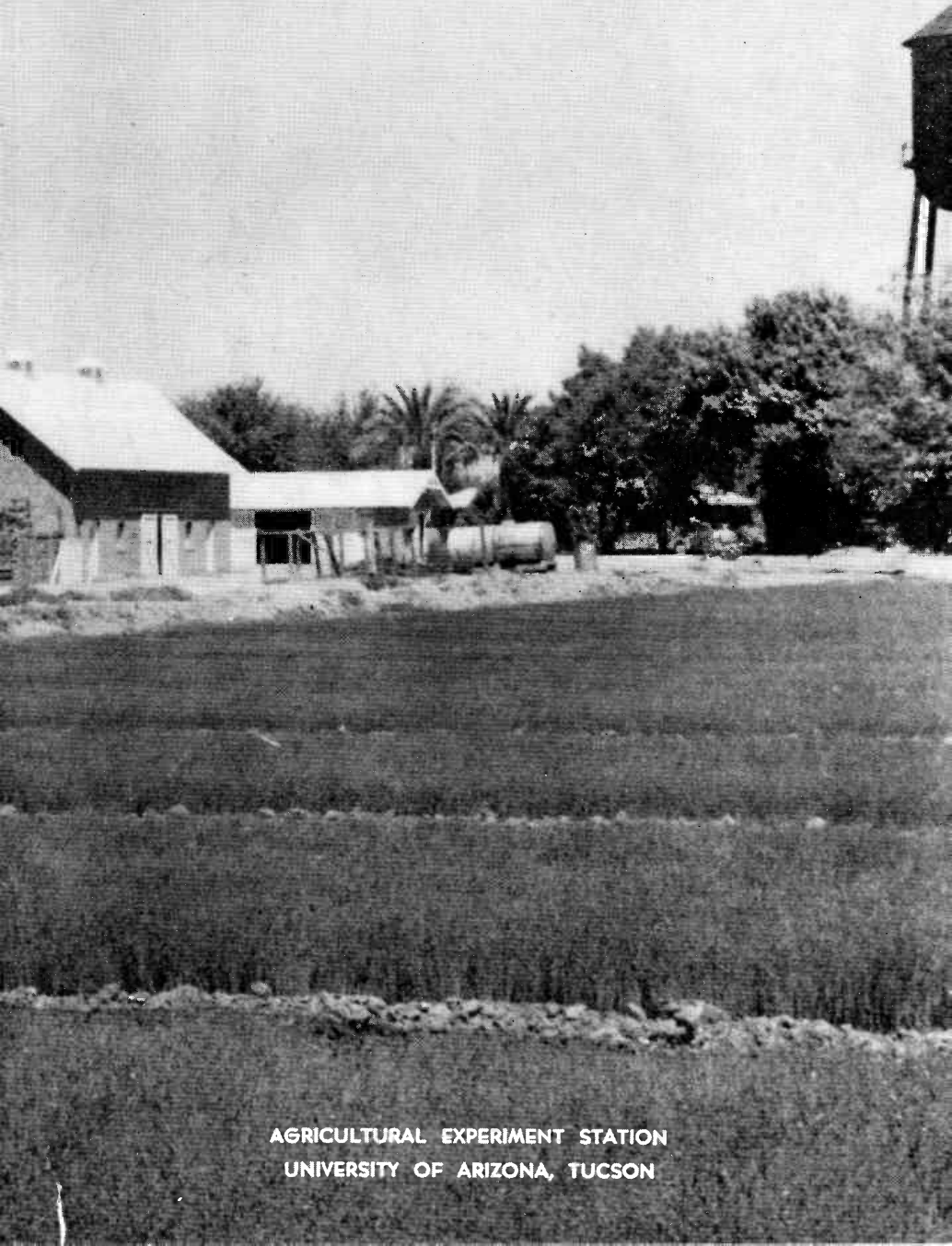
FIFTY-SEVENTH ANNUAL REPORT FOR THE YEAR ENDING JUNE 30, 1946



AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF ARIZONA, TUCSON

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PLANT PATHOLOGY DEPARTMENT
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RUPERT B. STREETS, Ph.D. — Associate Plant Pathologist
PAUL D. KEENER, Ph.D. — Assistant Plant Pathologist
ALICE M. BOYLE, M.S. — Research Assistant

POULTRY HUSBANDRY DEPARTMENT
HARRY EMBLETON, B.S. — Poultry Husbandman
HUBERT B. HINDS, M.S. — Associate Poultry Husbandman

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*Resigned during fiscal year or at its end.
†On leave.
‡In co-operation with United States Department of Agriculture, Bureau of Plant Industry.

January 1, 1947

PRESIDENT ALFRED ATKINSON
UNIVERSITY OF ARIZONA

Dear Sir:

I have the pleasure of presenting herewith the Fifty-seventh Annual Report of the Arizona Agricultural Experiment Station for the fiscal year ending June 30, 1946. It contains reports of progress on active research projects, brief summaries of other station activities, and the summarized fiscal statement.

Respectfully submitted,

P. S. BURGESS, *Director*

Note: The illustration on the cover shows a few experimental flax plots on the Experiment Farm, Mesa, Arizona.

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FIFTY-SEVENTH ANNUAL REPORT

P. S. BURGESS, *Director*

R. S. HAWKINS, *Vice-Director*

INTRODUCTION

The present report deals with the work of the Station during the fiscal year 1945-46. This will be remembered as the year when armed conflict ceased in Europe and in the Pacific and as the beginning of the postwar period. For the past five years the American farmer has had to feed not only our own civilians and armed forces but also those of our allies together with portions of their civilian populations. Our farming people have met these great demands. They have responded to every request for greater production despite shortages of supplies, equipment and man power. Previous research, and research carried on during the war years has, in no small measure, made possible this tremendously expanded production. These researches have not only resulted in better breeds of livestock, better crop plant varieties, better fertilizers, better methods of combating plant and animal diseases and insect pests, better farm machinery, and a better way of life, but also in better conservation methods, better methods of preserving and transporting foods, better methods of improving food quality, better dietary practices, and a more extended use by industry of agricultural raw materials and waste products.

A period of readjusted production is now faced by American agriculture. With World War II at an end, this country is already being called upon to help feed millions of people in the devastated countries. Continued high production of certain commodities will probably be required to meet this new challenge for at least one or more years.

Postwar demands for research into additional phases of Arizona agriculture are coming from many sources, new cash crops; better varieties; more extensive fertilizer experiments on our different soil types; trials and advice on the many new chemical weed killers; insecticides and medical compounds; marketing research and market information; commercial date production; and many others. Present facilities of personnel and equipment are taxed to capacity by these new demands. The absence of twelve of our staff members to enter the armed services and contributing civilian services has seriously curtailed the work of certain departments. A few have returned but many have permanently resigned to accept other positions. We are hoping soon to fill these vacancies. We realize our responsibility to the farmers and ranchers of the state and we are anxious to attack their newer problems as soon as personnel is available.

This Fifty-seventh Annual Report summarizes the progress made on our research program during the past year both here at the University and at the six experimental farms.

The following personnel changes took place during the year:

RESIGNATIONS

Ian A. Briggs, Associate Agronomist.
E. C. Currlin, Assistant Superintendent, Yuma Mesa Farm.
A. H. Finch, Horticulturist and Head, Department of Horticulture.
A. E. Griffiths, Associate Horticulturist.
R. H. Hilgeman, Associate Horticulturist.
W. G. Hoyman, Assistant Plant Pathologist.
Robert Keswick, Assistant Horticulturist.
George Seamans, Superintendent, Gila Project Farm.
T. J. Smith, Assistant Agronomist.
Harold Thurber, Research Assistant, Botany and Range Ecology.

NEW APPOINTMENTS

Lawrence Beal, Assistant Superintendent, Yuma Mesa Citrus Farm.
René Bolomey, Assistant Nutrition Chemist.
Leland Burkhart, Associate Horticulturist.
Larue Chapman, Assistant Agronomist.
Steve Fazio (reappointment), Assistant Horticulturist.
John W. Hankin, Assistant Horticulturist.
F. G. Harland, Assistant Dairy Husbandman.
Ernest H. Hussmann, Superintendent, University Farms, Tucson.
Ralph Jorgenson, Assistant Animal Husbandman.
Paul D. Keener, Assistant Plant Pathologist.
A. R. Kemmerer, Head, Department of Nutrition.
R. L. Matlock, Head, Department of Agronomy.
George A. Pearson, Assistant Agricultural Chemist.
Hudson Reynolds (reappointment), Assistant Range Ecologist.
Charles E. Robertson, Assistant Agricultural Economist.
Max E. Robinson (reappointment), Assistant Animal Husbandman.
William I. Thomas, Assistant Agronomist.
M. G. Vavich, Associate Nutrition Chemist.

RESULTS OF THE YEAR'S RESEARCH
AGRICULTURAL CHEMISTRY AND SOILS

CITRUS CHLOROSIS

The study of this problem has been a major project for several years. It involves an investigation of chlorphyll destruction or loss in citrus leaves with particular emphasis on the soil conditions which contribute to chlorosis. The usual approach to this problem has been leaf analyses, but such analyses have not yielded satisfactory differences indicative of the nature of the trouble. In view of this a seedling method was developed, using

barley and rye, for studying micronutrient element availability in the soils. A progress report on this study has been prepared for publication as a bulletin.

