Fort Collins from June 15 to November 12, when the ants were found to become inactive.

During the winter and spring months numerous field trips were made to ascertain the condition of the hills and the activities of the ants. This spring, data were collected to get the time of appearance of ants above ground and to ascertain the approximate date that activity begins in the hill. It is believed that this is an important factor in the control of this pest, since early treatments give better results than those made during swarming season. Various types of recommended materials have been used in random selection plots with five replications of five each. Some materials are promising and others are of little or no value. Seven different materials were used and more than 700 applications in all have been made. Sodium cyanide and water have given the most promising results. Two types of application nozzles have been developed, one for liquid and the other for dust.

Peach Mosaic

In June 1940 the first positive evidence of insect transmission of the severe peach mosaic virus was obtained in two trees from the set of experiments started in 1939. On the basis of these results nearly 200 new experiments were carried out during the season of 1940. An insectary and large cloth house have been constructed at the Whitewater plots. More than 3,000 trees have been budded under the cloth house for experimental work this season. Small potted peach trees are being grown at Fort Collins to provide feeding plants for rearing insects for transmission experiments at Whitewater. The germination technique and the providing of a continuous supply of this material are being worked out.

Sprayer Efficiency

In July 1940 the work on the sprayer efficiency project was resumed. During the season speeds of horse-drawn and tractor-drawn outfits were ascertained. Three standard-sized disks were used and the amount of material being applied per plant, at different pressures and speeds, was ascertained. These data have been tabulated and are now being supplied to potato growers. The amount of leaf surface to cover in spraying potato plants at different times during the season, together with the total amount of leaf surface per acre for the three potato sprays, has been calculated. Leaf surface consumption by individual flea beetles was also determined. The results of spraying at different speeds, with different types of equipment, was checked on the harvested potatoes. Samples were graded on the amount of worm track injury in the tubers. The percentage figures of injured and uninjured tubers were obtained from three Eaton fields and the Greeley station.

The "Potato Spray Timer" has been printed and sent in for copyright registration. The first deliveries were made April 14, and it is now going out to the growers of Colorado, Wyoming, and Nebraska. This timer should be of great value to the potato grower since by its use he can readily calculate the time for spray application, materials to be used, and type of insect to be controlled.

Psyllid Resistance

The work on psyllid resistance has been continued. In January 3,276 potato plants representing some 32 family lines were planted. On February 15 the first release of psyllid adults was made.

The development of symptoms, various generations, and potato strain reactions have been followed closely. Histological material has been collected at intervals and is being run through for future study. Several strains are showing resistance this year. The relation of the severity of symptoms to the number of psyllid nymphs has been worked out this year.

Fringed Tapeworm

In February 1941 a request was made for assistance on the project dealing with fringed tapeworm of sheep. The work is in cooperation with the Pathology and Bacteriology Section. The Entomology Section's part deals with the Orbatid mites so common in pastures and on the range lands as a possible intermediate host for the Cysticercoid stage of the tapeworm. Three Berlese funnels have been constructed and placed in the greenhouse. Soil samples are collected for mite population in areas where the tapeworm is known to exist.

Cucurbit Insects

The curcurbit insect project was carried at Fort Collins and Rocky Ford. The two principal insects treated were the striped cucumber beetle and the squash bug. Other timely controls on other insect pests were also handled when opportunity permitted. Nineteen different insecticides were used on honeydew melons near Crowley, Colo. The tests were applied on randomized blocks with three applications each.

The following formulas gave the best results:

- 5 percent pyrocide, 7 percent cupricide, 88 percent pyrax.
- 10 percent calcium arsenate, 7 percent cupricide, 83 percent pyrax.

Zinc arsenite, 10 percent, with 90 percent pyrax, appeared very good. Copper compounds gave added protection in keeping the beetles from reinfesting the plants.

Tomato Insects

During the summer and fall, plots were given treatment for psyllid control that would equal that necessary under the heaviest psyllid infestations. Tomatoes from these plots were followed through the canning company plant, and samples of canned juice were taken for tests. Known amounts of sulphur were also added to juice from un-

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treated tomatoes. The different samples were each divided into two lots, one lot being stored at room temperature and the other at 98° F. These are being examined periodically for any changes in the pH or in the vacuum that occurs in the cans. Work has shown that any spoilage is indicated by a loss of vacuum. At the last examination no change in the pH was detectable. No significant change had occurred in the vacuum in the lots stored at room temperature. The lots stored at 98° F. show a slight loss of vacuum but the difference in loss between those from untreated and treated fruit is not significant. The loss in the lots with known amounts of sulphur is not different from the untreated. Six months storage at 98° is considered equal to 1 year's storage under normal storage conditions.

Personnel

Miss Miriam A. Palmer was transferred to full-time teaching funds, and part of the time of Dr. George M. List was put on Station funds.

Home Economics Section

Baking of Flour Mixtures at High Altitudes

Work has been completed upon the whole-egg, butter-type cake. A basic whole-egg cake formula was rebalanced stepwise with added increments of sugar, egg-solids, shortening, and liquid so that cakes of comparable volume, texture, and quality, but considerable difference in nutritional value and sweetness, could be produced. Altitude corrections for this indefinite number of whole-egg, butter-type cakes were established.

A modification of the single-stage method of mixing made it possible to use ordinary hydrogenated shortenings in the preparation of these high-sugar, high-liquid cakes instead of the special shortening containing added emulsifiers. High-sugar, high-liquid cakes keep much better under the semiarid atmospheres of the west. A similar investigation is now being applied to white and gold type cakes.

This project was originated to meet the widespread demands for help in the solution of problems arising from the effects of altitude upon the baking of flour mixtures. It is in the region between western Kansas and central California where variation in atmospheric pressure due to altitude causes difficulties in baking.

The modification of the single-stage method of mixing announced this year permits the use of hydrogenated shortening, selling for about 2 cents per pound less than the special shortenings generally used. Although this procedure was developed to meet the high-liquidcontent demands of batters at high altitudes, it is even more readily applicable to baking at the lower altitudes. This widespread saving which is now possible may be accomplished with an actual improvement in cake quality, flavor, and nutritional value.

Cooking Quality of Eggs

The project on cooking quality of eggs is carried on in cooperation with the Poultry Section. Eggs of known quality from individual birds have been made available by the Poultry Section. Such a source of samples of controlled quality reduces the cost of the project.

Length of storage period, percentage of initial weight of eggs, height of firm albumen, and yolk index are all measures which may serve as an indicator of egg quality when eggs are to be used in the preparation of cake. The volume and tensile strength of cakes are significantly related to these measures of egg quality. Length of storage period is negatively correlated, while the remainder of the measures are positively correlated, with cake volume and tensile strength.

Rates of deterioration of eggs as indicated by both physical measures upon the eggs and quality measures upon cakes produced therefrom have been followed for the eggs from individual hens. Eggs from these individual hens differed significantly in both these types of quality measures, when newly laid and at the end of the storage periods. Great differences in deterioration rates, as indicated by these quality measures, were found for the eggs of individual hens whether these eggs were of high initial quality or low quality.

In cake baking it is possible to correct at least in part for inferior quality in the eggs used. In many respects the effect of decrease in egg quality is similar to the effect of increase in altitude. Formula corrections to overcome egg deficiencies are similar to those necessary to correct for a decreased atmospheric pressure. Limits in the characteristics of the ingredients used and the atmospheric pressure found in our physical world limit definitely the extent to which these corrections can be carried. For this reason it is possible to take maximum advantage of ingredient-correction possibilities for inferior egg quality at the lower altitudes.

A practical method for estimating egg quality by means of cake baking tests has been developed. Several methods for decreasing rates of deterioration of eggs in storage both with and without refrigeration have been followed. This work must continue over a long period before its value can be accurately estimated.

It has been shown that it is possible to select strains of breeds of hens which will lay eggs of significantly higher-than-average quality. The work on egg deterioration rates reported here indicates that it may also be possible to select hens from these high-qualityegg strains whose eggs will deteriorate much more slowly than the average. Since approximately half the initial quality in many of the eggs now sold is lost before they reach the consumer, this discovery is of great economic importance.

Since pullet eggs, although small, are almost invariably of very high quality, it has been suggested that these quality characteristics might be preserved for the consumer if the frozen egg industry could arrange to handle and freeze these eggs separately.

Culinary Quality of Potatoes

The tubers for the project on culinary quality of potatoes are grown under the supervision of the Horticulture Section. The cooperation of this section makes available samples of various varieties of potatoes the cultural and storage history of which are known. The value of such information and cooperation is very great indeed.

