Fifty-Seventh
Annual Report

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Colorado Agricultural Experiment Station

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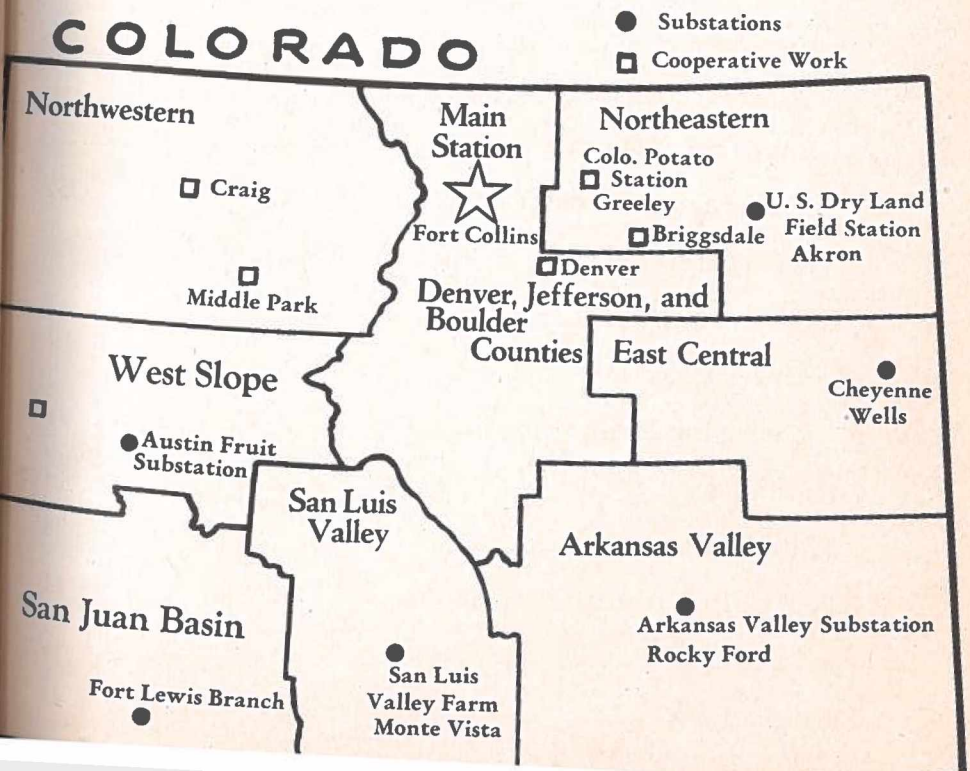
1943-44

COLORADO STATE COLLEGE
Fort Collins



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Letter of Transmittal

Fifty-Seventh Annual Report
Colorado Agricultural Experiment Station

Hon. John C. Vivian
Governor of Colorado
Denver, Colorado

Sir:

In compliance with the law, I herewith present the Fifty-Seventh Annual Report of the Colorado Agricultural Experiment Station for the fiscal year of July 1, 1943 to June 30, 1944, inclusive.

Homer J. Henney

Director

Fort Collins, Colorado
July 1, 1944

57 Years of Service

With the ending of the fiscal year of 1943-44, the Colorado Agricultural Experiment Station brings to completion 57 years of scientific service to the agriculture of Colorado and the nation.

An experimental department was maintained in connection with the State Agricultural College, now known as Colorado State College of Agriculture and Mechanic Arts, from the time of its organization in 1879. In 1888 the Colorado Agricultural Experiment Station was organized under the provisions of a Congressional act of the preceding year.

The organization was effected at a special meeting of the State Board of Agriculture held at Del Norte on February 20, 1888. Management of the Station was vested in an executive committee consisting of three members of the State Board of Agriculture. Officers of the Station were the director and the secretary-treasurer, with a working staff representing the various departments of the experimental work.

During the 57 years of its existence the work of the Colorado Agricultural Experiment Station has been under the supervision of the following men who have served as directors: C. L. Ingersoll, 1888-91; Walter J. Quick, 1891-93; Alston Ellis, 1893-99; L. G. Carpenter, 1899-1910; C. P. Gillette, 1910-32; E. P. Sandsten, 1932-39; Charles H. Kick, July 1-August 27, 1939; I. E. Newsom (acting), 1939-41; Homer J. Henney, 1941 to date.

Director's Annual Report

Fifty-Seventh Fiscal Year 1943-44

Colorado Agricultural Experiment Station

To The President and State Board of Agriculture:

Fully 80 percent of the activities of the Station research program at the end of the 1943-44 year were devoted directly to tangible research projects that would aid in prosecuting the war. The other 20 percent were in administrative contact work for enlarging the program of the Station.

Some of the problems being studied are: How to get along with less labor through farm work simplification and improved machinery, how to save more livestock by disease control, and how to control plant diseases. These demands became of prime importance to many farmers and ranchers who had neglected to learn the solutions for these problems in years past, even though many of the solutions were known.

The problem of how to make the most from farming so the income would be equal to labor incomes from defense plant opportunities has increased precipitously the demand from tenants for information about buying a farm. Likewise, demands from businessmen as to where to buy a ranch have been increased because of low interest rates on other investments. Present owners are writing to the Station asking for information as to whether to sell out entirely and put one's money in bonds or stay on the farm. Most demands for Station information indicate confused thinking.

What Was Accomplished

Station research in 1943-44 centered around an answer to the problem of producing more beef and lamb without concentrates. A second and only slightly less important achievement was the results in freezing and dehydration of vegetables. The Station found that certain proteins would replace the standard proteins in livestock feeds. The Station also is one of the first to find indications that the protein in soybeans may have some injurious effects when it is used to entirely replace certain other proteins in rations. Grazing studies partially completed indicate month by month the nutrient loss in forages so that advice on season of year to graze certain grasses can now be given with more assurance of correctness.

The several research projects dealing with plant and animal diseases have proved that cattle finished in Colorado are more

susceptible to the liver abscess disease than are cattle finished at lower altitudes. Studies to date have found no one thing that seems to be the cause. Analyses up to date indicate that Colorado-grown vegetables have a vitamin quality preference over vegetables in some other areas.

Recommendations for Improvement

The Director recommends that the program of the Station for 1944-45 be divided into immediate wartime projects and longer-time 20-year-program projects. The Director is further convinced that at least 50 percent of the present projects should be shelved for the "duration" and the time spent on only a few major projects.

Some of the immediate problems on which the Station should coordinate its efforts during 1944-45 are: **First,** determine the nutrient value of native forage, mostly grasses, by months for sheep and cattle breeding herds. Farmers and ranchers want an answer as to just what is necessary as a supplement to their native-grown grass so that labor can be eliminated in putting up so much winter feed. The New Mexico and Wyoming stations both have approached this problem, but the situation in Colorado needs immediate attention from our Station. A range cow herd and a band of ewes will be necessary if the greatest value for competitive uses of forage is to be studied and determined satisfactorily.

A **second** consideration is finding out more about how to process Colorado fruits and vegetables so that Colorado processors can invest more funds in processing plants. Perhaps 20 percent of the Station's efforts on this program during 1943-44 made a start on this problem. It should be pushed to 30 percent the next 2 years.

Next and of equal importance are labor-saving devices on the farm and improved technic in wool production.

Estimated Costs 1944-45

The costs for the 1944-45 year should be no larger than the previous year. Since the big cost of operating the Station, other than salaries, is materials, supplies, and feed for livestock, the salary savings of 10 to 15 staff members in war work does not reduce the salary budget as much as the increase in costs of these other items. The costs for feed and supplies for 1944-45 should be no higher than in 1943-44. The estimates on future

costs are as follows: Hay, $18-$20 instead of $12-$18; grains, $2.30-$2.50 per hundredweight compared with $2-$2.50 per hundredweight; labor, 55 cents to 60 cents per hour compared with the same last year; monthly men, $110-$120 per month compared with $100-$110.

These now fixed competitive cost items will need to be supplemented by increased capital cost items for dehydration, agricultural engineering, and range management studies. Total costs should not exceed $290,000 to $300,000.

Sales receipts from all sections during the 1943-44 year were $20,000 in excess of earlier estimates. Receipts from special interest groups in Colorado should be increasing. Certain corporations are looking with favor on the Colorado Agricultural Research Foundation. Thirty to fifty thousand dollars is not too much to expect from organization gifts during this emergency period. More than ten agencies have already contributed from one hundred to four thousand dollars apiece to the Foundation.

AGRICULTURE DIVISION

Agronomy

The aim of our agronomic program is to obtain greater production of food, feed, and forage crops. Production can be increased through a two-fold program. (1) The highest production can only be obtained on fertile soils. Accordingly, the Station is making an effort to get soil fertility information in the hands of farmers and extension people so that it may be applied at once. (2) After the soil has been brought to a high state of fertility, the highest yields can be produced only by using the best crop varieties. The Station is attempting to get the best by, first, testing available varieties and finding which are best adapted for various situations, then, through a program of improved seed distribution, making available to farmers seed of these varieties; second, by crop breeding, producing superior new varieties so that they may enter the test program and get into the hands of growers.

By contracts with hybrid corn seed producers, F_1 hybrid varieties have been tested at several locations in the State. The hybrid companies in this test series agree to send to Colorado

for sale to farmers only the adapted sorts as proved by Station tests. This p 'am has largely prevented the sale of unadapted hybrids in Co.rado. Similar programs have been carried on with wheat, oats, barley, and sorghums, and, in a little different way, with alfalfa and other forage crops. Only about three of the varieties common 20 years ago are now grown.