Seedling study

It was found that the micronutrient element uptake by barley or rye seedlings after a fifteen-to-seventeen-day growth in soils is indicative of the available iron, manganese, zinc, and copper in the soil. By using a weighed amount of soil the method can be made quantitative. This method when applied to a group of Arizona soils showed a good supply of micronutrient elements in all the soils examined. Two other important facts were indicated:

(1) A comparison of micronutrient element uptake from alkaline-calcareous soils and acid soils showed a greater uptake in the former. Alkaline-calcareous soils do not *seriously* interfere with the uptake of micronutrient elements as was formerly believed to be true.

(2) Applications of sulphur to alkaline-calcareous soils increased uptake of zinc, iron, and manganese. This shows that our recommendation that soil sulphur be used in chlorotic citrus groves is fundamentally sound.

Following the studies just presented the seedling technic was tried on a group of soils from citrus groves of which six were chlorotic, two slightly chlorotic, and four nonchlorotic. This study showed a greater uptake of iron and manganese for soils from the chlorotic groves. However on analysing the roots and tops separately it was found that the seedlings grown in soils from chlorotic groves had a larger percentage of these elements fixed in the roots.

These seedling studies indicate that chlorosis is due to failure of the plant to utilize micronutrient elements rather than a failure of the plant to take them up from alkaline-calcareous soil. Some factor resident in this type of soil interferes with the activity of the elements within the plant.

A search for this resident factor in the soil shows a good correlation between certain calcium values obtained from an examination of the soils. The soils from the chlorotic groves contained the highest percentage of $CaCO_3$ and active calcium. They also gave the highest calcium Neubauer values which means that these soils were very high in available calcium. Calcium carbonate alkalinity and its activity therefore contribute to micronutrient element deficiency symptoms, but this contribution is largely indirect in that it interferes in some way with the ability of the plant to utilize these elements after they have been taken up from the soil by the plant roots.

Citrus studies

Field studies on citrus chlorosis have been continued in two groves where a mixture of sulphur and manure is being applied to the soil in an attempt to correct it. Leaf analyses have been made at intervals to note chemical changes in composition from

the soil treatment. There has been little or no change in iron and zinc but a definite increase in manganese uptake has resulted. Since the leaf analyses over a period of several years show that the micronutrient element problem is not one of total amount but of active forms, the chemical analyses have been modified to determine the amount of active elements in the leaves. Results indicate that the use of the solvent power of 1 N HC1 for the determination of active iron, manganese, and zinc in the leaves may be fruitful in the study of citrus chlorosis. The method has been applied to leaves with zinc and iron deficiency patterns, leaves from trees growing on wet versus dry soils, neglected versus well-cared-for groves, and to other conditions which typify chlorotic and nonchlorotic trees.

FRUIT QUALITY STUDIES

A comparative study of grapefruit quality was started last year in co-operation with the horticulture department. Twenty groves were selected on the basis of the packing house records for producing poor quality or good quality grapefruit.

Chemical analyses of leaf samples taken each month for twelve months have been completed. The object of these analyses was to study nutritional relationships in the different groves. No difference was found in the per cent ash, phosphate, calcium, potassium, iron, or zinc in leaves from the different groves. Magnesium was found to be higher in leaves from groves producing fruit with thinner rinds, and manganese was consistently lower in these same groves.

The location of all the groves on soil survey maps showed that there is no relation between soil type and quality of fruit produced.

Extensive soil analyses and nutritional tests are being made on the soils from these twenty groves. This phase of the study has not been completed, but the salinity determinations show a higher average salt content in the soils from groves producing fruit with thin rinds.

SOIL MINERALS

Among the irrigated soils of the state there are wide differences in cultural behavior and structural characters which influence water penetration, root growth, and therefore crop yields. There is also some variation in the response of different soils to soil correctives. Research is being conducted to determine the relation of clay minerals in the colloid fraction of the soil to structural properties.

Extraction of colloid

The colloid fraction, 0.2 micron in diameter or less, is the soil fraction which largely determines the structure of the soil. Much time has therefore been devoted to determining the best method for extracting the colloid from the soil. Obviously it must be separated from the soil particles of other dimensions and from salts, carbonates, and organic matter. The colloid is separated

from the coarse soil particles by dispersion and coagulation, from carbonates by acidulation, from salts by washing, and from organic matter by alkaline hypobromite as an oxidizing agent.

Methods

The mineral identification is accomplished by high temperature decomposition. Clay minerals lose their combined water at well-defined temperatures. Two methods have been developed.

The hydrothermal method determines the combined water loss on heating. A balance was constructed to measure the loss in weight of the colloid sample held in a platinum dish which is suspended in the furnace. Temperature measurement is made by means of a chromel-alumel thermocouple and a Hoskins pyrometer. It takes about two hours to make a complete determination.

The differential thermal method measures the energy change involved in the thermal decomposition of the colloid mineral. In this method the colloid is placed in a cylindrical block of pure nickel. Similar samples of pure anhydrous aluminum oxide are placed in other holes in the nickel block and serve as reference material in the temperature measurement. Thermocouples of chromel-alumel embedded in a colloid and an aluminum oxide sample are connected in series with a sensitive galvanometer. The temperature difference so measured indicates the magnitude of the change occurring in the colloid sample at the characteristic decomposition temperatures. Another couple mounted in the aluminum oxide alone, and connected to the pyrometer, gives the actual temperature of the block at any moment. The heating rate is maintained at 10 degrees C. per minute.

Results

The data obtained by thermal methods are analysed by means of reference curves obtained from known clay minerals. Pima clay colloid has been found to be dominantly montmorillonitic. Gila clay, from the University farm, was found to be a mixture of montmorillonite and hydrous silica. A clay from Yavapai County showed montmorillonite and brucite (hydrated magnesium oxide). The colloid from a soil giving a notable response to gypsum was chiefly hydrous mica. An acid soil showed the presence chiefly of kaolinite and some goethite (hydrated iron oxide). The investigation will be continued until a survey of the more important soil types of the state has been made. The data will then be studied in relation to the behavior of these soils in the field.

BOUND WATER IN SOILS

The department has published a series of technical bulletins dealing with soil structure problems. Soil structure is without question one of the most important growth-limiting factors met in the cropping of irrigated soils. A sixth bulletin in this series was submitted for publication during the year entitled, "Studies in Soil Structure VI; Water Bound by Individual Soil Constituents

as Influenced by Puddling." It presents dilatometer studies made on the textural fractions of Arizona soils, the effect of soluble salts, individual clay minerals, organic matter, and the part they play in the availability of moisture in puddled and unpuddled soils.

BEE POISONING FROM INSECTICIDAL DUSTS

The department has co-operated with the Bee Culture Division, U.S. Bureau of Entomology and Plant Quarantine, in the study of bee losses from arsenical insecticides. This research was completed during the fiscal year 1944-45. During the past year the information obtained during this research was put into use in the field. It was used in drawing up an agreement between bee keepers, insecticide dealers, airplane crop-dusters, and growers. In brief this agreement eliminates the use of arsenical dusts in all cases where other insecticides can be substituted. In cases where there is no satisfactory substitute for arsenicals, the bee keepers are notified in advance regarding time and location of fields to be dusted.

In addition to bee losses there have also been cattle losses from arsenicals. Cattle mistake arsenicals for salt where empty containers are left on the ground by the crop dusters. This hazard has been corrected by a regulation requiring that all container bags be marked for destruction when empty.

FLUORINE

Interest in the fluoride salts in well waters continues. At the Tucson laboratory 458 samples of drinking water were analysed for fluoride, while in the Phoenix laboratory 533 fluoride analyses were made. Some time was also spent in consultation with private individuals, civic clubs, public utility authorities, and city officials in helping them solve their fluorine problems.

ANALYTICAL SERVICE

The analytical service which the department gives to farmers continues in considerable volume. During the past year 1,393 samples were analysed in the Tucson laboratory and 2,229 samples at the branch laboratory in Phoenix. Most of these samples were soils and irrigation waters. Increased interest among farmers in soil and water analyses has made it necessary to increase the number of determinations on each sample.

Waters

Practically all water samples are now being analysed for nitrate nitrogen and fluorides and the sodium:calcium ratio is being calculated. Interest in fluoride content is due to the relation of fluoride salts to mottling of tooth enamel. Interest in nitrate is due to the plant food value of nitrate salts and the fact that many of our waters contain rather large amounts. The sodium: calcium ratio is determined in order to evaluate the water in terms of its ultimate effect on soil properties. A high sodium:cal-

cium ratio is undesirable and when such exists it is advisable to use gypsum either in the water or as a soil corrective.

Soils

In irrigated agriculture the structure of the soil is closely related to its productivity. Therefore there is a great need for laboratory methods to determine soil structure. In most of the soil analyses now being made moisture equivalent and apparent specific gravity determinations are being included to learn something about the moisture holding capacity and the degree of dispersion.

HIGH NITRATE WATERS

While well water samples from over the state often contain from 15 to 30 parts per million nitrate, occasionally a sample will show a very high nitrate content. A few years ago a new well in Deer Valley near Phoenix was found to contain slightly over 400 p.p.m. During the past year a sample from a well near Sonoita was found to contain 2,700 p.p.m. nitrate. Since 10 p.p.m. is equivalent to 27 pounds per acre-foot of water the importance of determining nitrate in irrigation water is self-evident.

NEW NITROGENOUS COMPOUNDS

The department has a grant-in-aid from the American Cyanamid and Chemical Corporation for the study of new nitrogenous compounds. Research on this project has continued during the past year.