During the year investigations of factors affecting the culinary quality of potatoes were greatly extended because of the initiation of the San Luis Valley project. Because of this the number of samples available representing different cultural treatments was greatly increased. Within any given variety the specific gravity of the tubers serves as an excellent indicator of the potential quality of potatoes, when cooked by any of the usual methods, provided the effects contributed by the storage conditions are eliminated by a suitable tempering treatment.

Potatoes taken directly from commercial storage for cooking tests often will indicate inferior cooking characteristics, largely because of the low temperature of storage. Two weeks storage at moderate temperatures (65 to 75° F.) will eliminate the storage effect. Shrinkage at this higher temperature may be practically eliminated by maintenance of high humidity.

Nitrogen plus phosphorus fertilization (6-30-0 ratio) yielded potatoes of the higher cooking quality under Colorado conditions. New varieties with considerable promise from the standpoint of disease resistance and high yields were compared in cooking quality with all of the commercial varieties adapted to Colorado conditions.

The value of the Colorado potato crop approximates \$18,000,000 yearly. Buyers of potatoes in quantity require cooking tests before the purchase is made. Therefore it is essential that the producer use cultural and storage practices which will insure the best cooking quality obtainable for his potatoes. For several years certain producers have been able to obtain a contract premium of as much as one-half cent per pound for their crop because their potatoes made excellent chips.

Information made available from the results of these investigations makes it possible for any grower to qualify for premium prices. An indirect method for the measurement of potato chip color has been developed which requires an investment in equipment of less than one-tenth of that required for direct measurement. The method is rapid and convenient.

Stone and Pome Fruits

The project on stone and pome fruits is also in cooperation with the Horticulture Section. The samples for the work for the most part come from the experimental orchards of the Horticulture Section. Their cultural history is thus accurately kept and is available.

Formulas and methods for producing attractive and nutritious cherry juice products were reported by this section. It was found in a series of juice-yield determinations on a semicommercial basis that U. S. No. 1 Montmorency cherries yielded 70 percent filtered juice, while cherries slightly under U.S. No. 1 in size yielded 67 percent filtered juice. There was no significant difference in juice yields from U. S. No. 1 cherries grown by any of the prevalent field treatments. However, the percentage of cherries falling below the U.S. No. 1 size requirements was considerably greater from unirrigated unmulched plots. The other three field treatments followed were irrigated mulched, irrigated unmulched, and unirrigated mulched. It was also found that the dissolved solids in the juice of Montmorency cherries progressively increased during the picking season. Cherries to be used for juice should be left on the trees about 2 weeks longer than is customary for cherries which are to be used for canning.

Colorado cherry growers have been confronted with the problem of finding a suitable market for sound but undersized fruit. These yield experiments have shown that high-quality cherry juice may be produced more cheaply from these smaller cherries when a price differential of one-half cent per pound exists between U. S. No. 1 and slightly undersized fruits. Practically no market has existed for this type of fruit heretofore.

Horticulture Section

Vegetable Crops

Potato Breeding and Variety Testing

Many new varieties are tested, new seedlings developed, and foundation stock seed potatoes are maintained under the project on potato breeding and variety testing in which the United States Department of Agriculture collaborates. For vine type, tuber type, quality, and yield 425 seedling lines were tested in the field. These lines were developed by the Horticulture Section and the Department of Agriculture. Inferior strains were discarded at harvest time, and 223 lines were saved for storage tests and will be planted this year. A number show promise.

New varieties were tested in the major districts of Colorado, and the Houma and Earlaine varieties were discarded. Pontiac looks promising, although it is susceptible to mosaic disease. The new foundation seed program is under way, and ring rot free seed can be distributed in small quantities each year.

Commercial Fertilizers for Potatoes

The test carried on with the Red McClure variety in the San Luis Valley showed that nitrogen, phosphorus, or potash alone had little consistent effect on yield. Nitrogen applied alone decreased the quality of the crop by producing more growth cracks, more second growth, and a more tender skin which caused difficulty in harvesting. Nitrogen and phosphorus in combination or a complete fertilizer containing the three elements gave consistent slight increases in yield and did not decrease the quality of tubers harvested. Lime applied in row applications also increased the yield of potatoes under soil conditions on the farm in the San Luis Valley. The two trials in highly fertile northern Colorado soils showed no benefit from fertilizer applications. In many instances the mineral fertilizers decreased the yield of tubers.

Bacterial Ring Rot of Potatoes

As previously reported, losses from bacterial ring rot can be reduced by the planting of disease-free seed and by using sanitation methods, such as disinfecting cutting knives and treating seed. The efficiency of ultraviolet light for detecting ring rot in tubers was tested; 7,400 tubers from ring rot infected seed were examined and it was found that the ultraviolet light method of detection was more

accurate at 40° F. than at 70° F. At 70° F., 3.37 percent of infected tubers escaped detection, while at 40° F. only 0.44 percent escaped. The tubers escaping detection by the light method were found by the gram-positive test under the microscope.

The work on knife disinfection has brought out several pertinent facts. The deterioration of the disinfectant by dirt and pieces from the potato, strength of disinfectant, best material to use, and cost are being considered and tested. The results show that a larger volume of disinfectant solution, as well as frequent replacements with fresh disinfectant, is necessary.

This work is cooperative with the Botany and Plant Pathology and the Pathology and Bacteriology Sections.

Onion Breeding

This year the first readings on resistance to purple blotch disease were taken on some 21 onion hybrids. The degree of infection varied in some lines from no purple blotch up to about 82 percent infection. Bulbs from the more resistant hybrids are being saved this year and will be back-crossed again to Sweet Spanish.

Thrip resistant lines are also being carried and back-crossing to Sweet Spanish will be continued. The United States Department of Agriculture is collaborating in this work.

Commercial Fertilizers for Onions

Over a 5-year period a combination of nitrogen and phosphorus commercial fertilizer has given the most consistent significant increases in yield of onions over phosphorus alone and over complete fertilizers and the check plots. This work has been done at the Rocky Ford substation.

Fruit Crops

Sour Cherry Fertilizer Trials

The 1940 results from the sour cherry fertilizer trials, which are cooperative with the Agronomy Section, followed the trends previously reported. Only nitrogen and annual applications of manure have given consistent significant increases in yield.

Chlorosis of Stone Fruits

In the project on chlorosis of stone fruits, which is cooperative with the Botany and Agronomy Sections, application of sulphur to chlorotic peach trees in the Palisade district improved conditions in some instances the year following application. Dip tests on chlorotic foliage of sour cherries and grapes, and plugging of affected cherry trees, showed responses only to iron salts. These responses suggest quite definitely that the chlorotic conditions are of the type attributed to lack of iron.

The pH measurements between chlorotic and normal leaves showed consistently lower pH values in the nonchlorotic tissue.

Montmorency sour cherry trees on mazzard rootstocks showed significantly more chlorosis of a severe type than did trees on mahaleb rootstocks.

Fruit Variety Tests

Peach variety tests at Austin indicate that July Elberta survived the freeze of blossom time and set more fruit than the other varieties in the test. The fruit also withstood a heavy wind and hung well to the tree. Candoka variety is sensitive to soil types and fails to form many fruit buds. The Golden Jubilee produces pointed fruit which ripens at the point before it is ready to pick.

PLUM VARIETIES.—The most promising plum variety at Austin is the Albion, while at Fort Collins the Stanley is the best.

PEARS.—The Gorham variety of pear continues to show up well for commercial plantings.

APRICOTS.—Of the newer apricot varieties the Riland is most promising.

Commercial Fertilizers for Apples and Peaches

There are now on test 12 randomized plots comparing barnyard manure with commercial fertilizers on peaches and 50 randomized plots on apples with similar treatments. Fruit weight and growth measurements have been taken on each plot, but since tests were just started last year, no results are reported.

Straw Mulch on Sour Cherries

In the study of straw mulch on sour cherries, which is cooperative with the Agronomy Section, the greatest difference between mulched and unmulched plots was in the nitrate level. In soil under mulch the nitrate level was about 50 percent of that unmulched. Potassium was much greater in soil under mulch than in unmulched soil.

Winter Injury on Raspberries

The chemical analysis phases of the project on winter injury on raspberries, which is cooperative with the Botany and Plant Pathology Section, have not been carried by the plant physiologist. One new treatment in addition to the irrigation and fertilizer

treatments was started this year. Sugar beet molasses dissolved in water was applied to the soil in late summer on the assumption that winter injury may be due in part to failure of canes to ripen properly where nitrogen is abundant in the fall. This treatment will test the power of sugar to tie up nitrates. So far irrigation and fertilizer treatments have shown no effect on degree of winter injury.