The work on the time of seeding winter wheat alone gave almost complete control of the Helminthosporium and Fusarium foot rot diseases and made possible present high yields of wheat.

During wartime more attention is being given to wheat, dry beans, and feed crops because these are critically needed agronomic crops.

Besides providing technical information on the inheritance of the gene and the genes possessed by barley, the barley genetics project has given rise to new barley varieties.

Our soils are progressively becoming less fertile. Nitrogen is more widely needed than any other fertility element. There is a possibility that some of the so-called "trace elements" may be needed, but that remains to be proved. (In cooperation with Horticulture Section.)

Also needed are studies which will show how to handle soils to prevent them from becoming over-alkaline and studies on how to reclaim and what is reclaimable of the soils already oversalted.

The development of Soil Conservation districts has brought a new set of needs which have meant an altering of types of soil survey. These new needs include a need for a study of alkali conditions. Soil maps have enabled us to assist the War Department and War Boards and to furnish much information to the Soil Conservation Service; the Bureau of Plant Industry, Soils, and Agricultural Engineering; and the Case-Wheeler workers. Much of our information has been useful also to the Reclamation Service.

Completed land use maps (in cooperation with the Soil Conservation Service and the Reclamation Service) are being used by post-war committees.

There is being developed a "combine" type of grain sorghum which will yield as well as our present Improved Coes and Highland types, or even better, and which will be non-shatterable so that it will stand in the field without shattering until it can be harvested with a combine.

Animal Investigations

The Animal Investigations Section and the Range and Pasture Management Section have been working together planning the use and future development of the Thomas farm. It has made an excellent fall and wintering headquarters for livestock and considerable reseeding work has been done by the Range and Pasture Management Section. If the farm is to be developed to the point of greatest usefulness, many changes and improvements must be made. Building of north and east boundary fences, clearing the grounds of waste and junk, and reseeding much of the area has been in progress.

Laboratory studies in connection with the Middle Park nutrition problem are continuing, but no report is ready. (In cooperation with Grand County Hereford Breeders.)

The sheepmen and wool producers of Colorado have shown a rapidly increasing interest in the Wool Laboratory and culling program in the field. From April 1, 1943 to April 1, 1944, the Wool Scouring Laboratory scoured 50 clips of Colorado wool (45 in the spring and summer of 1943, and 5 in the spring of 1944) for shrinkage determination. Eleven counties are represented in the work done. Fineness and variability studies have been carried on in conjunction with the sheep and wool improvement program. Samples from 190 sheep have been analyzed for fineness and variability. Data are now being accumulated from both the scouring work and the fineness and variability studies for statistical analyses and publication, which should cover a 3-year period of the work.

The following are experimental projects and studies on which progress reports have been made:

1. Beef from less grain and the utilization of roughages in wartime cattle fattening rations.

2. Utilizing short grass range and sorghums for wartime beef production.

3. Irrigated pastures for dairy cattle. (In cooperation with Agronomy Section.)

4. Roughages for dairy cattle—the value of peavine silage for milk production.

5. Utilizing g and roughages in wartime lamb fattening rations.

6. Fattening crossbred lambs.

7. Comparison of wheat and milo and different grades of corn when fed with two levels of soybean oil meal in fattening pigs.

8. Utilizing Colorado feeds for fattening pigs in wartime —feeding cull pinto beans.

9. Utilizing Colorado feeds for fattening pigs in wartime —alfalfa pasture vs. drylot method of fattening pigs.

10. Vitamin snythesis in the rumen. (In cooperation with Chemistry Section.)

11. Nutritional control of mastitis. (In cooperation with Animal Pathology and Veterinary Medicine Section.)

12. Nutrient utilization by cattle of certain native mountain meadow hays showing a history of toxic properties.

13. Harvest, storage, and utilization of alfalfa silage.

14. Improved range practices to improve cattle production. (In cooperation with Range and Pasture Management Section.)

15. Crossbreeding range ewes for heavier market lambs.

16. Ammoniated dried beet pulp as a source of protein in steer fattening rations.

Animal Pathology and Veterinary Medicine

Previous investigations have established that the organism *Actinomyces necrophorus* is present in nearly all liver abscesses of beef cattle. It is presumed that this organism is the direct cause of liver abscesses and that it is present in the alimentary tract of healthy as well as diseased animals. The conditions which enable the organisms to get into the liver and to establish abscesses are not known.

Throughout the first half of the past year, investigations were continued to determine the correlation between ulcerative lesions of the rumen and abscesses in the liver. In the series, 1,807 cattle having ulcerative lesions in the rumen were examined.

Twenty-six percent of all cattle examined showed ruminal lesions and 18 percent showed liver abscesses. Of the cattle exhibiting ruminal lesions, 42 percent had abscesses in the liver, while only 9 percent of those without such lesions showed hepatic abscesses. Conversely, of the animals showing liver abscesses, 62 percent had ruminal lesions while only 18 percent of those without hepatic abscesses carried lesions in the rumen.

It is well known that beef cattle are frequently low in vitamin A reserves. To test the hypothesis that relative vitamin-A deficiency predisposes the livers of cattle to abscessation, the following experiment has been devised and is now in progress. A cooperative arrangement has been made with a prominent feeder of beef cattle in the vicinity of Greeley, Colo., whereby a lot of 420 cattle received for fattening was divided at random into two sub-lots of 210 animals each. These lots have been placed in adjacent pens for fattening. They are being given identical management and identical basal fattening rations. However, the ration of one pen is fortified with 44,000 U. S. P. units of vitamin A per animal daily, which is well above the requirements of cattle for significant storage of this vitamin. These conditions will be maintained throughout the entire fattening period of approximately 100 days. At the time of slaughter the percentage of abscessed livers for each pen will be determined. This experiment should indicate the role of vitamin A in liver abscessation of beef cattle. (In cooperation with Animal Investigations Section.)

Four phases of the problem of overeating in feedlot lambs have been or are being investigated, with results to date as follows:

1. Chemical changes in the blood.—The only significant change in the blood which occurs consistently is a great increase (up to 400 percent) in the blood sugar in acute fatal cases.

2. Reproduction of the disease in experimental animals.—In the past year the typical clinical picture of the disease has been reproduced in four out of 16 lambs used by producing a preliminary mild enteritis with $MgSO_4$ which was followed by feeding the organisms in milk or cornmeal 24 hours later.

3. Immunization.—Work is under way in an attempt to immunize lambs with one or more doses of a toxoid prepared from the toxins of *Cl. welchii* type D, the causative organism. Methods of growing the organisms for toxin production have been studied, and the minimum lethal dose of toxin for lambs

has been fairly well determined. It is intended that experimental lambs be treated with toxoid and then after a suitable period be injected with lethal doses of toxin to determine the efficiency of the treatment. It is also proposed that an experiment be conducted in the feedlot where half the lambs will be treated with the toxoid while the other half will serve as controls. In this experiment we will depend on natural infections to occur.

4. Feeding sulfur as a prophylactic agent.—An experiment is now about to be concluded in a lot of 1,200 lambs belonging to a local feeder. Half this group of lambs has received approximately 7½ grams of sulfur per lamb per day in their feed, while the other 600 have been given the same feed but without sulfur, and serve as controls. To date 7 lambs in the sulfur-fed group have died as compared with 19 of the controls. The weights and dressing percentage of the first two carloads sent to market show that there is no significant difference in the weight and quality of the two lots.

Experiments were conducted to obtain further information on the effect of drenching feeder lambs with cunic solution on the reduction of liver condemnations due to fringed tapeworms. In one experiment, 4 groups of 30 lambs each, raised on pasture known to harbor the tapeworm, were drenched either on the range or in the feedlot, or both, while one group of 30 lambs served as untreated controls. In a second experiment, 3 groups of 40 lambs each were drenched with a cunic solution either once or twice while in the feedlot, while a fourth group was left untreated for control.

In the experiment on combined range and feedlot drenching, the incidence of liver infection with fringed tapeworms in the control lambs was only 3.3 percent, as shown by liver examination at slaughter. Consequently, no conclusions could be drawn as to the relative effectiveness of the various drenching programs. The experiment on feedlot drenching exclusively showed 5 percent fringed tapeworm infection in lambs drenched twice, 7.5 percent in lambs drenched once 5 weeks after being placed in the drylot, 10 percent in lambs drenched once when first placed in the drylot, and 12.5 percent in undrenched control lambs. Here again, however, the low incidence of parasitism in the control lambs makes it impossible to determine the effectiveness of the drenching procedures.

The problem of determining the intermediate host for the fringed tapeworm (*Thysanosoma actinioides*) has been con-

tinued. It is assumed that certain species of an aberrant family of mites serve as the intermediate host.

During the year frequent trips have been made to pastures known to be contaminated for grass collections in order to determine the presence of these mites. From these samples, 37 mites have been collected and examined. All were negative for cysticercoids or larval stages of the tapeworm.

The following facts seem apparent but should not be considered as final. Mites cannot be found in the grass during winter months. In the eastern part of the United States the mites are active throughout the winter. The oribatid mite found in this section is similar to the eastern fauna rather than intermountain fauna.