Unfavorable nitrification for thiourea and cyanamid when applied at the rate of 200 parts per million parts soil was studied from the standpoint of several variables, notably *p*H of soil and reinoculation with nitrifiers. This study revealed that the poor nitrification was due to a heavy application to the soil as the nitrification rate was increased when 100 parts per million parts of soil was used.

Most of the work on this project is now being conducted with plants. The object of this phase of the investigation is to determine whether any toxicity is developed during the bacterial breakdown of the compounds. Using barley seedlings and Neubauer technic 100 mgs. of nitrogen from cyanamid, dicyanodiamid, guanidine nitrate, guanylurea sulphate, thiourea, N-20, N-40, and ammonium sulphate per 100 grams of soil were incubated for 0, 15, 30, 60, 91, 149, 210, and 271 days. The seedlings were planted in the soils at the end of these periods of incubation and plant behavior noted. These tests showed slight tip burn for several of the compounds, but there was no evidence of any serious adverse effect on plant growth at any of the incubation periods. This experiment indicates that no significant toxicity develops during the breakdown of any of these compounds when they are applied to soils at the rate employed in this experiment.

FEEDS, FERTILIZERS, ECONOMIC POISONS

In 1937 the legislature passed feed and fertilizer control laws and placed responsibility for their control in the Chemistry and Soils Department. In 1945 an economic poisons law was passed and responsibility for its enforcement was also placed in the department.

Feeds

During the year 1945 a total of 395 samples of commercial feeds, twenty-nine samples of cottonseed meal, and twenty-one mineral feeds were collected from those on sale in the state and analysed. The tonnage of feed sales in the state for the period 1938 to 1945 inclusive is as follows:

Year	Commercial feeds	Cottonseed meal
1938	31,000	25,000
1939	34,000	35,000
1940	45,000	22,300
1941	48,400	19,100
1942	55,700	21,900
1943	82,500	17,400
1944	102,234	18,568
1945	82,046	16,699

The reduction in volume of cottonseed meal during this period is significant. The high volume of feed sales for 1944 is believed to have been due to sales to small poultry feeders during the war.

Fertilizer

During the year 1945 a total of sixty-six fertilizer samples was collected and analysed. Total fertilizer sales, mixed and simples, for the state are as follows:

Year	Tons
1938	8,000
1939	8,500
1940	6,500
1941	9,500
1942	14,000
1943	15,500
1944	21,708
1945	29,453

Except for the year 1940 there has been a steady increase in fertilizer use in the state. Even during the war years with their accompanying problems of supply and transportation this increase continued. During the year 1945 the supply did not meet the demand as more Arizona farmers are becoming fertilizer conscious.

Economic poisons

The first annual report on the operation of this law was issued as of June 30, 1946. The operation of this law requires only registration of brands. The office does not therefore have data on volume of sales. Sixty-two companies have made registrations

for 536 insecticides, fungicides, and herbicides. A large part of the first year was devoted to the assembly of equipment for analysing samples and for assembling and trying out methods of analysis. Sixty-two samples were collected from poisons on sale in the state and analysed.

LYSIMETER STUDY ON NITROGEN BALANCE

This is a long-time experiment in which nitrogen balance is being studied in soils under a six-year rotation program without fertilization. Only the routine work of planting, irrigating, harvesting, and chemical analysis of the crops was done during the past year. Data on nitrogen balance at the end of the second six-year rotation have been published. Another balance will be made at the end of the third or fourth six-year rotation period.

BORON

During the year ending June 30, 1946, work on the boron project continued along the same general lines as in the past year. Pot experiments in which alfalfa was watered with various concentrations of boron showed no further reduction in the 3.0 p.p.m. threshold value over the previous year.

Boron was applied to several trees in an apple orchard in Oak Creek Canyon during the late spring as a possible means of improving the health of the trees. Field observations cannot be made until the spring of 1947.

Neither visual observations nor chemical analyses of leaves from the citrus groves which have been sprayed with lime and treated with gypsum as a means of supplying soluble calcium to the tree showed any reduction in boron injury to the leaves.

About 215 miscellaneous samples of soil, water, and plant material were analysed during the year. A manuscript on the subject of boron in Arizona's agriculture is being prepared and will be presented for publication as a technical bulletin.

AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

The total amount of land irrigated in Arizona now stands at about 775,000 acres. It appears that the peak of Arizona irrigation development, except in Yuma County, has been reached for the present. The securing of additional sources of water for irrigation, or far greater than normal rainfall on the watersheds, will be necessary to bring about a new period of advancement.

COST OF PUMP IRRIGATION

A doubling of the amount of water pumped for irrigation in Arizona from 1941 to 1945 calls for special consideration of the cost of this important source of water. Principal additions to the area supplied by pumps since the year 1940 have been in the Santa Cruz basin of Pinal County, the Queen Creek area of Maricopa County, the Upper Gila Valley of Graham County supplementing gravity water, and the South Gila irrigation project of Yuma County.

The cost of pump water appears to be almost directly proportional to the total water lift. Roughly calculated, it cost producers about 13 cents for each foot of life to deliver water to and produce an acre of cotton. This lift varies from about 40 to 240 feet. For possibly one half of the lands of the state that depend entirely upon underground water supplies, the lift is 150 feet or more. About 60 per cent of the cost is for power, and the remainder is interest, depreciation, repairs, maintenance, and taxes on the motor, well, and pump.

DAIRY PRICES AND COSTS

Fluid milk and cream have tended to be scarce in Arizona for the years of the war period. Costs of labor and feed have increased more rapidly than the price received for milk. The return for Grade A milk, plus the subsidy paid the farmers direct was 113 per cent higher in December, 1945, than the December return in the prewar period 1935-39, but the cost of feed in December, 1945 was 130 per cent higher and the cost of labor 170 per cent higher. These unfavorable relationships between price of milk and principal costs of the dairyman discouraged the increased production that could readily have been consumed by the increased population of the state and encouraged the marketing of Arizona milk cows to the Los Angeles market milk area. This transfer was possible because the ceiling prices allowed in the Los Angeles area for fluid milk were higher than the ceiling prices allowed in the Arizona area. One result of this differential between Arizona and California follows: Arizona increased its milk production about 2.3 per cent in 1945 over that of 1944, while the California Crop and Livestock Reporting Service states that California increased its production in the same period 7.56 per cent. The foregoing relationships also indicate that if the federal government subsidy were removed without price adjustments, the Arizona dairymen would operate at a large loss. In case the government removes the subsidy some time during the year 1946, it would appear that the ceiling price would have to be raised to compensate for the present subsidy which amounts to 1½ cents per quart in the winter months.

War brought many changes in dairy production and delivery, many of them undesirable in peacetime. In the months ahead the consumers will be looking for high quality, and dairymen and dairy distributors should arrange to provide the quality desired. Some of the economies developed during the war period should be retained—the use of larger containers for retail sales, less frequent delivery, no overlapping routes. The continuance of some of these practices cannot but benefit producer, distributor, and consumer.

AGRICULTURAL ENGINEERING

GROUNDWATER STUDIES

Upper Santa Cruz Valley

The water level measurements in October, 1946, again illustrate

the beneficial effects of summer flood flows in the recharge to the groundwater basin of this portion of the Santa Cruz Valley. The rainfall in July and August of both 1945 and 1946 resulted in surface runoff sufficient to provide significant recovery in the water levels in the upper portion of the area.

In October, 1946, water levels in wells between Calabasas and the Mexican Boundary were up to approximately the same level as in the fall of 1939. Between the Pima County line and Calabasas groundwater recharge about equaled the pumping draft with little change in the average water level as compared with that of October, 1945. From the Pima County line to the City of Tucson a lowering of about 2 feet occurred in the more concentrated pumping areas in the vicinity of Sahuarita. Wells in other parts of this same section of the Valley showed recovery of the same amount during this period.

Cortaro-Marana district

The pumping draft from the groundwater supply of the Cortaro area was about 25,500 acre-feet in 1945, approximately 5,000 acre-feet more than in 1944. Late season pumping for alfalfa and grain in November and December of about 4,500 acre-feet left little time for establishing the equilibrium of the water table prior to the 1946 late winter water level measurements. Those measurements indicate an average lowering in the water level of 4.5 feet as compared with measurements made a year previous, which is probably greater than the true residual lowering. Water levels in wells on the valley slopes, above the pumping area in the trough of the valley, continue to lower.

Surface runoff in the summer of 1945 as measured at Rillito, at the lower end of the Cortaro area, amounted to over 17,000 acre-feet. Most of this flow originated from precipitation on the drainage area in the immediate vicinity of Tucson during the latter part of July and the early part of August. The flood flows were short-lived and therefore did not afford any great opportunity for recharge from seepage to groundwater storage. The flow during these two months was larger than the total flow for any year since 1940. The winter rainfall of 1945-46 was low and the stream flow in this section of the Santa Cruz River was negligible in amount.

In 1946 about 7,600 acres were planted to cotton and during August a total of 5,000 acre-feet was pumped from the wells in the Cortaro area. This is the largest amount pumped during any one month in the history of the project. Pumping from wells in the Marana area amounted to 2,300 acre-feet in August, or a total of about 7,300 acre-feet for the 7,600 acres in crop. This indicates a gross water requirement of 0.96 foot of water at the pumps per acre of cotton for the month of August, 1946.