Flower Crops

Carnations in Nutrient Solutions

One year's results have indicated that of 10 different substrates tested, fine gravel, vermiculite, and mixtures of the two are the most desirable ones in which to continue the work for the coming year in the study of carnations in nutrient solutions.

Of 10 different nutrient solutions used this year, those in which nitrogen and phosphorus levels were varied from standard gave enough better production of cut flowers to warrant further replication and continued testing in the coming year.

Personnel

Dr. John G. McLean was appointed to the staff on September 1. His work is mostly on potato research.

Pathology and Bacteriology Section

Overeating (Enterotoxemia) in Feedlot Lambs

Toxic intestinal filtrates were obtained from 75.6 percent of the overeating cases examined, which compares favorably with the results of the past 2 years. When intestinal filtrate, or pancreatin, from normal lambs is added to the toxin produced in culture by *Cl. welchii* Type D, a marked increase in toxicity results to a degree approaching that of intestinal filtrate from overeating cases. Type D antitoxin will still neutralize the toxin produced by enzyme action. The intravenous injection of either the intestinal filtrate or the culture toxin, plus enzyme, into rabbits and sheep results in a marked increase in blood sugar. If death is delayed, sugar appears in the urine. These symptoms are frequent in field cases of overeating. Further attempts to reproduce the enterotoxemia syndroma by way of the intestinal route have met with failure, suggesting that the conditions necessary for absorption from the alimentary tract have not been duplicated. A study of the bacterial flora of the intestinal tracts of

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normal and overeating lambs was begun. Bacteria were more numerous in the overeating cases. *E. coli, B. subtilis* and *Micrococcus lutcus* were the only aerobic organisms recovered. Classification of the anaerobes is not yet completed. Further work on the pathology of overeating is in progress.

Feedlot Gains of Lambs as Affected by Drenching

In cooperation with the Animal Investigations Section the effect of single treatments of lambs against parasites was studied. A reduction of more than 60 percent in ova of *Strongylidac* was observed immediately after treatment in composite fecal samples from the lots treated with phenothiazine and with copper sulphate-nicotine mixture. In the parasite counts of the contents of the viscera of four representative lambs from each lot, significantly fewer *Hemonchus*, *Ostertagia* and *Cooperia* spp. were found in the treated than in the untreated lambs. At slaughter, fringed tapeworms were present in the bile ducts of 40.9 percent of the phenothiazine-treated lambs and 9 percent of the copper sulphate-nicotine-treated lambs, as compared to 50 percent in the untreated lot.

Control of Coccidiosis in Lambs through Management

In cooperation with the Animal Investigations Section, two trials were conducted in the study of the control of coccidiosis in lambs through management. In each trial six different feeding practices were followed. In neither trial did a sufficient number of cases of coccidiosis occur to be considered as an outbreak. Daily composite fecal samples from each lot were examined for a comparative level of eliminated oocysts. The problem is of sufficient importance that it should be repeated.

Urinary Calculi in Feedlot Lambs

The study of urinary calculi in feedlot lambs is being continued in cooperation with the Animal Investigations and Chemistry Sections. No cases of urinary calculi have developed among the 15 lambs on trial since November 20, 1940. The work this year is designed largely to study the influence of vitamin A in calculi formation.

Listerellosis in Lambs

Listerellosis was diagnosed for the first time at this Station in two lots of lambs. The organism, *Listerella monocytogenes*, was isolated from 5 of the 10 lambs autopsied. The lesions were confined to the brain and were characterized by a meningitis and encephalitis. Both lots of lambs originated in the same area in Wyoming. The mortality was 5.18 percent and 6.6 percent in the two groups, with almost all of the affected lambs dying.

Fringed Tapeworms in Lambs

Following the identification of the egg cases of the fringed tapeworm in lambs, more than 500 gravid segments, containing these eggs, were collected from feedlot lambs at slaughter. Approximately 9,000 egg cases (90 gravid segments) were fed to newborn lambs. Following 7 months' confinement in individual cages these animals were found to be free of fringed tapeworms at the time of slaughter. This proved definitely that this tapeworm cannot be transmitted directly from lamb to lamb but requires an intermediate host, possibly an invertebrate. It was found for the first time that the College pasture is infected with the precursors of these tapeworms. Twenty-eight percent of the livers of 105 lambs which were born and reared on this pasture were found to be infected with fringed tapeworms at the time of slaughter. The collection of soil and forage samples from the pasture was started this winter. The study of the life cycle of the tapeworm is being continued. The project is in cooperation with the Animal Investigations and Entomology Sections.

Feeding Trials with Middle Park Hay

Trials were carried out to determine the effects of feeding cattle Middle Park hay, reported as being injurious. Similar cattle, fed North Park hay, made larger gains and appeared better physically. The Middle Park hay contained 55 parts per million of molybdenum, which is considered rather high. The differences in the two lots of cattle might well be accounted for by the difference in the quality and nutritional value of the two hays.

Iodine Supplementation

The studies of iodine supplementation are continued on two different levels of iodine for reproducing ewes. At lambing time the lots receiving 6 mg. and 12 mg. per head per day compare very favorably with the check lot.

Pullorum Testing

The tube agglutination test was run on 1,341 samples of turkey blood from 19 flocks. One hundred eighty seven reactors were found. No reactors were found among 492 samples from chukar partridges.

Iodine Requirements of Poultry

The studies of iodine requirements of poultry have been continued in cooperation with the Poultry Section. Based on histological studies of the thyroid glands of birds on various iodine levels, the need during the period of growth is about 1,000 parts per billion and during production about 500 parts per billion. In birds on iodine levels ranging from 5,000 parts to 180,000 parts, increasing damage resulted to the structure of the gland.

Goitrogenicity of Soybeans

Further studies revealed that two factors are contained in the soybean which act apparently over the hypophysis on the thyroid glands of birds. Reproduction is impaired.

Thymus-Thyroid Relationship

Thymus tissue is frequently incarcerated in the thyroid, and thyroid follicles have been observed to develop within the posterior lobes of the thymus. This accounts for the difficulty in completely thyroidectomizing a bird.

In cooperation with the Chemistry Department, University of Colorado, further investigation of the effect of chronic estrogen therapy on the thyroids and the reproductive apparatus of rats gave the following results:

- 1. Diethyl-stilbestrol and estrone depress thyroid function, iodine storage, and general growth.
- 2. Both substances cause epidermoid metaplasia in the uterine lining. Complete stratification of the epithelium was found in some cases.
- 3. Ovaries show cystic atrophy and testes show degeneration of the seminiferous epithelium, while seminal vesicles atrophy.
- 4. Thyroids contain multiple epidermoid pearls of low malignancy, possibly as a result of stimulation of embryonal remnants by estrogens.
- 5. Both sexes were rendered sterile.

A rest period of 12 weeks following injections for 12 weeks caused some ovaries and uteri to recover. Others still showed the latent effect of the estrogen treatment. Epidermoid pearls were found in the thyroids of all animals.

Bang's Disease

The herd at Fort Lewis has been tested for Bang's disease monthly for the past year, and 15 reactors have been slaughtered as rapidly as they were detected. Three new reactors were found on the test run in February and since that time no new reactors have been found. There are at present 10 cattle in quarantine that reacted suspiciously. It appears that this outbreak is at last under control.

In January 1941, 58 calves of this herd, under 8 months of age, were vaccinated with the live organism vaccine (Strain 19). Monthly

agglutination tests have been run on these calves. All showed a positive reaction on the test run 1 month after vaccination and all are positive to some degree at present.

It was found that 22 percent of the horses kept on the farm reacted in some degree to the agglutination test for Bang's disease. Three of these horses, all showing a high titer of reaction, were brought to this Station for further studies relative to their ability to spread the disease. This work has not progressed sufficiently to report on at this time.

Routine testing of bovine blood samples in cooperation with the United States Bureau of Animal Industry has continued. In the 6 months previous to April 1, 1941, 20,778 samples were tested, 505 of which were positive.