The mite which has been found to be most abundant is thought to be *Galumna minuta,* which is also the most abundant form found in the eastern part of the United States. This mite has been studied in detail in the experiments conducted elsewhere on the broad tapeworm of sheep (*Moniezia expansa*), and no evidence of the mite being an intermediate host has been found.

The species of mite suspected of being the intermediate host of *Thysanosoma actinioides* has not been found to date.

The orbatid mites in this section appeared in grass for the first time in April, and their appearance was independent of moist conditions. The first larval mites appeared 15 days after the first adults were taken. Consequently, it is suspected that mature mites live through the winter in the ground.

For several years pullorum disease in turkeys has been, and continues to be, an economic problem in that chronically infected turkey hens in breeding flocks transmit the infection through their eggs, with a resulting high mortality in turkey poults. It has been shown that the pullorum test commonly employed in testing chickens is not very satisfactory for turkeys.

It is hoped that this work can be carried on until a workable method of pullorum disease control can be established in Colorado.

The severe outbreak of distemper on one fox ranch in the spring of 1943 resulted in a total loss of 38 percent by the end of the year. It was impossible to definitely determine the source of the virus. There is strong evidence that magpies were responsible for transmission of the disease.

Three mink ranches were affected by distemper. The losses were especially heavy in one, being 64 percent. Methods of diagnosing distemper were improved and are now routinely performed.

The housing of foxes with lungworm infection on raised wire floors was found to be only partially effective in eliminating these parasites. Sixty percent of experimental foxes so housed still show the same degree of infestation. The lungworm egg requires 28 days to embryonate under laboratory conditions, and up to 12 days less than under field conditions. The use of wire-floored pens in the control of coccidiosis was found to be effective.

The problem of pup losses at and after birth is still very serious. The value of dietary vitamin K with and without iron, copper, manganese, and cobalt is being investigated. Since most fur farmers add up to 15 percent of fresh liver to the whelping ration, it is unlikely that lack of vitamin K is responsible for pup losses. Preliminary results indicate that the addition of iron to the diet prevents pup mortality to a large extent.

Botany and Plant Pathology

Hydrocyanic acid present in cane and certain pasture plants was given in small doses to calves and rabbits for 3 months. There were no signs of residual effects of so-called blind staggers. Photosensitization of horses was studied at Deertrail, Colo., and scrub oak poisoning at LaVeta. (In cooperation with Animal Pathology and Veterinary Medicine Section.)

Mild strains of peach mosaic continued to show antagonism to severe strains. Microchemical tests continued. Our method is being widely used in peach areas of California. Use of nursery stock inoculated with harmless mild strains may be a means of mosaic control where eradication is not feasible.

Dusting with copper oxide proved effective in controlling tomato fruit rot. It was equally as effective as Bordeaux spray. For home gardens staking and mulch were effective in reducing or preventing rot. (In cooperation with Horticulture Section.)

Technical studies of the disease show that the fungus chiefly attacks the blossom end of the fruit. In certain susceptible varieties the stem end is more resistant than the blossom end and resistance appears correlated with presence of

crystals in the fruit cells. Resistance was shown by some varieties.

Tests were completed on the time and temperature necessary for infection. Field crosses have been made of resistant plants and first generation plants have been grown in the greenhouse and second generation seed are ready for field planting.

Tests made of certain commercial varieties and experimental selections of potatoes show that a wide range of symptoms exists. Some varieties are carriers of ring rot but show no symptoms. Tests were made on the effect of moisture level on the expression of ring rot. The use of ultraviolet light appears to be a promising method of identifying not only ring rot but also other diseases of the potato tuber. (In cooperation with Horticulture Section.)

Some 130 isolates of fungi and 22 varieties of peas were tested for root rot in several localities in the State. Seed treatments and fertilizer tests were made in the greenhouse and the field. The infection story is complex as the several strains of fungi act differently. They are soil-borne. (In cooperation with Horticulture Section.)

Seed treatment is fairly effective in controlling primary seedling blight but when the sprout grows beyond the zone of chemical protection rot results. Seed treatment gives early protection and materially increased stand.

Several thousand barley head inoculations were made to test for variety resistance to smut. (In cooperation with Agronomy Section.)

A preliminary study was made of root rots of sugar beets in various parts of the State. Verticillium wilt of sugar beets is correlated with soil temperature. The addition of fertilizers to the beet seed plus fungicides gives better seedling stands than the use of fungicides alone. This is of great importance now that sheared seed is being planted. (In cooperation with Federal Sugar Office.)

Chemistry

Heavy mineralization of irrigation waters and livestock well waters can be harmful to the best success of crop and livestock production in the State. Sampling and analysis of these waters will be taken at 6-month intervals (April and November) for at

least 2 years, in order to establish fundamental criteria for future reference. One such sampling was made (November 1943) and a second is in progress. On the basis of the first tests, the stream waters show variations ranging from 150 parts per million of minerals in the mountain tributaries to 1,500 parts per million in the main South Platte as it approaches the eastern boundary of the State. Shallow wells in this region show similar mineralization except in seep depression areas and in the dry lands where the mineral content rises sharply. (In cooperation with Civil Engineering Section.)

Fourteen composite meadow samples and 48 individual plant species of Middle Park area were collected during the 1943 growing season. Fodder analyses are in progress. For this third year of the project, the meadows of the region show continued improvement in nutritive value. This is due in part to improved moisture conditions and in part to better management through the suggested practices of (1) seeding more alsike clover, a plant high in protein, (2) changing irrigation practice (from heavy and continuous irrigation to lesser and intermittent irrigation), (3) using fertilizer on these meadows, and (4) diminishing the heavy spring grazing on the meadows. (In cooperation with Range and Pasture Management Section.)

Seasonal and annual trends in nutritive value of native forage plants in relation to range livestock production were studied. (In cooperation with the Range and Pasture Management Section and the Rocky Mountain Forest and Range Experiment Station.) During the season a total of 178 samples of grasses and herbaceous plants and shrubs were collected. Fodder analyses have been completed and mineral analyses are about one-third complete. This was the second year for the project and the chemical findings were checked against actual livestock gains at three levels of range grazing. One of the major findings appears to be that herbaceous plants and shrubs and even some non-toxic weeds have far more nutritive value as a winter pasture than do the dead and leached grasses. This is not the view usually held by ranchers.

Chemistry B

Considerable time was spent in completing organization of the 20-year breeding records for final statistical analysis in the study of improving the reproductive efficiency of beef cattle. Considerable work was also done in analyzing bovine blood for

calcium, phosphorus, vitamin C, and carotene, and bull semen for vitamin C in an attempt to discover the normal levels of these substances in animals of different age groups, on different diets, and to gain some information on seasonal variations. Some of these levels were established for Hereford cattle. (In cooperation with the Wyoming Hereford Ranch Association.)

Entomology

The adult grasshopper survey showed that there was an upward trend of the pest for next season, but the egg survey indicates that the grasshopper crop, except in a few sections, will be about the same as the past season.

The oil experiment on the cherry leaf roller, carried on in the Loveland area, fully demonstrated that certain miscible oils and oil emulsion can be used as a dormant cherry tree spray, up to a 10-percent solution. Data on leaf-roller control is very meager as the infestation the past season was very slight. However, from the experiments conducted we have established that the dormant oil sprays are effective in leaf-roller control.

Due to the U. S. agricultural requirements that each farmer plant a given portion of his acreage to beans, the bean beetle pest was in its paradise. Injury to all types of beans was very severe, especially along the foothills and in irrigated sections. A survey showed very little beetle injury to beans grown on dry land in the plains areas. In these sections the beetles were not in evidence in the early growing periods of the beans, but showed up after the beans were set and maturing.

In irrigated sections the beetles left the bean fields after harvest and went to adjacent alfalfa fields where damage to second and third hay cuttings amounted to at least 20 percent.

Dusting and spraying experiments were conducted around Fort Collins, in the Greeley area, and in the Loveland and Longmont areas in cooperation with Kuner-Empson Canning Company.

Studies of insect abundance on stripland and trashy fallow practices were not as successful as they could have been; only two out of nine experiments were carried to completion. Insect collections were made to determine the population on areas where trashy fallow and stripland cropping had been practiced, and adjacent areas. In general the insect population in experimental

fields were of the same species as those collected in adjacent fields but were not prevalent enough to cause any alarm. (In cooperation with Agronomy and Range and Pasture Management Sections.)

Control of the bean cutworm so far is only about 80 percent effective. In the coming season's work Mesa County will furnish dividers or vine lifters for the spraying of beans late in the season when the bean cutworm is about half-grown. Perhaps control applications at this stage of development of the pest will give satisfactory results.

Emphasis has been given to research for substitute and replacement insecticides. A total of 232 plots were used in testing insecticides for bean-beetle control. Ninety-six of these were used in comparing fifteen treatments with arsenite of zinc spray, our most generally used control. Eight treatments in this test gave significantly higher yields of dry beans than the standard control, while seven treatments gave yields not significantly different.

One hundred and twenty plots were used in testing four materials as dusts in five strengths each to determine the most practical dust mixtures. The remainder of the 232 plots were used in comparing pyrophollite and dusting sulfur as carriers for cryolite and basic copper arsenate in dust mixtures.

For potato psyllid control, wettable sulfur, 8 pounds to 100 gallons water; barium polysulfide, 5 pounds to 100; dry lime sulfur, 8 pounds to 100; liquid lime sulfur, 2½ gallons to 100; and dusting sulfur, 20 pounds per acre, gave results in plot and field tests that were not significantly different. The difference in yield of U. S. No. 1 potatoes as to size produced with wettable sulfur over liquid lime sulfur approached significance in the plot experiments and in two of four field tests.