Pumping in the Marana area of approximately 14,000 acre-feet in 1945 was greater than in any year since 1937, when pumping for irrigation began. Water levels in six irrigation wells in the spring of 1946 indicate a lowering of over 1 foot as the result of the 1945 pumping.

The Tucson area

Through the co-operation of the City of Tucson and Pima County the Agricultural Engineering Department is conducting a survey of groundwater conditions in the Tucson area. Funds for this work are provided jointly by the City of Tucson and Pima County and the work is being done under the direction and supervision of the department. The work now in progress includes the preparation of a detailed groundwater contour map of that portion of the Santa Cruz Valley groundwater basin immediately tributary to the City of Tucson and vicinity. Chemical analyses of samples collected from wells in the different parts of the area are being made. Logs of these wells and other information needed in the general study of the water supply for this area are being secured.

The Eloy district

Considerable expansion of the area irrigated by pumping in the Eloy district occurred during the crop year from March, 1945, to March, 1946. This new development took place notwithstanding the already rapid depletion of the groundwater supply by overpumping. In general, the new wells are located along the west and north edges of the district where the water table is relatively shallow.

Measurements of the depths to water in wells made in February, 1946, showed that during the previous year the average residual lowering of the water table at seventy-two wells was 6.4 feet.

The volume of ground unwatered during the year ending March 1, 1946, was computed to be 910,000 acre-feet. This represents a removal of approximately 100,000 acre-feet of water from the groundwater supply that had accumulated during past centuries. It is estimated that the total amount of water pumped in the district during the year was about 150,000 acre-feet. Of this amount only about one third was from water entering the area as new water or from seepage from the irrigation canals and irrigated fields.

Since the beginning of the expanded development in this area in 1936, the total volume of ground unwatered has been computed to be 5,900,000 acre-feet. This is equivalent to a withdrawal during the ten-year period of approximately 650,000 acre-feet of water from the groundwater supply in excess of the recharge.

Little Chino Valley

Studies in the Little Chino Valley artesian area were initiated in the spring of 1938 with the measurement of water levels and artesian pressures in a limited number of wells. At that time the area irrigated from wells was only about 650 acres. This has increased each year until in 1946 there were about 2,100 acres securing their entire water supply from wells, and supplemental water was being supplied from three wells for lands in the Chino Valley Irrigation District. With the drilling of several new wells in the fall of 1946 it appears that the acreage will be somewhat larger in 1947.

Water levels and artesian pressures are taken each year prior to the beginning of the irrigation season at which time it is believed that a condition of approximate equilibrium has been reached. A comparison of measurements made in 1946 with those in 1938 indicates a general residual lowering of water levels and pressures of approximately 9 feet in the period of eight years. Measurements in the spring of 1946 show a residual lowering of slightly less than .80 foot in the north and central portion of the artesian area, as the result of the 1945 pumping season. Wells in the south end of the area showed a loss of over 1 foot for the same period. Water levels in the few scattered wells along Granite Creek and in Lonesome Valley have been measured since 1939. These wells are quite distant from the area of pumping draft—two of them being more than 6 miles away—but apparently they are connected directly with the artesian aquifer in Little Chino Valley. The elevation of the water surface in this area stands from 4 to 9 feet above the artesian pressure surface, depending upon the distance away from Little Chino Valley.

The lowering of the water table in the Granite Creek and Lonesome Valley area between the spring of 1945 and the spring of 1946 was about 1.3 feet. During the period from 1940 to 1946, the accumulated residual lowering in this area amounted to about 7 feet. During this same period the accumulated lowering in water level and artesian pressure in Little Chino Valley was approximately 7.5 feet. It is difficult to conceive of such extensive effect from the pumping draft in Little Chino Valley unless the open, porous lavas underlying this area extend to the east under the Granite Creek and Lonesome Valley area. Wells in this area have been drilled primarily for stock watering purposes and have therefore not penetrated the valley fill to any appreciable depth below the water table. Lava formations have not been reported to have been encountered in any of the wells in this area.

The rainfall records from stations in and adjacent to the drainage area show that the average rainfall for the period 1938-46, inclusive, was slightly above average. Most of these records cover about the last thirty years, but the period 1938-46 apparently includes the years of maximum rainfall, 1941, and of minimum rainfall, 1942, for the entire period of record. Records of water levels and artesian pressures for this period do not reveal any significant effects from the drouth year of 1938 or from the heavy rainfall of 1941. It is therefore concluded that variations in annual rainfall have not contributed to the consistent lowering of water levels and artesian pressures since 1938.

Shallow surface water wells in the north end of the artesian area have not shown any wide variations in water level except in those cases where they are affected locally by deep percolation losses from adjacent irrigated fields. A maximum fluctuation in water level was observed in one of these wells from 15 to 52 feet during the eight-year period, 1938-46. Seepage losses from irrigation also have resulted in waterlogging of small areas in the lower end of the artesian area.

MISCELLANEOUS

New University Farm well

A new irrigation well was completed on the University Farm on Campbell Avenue in November, 1945. The well was drilled to a depth of 300 feet and cased to a depth of 234.5 feet with 12-inch, stovepipe casing. The casing was perforated from a depth of 31 feet to the bottom with six holes per foot using a Mills Knife perforator. The driller's log of the well is given below.

Prior to perforating, a baler test of the well indicated that the capacity of the well from below the bottom of the casing was only about 10 gallons per minute with a drawdown of 6 feet.

Developing of the well was accomplished by means of a plunger attached to the bottom of the drill stem facilitating washing into the well the fine grained sand, silt, and clay materials adjacent to the casing and in the perforations. During this process about 10 cubic yards of fine material was washed into the well and baled out. Most of this material came in from above the depth of 120 feet with the major portion coming from the sand and gravel stratum near the top of the well just below the water surface. As a result a small cave-in occurred on one side of the well casing, which extended to the ground surface. Into this hole was poured 7 cubic yards of 1½-inch crushed rock, which was worked down along the side of the casing in the developing process. It is believed that this left the well with an effective gravel envelope type screen adjacent to the casing.

A pump test of several hours' duration gave a capacity of 640 gallons per minute with a drawdown of 22 feet. The static water level was 30.2 feet and the pumping water level 52 feet. A pump has been ordered for the well with a capacity of 650 gallons per minute at a total field pumping head of 60 feet. The pump will be connected with the cement pipe distribution system on the farm. This will permit the use of the combined discharges from both wells on the farm in a single irrigation.

LOG OF IRRIGATION WELL NO. 2, UNIVERSITY FARM, CAMPBELL AVENUE, TUCSON

Depth in feet		Formation
From	To	
0	8	Sandy loam soil
8	18	Coarse sand
18	34	Sand and gravel with a few boulders
34	50	Packed white sand with a little red clay
50	73	Red packed sand
73	76	Loose sand with little gravel
76	126	Red packed sand, caving a little
126	135	Hard sandy red clay
135	172	Hard red sandy clay with gravel, caving in streaks
172	180	Cemented gravel
180	214	Red clay with gravel, some caving
214	265	Sandy red clay, sticky
265	283	Sandy red clay, hard
283	290	Hard red clay*
290	300	Red shale*

*Note: This same formation was encountered in a well about 2 miles east at a depth of 235 feet.

The annual water supply forecast

The forecast for 1946 was broadcast by radio over an Arizona network on April 1. Reservoirs in northern Arizona were less than half full. Salt River reservoir storage was at about one fourth of capacity, and San Carlos reservoir was nearly empty. No snow remained except on very small areas.

On the San Carlos project the main dependence was on water pumped from wells, limited to 100,000 acre-feet. In the broadcast it was recommended that the area to be irrigated on the white-owned lands be cut to 46 per cent of the total 50,000 acres, and that both cotton and alfalfa acreages be cut to one half of the previous year's area.

The stored supply for the Salt River Valley project, which had decreased steadily for five years, was still sufficient for irrigation of the entire acreage but with the prospect of empty reservoirs by October, emphasizing the oft-repeated warning "not to waste a drop of water." (Extraordinary rains occurred in September; the direct and indirect effect of these rains was to end the season with 350,000 acre-feet in storage.)

Elsewhere, the forecast stated, prospects were less than fair, severely limiting the planting areas. Arizona farmers have learned to live with drouth, and in no western state is water used less wastefully.

THE TAMARISK TREE AND ITS WOOD

Preservative treatment of tamarisk fence posts

This project was initiated in 1934. Fence posts treated,* some with creosote and some with other preservatives, are being tested in the ground. Annual inspections are being made near the end of each year. Condensed reports for December, 1945, are as follows.

The lot of twenty-five posts treated in West Oakland has been in the ground eleven years. The post, No. 3-1, broken by the fall of a heavy limb in 1942 and reset on the University Farm was found to have decayed and was harboring many termites. The original butt end, buried close by the post, was in sound condition. The two untreated posts at the University Farm, when pushed, broke off at 6 inches and 12 inches below the ground line respectively and were removed. Of the two untreated posts at Esmond, one had been turned upside down and reset since the last inspection; the portions of both posts below the ground surface were under attack by termites but retained considerable strength.

Of the 139 posts in the east fence line of the George Kinne ranch, seven more failed by breaking under a firm push. The breaks occur from 4 to 7 inches below the ground line. All of the original posts are doing service, none have been removed from the fence line.

*For details of treatment consult *Arizona Agricultural Experiment Station Tech. Bul. 92*, "Creosoted Tamarisk Fence Posts and Adaptability of Tamarisk as a fine Cabinet Wood."