Diagnostic Services

A summary of the diagnostic service for the 6-months period ending April 30, 1941, follows:

No. of Bang's tests run	4,622	(601 reactors)
Chickens	397	examinations
Ovine	125	autopsies
Water samples run	31	
Miscellaneous	27	examinations
Bovine	19	examinations
Porcine	12	examinations
Furkeys	8	examinations
Equine	3	examinations
Total	5 193	

Bacterial Ring Rot of Potatoes

In cooperation with the Horticulture Section, 4 acres, comprising nine varieties of potatoes, are being maintained free from ring rot at Fort Lewis. Bacteriological tests have been applied to disinfectants used with rotary seed potato cutting knives to ascertain the rate of deterioration of the disinfectants. Smears from suspected tubers and vines from all potato-growing sections of the State have been examined microscopically as a means of identifying infected seed potato sources. Sack disinfectants are being tested both for their ability to kill the ring rot bacteria and for their effect on sack strength. An experiment is under way in the greenhouse to ascertain whether ring rot may be transmitted by irrigation water. During the summer of 1940 portable ultraviolet light equipment was used in the field as an aid to diagnosis of ring rot. All these studies are being continued.

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Azotobacter

Research has been completed dealing with methods for the isolation of the nitrogen-fixing bacterium, Azotobacter vinelandii, and with the distribution of this microorganism in Colorado. As an aid to isolation, various non-nitrogenous organic compounds have been shown to stimulate the growth of this bacterium in soil in the laboratory. Of 283 soil samples examined 210, or 74 percent, contained Az. chroococcum, while only 2, or 0.7 percent, demonstrated Az. vinelandii. Of 29 water samples taken from streams, lakes, and irrigation ditches 19, or 66 percent contained Az. chroococcum and 9, or 31 percent, contained Az. vinclandii. A study has been made with numerous strains of Azotobacter to ascertain the effect of aeration upon nitrogen fixation in soil in the laboratory.

Microorganisms in Greenhouse Cultures

In cooperation with the Horticulture Section research is being conducted to ascertain the numbers and kinds of microorganisms to be found in culture solutions used to support greenhouse crops. At present the microorganisms found are being identified. The biochemical activities of the microorganisms in greenhouse culture solutions will be investigated.

Pure cultures of ammonia-oxidizing and nitrite-oxidizing bacteria are being prepared in a study of the effects of inoculating these microorganisms into steam-disinfected soil in an effort to overcome the lag period in plant growth in such soil.

Personnel

Dr. Frank Thorp, Jr., and Dr. H. W. Reuszer resigned early in the year to take positions with other institutions. Part of the time of Dr. Dudley P. Glick was transferred to Station work, and Dr. Hilton A. Smith and Dr. Thomas D. Kroner were employed. Dr. Alvin B. Hoerlein substituted for Dr. A. W. Deem while the latter was on leave.

Poultry Section

Sources of Green Feed for Poultry

In samples of alfalfa hay cut 3, 4, and 5 times during the 1939 season, the vitamin G (riboflavin) content tended to be higher in the more frequent and hence more immature cuttings. The lower yield of hay per acre caused by more frequent cuttings slightly more than offset this greater vitamin concentration and lowered the vitamin G

yield per acre. The vitamin G content of all samples was lower and the fiber content was higher than expected, presumably because of the high ratio of stem to leaf. This phase of this project is being conducted in cooperation with the Agronomy Section.

Chick bioassays and microbiological assays on these alfalfa samples failed to agree as well as they should. Incomplete extraction of riboflavin was obtained from alfalfa meal following autoclaving in water or boiling in hydrochloric acid.

In attempting to supply all the vitamin A in the ration of laying hens through the use of alfalfa leaf meal in the concentrate method of feeding, it was noted in 1940 that the large amount of alfalfa incorporated in the concentrate rendered it highly unpalatable. As a result egg production and hatchability were seriously reduced. Leghorn pullets appeared to give better production and hatchability under these conditions than White Rocks or New Hampshires.

During the year an attempt was made to supply the alfalfa entirely as hay in racks. Consumption amounted to about 1 percent of the ration. A heavy mortality from vitamin A deficiency resulted, especially in the Leghorn pullets. Grinding the hay to a coarse meal and incorporating it at a level of 20 percent in the concentrate has improved consumption.

Preliminary results on turkeys show that production, food consumption, and body weight are being satisfactorily maintained on a ration consisting of whole grains and a pelleted concentrate containing 20 percent of alfalfa leaf meal.

Inorganic Elements in Poultry Nutrition

A local gravel rich in iron significantly increased the incidence of perosis in chicks when it was made available to them as grit. This demonstrates the practical application of the finding last year that iron salts increase the severity of perosis by interfering with manganese utilization.

This Section collaborated with the Animal Vitamin Research Council in a nation-wide study of the official chick assay for vitamin D prescribed by the Association of Official Agricultural Chemists. The experiment conducted here strikingly demonstrated that the present official test ration is deficient in other factors in addition to vitamin D, since inferior growth and symptoms associated with lack of riboflavin, pantothenic acid, and another vitamin were encountered. The proposed new ration afforded good growth, freedom from deficiencies other than vitamin D, and a lower percentage of ash in the leg bones. Further work on this project is temporarily discontinued owing to lack of funds.

Factors Influencing Reproduction in Turkeys

During the 1940 hatching season, hatchability of eggs from 6 pens of turkeys fed levels of vitamin G varying from 140 to 345 units per 100 grams of ration (calculated) was not significantly different. It varied in outdoor pens on limed runs from 38 percent to 46 percent. Turkeys of three strains and two varieties confined to small indoor pens and fed a ration calculated to contain 265 units of vitamin G per 100 grams produced eggs that hatched slightly better, averaging about 57 percent. Dried buttermilk, or alfalfa leaf meal, or a combination of both gave similar results.

Owing to these poor results, a number of different possible causes are under investigation during the 1941 season.

Iodine Requirements of Poultry

Earlier observations that replacing meat scrap and dried buttermilk with casein and yeast would result in lowered hatchability and that iodine would not correct this effect have been corroborated.

Statistical analysis of the weights of chicks at 12 weeks of age in one experiment shows that a goitrogenic ration containing about 25 parts per billion (mcg. per kg.) of iodine did not affect the weights of pullets but did significantly lower the weights of cockerels below those obtained on 250 or more parts per billion of iodine.

Continued preliminary observations have shown that levels of iodine as low as 250 and as high as 180,000 parts per billion in a practical ration have not materially affected egg production, egg weight, interior egg quality, fertility, or body weight. In one experiment hatchability was apparently subnormal on the ration containing the low level of 250 parts per billion. These observations are being continued to ascertain their possible significance.

On the basis of histological examination and weight of the thyroid gland, it is concluded that the chick requires about 1,000 parts per billion of iodine during the early growing period to produce a normally active gland.

The iodine content of poultry feedstuffs from representative areas in the United States is being ascertained.

This project is being conducted in cooperation with the Pathology and Bacteriology Section.

Personnel

Earl R. Reeves resigned as research assistant to accept the position of inspector for the Colorado Poultry Improvement Board, effective September 15, 1940.

Range and Pasture Management Section

Grass, its utilization and perpetuation, is one of the most important problems confronting the people of the State of Colorado. It is the "backbone" of the range livestock industry of the State; it is one of the most important conservers of the soil resource; it slows up the rapid rush of water down steep slopes; and it affects the economic life of many communities in various ways. In the management of the grass resource, many problems arise, some controllable and others non-controllable. One may, however, regulate numbers, distribution, and seasonal use of livestock on the range, which will to a great extent minimize the effects of adverse climate.

Following are some of the problems that are being investigated.

Management of the Native Range Resource

Utilization of Native Range by Cattle

A 10-year study was started in the spring of 1937, in cooperation with the Animal Investigations Section, to ascertain the effect of two systems of grazing upon cattle gains and range vegetation. The range experiment is being conducted in three native range pastures about 4 miles west of Fort Collins. The vegetation consists principally of blue grama, buffalo grass, western wheatgrass (Colorado bluestem), and, to a lesser degree, green needlegrass. The grazing capacity for each pasture was ascertained by a range survey in 1936.

The project as originally outlined has been somewhat interfered with by adverse climatic conditions, especially during the main growing season (March 1 to August 31). In the 4 years, (1937 to 1940, inclusive) the seasonal precipitation shows an accumulated deficiency of 10.78 inches, which is slightly in excess of the long-time seasonal mean.

Studies on meter chart quadrats show definitely the downward trend in density of the better native grasses. Prior to 1940 the greatest decline in density occurred in the shortgrass vegetation, while in 1940 Colorado bluestem, a tall grass, suffered the greatest loss.