Three varieties of potatoes were grown under three degrees of psyllid control to determine the effects of psyllid injury on tuber characteristics. Certain characteristics of the tubers are being studied by the Home Economics Section. Significant differences were evident in 1942. These differences also approach significance in this year's data.

Effects of sulfur residues from psyllid treatments on the keeping qualities of canned tomato products are being studied. Canned tomato juice from treated field plots and with known amounts of sulfur added are now in storage for the third year.

The presence of sulfur is not materially affecting the pH or the rate of vacuum loss.

Coverage and the maintenance of coverage through the growing period are recognized as essential to the successful control of flea beetles. The type of spray nozzle, size of disc, nozzle position, pressure, and speed of the machine through the field have been investigated. The size and type of spray cone have been considered. Comparisons of the different makes of duster and spray equipment have been made. The nozzle type of spray cone gives best coverage.

The potato flea beetle work carried out at the Greeley Potato Station, using sprays and dusts, has given very satisfactory results. Combinations of sprays and dusts were used in three, four, and five applications. Three applications are ineffective. Four applications increased the number of U. S. No. 1 tubers 39 percent over the plots receiving three. The average percent of U. S. No. 1 tubers in four applications was 95 percent in Triumphs and 99 percent in Pawnee. There was no significant difference between the fourth and fifth sprays or dusts in the 1943 season. (In cooperation with Mechanical Engineering Section.)

Peach mosaic vector work has consisted of developing case histories from 1942 field tests and the carrying out of a program of testing under greenhouse conditions. More than 40 greenhouse tests have been made. In the 25 tests made in the spring of 1943, 18 cases of mosaic are present. Ten positives have been bark grafted onto healthy seedlings to further prove the presence of the virus.

The psyllid resistance work being carried out in cooperation with the Greeley Potato Station is now under way for the sixth year. Eighteen seedlings have shown some resistance. These will be tested further this summer. After releasing psyllids on experimental potatoes, haywire condition showed in 12 days and psyllid yellows developed in 18 days.

Home Economics

The eggs from selected hens have been examined and classified according to interior quality. Relationships between quality measurements of eggs of daughters as compared with mother hens have been recorded. For the most part, hens producing high quality eggs transmit this characteristic to their

offspring. (In cooperation with Poultry and Chemistry Sections.)

Work on the baking of flour mixtures at high altitudes has been continued by initiating a study of the behavior of general purpose flour in formulas already developed for cake flours. It has been possible to make the necessary adjustments so that cakes of good volume, texture, and eating quality may be produced from general purpose flour at 5,000 feet altitude. The rate of staling of such cakes has been much higher than that of comparable cakes made from commercial cake flours. (In cooperation with Chemistry Section.)

The project on properties of Colorado fruits and vegetables and other factors which affect the processing, preserving, and culinary qualities of these products is being carried on through the cooperation of the Home Economics, Chemistry, Horticulture, Poultry, Pathology and Bacteriology, Mechanical Engineering, Animal Investigations, Agronomy, and Entomology Sections, the Western Regional Research Laboratory, the Colorado Extension Service, and the cooperating experiment stations of the Western Region.

Commodities investigated were: asparagus, snap beans, lima and shell beans, beets, broccoli, cabbage, carrots sampled throughout the growing season, cauliflower, sweet corn, eggplant, kale, kohlrabi, head lettuce, okra, onions, parsley, parsnips, peas, green sweet peppers, potatoes, rutabagas, spinach, squash, Swiss chard, tomatoes, turnips, cherries, peaches, and rhubarb. Processing methods used were dehydration, canning, freezing, and pickling where each was applicable.

Vitamin assays made were of carotene, some thiamin, riboflavin, niacin, pantothenic acid, and ascorbic acid. Some carbohydrate and crude fiber determinations were made. Tenderness values were obtained for carrots by the penetrometer method. Assays were made on processed and stored material.

Vitamin values of commonly grown varieties of Colorado fruits and vegetables have been obtained and are now fairly complete. Vitamin retention values for vegetables and fruits when processed in various ways and when stored in different ways and for various periods of time are being accumulated. The varietal differences in vitamin production and retention under different methods of handling and storage were followed. Potato psyllid work was continued. While in 1942-1943 significant differences were found, during the present season the dif-

ferences fell slightly below the level of significance. Potato variety evaluation was continued. Study of the influence of packaging and wrapping materials upon keeping qualities of frozen fruits and vegetables was continued.

The most important improvement needed in the physical plant of the Section in the addition of a walk-in type storage room for frozen food storage. A mobile laboratory for field use should also be designed and procured.

Horticulture

The research program on fruit and vegetables is based on solving grower problems brought to the Section by growers of the State. The practical application of research results has contributed to the increase in yields of war-essential crops through the use of (1) recommended balanced commercial fertilizers, (2) disease-free seed, (3) better varieties with higher food value per acre, (4) short-cut growing methods that reduce labor requirements, (5) improved cultural practices, (6) better methods of storing potatoes and other vegetable crops, and (7) better methods of disease control on vegetable crops.

A new method of identifying virus disease in Bliss Triumph variety of seed potatoes by the use of the ultraviolet light was discovered. This method provides a technique for decreasing virus content of potato seed stocks which may be used by foundation seed growers. This method should result in lowering the cost of growing potato seed by reducing field roguing and tuber uniting of potato seed.

The object of a study of the effect of soil treatments on skin color and quality of potatoes was to determine why the red color of Red McClure and Bliss Triumph potatoes fades when grown under certain soil conditions. Results to date indicate that copper, iron, and manganese increased the red skin color of the tubers, and that these three elements in combination with sulfur and various fertilizers increased the skin color of tubers. These same combinations markedly increased the quality. These tests will have to be repeated several years before final conclusions can be made.

Onion breeding work was continued, and 176 lines were set out under heavy thrip infestation conditions on the Western Slope. Comparative tests of thrip-resistant lines were conducted for the purpose of determining the relative degree of resistance

and their commercial characteristics. New work was started on selecting of plants which were showing resistance to the destructive pink root disease in the Arkansas Valley. Comparative dehydration tests indicate that the Mountain Danvers variety is satisfactory for such purposes, but the Sweet Spanish variety is not suitable for that use. (In cooperation with U. S. D. A.)

Various means of controlling tomato fruit rot by means of chemicals, cultural treatments, and resistance of various varieties were investigated. Cuprous oxide dust and Bordeaux spray were equally effective, and mulching and staking plants were also effective in preventing the disease. Spores of the pathogen attack the under side of the fruit and invade the blossom end. Formation of crystals in cells of stem are apparently correlated with resistance to rot. Seed was selected from fruit resisting the disease. Field crosses were made between resistant types and F_1 generation plants from greenhouse crosses planted in the field in 1943. F_2 generation seed is now on hand for 1944 setting. (In cooperation with Botany and Plant Pathology Section.)

In investigations on bacterial wilt and ring rot of potatoes, the effect of moisture in field and greenhouse and the effect of irrigations twice weekly, weekly, at 2-week, and at 4-week intervals on symptom expression of inoculated Cobblers were tested. Two resistant varieties and five U. S. D. A. seedlings were compared with standard varieties for visual symptoms, and each stem and tuber smeared and read for presence of infection. Use of the ultraviolet light was extended to include virus determination in potato tubers. There was a slight difference between varieties in symptom expression. All varieties were infected in both stems and tubers even though no symptoms were shown. A direct correlation appears to exist between bacterial load and symptom expression. The virus constitution of Bliss Triumph tubers was identified with reasonable accuracy by inspection in ultraviolet light. The results provide an explanation of failure to eliminate ring rot in certain varieties because of failure of symptoms to appear, even though disease is present. The ultraviolet light provides a technique for decreasing virus content of seed stocks. (In cooperation with Botany and Plant Pathology Section.)

Fruit variety tests on apples, peaches, apricots, nectarines, plums, and grapes were continued, as were the testing of cover crops, spray materials, fertilizer trials, spray residue removal

and storage studies. In addition, some work was initiated on mineral deficiencies and excesses which produce troubles such as chlorosis, rosette, dieback, and cork, particularly in pear trees. The Fisher and Viceroy varieties of peaches show promise as new early maturing types. Fertilizer trials on peaches in Mesa County continued to show increased yields, particularly where quickly available nitrogen applications were used. No responses were obtained with the use of potassium or phosphorus alone or together. The use of earlier maturing peach varieties will serve to spread the harvest period over a longer period, beginning about August 1. (In cooperation with Agronomy Section.)

The testing of varieties of major vegetable crops was continued at the different substations in Colorado. New work included seed production tests on carrots, beets, and onions. The object was to determine the adaptability of different areas of Colorado to seed production and determine the yield and quality of seed produced. The Bounty variety of tomatoes was found best for dry-land gardens, and on the Western Slope selections of Early Baltimore and the Cardinal varieties were found to be most productive canning types. Low yields were obtained on beet seed tests. On carrot seed production tests, the highest yields per plant were obtained in the San Luis Valley area. This indicates a possible new seed-growing area for the State. Seed-to-seed wintering-over methods of producing onion seed are working out well on the Western Slope. (In cooperation with U. S. D. A.)