In many cases termite tubes are found on the posts above ground, but usually the termites have gone. Apparently they are unable to penetrate the dry wood or the small quantity of creosote which ascended in the fine tubes of the wood repels them.

Of the ninety-nine posts treated and set in 1942, the forty-nine posts set on the Trowbridge-Page ranch were found in good condition. Of the fifty posts set on the University Farm, five of the sixteen posts treated with wood tar creosote were easily broken off at or below the ground line. The buried parts were both decayed and termite eaten. As a result, wood tar creosote definitely is not to be recommended as a wood preservative for farm use. Although it contains toxic components (methanol, acetone, acetic acid, aldehydes), these components are relatively water-soluble and are lost in solution in the soil water or are volatilized.

On the other hand pentachlorophenol solutions are promising and may give to fence posts as long life as the best coal tar creosote. Further, the cost is much less than that of creosote, if the solution is shipped as a concentrate.

A 10-acre tract in the Higley district has been planted to tamarisk by the owner with the objective of providing the market with fence posts treated with creosote or other proved preservative.

Plantings of tamarisk trees for saw logs

A total of 2,951 cuttings of the tree tamarisk, *Tamarix aphylla,* were set on the Yuma Valley Farm in March, 1942. After two seasons' rapid growth a pathologic or nutritional condition developed on about three fourths of the trees. (See photograph in the last Annual Report.) Although the growth in subsequent years was very restricted, yet not one of the trees has died.

Efforts to determine the cause and a remedy have not been successful. It was hypothesized that, because of the close spacing of the trees and in the case of the south planting the sandy character of the soil, some needed nutritional element had become exhausted. The grove of best trees, which has remained green and has grown vigorously, is on a location previously devoted to the burnings of stalks, straws, and other farm trash and the ash was added to the soil. Therefore fertilizer tests have been made on selected rows. In 1944 phosphorus, nitrogen, and iron sulfate were tried separately. In 1945 potassium sulfate also was tried. In the spring of 1946 a finely-ground "mineral mix," obtained from Research Foundation and containing sixty-four minor or trace elements, was applied, separately and with nitrate and phosphate, and sulphur and boron were applied separately. No responses have been shown. The tests have been on the south planting.

In the meantime the north planting has recovered voluntarily. In February, 1946, the foliage was becoming thicker and greener, though still somewhat greyish green. By midsummer the trees had a healthy green color. The only factor which has changed significantly has been the depth of the water table. This was about 5 feet except in the fall months when it rose about a foot

due to heavy irrigations on the lettuce field on the north side. There has been a general rise in the water table, and in the fall of 1945 the water table was about 3 feet below the ground surface. The lettuce fields are heavily fertilized each fall with phosphate and nitrogen.

The trees of the best grove had reached heights of 35 to 44 feet at the end of 1945. In January great damage was done by wind storms. No trees were flattened but they were made to lean at angles of 10 to 40 degrees, and tree tops became knotted. In March, 1946, the trees in this grove were stripped and topped at about 20 feet height and a few of the leaning trees were removed.

It is probable that close spacing had forced the growth into height instead of diameter. The ratio for most of the trees was more than 100 to 1. It will be determined now if the stubbed trees increase rapidly in diameter. The trees should have been topped a year earlier, or the grove should have been thinned.

A complicating factor is sunburn on the south side of trunks which causes eccentric growth.

The stubs sprouted anew from the ground to the top. The sprouts up to a height of 9 or 10 feet have been rubbed off or cut twice before July.

AGRONOMY DEPARTMENT

SMALL GRAIN EXPERIMENTS

Southern Arizona

Wheat yields are shown in Table 1 for most of the varieties grown at the Experiment Station Farm, Mesa, during the past year. Only those varieties are included which have been grown for three years or more.

TABLE 1.—WHEAT VARIETY YIELDS, MESA FARM

Variety	Date headed	Plant height (in.)	Bu. wgt. (lb.)	Av. yield (Bu. per acre)	Annual av. yield (% Baart-38)
Baart	3/26	48	64.0	33.9	90.6 (7)*
Baart 38	3/26	48	64.5	34.9	100.0 (7)
Baart (awnless)	3/27	50	62.0	35.9	104.8 (3)
Onas (awned)	4/5	44	61.5	43.4	123.5 (3)
Onas	4/5	45	60.5	38.4	118.9 (3)
Thatcher	4/11	46	61.0	32.2	90.2 (3)

*Numbers in parentheses indicate number of years grown in comparison with Baart 38.

The average yield of Baart 38 has been 9.4 per cent higher than Baart during the seven years both varieties have been grown.

Awned Onas, a soft white variety, has outyielded Baart 38 by 23.5 per cent. No doubt because of the awns (beards), Awned Onas has outyielded the regular (awnless) Onas. Thatcher, a hard red spring variety, has had the lowest yield. That result shows again that hard red spring wheats are not suited to the lower valleys in southern Arizona.

Attempts have been unsuccessful to find an oat variety that will outyield California Red at Mesa Farm. Some of the newer varieties, developed mostly in western states, have been tested during the past three years. All of the following varieties have given average yields ranging from 7.5 to 25.0 per cent below that of California Red: Lega, Ventura, Osage, Uton, Bannock, Marida, and Westdale. All of these varieties produced lower hay yields in 1945-46 than did California Red or Markton.

Data are given in Table 2 for some of the barley varieties tested in 1945-46 and included for at least three years. Arivat, the leading variety, has outyielded both Vaughn and California Mariout by about 9 per cent. During the last three years two selections from Arivat have outyielded that variety each year. Arivat Selection 18 has slightly but consistently higher yields than Selection 19. While Selection 18 has characteristics almost identical with the old Arivat, it has produced a 6.7 per cent higher grain yield.

TABLE 2.—BARLEY VARIETY YIELDS, MESA FARM

Variety	Headed	Lodging (per cent)	Plant height (in.)	Bu. wgt. (lbs.)	Av. yield (Bu. per acre)	Annual av. yields (% Arivat)
Vaughn	3/26	0	37	50.5	63.1	90.8 (10)*
Arivat	3/23	0	35	49.5	63.8	100.0 (10)
Calif. Mariout	3/18	5	29	52.0	61.1	91.0 (7)
Arivat Selection 18	3/23	0	35	49.5	67.6	106.7 (3)
Arivat Selection 19	3/23	0	35	49.0	65.1	105.3 (3)

*Numbers in parentheses indicate number of years grown in comparison with Arivat.

About 100 selections from a Vaughn x Scarab cross made several years ago were included in a test at the University Farm, Tucson, this year. The number has been reduced from about 500 included in 1943-44. Determinations for pasture value were made of the better selections in a plot seeded in October. Replicated areas were clipped three different times during the growing season. More than fifteen of the selections gave clipping yields that exceeded the nearest Vaughn check by 10 per cent or more. Grain yields this year, and on a two-year average basis, were higher than either Vaughn or Arivat for about twenty of the selections.

Some of the selections which exceeded Vaughn, our standard pasture barley, in clipping yields also exceeded Arivat in grain yields in each of the last two years.

Northern Arizona

The smut-resistant Bridger oat variety in a variety test conducted in 1945 and 1946 at Eagar (Apache County) gave the highest yield each year with a two-year average grain yield of 87.9 bushels. That yield is almost 10 bushels higher than that of the commonly grown Markton.

The old, rough-awned Trebi variety of barley gave the highest grain yield in both years. The Trebi average of 72.2 bushels, however, is only 3 bushels higher than that of the smooth-awned, smut-resistant Velvon 11.

A new durum wheat, known only as Ld. 153, produced the highest average of the wheat varieties—33.7 bushels per acre. Pilot, a hard red spring variety, had the second highest two-year average yield with 31.9 bushels per acre. That was but .3 of a bushel higher than Baart 38.

ALFALFA FERTILIZATION

Mesa Farm, 1946

A fertilization test on Hairy Peruvian alfalfa was started with a February seeding on a series of replicated plots which had been cropped to SxP cotton in 1945. The results, measured in terms of field-dry hay, are given in Table 3 for the three cuttings secured. Ordinarily a second fall crop would have been cut. This year, however, summer grasshopper damage was heavy and it continued so far into the fall that only a single light crop was cut.

Both the treble superphosphate and the manure were applied broadcast on the plowed ground and disced into the seedbed. The manure so handled interfered with drilling to the extent that the early stands were imperfect on those plots. While it is thought manured plots may improve in 1947, it is noticeable that the yields were not so good from the 10 tons manure plus 200 pounds treble superphosphate as from the plots receiving just 200 pounds of treble superphosphate.

The liquid phosphoric acid was applied in the irrigation water immediately after planting. With both the treble superphosphate and the liquid phosphoric acid series, one plot received three times the rate of treatment. The yields from those single plots cannot be compared directly with the yields from the lesser rates of phosphate. They do indicate, however, that heavier rates of phosphate treatment would produce more alfalfa hay on that soil.

While the data are for one crop year only, so not conclusive, there is some indication that the alfalfa responded better to the phosphorus in the treble super than to that in the liquid phosphoric acid.

In order to check any carry-over effects of the different fertilizers the plots will be continued for at least two more years without further treatments.