The perennial grasses in all pastures reached a long-time low density in 1940; in the conservatively grazed pasture only 25 percent of the 1937 density remains, and in the deferred and rotation pastures, 57 percent. A study of the 1937 stand of grass showed evidences of decline from a once more productive cover. Blue grama declined 10 percent more in density under conservative grazing than under deferred and rotation grazing; buffalo grass declined 47 percent more and Colorado bluestem declined 14 percent more under the second system of grazing. The annual growth of range vegetation is closely correlated with soil moisture. The moisture content of the upper 6 inches of soil in 1940 dropped below the hygroscopic coefficient by mid-June and in the subsoil by early July. Subsequently plant growth and development stopped by early July.

The 1940 grazing capacity of the pasture grazed early in the season on the deferred and rotation plan was 66.8 percent of the 1936 grazing capacity; that of the deferred pasture was 38.0 percent and that of the conservatively grazed pasture was 33.2 percent of the 1936 capacity.

A study was made in the experimental pastures in 1938, 1939, and 1940 to ascertain the extent of damage to range forage by grasshopper defoliation. The degree of damage was approximately the same, irrespective of grass species. An estimate of the damage in 1938 showed 10 percent of the total palatable forage defoliated or removed (grazed); in 1939, 15 percent; and in 1940, 25 percent. Because of a very poor forage crop in 1940 the damage by grasshoppers was rather serious. The use of forage by grasshoppers in the deferred pasture greatly reduced the volume of forage available for livestock. An indication from the study is that continuous conservative grazing in the years of bad grasshopper infestations may be more desirable than the deferred and rotation plan. The severity of damage to the range and the lowered grazing capacity warrant more intensive study of the economic aspects of poisoning of grasshoppers on native range lands.

Increasing the Grazing Capacity of Sagebrush Lands

Studies in North Park show the value of improving sagebrush lands of low forage productivity. Grass on dense sagebrush ranges was increased substantially by eradication of the sagebrush. Burning, scraping with a road grader, and railing were used in eradicating the sagebrush. The burned sagebrush area showed the greatest increase in grass of the methods used and the minimum "comeback" of sagebrush.

To prevent destructive soil erosion or damage to valuable adjacent timber and croplands, certain considerations are necessary before burning is attempted. Undesirable plants such as rabbitbrush may increase in stand after burning, which will offset the advantage gained. The effectiveness of scraping depends upon the proper control of the blade depth to remove the crowns of shrubs and at the same time leave the grass tufts as little injured as possible. Although railing results in the least improvement it is effective in breaking down the sagebrush and making the other range forage available to livestock. The rate of recovery of the better forage plants following eradication of sagebrush is dependent upon how closely they are grazed by livestock.

Shortgrass Ranges in Central and Eastern Colorado

The intensive study of grazing capacities was continued in 1940 on shortgrass ranges. The results obtained in the range resource surveys of that year substantiated those of previous years. A preliminary analysis of the El Paso County field data indicates the importance of blue grama as the "sustaining grass" of the range livestock of that area. However, the stands of this grass are greatly depleted on extensive areas of range land. Because of this the native ranges in general are greatly reduced in productivity and must be carefully managed to bring them back.

The variations in grazing capacity are strikingly brought out in the analysis of the Elbert County data. Two areas of native range of the same character of vegetation lying adjacent to each other varied as much as 23 percent in annual grazing capacity. It was found that the operator with the better range had managed his grass to manage his cattle. The other operator did the opposite. As a result the second operator does not have a stabilized business.

Progress reports are being prepared on the range resource studies. The compiled grazing capacity data and vegetative type maps are being used to advantage by officials of three Soil Conservancy Districts in Elbert County. The information is of value to them in planning the readjustment of agriculture in their respective areas. Information on grazing capacity of range lands has been furnished various individuals who are studying the tax problem.

Natural Vegetative Recovery of Abandoned Croplands

Studies were continued on abandoned croplands to ascertain the rate of recovery back to potential range land. Range operators in the Great Plains who contemplate the purchase of abandoned cropland to increase their range feed areas should consider carefully the grazing capacity of such land. According to grazing capacity standards, cropland abandoned 5 to 10 years will carry about 10 head of cattle per section for 10 months. Because of the presence of many range plants that are of little value for fall and winter grazing, such land should be grazed in the spring and summer. However, too heavy use in the growing season seriously retards the increase in density of blue grama and buffalo grass, highly desirable forage plants.

Artificial Reseeding of Depleted Range and Abandoned Croplands

Studies on artificial reseeding were continued despite unfavorable climatic conditions. It is important to have information on the growth and behavior of forage plants in drought years. Certain species that appeared promising prior to drought years may thus be found unsatisfactory.

Since 1935 many introduced and native species have been tried to ascertain their adaptability to this area. Two tall Russian wheatgrasses, one a typical bunchgrass and the other a slow spreading turf grass, show considerable promise. Sufficient seed was produced from these two grasses to send out small samples for seeding trials in other parts of the State.

The trends of forage and seed production have been generally downward for all grasses the past 2 years because of drought. An old broadcast sowing of smooth brome has actually increased 46 percent in density between 1938 and 1940, while commercial crested wheatgrass decreased 59 percent in the same period. Smooth brome appears to be the most drought-resistant grass of the many introduced species for this area.

The study on source of seed of native grasses was continued. Blue grama seed was obtained from other sources throughout the West and was sown in replicated rows. The plants of this species grown in the nursery from seed of other localities show many different characteristics. However, after 5 years, plants grown here from Montana seed still retain the characteristics of the first year growth.

In some years extremely favorable moisture conditions in September account for excellent aftermath or regrowth of most grasses. Blue grama and buffalo grass make rather meager regrowth. Chemical analysis of the aftermath growth of blue grama indicates nearly as high protein content as in the early spring growth. Livestock men should not follow the practice of too close grazing of aftermath in the fall, because it is detrimental to the plants. This is particularly true if rainfall is very deficient in the summer months.

On 25 acres of abandoned cropland available for reseeding on a pasture basis, study is under way to test out promising species. It is planned to carry on grazing tests with both cattle and sheep to ascertain the feed value of the grasses.

The Section is cooperating with the Extension Agronomist in sending out small seed samples of range and pasture species to various county agents throughout the State. The objective is to acquaint the livestock men and farmers of the State with the different forage plants. In the past 2 years nearly 700 samples of seed have been sent out to 34 county agents.

Rural Economics and Sociology Section

Type of Farming Studies

Two phases of work have been included in the type of farming studies. One of these relates to the analysis of financial records and feedlot costs for lambs and cattle in the irrigated districts of northern The other deals with farm accounting records assembled Colorado. in the dry farming areas of northeastern Colorado. The records appear to show that cattle made a more profitable use of sugar beet byproducts than did lambs. The use of corn silage was associated with more profitable cattle feeding in comparison with the use of corn fodder. In the cases of both cattle and lambs the highest rates of daily feeding of grain were associated with more rapid daily gains but with a higher feed cost per pound of gain and a lower relative profit per head. Lamb feeders as a whole were not using average daily amounts of feed which would be adequate for full feed requirements. This is borne out by the fact that the average feeding period for lambs is about 1 month longer than is necessary under full feed. This tendency to "coast" in lamb feeding is an outgrowth of longtime experience, pointing toward a tendency for late winter and early spring markets which are relatively more profitable than the mid-winter markets. No such tendency to hold back has been noticeable in cattle feeding operations.

In northeastern Colorado 20 farmers operating units with an average value of \$22,000 and located on first-grade dry farming land received a net average cash income of \$1,449 during the year 1939. After including the net inventory increases of \$954, the total net farm gain amounted to \$2,403. This figure represents the income from the average investment of this group of farms and it includes the wages and profits of the farm operator as a laborer and manager as well as the services performed by the members of the farmer's family. It excludes about \$250 worth of farm products used in the farm home. The average size of farm was 783 acres for the year in question. It is significant that the most profitable one-third of the farm units in this group included an average of 1,004 acres. These farmers obtained average yields of 14.8 bushels per acre of wheat and 11.9 bushels of corn or three times the per-acre yields received by the least profitable group. However, the less prosperous farms were located quite generally in low rainfall areas.

Economics of the Colorado Range Livestock Industry

The response to the suggestions embodied in Colorado Experiment Station bulletin 460, "Possibilities for Cattle Income", has been gratifying. It has served a useful purpose in assisting those who desire to study the cattle business and the possible effects upon income of changes in management. A similar report has been prepared with respect to the factors that affect income from lambs and wool. Both of these studies differ from former range reports in that they stress the mathematical effects of important production factors rather than emphasizing the existing methods on specific ranches. Experience has demonstrated the need for this handbook type of analysis in order to increase the effectiveness of further research relating to the production of cattle and sheep on the range. A further benefit from this type of analysis has been disclosed in analyzing and evaluating cattle and sheep records that have been maintained through a period of years. By applying the methods outlined in these two reports it has been possible to approximate the returns for the use of grazing lands in the western part of the State.