New seedlings and hybrids developed in cooperation with the Colorado Potato Station at Greeley were included in comparative trials in northern Colorado, the San Luis Valley, and Western Slope areas. The purpose was to determine their resistance to scab, fusarium wilt, and virus diseases, and to determine their commercial characteristics. Some very promising scab-resistant lines were selected out of the seedlings under test, which indicates that there will be a new variety to release within the next 2 or 3 years. The scab disease is one of major importance to Colorado, and the resistant selections made show promise of reducing losses from this trouble by breeding and selecting out resistant types. The Pawnee variety released last year for extensive trial by commercial growers indicated that it is susceptible to a certain race of scab which had not previously shown up in past trials.

The object of potato and onion storage improvement projects was to design and construct an experimental storage on the campus, using various war substitute materials and ex-

perimental design features. A cooperative 66,000-bushel storage and shipping plant embodying various experimental features was designed at Wiggins, Colorado. Observations were made on conditions and performance of both storages. A small outdoor farm storage was designed, constructed, and tested at Fort Collins, and various storage containers tested. Storage of vegetables requiring high humidity in vapor-resistant paper-lined containers placed in a low humidity room with vegetables requiring low humidity was found practical. Moisture shrinkage during a 120-day storage period was less than 3 percent on potatoes, 5 percent on rutabagas, 5½ percent on turnips, and about 10 percent on carrots, while onions in slat crates shrank 5 percent. The results show the proper use of wood substitutes during wartime; a reduction in storage and nutritive value losses in commercial and home storages by better storage design and use of special containers; and lengthened the sprout-free common storage period on potatoes in warmer sections of the State. (In cooperation with the U. S. D. A.)

Experimental work in the greenhouse included seed and fertilizer treatments on pod peas, onion and tomato breeding work, ultraviolet disease identification in seed potatoes, and tuber testing carried by the certification agency of the Extension Service. The space used in the greenhouse on the breeding project reduces the time required to complete a generation on these crops, and thereby saves at least 1 year's time where such crops are planted under field conditions. The work on nutrition is important in that it eliminates many unnecessary field treatments.

Poultry

Further details on analytical methods of determining the carotene and riboflavin content of alfalfa and of sprouted grains were worked out. Carotene, riboflavin, and niacin assays of three cuttings of different varieties of alfalfa were made and the results of the carotene and riboflavin analyses formerly reported were confirmed.

Maximum vitamin yield in sprouted grains was obtained at about 8 to 10 inches stem length or just before brown tipping of the stem occurred. Practically all, if not all, the carotene of the sprouted grain is carried in the green part of the stem. Sprouted wheat contains about three times as much riboflavin per unit weight of stem as barley or oats. (In cooperation with Agronomy Section.)

A life-span experiment is being conducted to ascertain the effect of various proportions of soybean oil meal in poultry rations fed throughout the life cycle for several generations. This experiment is now in the second generation. Complete records of production and reproduction are being kept upon the four groups of birds in this study. Fractions of soybean oil meal have been prepared and are now being tested by chick experiments to determine whether separation of the goitrogenic principle of soybeans can be achieved.

No marked differences in egg production and hatchability are yet apparent in the life-span experiment. Chicks from the groups with 25 percent, 50 percent, and 75 percent of their supplementary protein in the form of soybean oil meal are making satisfactory gains, but chicks from the group in which all the supplementary protein is from soybean oil meal show very poor growth and livability.

At a time when sources of animal protein are limited, soybean oil meal is being used extensively in poultry feeding. This life-span experiment shows that while satisfactory results may be obtained over a short period by using soybean oil meal as a sole protein concentrate, its continued use will lead to poor growth and high mortality in the second generation. (In cooperation with Animal Pathology and Veterinary Medicine Section.)

The poultry ration containing alfalfa was supplemented with a grain mixture containing beet seed to test its value as a poultry feed. Beet seed proved unsatisfactory as a litter material and also as a poultry feed when used to replace the grain mixture. Experiments now in progress indicate that beet seed may be used satisfactorily at a 10-percent level of a grain mixture to be fed with mash.

Poultry laying houses of the following types were built: (1) Colorado laying house, (2) Cornell laying house, and (3) Wyoming laying house. Pullets were placed in each house in September 1943 and complete records are being kept of their performance. Little difference has been noted in the performance of the birds in the different houses during the winter. The Wyoming house with its straw loft was about 5° F. warmer than either of the other houses on cold days during the winter, but it also was much more damp than the other houses. Air currents were more marked in the Colorado type house than in the other houses. It is as yet too early to draw definite conclusions relative to the merits of various types of poultry houses

for Colorado. (In cooperation with the Chemistry, Home Economics, and Mechanical Engineering Sections and the Extension Service.)

Range and Pasture Management

Southern strains of smooth brome (Nebraska and Kansas) produced more seed and forage than northern strains. However, no significant differences in forage yields of crested wheatgrass strains were obtained from various seed sources. Blue grama from the Central and Southern Great Plains produced more forage than Northern Great Plains seed sources. The blue grama from Flagstaff, Ariz., still outyields the other blue grama strains.

In reseeding with native grasses, it is advisable to use local seed or seed from a source not more than 200 miles east or south of the area to be seeded.

A grass mixture with intermediate wheatgrass (an introduction) as the base outyielded two other mixtures. Blue grama mixtures are low in yield while crested wheatgrass-smooth brome and Russian wild rye mixtures are intermediate between blue grama and intermediate wheatgrass.

A grazing trial with dairy heifers in the nursery during the fall months showed a distinct preference for certain species and strains of several common reseeding grasses. These trials indicate that reseeded pastures complement native pastures and may extend the productive grazing season about 2 months.

At Cheyenne Wells, 2-year-old seeded stands of native and introduced grasses produced nearly 2.6 times more beef (pounds) per acre than did native range.

Based on quadrat analysis, density of better grasses increased 65 percent in the deferred pasture as compared to 145 percent in the conservatively grazed pasture from 1940 to 1942 inclusive. More than one good rainfall year is needed for recovery of drought-stricken ranges since results indicate that the greatest improvement in density occurred in the second year after the drought (1942).

In the past 2 years, conservative season-long grazing has produced 20 percent more beef than deferred-rotation grazing. If livestock are left on the range after peak gains are made (late September) there will be a marked shrinkage in weight.

From one-fourth to one-half the total seasonal gains may be lost by too late fall grazing. (In cooperation with Animal Investigations Section.)

Forage samples of four grasses, one weed, and two browse plants were collected monthly from early spring to late fall in 1943 and at midwinter (February 1944) at the College experimental range for chemical analyses. Other miscellaneous grass samples from the nursery were also obtained for fodder analyses. Phenological data at various stages of growth, seasonal yields, and seasonal utilization of the species under study were recorded.

The fodder analyses of 1942 and 1943 indicate marked annual differences and seasonal variations in all species. For example, the percentage of crude protein in three range grasses in mid-June 1943 ranged from 10.4 percent to 19.4 percent higher than at the same period in 1942. The different species of range plants varied in percentage of crude protein throughout the same season. Furthermore, as a plant matures, particularly the grasses and weeds, there is a gradual decline in crude protein. Aster (a perennial weed) and wormwood (a non-woody shrub) rank high in protein during the growing season but are seldom to lightly grazed. However, winter fat, a shrub extremely high in crude protein, was moderately to heavily utilized by cattle.

The 2-years' study indicates that the shortgrasses (blue grama and buffalo grass) may decline 25 to 40 percent in protein value by mid-August and the spring-fall and early summer growing grasses (green needlegrass and western wheatgrass) from 45 to 60 percent. Further loss of crude protein in the grasses by late fall accounts to a certain degree for the decline in weights of range cattle. (In cooperation with Chemistry Section and Rocky Mountain Forest and Range Experiment Station.)

Improving sagebrush lands at the Great Divide experimental range northwest of Craig consisted of sagebrush eradication, grass adaptation trials, and grazing systems to improve sagebrush range naturally. Vegetation plots established in 1942 on railed and untreated sagebrush were remeasured for changes in character of vegetation. Three series of grass adaptation trials seeded in 1942 in replicated rows were examined for percent established stand and vigor of plants.

Railing eliminates from 50 to 75 percent of the sagebrush and damages, but not seriously, the stand of native grasses and bitterbrush (a palatable shrub).

Results indicate that railing heavy sagebrush is justified if the stand of better forage plants is 25 to 35 percent of the total vegetation. Adaptation trials of new grasses are desirable before any large scale seedings are undertaken.

Rural Economics and Sociology

Northern Colorado irrigated farms and northeastern Colorado dry-land farms had a very successful year in 1943, according to records from cooperating farmers. Data secured from these records are the basis for preparing estimates and reports for federal officials to aid in their administration of war food production and in advising farmer groups as to general economic conditions. The reports are also used by the department staff in classroom work, for correspondence, and in conferences.

The trends of costs and returns from ranching provided sound economic information for departmental and state use. During the current year major emphasis has been on the analysis of ranch data as a part of the state-wide reports on wartime production of food.

A report was completed from the previous year's survey, showing that Colorado peaches are considered superior in midwest markets and that poster advertising at point of sale has been less successful than local newspaper and radio advertising. The study also showed need for attention to quality and ripeness in planning for shipment to specific markets. Too many times the ripest peaches were shipped to distant markets.