TABLE 3.—INFLUENCE OF ALFALFA FERTILIZATION ON THE POUNDS OF FIELD-CURED HAY PRODUCED PER ACRE ON THE MESA FARM, 1946

Treatment	Cuttings and dates			Total	Seasonal increase over check	
	1st-6/3 (lb.)	2nd-7/15 (lb.)	3rd-11/6 (lb.)	(lb.)	(lb.)	(%)
Check - none	2338	3098	1897	7334	0	0
600 lb. tr. superphosphate	3044	4255	2098	9397	2063	28
200 lb. tr. superphosphate	2872	3564	2263	8699	1365	19
525 lb. liq. phosphoric acid*	2789	3839	2160	8788	1454	20
175 lb. liq. phosphoric acid	2668	3386	2218	8272	938	13
200 lb. tr. sup. & 10 T manure	2851	3513	2200	8564	1230	17
10 T manure	2436	3137	2100	7673	339	5
Av. per cutting	2714	3542	2134	.....	.....	....

*One replication only

CORN

Arizona vs. New Mexico Mexican June

Arizona Mexican June and New Mexico June corn strains were grown at Tucson on alternate borders replicated eight times. Silage yields were obtained by harvesting five 50-foot sections from each border at a proper silage stage. Grain yields were obtained from four 30-foot sections harvested at maturity from each border.

The Arizona strain significantly outyielded the New Mexico strain in grain produced while the opposite was true when consideration was given to total silage weight as shown in Table 4. Since the Arizona strain produced considerably more ear weight at the silage stage, planting of the New Mexico strain for silage cannot be recommended in our lower valleys on the basis of this one-year test. As shown in the table, a significant stand difference between the strains existed, despite comparable treatment at planting time. The effect of this factor on silage yield was not determined. It is believed, however, that it had little effect on yield of grain, since a comparison of sections with comparable stands gave results similar to those obtained when all sections were averaged.

TABLE 4.—YIELDS OF ARIZONA MEXICAN JUNE VS. NEW MEXICAN JUNE CORN, TUCSON, 1946, IN POUNDS PER ACRE

	Arizona	New Mexico
Silage weight	32,109	35,131
Ear weight at silage stage	7,250	5,891
Weight of shelled corn	2,638	1,820
Number of plants per acre	8,980	13,619

The increased yields this first year did not pay for the fertilizer in all cases with hay valued at $1.25 per hundredweight (1946 prices). The 200 pounds of treble superphosphate returned about $10 in hay value above the fertilizer cost, and the 600-pound rate of treble superphosphate only about $7. On the other hand, the first season gains in yield showed little profit from the liquid phosphoric acid. There was an actual loss from applying the 525 pounds of liquid phosphoric acid but it may be overcome in subsequent years.

Co-operative corn variety tests

Hybrid corn variety tests have been conducted in co-operation with the Arizona Agricultural Extension Service for three years in those counties of the state where corn is the principal crop. Generally these areas are too small to warrant the production of local hybrids so use has been made of the more promising hybrids from other states. In some areas hybrids have been found that consistently yield 15-20 per cent better than the local variety. Those hybrids have been recommended and are being used for limited production. For some other areas suitable hybrids have not yet been proved. Due to this and to lack of a local seed supply no recommendations can be made. Further tests will be made in 1947 in those areas where the tests are not conclusive.

COUNTIES AND RECOMMENDED HYBRID VARIETY

County	Leading hybrid
Apache	Wis. 531 for grain, Wis. 606 for silage
Cochise	Funk's G-711 for grain
Gila	Wisconsin 692 for grain
Graham	Texas 7 and 12 and Funk's G-711 for further testing
Navajo	Wisconsin 692 for grain, Wis. 695 for silage. Tests not complete.

COTTON

Defoliation

Cotton defoliation with Calcium Cyanamid during the 1946 harvest season was generally successful both experimentally and commercially due to the periodic rainfall received and favorable relative humidity conditions. Studies with machine moisture applicators and chemicals other than cyanamid were undertaken to obtain more positive results especially under dry atmospheric conditions. Experimental results as shown in Table 5 were only partially successful:

TABLE 5.—DEFOLIATION TRIALS, MESA FARM, 1946

Experiment	Effect on cotton leaves
1. Sprays with dilute solutions of the the various acids 2, 5 and 10 per cent Sol. H_2SO_4 2, 5 and 10 per cent Sol. HCl 5 per cent HNO_3 10 per cent Phenol	Rapid killing of the leaves in all cases. Leaves did not abscise.
2. Sprays with fertilizer compounds	10 per cent spray ammonium phosphate gave 10-15 per cent abscission.
3. Artificial application of moisture—fog sprays applied before and after dusting operations. Morning and evening tests.	5 per cent additional leaf drop obtained. Difficulty of application and rapid evaporation of moisture from the leaf surfaces tend to make this type of approach impractical.

Moisture in cotton

Rather definite relationships between moisture in raw cotton and strength of yarn produced have been established in the past year. Where to add moisture, how much to add, and possible effects in marketing and spinning processes are being investigated. Only those tables and graphs that may be of immediate interest are presented.

The most important improvement made by additional moisture is the high equivalent staple length obtained by having the moisture content of the raw cotton 5.5 per cent or above. The greater strength in yarns manufactured from moist cotton is readily reflected in high equivalent staples. Those cottons with less than 5 per cent moisture gave negative equivalent staples in every case.

Those yarns manufactured from cotton with about 5 per cent moisture content were of excellent strength, whereas those of less than 5 per cent moisture were only of average strength.

Increased moisture gave an increased nep count at the cards, yet this was not apparent in the yarns produced as indicated by Table 6.

TABLE 6.—EFFECT OF MOISTURE IN RAW COTTON ON SPINNING PROPERTIES—1945

Per cent of moisture	Number of samples	Neps @ card	Gain or loss in ed. staple	Yarn appearance			Strength			Average strength index
				22's	36's	60's	22's	36's	60's	
Above 8.0	5	51	+3/32	C−	D+	D	103.6	55.6	27.7	110.4
7.5 - 7.9	1	44	+4/32	C	D+	D	106.3	56.4	27.5	116.8
7.0 - 7.4	3	51	+3/32	D+	D+	D	103.6	56.9	28.8	110.6
6.5 - 6.9	2	35	+4/32	C+	C+	C	112.1	61.6	31.0	120.2
6.0 - 6.4	5	30	+2/32	C	C−	D+	103.3	56.3	27.5	108.7
5.5 - 5.9	2	35	+4/32	C+	C	C−	108.6	59.2	31.0	122.3
5.0 - 5.4	2	27	+1/32	C	C−	D+	102.2	54.9	27.2	107.6
4.5 - 4.9	7	38	0	D+	D	D	94.1	50.4	24.5	101.3
4.0 - 4.4	5	23	−1/32	C	D+	D	101.3	53.4	26.4	102.6
Below 4	4	35	−2/32	C	D+	D	96.1	50.4	24.9	94.5

TABLE 7.—INFLUENCE OF MOISTURE IN RAW LINT AND PICKER ROOM HUMIDITY ON YARN STRENGTH, YARN APPEARANCE AND EQUIVALENT STAPLE LENGTH. SAMPLES TAKEN FROM SAME BALE, (A) MARANA AND (B) SAFFORD

Sample no.	Per cent moisture raw lint	Grade	Staple	Picker room humidity	Av. index yarn strength all counts	Index differences	Yarn appearance	Equivalent staple length (in.)	Difference
A. MARANA									
40	8.04	SM sp	31/32	63	99.8		D—	15/16	
41	5.61	SM sp	31/32	65	99.4	0.4	D—	15/16	0
38	8.50	SM sp	31/32	39	98.7		D—	15/16	
43	5.00	SM sp	31/32	37	95.6	3.1	D—	29/32	1/32
39	8.32	SM sp	15/16	25	99.7		D—	29/32	
42	5.26	SM sp	31/32	27	90.4	9.3	D—	7/8	1/32
B. SAFFORD									
55	7.72	SML sp	1-1/32	80	119.3		C+	1-3/16	
50	3.64	ML sp	1-3/32	80	109.0	10.3	C+	1-5/32	1/32
54	7.69	ML sp	1-1/16	65	117.7		C+	1-3/16	
49	3.75	ML sp	1-1/16	65	110.8	6.9	C+	1-5/32	1/32
53	7.17	SML sp	1-1/16	40	112.5		B	1-5/32	
48	3.52	SML sp	1-3/32	40	103.7	8.8	C+	1-1/8	1/32

Every other sample in Table 7 had additional moisture in the raw cotton. Increased yarn strength resulted from the extra moisture in all cases and a higher equivalent staple in all cases except one.

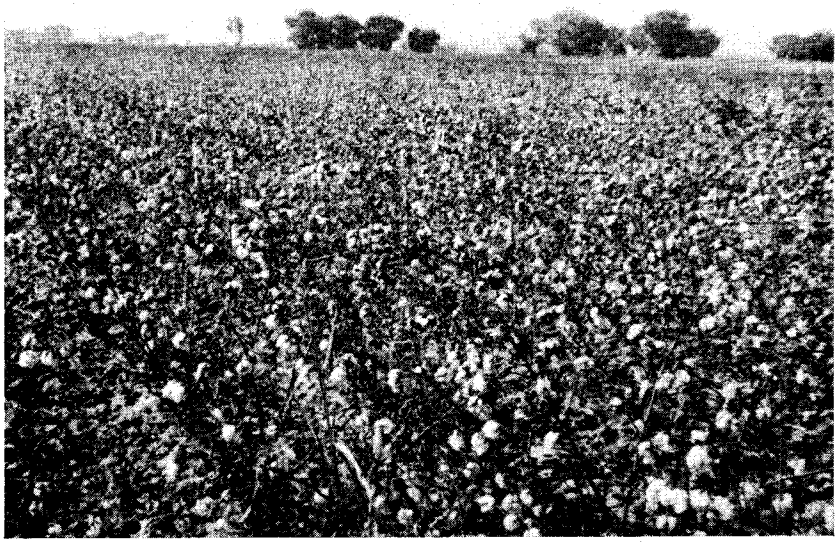

Plate I.—Commercially defoliated cotton field south of Chandler, Arizona.