Study of F. S. A. Clients' Record Books

During the past year 500 records relating to the calendar year 1939 were made available for analysis. These records came from 37 Colorado counties; 221 were from irrigated farms, 222 were from dry farms, and 57 were partly from both types. The average cash farm receipts for the total group were \$1,357, cash farm expenses \$839, and farm living expenses \$411. This study has given us an opportunity to tabulate and analyze a group of farm records relating to operating units on which the individuals in question are endeavoring to readjust their enterprises and improve their management practices so as to reach a more successful level of operation.

Agricultural Land Use Planning

In the field of agricultural land use planning two specific tasks have been given consideration during the year. The first represented an effort to study the planning process itself in order to ascertain what factors have tended to contribute to the success or failure of the planning program. The second task has dealt with the matter of obtaining certain basic data of a sociological nature in Washington County. In this case attention has been given to (1) a population analysis of the county, (2) a community delineation analysis, (3) an inventory of organizations, membership, and participation and (4) a study of some problems of recreation in sparsely settled dry farming areas. This research has provided the planning committees with basic information for discussion groups.

Some Health Practices and Attitudes and Related Problems

Detailed information has been obtained from 325 rural families regarding the various health practices. The process of collecting the information aroused considerable interest in the communities where this research was conducted. This interest has found expression in such things as parent-teacher and home demonstration groups where special attention has been given to the study of the problems of health. In two communities people have seen the need of hot lunches for their children. In another community certain questions in the schedule concerning personal cleanliness and hygiene were partly responsible for a movement to install showers in the high school so that these might be used by students following physical education classes.

Farm Population and of Farm Population Movements

During the year 675 schedules were obtained from people in various parts of the State showing the changes in farm and ranch population on their own and adjoining farms. These records have been sent to Washington and will become a part of the basic data on which estimates of the national farm movements for the year 1940 will be calculated. The figures for Colorado will serve as a basis for a special mimeographed report relating to the State's population situation.

Colorado Experiment Station Bulletin 462, "Population Trends in Colorado", appears to indicate that Colorado is approaching its population saturation point under its present economic structure. This bulletin provides a historical perspective for agricultural, industrial, and human planning in the State and shows how a number of Colorado's problems dealing with governmental, economic, and social affairs can be partially attributed to a diversity of cultural heritage by the people of the State. It points out further how migration frequently intensifies maladjustments in rural institutions and organizations. It also indicates how the decline in the proportion of persons in the productive age group in the State may mean increased taxation and financial burden in the future for those who belong to the productive age groups.

Youth Problems

Some of the more serious problems of youth in Colorado revealed in a preliminary analysis were as follows: (1) lack of opportunities to learn how to do productive work and develop constructive attitudes toward work, (2) limited opportunities to learn the value of money and effective ways for its expenditure, (3) lack of the privileges of higher education, and (4) lack of vocational guidance and limited assistance in the selection of business enterprises to which they are adapted.

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Beet Labor Problems

An analysis of housing conditions, work patterns, and related problems of sugar beet laborers in Colorado reveals that as a minority group, consisting mostly of Mexicans and Spanish-Americans, these people are confronted with many of the basic problems that have faced the Negroes in the South. Each has experienced rapid rates of natural increase. The birth rate among the Spanish and among the Mexicans is more than twice that of the general population of Colorado and is nearly three times as high as is needed to maintain a stable population. Spanish-Americans in Colorado are in the process of attempting to emancipate themselves. These individuals enjoy some of the privileges of democracy without understanding or assuming many of its obligations. It is evident that the solution of these problems lies in a more constructive adult educational policy for all of the people of the State concerning these issues and a reorganization of some institutional programs to meet the needs of this class more adequately.

Personnel

R. C. Whitney, assistant professor in economics, resigned effective March 1 to take a position with the United States Department of Agriculture at Lincoln, Nebr. Edward Rutledge was employed to take Mr. Whitney's place temporarily, and A. W. Epp is to fill the position permanently, beginning July 1. Robert Elliott was employed during the year as assistant in sociology under a cooperative arrangement with the Bureau of Agricultural Economics.

Seed Laboratory

The seed laboratory is set up to serve all Colorado citizens who are interested in seeds. During the past year occasional samples have been received from many individuals interested in lawn making, home flower or vegetable gardens, and parks. It has, however, served most the farmers, dealers, and investigators.

During one-half the year the laboratory staff has consisted of three trained analysts, a part time secretary, and a student assistant; during the remainder of the year the work has been carried on by one analyst and a part-time secretary.

In addition to current samples work has been completed on samples representing the seeds actually being planted in one Colorado

community. Tabulations of these results show clearly that many users of seeds are not safeguarding the farms they operate by using good seed. They continue to plant bindweed and other noxious weeds which in a few years will be competing with their crops.

The results of this survey are being made available to the county agent who cooperated by collecting seed from farmers at planting time.

In addition to testing samples submitted by users of seed, seed dealers, the Seed Registration Service, and the seed survey the laboratory has continued the longevity studies by making the twentyfirst annual series of germination tests of stored seeds. Work with frosted oats has continued.

Tests have been made as follows:

Purity	1,275
Germination	2,485
Identification	96
Total	3 856

Engineering Division

By action of the State Board of Agriculture August 23, 1940, N. A. Christensen, Dean of Engineering, was appointed Chairman of the Engineering Division of the Experiment Station. This action filled a position left vacant since the retirement of Professor L D Crain.

Civil Engineering Section

Snow Surveys

Since 1935 the Experiment Station has been cooperating with Federal agencies in making snow surveys for Colorado, Wyoming, New Mexico, and Arizona. At the present time there are 70 snow courses in Colorado, 50 in Wyoming, 15 in New Mexico, and 6 in Arizona. Several times each year data from these snow courses are forwarded to this office in Fort Collins for analysis and publication.

Regular reports are made for the months of February, March, April, and May on the snow conditions and the anticipated water supply. In addition to these regular reports many special reports are called for by the various groups who are interested in the water forecast for the coming summer.

The interest in the snow survey in this region is unusually widespread because four great drainages are involved, the Colorado, Missouri, Arkansas, and Rio Grande. The particular groups who request information on snow surveys are as follows: farmers, stockmen, irrigation companies, bankers, chambers of commerce, newspapers, city engineers, Federal and state offices, planning boards, and railroads. Each issue of snow survey reports comes to the attention of thousands of individuals composing the groups mentioned.

A great many agencies cooperate in the preparation of these reports. Some of these cooperators are: Forest Service, National Park Service, Bureau of Reclamation, Weather Bureau, War Department, Geological Survey, State Engineer, other State agencies, irrigation companies, and business associations.

These snow surveys make possible good forecasts of water supply. Efficient regulation of reservoirs, stream control, public water supplies of cities, and economical use of irrigation water all depend upon a rather accurate knowledge of potential water supply stored in the winter snow.

Snow surveying in the United States has probably come to stay. It is still in its infancy and it may be that some superfluous data is taken and some essential data is lacking. The records now being accumulated, however, will answer the how, when, and where of making snow surveys for the future.

High-Strength Wire for Concrete Reinforcement

The investigation of the feasibility of using high-strength wire for reinforcing precast concrete beams is being continued.

Tests performed to date indicate that this method of reinforcing is satisfactory in that adequate reinforcement is provided by about one-half as much steel as required in conventional design. Beams much smaller in cross section and hence lighter can be made. The principal difficulty is in shaping the wire properly. This phase of the problem will be investigated this summer.

Waterproofing of Adobe Construction

The investigation of waterproofing of adobe construction will be continued this summer. The work remaining to be done consists of checking results obtained by use of different methods of waterproofing adobe blocks made from soil from various parts of the State.

Experimental Check of Rohwer Evaporation Formula

By comparing computed and observed values from the 50-year record taken by the Colorado Experiment Station the reliability of the Rohwer formula for calculating evaporation will be checked over a long period of time. Progress on this project is slow because of the large amount of calculation necessary. The work is approximately 75 percent complete.

Meteorological Observations

To keep a complete record of climate at Fort Collins, observations are made twice daily of temperature, precipitation, wind direction and velocity, relative humidity, terrestrial radiation, and soil temperature at several depths. Evaporation is measured during the ice-free season.