In th poultry marketing project, a master's thesis was completed, showing that farmers lack egg markets which will pay a premium for quality eggs. Dealers are handicapped in supplying better services by the small volume of eggs from scattered small farm flocks. Colorado egg marketing laws are not effectively administered under existing conditions. Colorado farmers need improved methods for storing eggs, both locally and at central markets, and a satisfactory system of egg grading.

Major attention has been directed toward obtaining motion pictures of potato, sugar beet, and vegetable hand operations, and to the development of laboratory equipment for micromotion analysis of films. Preliminary findings include the discovery of a variation of 50 to 100 percent in the efficiency of individuals in hand harvesting operations on vegetables.

By analysis of extension reports and by personal work with extension workers, the conclusion has been reached that the key to successful rural leadership lies in finding the right man for the job at hand. Executives, planners, project leaders, and neighborhood leaders all require special qualifications. Extension work can be more effective if leaders with these qualifications can be found for each type of community work. Then the extension official can act as over-all manager to keep the work running smoothly and effectively in the local community.

Seed Laboratory

The number of samples received for testing this year was about 40 percent more than the number received over the same period last year and about 100 percent more than the number received 2 years ago.

Improvement of equipment has been continued with the result that at no time has the number of samples received exceeded the capacity of the mechanical equipment. However, conditions are extremely crowded in the laboratory both as to equipment and personnel. Further expansion in the laboratory's services is contingent upon increased floor space.

Although the number of samples received for test shows an increase, it is evident that far too few farmers are familiar with the importance of having seed tested, the services offered by the Laboratory, and the requirements of the Pure Seed Law when seed is offered for sale. Efforts to extend the services of the Laboratory will be continued.

The annual inspection of seeds in the dealers' hands will be carried on during April and May as during the past 2 years. This phase of the Laboratory's activities should be considerably expanded to properly carry on this important work and render it fully effective.

The cost of operating the Laboratory for the current year will exceed that of previous years, as a result of the increased number of samples received and the increases in labor costs. Increase in the number of samples received results in an increase in the fees received but not in proportion to the extra operational costs involved.

ENGINEERING DIVISION

Civil Engineering

Work in the design and invention of irrigation equipment, investigations in connection with pumping for irrigation and drainage, and the snow survey work are the principle cooperative projects. (In cooperation with the Division of Irrigation, Soil Conservation Service, United States Department of Agriculture.)

Meteorological observations were continued. Airways observations, supported by the U. S. Weather Bureau, provide a service of forecast on local weather conditions.

A submerged orifice headgate for measuring the discharge from irrigation pumps was calibrated at the Bellvue laboratory for the Emergency Rubber Project.

Attention was also given to the development of another water-measuring device equipped with an integrating instrument which would indicate the rate and quantity of water applied to a farm unit or crop. Such a device is needed for increased efficiency in the use of irrigation supplies.

A riffle-deflector-vortex-tube sand trap was recently built in the new Minnequa and Union Canal near Florence after a design based on laboratory models tested at Bellvue. This installation will afford opportunity for a comparison study between a model and its prototype. The model showed high operative efficiency and visual observation has indicated very satisfactory sand removal action in the canal structure.

Measurements were made of 114 irrigations of sugar beets, beans, alfalfa, small grains, corn, and potatoes. The smallest amount applied was found to be 0.9 acre-inches on potatoes, the maximum amount 25.4 acre-inches on small grains, and the average of all irrigations 6.8 acre-inches. Few farmers realize how much water they apply until it is measured for them. Some farmers are unaware that they are using excessive quantities of water while others deliberately over-irrigate. Excessive application may be corrected by shortening the run or increasing the amount of water in a furrow. These conditions have been pointed out and remedies suggested in personal contacts and in news articles.

An analysis is being made of the data obtained on the losses from both lined and unlined canals in an investigation conducted in California in 1922. These data had not previously been reduced to a usable form. They indicate that in a canal provided with a concrete lining of superior construction, the loss may be as low as 0.05 cubic foot per square foot of wetted surface in 24 hours. In an unlined canal built through sandy soil, the loss was found to be as high as 50 cubic feet per day.

During the second season of study of the ground-water conditions in Prospect Valley, the surface supply dropped to 6,400 acre-feet as compared with 13,600 acre-feet in 1942. The pumping draught increased to 14,600 acre-feet in 1943 as compared with 6,500 acre-feet the preceding season. This reversal of conditions resulted in a lowering of the water table comparable with the average annual rate of 2½ feet previous to 1942. The field work on the project will be practically completed with the April 1944 observations.

Tests were conducted at the Bellvue laboratory to determine the loss of head through 6-, 8-, and 10-inch check valves for various rates of discharge. These valves are used in pump discharge pipes and the tests showed that they cause an appreciable head loss. This work is part of a program of investigating the loss in head through the various fittings and accessories used in pumping plants and will be continued this summer.

Snow surveys for forecasting irrigation water supplies have been continued in Colorado, Wyoming, New Mexico, Arizona, and South Dakota in cooperation with Federal, State, and other agencies.

Photographs of a selected part of the highest mountain range in the Cache la Poudre drainage were again made on April 1 and May 1. In the 6 years in which these photographs have been taken there is a clear indication that the May 1 comparisons with the Cameron Pass snow course data are much better than for April 1. For April, only 3 years out of the 6 showed good relationship. It is proposed to carry on this project until at least a 10-year record has been obtained.

Mechanical Engineering

By observations and assistance in management of experimental storages and commercial storages embodying experimental features, improved structures and management are being

developed for the storage of white potatoes within the wide climatic range of Colorado. Onion storage work was postponed due to the high proportion of the crop sold at harvest time. (In cooperation with the Bureau of Plant Industry, Soils and Agricultural Engineering, United States Department of Agriculture.)

Major results included:

(1) Promoting the change from sack to bulk storage of potatoes by a few large producers in the San Luis Valley. Data indicate that this change will result in the marketing of 1.5 percent to 3.5 percent more of the crop stored.

(2) Comparing potato storage in boxes and bulk at the San Luis Valley Experimental and Demonstration Farm. Data indicate that because of improved market quality, box storage will result in an added profit of 6 cents per hundredweight.

(3) Designing, assisting in management, and making observations in a 40,000-sack capacity potato storage for the Wiggins Cooperative. Observations indicate sprout-free storage to April 15, which is better long-period storage than has hitherto been obtained in common storage on the Eastern Slope. Handling provisions were found unsatisfactory in new as well as in old storages. The design of the Keenesburg storage will have new type of handling provisions.

(4) Promoting "shell-cooling" in place of "through-bin-cooling" of various storages. Data indicate that this change will result in 2 percent to 4 percent more marketable potatoes from those stored.

(5) From the experimental storages on the campus at Fort Collins, determining capabilities of substitutes for lumber (needed in the war effort) and cooperating with the W. P. B. in the redesign of storages to save lumber. Also at Fort Collins the practicability of storing products requiring high and low humidity in the same room was demonstrated; this was accomplished by regulating the room at low humidity but storing the high humidity products in paper-lined containers.

Work during this past fiscal year has indicated: first, the practicability of mechanically thinning sugar beets, and second, progress toward mechanical harvesting.

The results of mechanical thinning tests, as published in Station Bulletin 476 in 1943, have been the basis upon which the government made their thinning labor rates for the year 1944. These rates represent a 25-percent reduction from $12.00

per acre to $9.00 where the grower followed recommended practices.

SUBSTATIONS

Substations have been established to aid farmers in meeting the obstacles and problems peculiar to farm and livestock production in the different districts of Colorado. The wide diversity of climate, soils, and farm production has created many special problems which can only be studied in the localities where they occur.

The program in general is: (1) To study problems on crops which cannot be grown at the main Station; (2) To test practical application of new facts developed by the main Station; (3) To act as service and direct contact agencies with growers by daily contacts and special field days; (4) To test the commercial possibilities of new crops, better crop varieties, and new grass species for grazing purposes; (5) To conduct livestock feeding tests on feed produced in those localities and to study grass revegetation methods; (6) To work out soil problems peculiar to local areas.

The programs have been developed at each substation through the cooperation of local grower advisory committees. The advisory committee helps decide on operating policies and problems of the district that need investigation, and reviews the progress of those under investigation and their relative importance.

The following substations are now in operation: Arkansas Valley Substation, Rocky Ford; Fruit Substation, Austin; Dry Land Station, Akron, in cooperation with the U. S. D. A.; the Colorado Potato Station, Greeley, in cooperation with the U. S. D. A.; San Luis Valley Potato Station, Monte Vista; Cheyenne Wells Substation (artificial revegetation research); and the Fort Lewis Substation, Hesperus.

In addition to the substations, special cooperative programs have been developed with Mesa County at Grand Junction and on grass studies in the Craig area.

EDITORIAL SERVICE

Publications Issued

Popular Bulletins:

No. *Title and Author*

480 "Growing Alfalfa in Colorado" by R. M. Weihing, D. W. Robertson, O. H. Coleman, and R. Gardner.

481 "Strawberry Production in Colorado" by L. R. Bryant and George Beach.

482 "Field Bean Production Without Irrigation in Colorado" by J. F. Brandon, D. W. Robertson, A. M. Binkley, and W. A. Kreutzer.

483 "Use of Ground Water for Irrigation in the South Platte Valley of Colorado" by W. E. Code.

484 "Grape Growing in Colorado" by George Beach and L. R. Bryant.