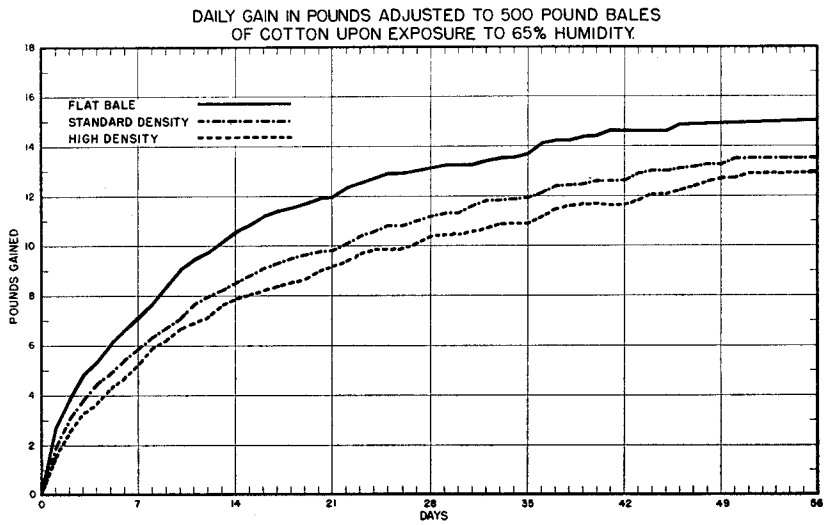

Figure 1.—Daily gain in pounds adjusted to 500-pound bales of cotton upon exposure to 65 per cent humidity.

Moisture in bales of cotton

Studies of moisture absorption and retention in gin run, standard, and high density bales were undertaken to determine the rate

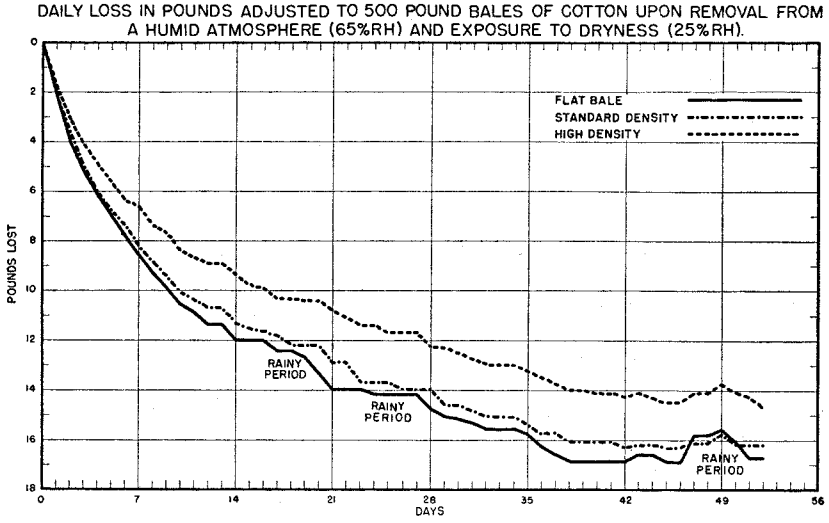

Figure 2.—Daily loss in pounds adjusted to 500-pound bales of cotton upon removal from a humid atmosphere (65 per cent RH) and exposure to dryness (25 per cent RH).

and extent of moisture absorption by dry bales under controlled humidity and temperature conditions and the rate of moisture loss when placed in a low humidity atmosphere. These data will be useful to explain certain weight differences that arise between gin, compress, ship side, and mill points.

FLAX

Spacing on beds and fertilizer treatment

Flax yields in experiments conducted at the Mesa Farm have been increased about 5 bushels per acre by planting three rows on a standard bed as compared with two rows. Applications of 300 pounds of ammonium sulfate and of ammonium phosphate 16-20 ahead of planting also yielded an increase of about 5 bushels over the nonfertilized plots on both the three-row and the two-row spacings.

TABLE 8.—EFFECT OF SPACING AND NITROGEN FERTILIZER ON FLAX YIELDS, MESA FARM, 1945

Spacing	Fertilizer	Rate (lb.)	Yield per acre (bu.)
3 rows per bed	Ammonium sulphate	300	21.6
	Ammonium phosphate 16-20	300	21.6
	Check	none	16.4
2 rows per bed	Ammonium sulphate	300	16.4
	Ammonium phosphate 16-20	300	16.4
	Check	none	11.3

Based on current fertilizer costs and a value of $6 a bushel for flax, the use of ammonium sulphate showed a profit of about $22, and of ammonium phosphate of about $20 an acre above the fertilizer cost.

SOYBEANS

The Armredo variety of soybeans produced at a rate of 29 bushels per acre at the Mesa Farm during 1945. Although Armredo is not the highest yielding variety tested, it is the most shatterproof. Efforts are being made in co-operation with the Plant Breeding Department to develop hybrid populations between Armredo and some of the higher yielding strains for reselection.

In a series of plots given 150 pounds of liquid ammonium nitrate per acre in the irrigation water during the blooming period an increase in yield of 3 bushels per acre was obtained with soybeans in 1946.

SORGHUMS

An experiment seemed desirable to test the coarse-stemmed sorghums with Sudan grass as to use for pasture and for hay. Varieties used were: Common, Tift, Sweet and California No. 23 Sudan grass, Atlas and Honey sargo, hegari and Manko grain sorghums. Using a grain drill the seed was planted at the following rates per acre: Sudan - 30-35 pounds; sorgos - 30-55 pounds; hegari - 35-40 pounds; Manko - 40-45 pounds. Actual pasturing was not done but clipping yields were taken. All varieties were cut for hay when just fully headed.

Results indicate that for pasture, the coarse-stemmed sorghums may give comparable yields on first cutting, but they fail to recover and yield as much as Sudan on subsequent cuttings.

For hay production, the sorgos and grain sorghums far outyield the Sudan on the initial cutting, but the ability of Sudan to regrow places it on a comparable yield basis, and the quality of Sudan hay is considerably better.

TABLE 9.—PASTURE AND HAY YIELDS SUDAN—DATE OF PLANTING TEST, MESA FARM, 1946

Planting date	First cutting (Tons)		Second cutting (Tons)		Third cutting (Tons)		Total (Tons)	
	Pasture	Hay	Pasture	Hay	Pasture	Hay	Pasture	Hay
5-20	1.3	3.5	1.8	2.5	1.6		4.7	6.0
	(7-9) *	(7-26)	(8-14)	(10-16)	(9-30)	none		
6-22	1.4	4.3	1.5	1.3	none	none	2.9	5.6
	(7-27)	(8-14)	(9-14)	(10-21)		none		
7-23	0.3	3.6	1.0	none	0.4		1.7	3.6
	(8-21)	(9-21)	(9-14)		(10-26)	none		

*Figures in parentheses show date of harvest.

DATE OF PLANTING SUDAN

In an effort to prolong the grazing and hay cutting period of Sudan grass, particularly in the fall, an experiment was started in 1946, using California No. 23 Sudan. Three dates of planting at intervals of approximately one month were used. Results tend to show that early plantings of Sudan grass are essential for higher yields whether used for pasture or for hay. The late planting did not result in increased production in the fall period. This simply emphasizes the fact that Sudan grass is a warm season plant.

SUDAN RATE OF SEEDING TEST

In an effort to determine the proper rate of seeding Sudan grass, plantings were made on June 8, 1946, using 20, 30, 40 and 60 pounds per acre. Two varieties were used, Sweet Sudan and California No. 23. Seeding at the rate of 30 pounds per acre gave the best yields, particularly in the second cuttings. With frequent shortages and current high cost of Sudan grass seed, it is noteworthy that both varieties gave best yields when seeded at 30 pounds per acre as shown in Table 10.

TABLE 10.—INFLUENCE OF RATE OF SEEDING SUDAN GRASS ON PERCENTAGE YIELD, 30 POUNDS PER ACRE USED AS 100 PER CENT—MESA FARM, 1946

Variety	Pounds seed per acre			
	20	30	40	60
Sweet	83.7	100	64.8	67.5
Cal. No. 23	81.6	100	76.0	79.1

MISCELLANEOUS CROPS

Mung Beans

This legume continues to show promise both as a seed crop and as a fast-growing cover crop adapted to midsummer planting. Variety tests have been conducted at Mesa and Tucson. The Hastings variety based on one year's results seems to be the best from a seed production standpoint. Besides being a high yielder it stands up well and bears its pods well off the ground, thus making a desirable combine type. The Pusa strains tested, while having small seeds, produce abundant vegetative growth and may be of more value for green manure purposes.

Plantings made in late July at Tucson showed much less tendency to shatter than did the same varieties planted early in June.

Yields for one year only are shown in Table 11.

Several other varieties were tested at Tucson but not at Mesa for which the yield data are not included in the table. Most promising among those were Pura 23, Indian 8286 and another strain of California obtained from the LaChoy Products Company.

No significant differences were obtained at Mesa between the bed and flat methods of planting.