In cooperation with the Weather Bureau, student observers make eight observations at the Station daily for the use of commercial air lines.

Photographic Method of Making Snow Surveys

Three years' photographic record of snow cover on a section of the watershed of the Poudre River at high elevations for the winter and spring months is complete. Correlation between area covered by snow and the water content of the snow at Cameron Pass as measured by the standard snow survey method is poor for the early winter months but becomes excellent for April and May.

Work has been done with air photography over the same area this winter and spring. Technical difficulties due to the lack of special equipment have made most of this work for the most part unsatisfactory.

Pumping for Irrigation and Drainage

In order to supply the urgent need for information on pumping for irrigation and drainage the following bulletins have been prepared:

1. "Design and Operation of Small Irrigation Pumping Plants", by Carl Rohwer. This bulletin is to be released in the near future as a United States Department of Agriculture publication.

2. "Putting Down and Developing Wells for Irrigation", Circular 546, by Carl Rohwer has been revised and submitted for republication because the first issue was exhausted within 6 months after its release.

3. "Small Irrigation Pumping Plants", Farmers' Bulletin 1857, U. S. D. A., by Carl Rohwer, in cooperation with M. R. Lewis, published December 1940.

Apparatus for Measuring Fall Velocity of Particles in Water

A piece of equipment for measuring fall velocity of particles in water has been developed during the past year and is a part of a more fundamental investigation of the action of sand in hydraulic models. The apparatus has been designed, constructed, and is now ready for a trial test.

Separation of Sand According to Fall Velocity in Water

An apparatus has been designed, constructed, and is now being tested, to classify sand according to its fall velocity in water. This apparatus also is a preliminary step to a broader and more fundamental investigation of the movement of sand in hydraulic models. The results of the preliminary test of this apparatus are encouraging.

Design and Invention of Irrigation Structures and Apparatus

More and more irrigation companies are adopting the Parshall flume as a method of measuring water, not only for large flows at the point of diversion but also for small flows distributed to the various farmers. Several large concrete flumes are being installed in the vicinity of Longmont. Near Fort Collins many small flumes of concrete are being constructed by various irrigation companies to provide a more accurate system of distribution.

A new inexpensive stilling well and staff gage has been devised for use in connection with Parshall flumes. This device will remove many of the objections to the old exposed staff gages which so frequently became damaged.

A laboratory model study of a large Parshall flume has been made. This flume was improperly located at the foot of a steep channel. As a result of the study channel modifications were recommended.

A series of investigations have been made on various methods of measuring the discharge of irrigation pumps. These tests have indicated that a Hoff current meter may be used for rapid and reasonably accurate measurements of pump discharges. This new method of measurement has greatly facilitated the Station project for the measurement of well discharges used for irrigation.

Various special pitot-type and end-orifice flow gages also have been investigated in the laboratory. Only a small amount of work has been possible in connection with sand traps during the past year.

Irrigation Use of Ground Water in the South Platte Drainage Basin

Last summer in cooperation with the Colorado Water Conservation Board, the discharges from most of the irrigation wells in the South Platte drainage basin were measured. It is estimated that the field work will be completed this summer.

The attempt in the last legislature to provide for a \$120,000 underground water survey of the State is evidence of a need for more information concerning the ground water resources of the State. In order to assist in the ground water problem, the present project will be continued next year. In addition preparation of an outline for an extended investigation of the ground water problems in Colorado is planned. In this effort cooperation will be solicited from the various State agencies, such as the State Engineer's Office, the Colorado Water Conservation Board, the State Geological Survey, and other State agencies whose assistance should be requested.

Fluctuation of Ground Water Levels

Fluctuation of ground water levels is being investigated in conjunction with the project on the use of ground water.

Mechanical Engineering Section

Largely because of the experimental work conducted at Fort Collins, single seed beet planting has been commercially accepted. There are at least six commercial single seed planters in the Fort Collins factory district this year which have been purchased by growers to plant their crops. One grower is planting his entire beet acreage, consisting of about 300 acres, using 9 pounds of seed per acre; this is a saving of about 58 percent on the cost of the seed. Although research is still being done on further improvement of sugar beet seed distribution it seems that past efforts are showing some gratifying results. The sugar companies have placed their approval on single seed planting.

During the summer of 1940 conditions were not favorable for any very extensive experiments on mechanical thinning because of a shortage of water. The Station did, however, successfully carry out some limited experiments along this line. In one case it was

possible to reduce the thinning time to one-third that ordinarily required for hand blocking and thinning methods with no significant loss of sugar at harvest time. On this particular test plot the beets had been planted with the conventional type beet planter using 21 pounds of seed per acre, which naturally caused overcrowding of the beet seedlings in the row at thinning time. The equipment used for this work was a row blocker and long handled hoe. The blocker was set to leave beet blocks on 4-inch centers cutting out 21/2 inches and leaving 1½-inch blocks. After the beets had straightened up following the chopping operation, which was about 36 hours after the machine operation, the field was gone over by a man using a longhandled hoe. The purpose of this operation was to cut out bunches and to reduce the population in the row to 120 beets per 100 feet. No "stoop" labor or finger thinning was used. With single seed planting using approximately half as much seed it is reasonable to suppose that even better results and a greater saving in time can be shown. Early in 1941 plans were to carry out more extensive planting and thinning trials.

In the past there has been difficulty in getting a stand of sugar beets to germinate. The proper depth of planting for one set of soil and weather conditions would not be correct for another set of conditions. In an attempt to overcome this difficulty there was developed here during the past winter a variable depth planter.

Editorial Service

Bulletins and Reports

The Station Editorial Service during the year 1940-41 has issued the following publications:

Popular Bulletins

No.

- 460-"Possibilities for Cattle Income", by R. T. Burdick.
- 461—"Foxtail Millet in Colorado", by J. J. Curtis, J. F. Brandon, and R. M. Weihing.
- 462-"Population Trends in Colorado", by R. W. Roskelley.
- 463—"Corn Production in Colorado", by Warren H. Leonard, J. F. Brandon, and J. J. Curtis.
- 464-""Why is Subsoil Unproductive?" by Robert Gardner.
- 465-"'Colorado Potato Pests'', by Leslie B. Daniels.
- 466-"Weeds of Colorado", by B. J. Thornton and L. W. Durrell.
- 467-"'Factors that Affect Sheep Income", by R. T. Burdick.

Press Bulletin

94—"Bacterial Ring Rot of Potatoes", by W. A. Kreutzer, D. P. Glick, and J. G. McLean.

Ouarterly Bulletins

Vol. II, No. 3, Colorado Farm Bulletin, July-September 1940.

Vol. II, No. 4, Colorado Farm Bulletin, October-December 1940.

Vol. III, No. 1, Colorado Farm Bulletin, January-March 1941.

Vol. III, No. 2, Colorado Farm Bulletin, April-June 1941.

Annual Report

Fifty-Third Annual Report, Colorado Experiment Station.

Legislative Report

"To Colorado Legislators, A Report from the Colorado Experiment Station."

Other Publications

During the year 37 papers by Station staff members for publication in scientific journals and elsewhere have been edited, as have the following mimeographed publications:

- "Colorado Rehabilitation Farms Income and Expense, 1938", by R. T. Burdick.
- "Feeding Trial of Middle Park Hay vs. North Park Hay on Cattle", by R. C. Tom, J. W. Tobiska, and Floyd Cross.
- "A Farm Business Report Relating to Twenty Farms Located in Phillips, Yuma, and Washington Counties, Northeastern Colorado", by Ramey C. Whitney.
- "Pullorum Disease—Whose Fault?" by H. S. Wilgus, Jr.
- "Controlling Poultry Diseases and Parasites", by H. S. Wilgus, Jr.
- "Colorado Rehabilitation Farms Income and Expense, 1939", by R. T. Burdick.

A "Potato Spray Timer" devised by Leslie B. Daniels also has been published.

"Colorado Farm Bulletin"

In the 10 numbers of the Colorado Farm Bulletin since its inception, there have been 79 major articles. Since all sections of the Experiment Station, as well as the College Farm Department, have contributed articles, the subject matter has been on all phases of the Station's work.

COLORADO EXPERIMENT STATION

News Writing

Since a year ago 56 articles for News Notes of the College have been written about Station work and 7 special features, 4 of them with pictures, have been written for farm magazines.

Miscellaneous

The indexing of Station bulletins which was started last year is being continued.