485 "Buying a Farm in Colorado" by R. T. Burdick, Alvin Kezer, A. M. Binkley, and R. C. Tom.

486 "Land Types in Eastern Colorado" by L. A. Brown, D. S. Romine, R. T. Burdick, and Alvin Kezer.

Technical Bulletins:

32 "Sedges and Rushes of Colorado" by E. C. Smith and L. W. Durrell.

33 "Key to Some Colorado Grasses in Vegetative Condition" by H. D. Harrington and L. W. Durrell.

Quarterly Bulletins:

Vol. V, No. 3, Colorado Farm Bulletin, July-September 1943.

Vol. V, No. 4, Colorado Farm Bulletin, September-October 1943.

Vol. V, No. 5, Colorado Farm Bulletin, November-December 1943.

Vol. VI, No. 1, Colorado Farm Bulletin, January-February 1944.

Vol. VI, No. 2, Colorado Farm Bulletin, March-April 1944.

Vol. VI, No. 3, Colorado Farm Bulletin, May-June 1944.

Annual Report:

Fifty-Sixth Annual Report, Colorado Agricultural Experiment Station, 1942-43.

Colorado Farm Bulletin:

Because of wartime demands for timely information, the Farm Bulletin has been issued every 2 months instead of every 3 as formerly. The number of copies has been increased to 5,200 per issue.

Other Publications:

Fifty-seven papers by Station staff members were edited for publication in scientific journals and elsewhere.

Fifty-two radio manuscripts and 162 news stories were written.

Much more emphasis was put on features for farm magazines this year. As a result 17 features were sent Western Farm Life, 5 to the Westerner (Record-Stockman), 2 to Through the Leaves, 8 to the Country Gentleman, and 2 to the Farm Journal—total of 36 features, most of them with pictures.

Miscellaneous:

Bulletins mailed out totaled 56,552. Of these, 30,066 were in answer to individual requests, 5,642 to the regular mailing list, and 24,902 to the Farm Bulletin mailing list.

During the year 1943-44, 1,916 inquiries on agricultural subjects which could not be answered by bulletins were referred to this office and forwarded to the various sections of the Station for reply.

Staff Contributions

Animal Investigations. Cull and Split Pinto Beans for Fattening Pigs. Colo. Agr. Exp. Sta. mimeo. June 19, 1944. Misc. Series 241

Animal Investigations. Utilizing Feed in Wartime Cattle Fattening Rations. Colo. Agr. Exp. Sta. mimeo. April 4, 1944. Misc. Series 232

Animal Investigations. Utilizing Feed in Wartime Lamb Fattening Rations. Colo. Agr. Exp. Sta. mimeo. March 20, 1944. Misc. Series 231

Animal Investigations. Wintering, Grazing and Fattening Steers in Eastern Colorado. Colo. Agr. Exp. Sta. mimeo. April 22, 1944. Misc. Series 236

Barmington, Ray. Experience with the John Deere Beet Harvester at the Colorado Agricultural Experiment Station in 1943. Proc. Amer. Soc. Sugar Beet Tech., pp. 99-101. 1944. Sci. Jour. Series 178

Barmington, Ray. 1942 and 1943 Mechanical Thinning Summaries. Proc. Amer. Soc. Sugar Beet Tech., pp. 78-81. 1944. Sci. Jour. Series 179

Binkley, A. M. Placement of Commercial Fertilizers on Potatoes. Spud Notes 2(5):2-3. May 1944. Misc. Series 240

Binkley, A. M. and (H. A. Jones.) A Comparison of Sweet Spanish Hybrids with Commercial Sweet Spanish Onion Strains. Proc. Amer. Soc. Hort. Sci. 44:485-7. 1944. Sci. Jour. Series 177

Binkley, A. M. and W. C. Sparks. Station Breeding Onions for Resistance to Insects, Purple Blotch, and Pink Root. Colo. Farm Bul. 6(2):8-11. March-April 1944

Bodine, E. W. Virus Diseases of Stone Fruits in 1943. Mesa County Research Comm. mimeo. Jan. 1944. Misc. Series 227

Brown, Floyd E. Great Variation Shown in Amount of Water Applied in Single Irrigations of Farm Crops. Colo. Farm Bul. 6(3):5-8. May-June 1944

Bryant, L. R. Peach Fertilizers in 1943. Mesa County Research Comm. mimeo. Jan. 1944. Misc. Series 225

Burdick, R. T. Book review. American Agriculture, 1899-1939, A Study in Output, Employment and Productivity, by Harold Barger and Hans H. Landsberg. Jour. Bus. 17(4):126-7. Apr. 1944. Misc. Series 236-A

Burdick, R. T. Profits on Lambs Average $1.89 per Head in 1942-43; Cattle Average $1.23 per Head. Colo. Farm Bul. 5(5):8. Nov.-Dec. 1943

Burdick, R. T. and R. D. Barmington. Man Labor Being Saved on Colorado Farms by Getting the Most from Available Power. Colo. Farm Bul. 6(1):7. Jan.-Feb. 1944

Charkey, L. W. and H. S. Wilgus, Jr. Chromatographic Determination of Carotene in Alfalfa. Ind. and Eng. Chem. 16(3):184-7. March 15, 1944. Sci. Jour. Series 161

Connell, W. E. and R. C. Tom. Carcasses from Cattle Feeding Experiments Show "Wartime" Rations Produce Good Beef. Colo. Farm Bul. 5(4):4-7. Sept.-Oct. 1943

Connell, W. E. and R. C. Tom. Good Quality Beef Produced with Wartime Feeds in Steer Fattening Tests at Station. Colo. Farm Bul. 6(3):3. May-June 1944

Connell, W. E. and R. C. Tom. How to Beat Shortages of Feed in Wartime Cattle Fattening Indicated by Experiments. Colo. Farm Bul. 5(3):6-8. July-Sept. 1943

Connell, W. E. and R. C. Tom. Protein Greatly Increases Value of Sorghum Roughage for Cattle, Wintering Tests Show. Colo. Farm Bul. 5(3):8. July-Sept. 1943

Connell, W. E. and R. C. Tom. Wheat is Good Feed for Cattle but Should Be Fed in Combination with Other Grains. Colo. Farm Bul. 5(3):30. July-Sept. 1943

Daniels, Leslie B. Insect Transmission Testing with the Peach Mosaic Virus for 1943. Mesa County Research Comm. mimeo. Jan. 1944. Misc. Series 226

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Dickey, H. C. and E. B. Williams. Peavine Silage Found by Tests to Be Good Feed for Dairy Cows; No Off-Flavor in Milk. Colo. Farm Bul. 5(4):12. Sept.-Oct. 1943

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COLORADO STATE COLLEGE

COLORADO AGRICULTURAL EXPERIMENT STATION

FORT COLLINS, COLORADO

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EXPERIMENT STATION STAFF§

AGRICULTURE DIVISION

Agronomy

Alvin Kezer, A.M. ..... Chief Agronomist
D. W. Robertson, Ph.D. ..... Agronomist
†Warren H. Leonard, Ph.D. ..... Agronomist
Robert Gardner, M.S. ..... Associate Agronomist (Soils)
Dale S. Romine, M.S. ..... Associate Agronomist (Soils)
†Ralph Weihing, Ph.D. ..... Assistant Agronomist
†Robert Whitney, M.S. ..... Assistant Agronomist (Soils)
†Robert F. Eslick, M.S. ..... Assistant Agronomist
Jasper J. French, B.S. ..... Assistant Agronomist

Animal Investigations

R. C. Tom, M.S. ..... Animal Husbandman
L. E. Washburn, Ph.D ..... Animal Husbandman
W. E. Connell, M.S. ..... Animal Husbandman
Howard C. Dickey, Ph.D. ..... Associate Animal Husbandman
†H. H. Stonaker, Ph.D. ..... Associate Animal Husbandman
†Melvin Hazaleus, M.S. ..... Assistant Animal Husbandman
A. Lamar Esplin, M.S. ..... Assistant Animal Husbandman
Eugene Bertone, B.S. ..... Assistant Animal Husbandman

Animal Pathology and Veterinary Medicine

Floyd Cross, D.V.M. ..... Veterinary Pathologist
I. E. Newsom, B.S., D.V.S., D.Sc. ..... Veterinary Pathologist
*Dudley P. Glick, Ph.D. ..... Associate Bacteriologist
A. W. Deem, D.V.M., M.S. ..... Associate Veterinary Bacteriologist
Frank X. Gassner, D.V.M. ..... Associate Pathologist
†Max E. Tyler, M.S. ..... Assistant Bacteriologist
Rue Jensen, D.V.M., M.S. ..... Assistant Veterinary Pathologist
Paul C. Brown, D.V.M., M.S. ..... Assistant Veterinary Pathologist

Botany and Plant Pathology

L. W. Durrell, Ph.D. ..... Botanist and Plant Pathologist
Bruce J. Thornton, M.S. ..... Associate Botanist
*E. W. Bodine, M.S. ..... Associate Plant Pathologist
W. A. Kreutzer, Ph.D. ..... Associate Plant Pathologist
A. O. Simonds, Ph.D. ..... Assistant Botanist
J. L. Forsberg, M.S. ..... Assistant Plant Pathologist

Chemistry

J. W. Tobiska, M.A. ..... Chemist
Earl Douglass, M.S. ..... Associate Chemist
C. E. Vail, M. A. ..... Associate Chemist
*C. F. Metz, Ph.D. ..... Associate Chemist
*Lowell Charkey, M.S. ..... Assistant Chemist
Merle G. Payne, B.S. ..... Assistant Chemist
E. B. Crone, Ph.D. ..... Assistant Chemist
Howard A. Durham, M.A. ..... Assistant Chemist
Paul R. Frey, Ph.D. ..... Assistant Chemist

Entomology

Charles R. Jones, Ph.D. ..... Entomologist
George M. List, Ph.D. ..... Associate Entomologist
John L. Hoerner, M.S. ..... Associate Entomologist
Leslie B. Daniels, M.S. ..... Associate Entomologist

Home Economics

Inga M. K. Allison, S.M.	Home Economist
W. E. Pyke, Ph.D.	Professor of Food Research
Elizabeth Dyar, Ph.D.	Professor of Home Economics Research
*Hazel T. Stevens, M.S.	Associate in Home Economics Research
William W. Allison, M.S.	Assistant Professor of Food Research

Horticulture

A. M. Binkley, M.S.	Horticulturist
Louis R. Bryant, Ph.D.	Associate Horticulturist
John G. McLean, Ph.D.	Associate Horticulturist
†George A. Beach, M.S.	Assistant Horticulturist
Walter C. Sparks, B.S.	Assistant Horticulturist

Poultry

†H. S. Wilgus, Jr., Ph.D.	Poultry Husbandman
F. Howard Kratzer, Ph.D.	Associate Poultry Husbandman

Range and Pasture Management

E. W. Nelson, A.M.	Range Conservationist
Clinton H. Wasser, B.S.	Assistant Range Conservationist
†Frank J. Kapel, M.S.	Assistant Range Conservationist

Rural Economics and Sociology

R. T. Burdick, M.S.	Rural Economist
J. L. Paschal, Ph.D.	Associate Rural Economist
R. W. Roskelley, Ph.D.	Associate Rural Sociologist

Seed Laboratory

Bruce J. Thornton, M.S.	In Charge
Helen M. Kroeger, B.S.	Seed Analyst

ENGINEERING DIVISION

*N. A. Christensen, Ph.D.	In Charge

Civil Engineering

*N. A. Christensen, Ph.D.	In Charge
W. E. Code, B.S.	Associate Irrigation Engineer
*Adrian R. Legault, M.S.	Assistant Civil Engineer
*D. F. Gunder, Ph. D.	Associate in Hydraulics Research
Maxwell Parshall, B.S.	Meteorologist
Floyd Brown, B.S.	Associate Agricultural Engineer
Cooperators:	
R. L. Parshall, B.S.	Senior Irrigation Engineer, U. S. D. A.
Carl Rohwer, B.S., C.E.	Irrigation Engineer, U. S. D. A.

Mechanical Engineering

J. T. Strate, M.S.	In Charge
*Raymond D. Barmington, B.S. M.E.	Assistant Mechanical Engineer
E. M. Mervine, M.E.	Agricultural Engineer
Cooperators:	
A. D. Edgar, B.S.	Agricultural Engineer, U. S. D. A.

SUBSTATIONS

Herman Fauber, M.S.	Superintendent, Rocky Ford
Ferris M. Green, B.S.	Superintendent, Austin
Dwight Koonce, M.S.	Associate Agronomist, Fort Lewis

§As of June 30, 1944. See page — for information on leaves, resignations, and new staff members.
†On military leave.
*On leave.

Personnel

On military leave during the entire year were George A. Beach, assistant horticulturist; Melvin Hazaleus, assistant animal husbandman; Frank J. Kapel, assistant in range management; Warren H. Leonard, associate agronomist; Max E. Tyler, assistant bacteriologist; Ralph Weihing, assistant agronomist; Robert Whitney, assistant agronomist; and Herbert S. Wilgus, Jr., poultry husbandman. Those who went on military leave dur-

ing the year were Robert Eslick, assistant agronomist, January 1944; Marvin J. Russell, editor, April 1944; and H. H. Stonaker, associate animal husbandman, November 1943.

Others on leave were Raymond D. Barmington, assistant mechanical engineer, from May 1944, for work in the research department of North American Aviation, Inc., Inglewood, Calif.; E. W. Bodine, associate plant pathologist, from July 1943, for special work on the emergency plant disease project of the Bureau of Plant Industry, U. S. Department of Agriculture; Lowell Charkey, assistant chemist, from July 1943, for work on his doctorate at Cornell University; N. A. Christensen, chairman, Engineering Division, during the entire year, to do special wartime research at the ballistics laboratory of the Army's proving grounds at Aberdeen, Md.; Robert Gardner, associate agronomist, from February 1943 to January 1944, for special research at the U. S. Salinity Laboratory, Riverside, Calif.; Dudley P. Glick, associate bacteriologist, from January 1944, to do sanitation work for the city of Akron, Ohio; Dwight F. Gunder, associate in hydraulics research, from November 1943, and Adrian R. Legault, assistant civil engineer, from May 1944, both to do special wartime research at the Army's proving grounds at Aberdeen, Md.; Charles F. Metz, associate chemist, from June 1944, to do special work for the War Department; and Hazel T. Stevens, associate home economist, from May 1944.

There were four resignations from the staff during the year. They were A. W. Epp, assistant economist, in September 1943; G. S. Harshfield, associate veterinary pathologist, in September 1943; Morris E. Paddick, assistant plant physiologist, in August 1943; and Hilton A. Smith, associate veterinary pathologist, in October 1943. L. A. Moorhouse, rural economist, retired June 30, 1943.

Those who joined the staff during the year were William W. Allison, assistant professor of food research, November 1943; Paul C. Brown, assistant veterinary pathologist, November 1943; Jasper J. French, assistant agronomist, May 1944; Josephine L. Harrington, assistant editor, March 1944; Rue Jensen, assistant veterinary pathologist, October 1943; F. H. Kratzer, associate poultry husbandman, February 1944; E. M. Mervine, agricultural engineer, January 1943; and J. L. Paschal, associate rural economist, September 1943.

Transferred from the College resident instruction staff were Floyd Brown, associate agricultural engineer; E. B. Crone, assistant chemist; Howard A. Durham, assistant chemist; and Paul R. Frey, assistant chemist.

FINANCIAL REPORT, COLORADO AGRICULTURAL EXPERIMENT STATION — *For the Year Ending June* 30, 1944

DR.	Hatch fund	Adams fund	Purnell fund	Bankhead-Jones fund	State mill levy fund	Special fund	Research Foundation	Total funds
Balance July 1, 1943					$ 14,864.00	$25,809.56*		$ 40,673.56
From the treasurer of the United States per appropriations for the fiscal year ending June 30, 1944, under the Acts of Congress approved March 2, 1887, (Hatch fund), March 16, 1906, (Adams fund), February 24, 1925, (Purnell fund), and June 29, 1935, (Bankhead-Jones fund)	$15,000.00	$15,000.00	$60,000.00	$22,430.96				112,430.96
Other sources than the United States					107,317.38†	142,022.34‡	$4,252.34	253,592.06
	$15,000.00	$15,000.00	$60,000.00	$22,430.96	$122,181.38	$167,831.90	$4,252.34	$406,696.58
CR.								
Personal Services	14,204.99	12,791.46	49,496.81	15,034.96	80,125.86	15,743.41	1,010.00	188,407.49
Travel	268.70	248.71	1,888.90	1,187.63	1,829.02	1,539.16	.....	6,962.12
Transportation of Things	.....	3.37	122.02	13.22	741.19	608.96	.50	1,489.26
Communication Service	24.29	23.26	111.74	52.90	1,366.08	416.58	3.35	1,998.20
Rents and Utility Services	4.10	203.77	980.26	523.57	5,130.95	4,507.21	.....	11,349.86
Printing and Binding	169.90	.....	125.55	1,076.09	2,101.34	1,411.82	.....	4,884.70
Other Contractual Services		136.59	694.13	547.23	3,783.24	3,101.47	.....	8,262.66
Supplies and Materials	79.77	1,152.68	3,358.64	2,915.97	14,584.15	50,339.41	418.98	72,849.60
Equipment	.....	108.33	2,173.30	806.29	2,736.05	6,535.25	48.30	72,407.52
Lands and Structures	.....	.....	62.35	.....	286.10	17,845.86	.....	18,194.31
Contributions to Retirement	248.25	331.83	986.30	273.10	714.65	.....	.....	2,554.13
Total—Regular Disbursements	$15,000.00	$15,000.00	$60,000.00	$22,430.96	$113,398.63	$102,049.13§	$1,481.13	$329,359.85
Bonds						50,000.00		
Total—Station Disbursements	$15,000.00	$15,000.00	$60,000.00	$22,430.96	$113,398.63	$152,049.13	$1,481.13	$379,359.85
Balance on hand June 30, 1944					8,782.75	15,782.77	2,771.21	27,336.73
Grand Total	$15,000.00	$15,000.00	$60,000.00	$22,430.96	$122,181.38	$167,831.90	$4,252.34	$406,696.58

* Includes $1,790.93 Sugar Beet fund, $282.64 Hybrid Corn fund, and $1,080.74 Potash fund.

† Includes $13,900 H. B. 44 and $4,500 Pure Seed fund.

‡ Includes $1,000.00 Sugar Beet fund and $621.20 Hybrid Corn fund.

§ Includes $1,024.02 Sugar Beet fund and $288.02 Hybrid Corn fund.