Staff Contributions

- Beach, George A. Carnation Variety Patrician in Various Nutrient Solutions and Substrates. Amer. Soc. Hort. Sci. Proc. 1940. 38:695-98. Sci. Jour. Series 118.
- Beach, George A. Experience Shows Raspberries and Other Brambles Should Be Covered for Winter. Colo. Farm Bul. 2(4):11. Oct.-Dec. 1940
- Beach, George A. Strawberry Variety Tests Show Only Lack of Uniformity; Winter Injury Often Severe. Colo. Farm Bul. 3(2):13-14. April-June 1941
- Beach, George A. and L. R. Bryant. Forty Varieties of American Grapes
 Tested for Resistance or Susceptibility to Chlorosis. Colo. Farm Bul.
 3(1):11. Jan.-March 1941
- Bodine, E. W. and L. W. Durrell. Host Range of Peach Mosaic Virus in Western Colorado. Phytopath. 31(4):322-33. April 1941. Sci. Jour. Series 107
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- Burdick, R. T. 17-Year Average Costs Give Basis from Which to Estimate Feeding Possibilities. Colo. Farm Bul. 2(4):8-9. Oct.-Dec. 1940
- Burdick, R. T. The Importance of Farm Accounts. Mtn. States Beet Grower 1(1):6. Feb. 1941. Misc. Series 102
- Burdick, R. T. An Analysis of Farm Records and Accounts. Colo. State College mimeo. April 1941. Misc. Series 108

- Burdick, R. T. The Effects of Lamb Crop upon Sheep Sales. Nat'l. Wool Grower 31(4):21. April 1941. Misc. Series 105
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- Daniels, L. B. White Grub Found Destroying Cactus Plants is Identified. Colo. Farm Bul. 3(2):12. April-June 1941
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- Dickey, H. C. Beet Tops for Dairy Cows. Sugar Jour. 3(9):19. Feb. 1941
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- Forsberg, J. L. The Effect of Soil Temperature on Fusarium Wilt of Carnations. Jour. Colo.-Wyo. Acad. Sci. 3(1):37. April 1941. Abs. Series 12
- Gardner, Robert and O. J. Kelley. Relation of pH to Phosphate Solubility in Colorado Soils. Soil Science 50(2):91-102. Aug. 1940. Sci. Jour. Series 99
- Gaskill, John O. and W. A. Kreutzer. Verticillium Wilt of the Sugar Beet. Phytopath. 30(9):769-74. Sept. 1940. Sci. Jour. Series 97
- Gaskill, John O. and W. A. Kreutzer. Verticillium Wilt of the Sugar Beet. Jour. Colo.-Wyo. Acad. Sci. 3(1):36-7. April 1941. Abs. Series 11
- Gassner, F. X. and Frank Thorp, Jr. Studies on Thysanosoma actinioides— Part II. Amer. Jour. Vet. Research 1(1):36-43. Oct. 1940. Sci. Jour. Series 104
- Gassner, F. X. and H. S. Wilgus, Jr. Congenital Goiter in Chicks (abstract). Poultry Sci. 19(5):349. Sept. 1940. Abs. Series 2
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- Gassner, F. X., Virgil Koenig, and R. G. Gustavson. The Occurrence of Epidermoid Pearl in the Thyroid of the Rat from Chronic Injections of Natural and Synthetic Estrogens (abstract). Jour. Colo.-Wyo. Acad. Sci. 3(1):19-20. April 1941. Abs. Series 9

- Glick, Dudley P. Bacteria and Disinfectants. Notebook for First Annual Potato Growers School, Colo. State College, Feb. 1941. Page 5. Misc. Series 96
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- Harshfield, G. S. Turkeys Have Own Carriers of Pullorum; Eradication Program Outlined for Breeders. Colo. Farm Bul. 3(2):8-9. April-June 1941
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- Kreutzer, W. A., E. W. Bodine, and L. W. Durrell. Cucurbit Diseases and Rot of Tomato Fruit Caused by *Phytophthora capsici*. Phytopath. 30(11):972-76. Nov. 1940. Sci. Jour. Series 105
- Kreutzer, W. A., E. W. Bodine, and L. W. Durrell. A Sexual Phenomenon Exhibited by Certain Isolates of *Phytophthora capsici*. Phytopath. 30(11):951-57. Nov. 1940. Sci. Jour. Series 108
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- Leonard, W. H., H. Fauber, and R. H. Tucker. Tests of Hybrid Corn in Colorado, 1940. Colo. State College mimeo. Feb. 1941. Misc. Series 90
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- McLean, John G. The Control of Virus Diseases by the Tuber Unit Method. Notebook for First Annual Potato Growers School, Colo. State College, Feb. 1941. Page 17. Misc. Series 101

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- Roskelley, R. W. Beet Labor Problems in Colorado. Proc. Western Farm Economics Assoc. July 1940. Sci. Jour. Series 94
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- Tom, R. C., J. W. Tobiska, and Floyd Cross. Feeding Trial of Middle Park Hay vs. North Park Hay on Cattle. Colo. Exp. Sta. mimeo. Feb. 1941. Misc. Series 94
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While I give up the work with regret I leave it with only the kindliest feelings toward all members who have so earnestly worked with me during this trying period.

Yours very truly,

U.E. Seevery

Acting Director.

FINANCIAL REPORT, COLORADO EXI	PERIMENT	STATION			For t	he Year E	nding June	30, 1941
DR.	Hatch fund	Adams fund	Purnell fund	Bankhead- Jones fund	State mill levy fund	Special fund	Pure-Seed fund	Total funds
Balance July 1, 1940					\$ 3,072.59	\$32,027.89*		\$ 35,100.48
From the treasurer of the United States as per appropriations for the fiscal year ending June 30, 1941, under the Acts of Congress ap- proved March 2, 1887, (Hatch fund), March 16, 1906, (Adams fund), February 24, 1925, (Purnell fund), and June 29, 1935, (Bank- head-Jones fund)	\$15,000.00	\$15,000.00	\$60,000.00	\$22,430.96				112,430,96
Other sources than the United States					\$0,920.14**	42,206.21	4,500.00	127,626.35
CR	\$15,000.00	\$15,000.00	\$60,000.00	\$22,430.96	\$83,992,73	\$74,234.10	\$ 4,500.00	\$275,157.79
To salaries	15,000.00	13,991.93	50,237.93	17,234.95	32,056.29	10,614.63	4,288.76	143,424.49
Labor		747.60	2,891.98	2,873.84	10,114.56	5,652.78	31.20	22,311.96
Stationery and office supplies			17.20	4.08	244.78	9.16	6.38	281,60
Scientific supplies, consumable		190.73	1,431.47	370.77	2,258.40	1,329.01	61.25	5,641.63
Feeding stuffs			501.21		4,928.90	713.55		6,143.66
Sundry supplies		5.80	44.07	43.80	768.91	653.33		1,515.91
Fertilizers					31.29	26.40		57.69
Communication service		1.83	92.97	29.27	1,235.95	154.73	13.60	1,528,35
Travel expenses		6.35	1,620.67	1,402.96	2,109.87	1,898.59		7,038.44
Transportation of things		***********	38.08		814.16	178.09		1.030.33
Publications			44.93		3,524.96	159.49		3,729,38
Heat, light, water, and power		47.83	99,39	17.42	4,988.19	977.39	21.50	6,151.72
Furniture, furnishings, and fixtures			49.37	3.60	1,195.61	127.68		1,376.26
Library			9.00	22,75	305.32	348.08		685.15
Scientific equipment		7.93	1,831.82	15.90	1,941.98	945.14	67.31	4,810.08
Livestock	****		546.08		1,385.00	1,680.84		3,611,92
Tools, machinery, and appliances	*****		127.95	390.87	1,695.79	3,130.87		5,345,48
Buildings, land, and nonstructural improve- ments			405.58		2.114.16	138.20		2 657 94
Contingent expenses			10,30	20,75	402.62	337.62	10.00	781.29
	\$15,000.00	\$15 000 00	\$60,000,00	\$22 430 96	\$79 116 74	\$29.075.59	\$ 4 500 00	8918 109 00
Balance on hand June 30, 1941	Sector Sector			çaw, 100.00	11,875.99	45,158.52	\$ 33000.00)	57,034.51
Grand total	\$15,000.00	\$15,000.00	\$60,000.00	\$22,430,96	\$81,742.73	\$74,234.10	\$ 4,500.00	\$275,157.79

*Includes \$2,000 for Investigations on Sugar Beet Machinery. **Includes \$2,250, H. B. 424