TABLE 11.—YIELDS OF MUNG BEAN VARIETIES

Variety	Seed yield—pounds per acre		Remarks
	At Mesa	At Tucson	
Hastings	1209	1024	Large seed—dark green
Green Mung	929	1056	
Mackie's	911		
Capitol	1012	976	
Manchurian	1054	944	
Purdue	935	752	
California	1053	736	
Pusa 18	1072	592	Small seed
Chinese	953	336	

TABLE 12.—EFFECT OF DATE AND METHOD OF PLANTING ON MUNG BEAN YIELDS

Date	Method	Av. yield in pounds per acre
8/1	Bed	742
6/30	Bed	727
6/30	Flat	682
7/16	Bed	605
6/20	Bed	500
6/2	Bed	190

Peanuts

Production of 1,359 pounds of Spanish peanuts and 3,654 pounds of Virginia peanuts per acre was obtained on the University Farm at Tucson this year. The planting was rather late and since no moisture correction was made the figures are only an indication of their production capacity. Peanuts are not being recommended as a cash crop for Arizona at this time, yet, if the harvesting problem could be solved satisfactorily, they do offer cash crop possibilities.

ANIMAL HUSBANDRY

THE EFFECT OF CASTRATION AND HORMONE ADMINISTRATION UPON CARCASS BEEF PRODUCTION

In no instance did the administration of hormones in the first and preceding test last year produce any apparent beneficial effects. For this reason a number of these hormones were not included in the current year's test and in their place new additions were made. The testosterone and anterior lobe hormone injections and the testicular implantation were not continued.

The synthetic oestrogenic hormone, stilbestrol, to inactivate the secondary male harmones was repeated and administrations of

TABLE 13.—THE EFFECT OF CASTRATION AND HORMONE INJECTIONS UPON CARCASS BEEF PRODUCTION, DEC. 1, 1945 TO MAY 25, 1946—175 DAYS

	Lot number and treatment						
	1 Check	2 Thiouracil[2]	3 Thiouracil[3]	4 Vitamin A[4]	5 Check	6 Stilbestrol injection	7 Delayed castration
No. of animals	15 steers[1]	15 steers	15 steers	6 steers	6 bulls	6 bulls	7 steers
Av. beg. wt. (lb.)	365	363	364	379	385	386	385
Av. final wt. (lb.)	792	754	780	789	889	804	782
Gain per head (lb.)	427	391	416	410	504	418	397
Av. da. gain per hd. (lb.)	2.43	2.24	2.38	2.40	2.88	2.39	2.27
Av. daily ration (lb.)							
Alfalfa hay	1.6	1.4	1.4	1.7	1.7	1.7	1.7
Rolled barley	6.5	6.8	6.8	7.0	7.1	7.0	7.2
Hegari silage	16.9	15.5	17.7	18.0	19.5	16.0	18.2
Potato meal	.84	.88	.88	.90	.88	.87	.88
Cottonseed meal	.99	.99	.99	.99	.99	.99	.99
Salt	.03	.04	.02	.03	.07	.04	.03
Thiouracil[5]							
Feed cost cwt. gain	$14.03	$15.36	$14.88	$15.08	$13.06	$14.97	$16.24
Return per animal above cost and feed	$18.24	$12.17	$14.44	$13.88	$14.34	$ 4.65	$ 9.25
Dress. per cent per lot	60.4	61.2	61.3	60.3	60.2	61.2	61.8
Government carcas Grades							
Choice	7	8	12	4			
Good	7	7	3	2	4	5	7
Bull					2	1	

[1]1 steer removed March 12
[2]Fed 118 days @ 3 grams per cwt. daily
[3]Fed 116 days @ 1½ grams per cwt. daily
[4]156,000 units Vitamin A per steer weekly for last twelve weeks
[5]Fed at rate of 3 grams per cwt. daily

thiouracil, a synthetic thyroid inactivator, and a vitamin A concentrate were introduced into the experiment. Study of steer calves with bull calves and the effect of delayed castration upon market beef production was continued.

The allotment of the test animals and results of their performance in the feed lot, together with their slaughter records, are shown in Table 13.

Comparison with the check lots does not reveal beneficial effects from any of the introduced products. Thiouracil was fed at the rate of 1½ grams per hundredweight daily continuously for 166 days in lot 2 and in lot 3 it was added to the ration 3 grams per hundredweight for a period of 118 days. The calves in this latter group receiving the greater allowance of the thiouracil made a slightly faster gain than those in lot 2 but both lots were appreciably below the check lot (1) in rate of gain.

The calves in lot 4 received the vitamin A concentrate in weekly allowances at the rate of 150,000 units per steer during the last twelve weeks of the test. Comparison with the check group will indicate that the addition of this concentrate was not effective.

Stilbestrol injections to the bull calves in lot 6 as in the preceding test were not productive of any positive effects. The rate of gain made by these calves was perceptibly lower than that of the check lot 5 of bull calves. The bull calves corresponding to these groups in the first test made identical gains.

Deferring castration of four bull calves in lot 7 three months and three calves four months failed to reveal any advantage in this practice.

The check group of steer calves, it will be noted, made an average daily gain of 2.43 pounds per head in comparison with a gain of 2.88 pounds by the check lot of bull calves. A similar advantage in gain was recorded by the bull calves in the 1944-45 test. It is interesting to note that nine of the bulls graded A and only three were classed as bulls in the carcass. Evaluated on the basis of their carcass grade and yield the steers (all lots) were sold for $16.32 per hundredweight and the bulls, $15.08. This difference in price was not sufficient to compensate for the cheaper cost of gain made by the bulls and resulted in a substantially greater net return for the steers. Because of a greater superiority in gain and a smaller price differential in carcass value, the bull calves returned a materially higher return than the steer calves in the first test.

THE EFFECT OF THIOURACIL IN A LAMB FATTENING RATION

Thiouracil fed at the rate of three grams per hundredweight daily for a period of seventy-five days to a group of twenty lambs receiving a ration of alfalfa hay, hegari silage, rolled barley and cottonseed meal did not produce any discernible beneficial effects as compared with a check group. Results are indicated in Table 14.

COMPARATIVE VALUE OF IRRIGATED PASTURES FOR BEEF PRODUCTION

Since the fall of 1944 the departments of Agronomy and Animal

TABLE 14.—THE ADDITION OF THIOURACIL TO A LAMB FATTENING RATION (ONE TEST OF TWENTY LAMBS IN EACH LOT) DEC. 1, 1945 TO FEB. 14, 1946—75 DAYS

	Lot no. and treatment	
	1—Check	2—Thiouracil
Average beginning weight (lb.)	75	75
Average final weight (lb.)	96	97
Gain per head (lb.)	21	22
Average daily gain per head (lb.)	.29	.30
Average daily ration (lb.)		
Alfalfa hay	1.0	1.15
Rolled barley	.96	.97
Hegari silage	2.7	2.7
Cottonseed meal	.12	.12
Salt	.01	.02
Thiouracil*		
Feed cost per cwt. gain	$17.59	$17.38
Return per lamb above cost and feed	—.99	—.99
Dress. per cent per lot	46.2	46.2
Government carcass grades		
Choice	17	16
Good	3	4

*Fed at rate of three grams per hundredweight daily.

Husbandry have made a study of pasturing beef cattle on the Salt River Valley Farm. Three types of pasture, 1. alfalfa, 2. a grass-legume mixture and 3. barley and Sudan pastures have been under observation.

A tract of land was fenced and cross fenced in such a way that the 9.6 acres allotted to each pasture crop was divided into three units of equal size to allow rotation of use and replication.

The alfalfa and the grass-legume mixture were seeded during October, 1944. The grass-legume mixture was sown at the following rates: Perennial raye, 4 pounds; meadow fescue, 6 pounds; orchard grass, 4 pounds; Dallis, grass, 8 pounds; alfalfa, 2 pounds.

The temporary pasture units were sown to barley during late September or October. The barley crops were pastured from January through May. The land was then prepared and sown to Sudan or sweet Sudan after the last pasturing of barley.

Records are kept on beef production as expressed in carrying capacity (steer days feed obtained) and on rate of livestock gain. The following studies also are being made: ecological, yield clipping, irrigation, and fertilization.

As this pasture test is being conducted, the best expression of carrying capacity is the use record obtained from grazing in rotation in the various pasture crops.

Line H of Table 15 shows the average number of animal days feed obtained from an acre for each pasturing. The number of pasturings entering into the average, hence the reliability of the average, is shown in line G. It will be seen that considerable variation exists not only between crops pastured but between the same crops pastured during different years. Entering into these carrying capacity figures, to further distort the picture, are

TABLE 15.—COMPARATIVE VALUES OF IRRIGATED PASTURES FOR BEEF PRODUCTION

A. Pasture Crop	Casa Grande 1941-42	Salt River Valley Farm, 1944-46						
	Alfalfa-barley	Alfalfa	Grass-legume		Temporary			
					Barley		Sudan	
B. Grazing dates	10/27/41 to 4/23/42	1946 5/13 to 7/3	1945 4/5 to 9/27	1946 3/28 to 8/26	1945 1/11 to 3/26	1946 3/2 to 5/13	1945 6/9 to 9/29	1946 7/20 to 10/14
C. Days of pasturing obtained	157	35	149	97	60	37	81	53
D. Average number animals pastured	122	26	17	24	22	20	30	26
E. Average weight	457	875	782	911	869	863	730	974
F. Animals per acre per pasturing	8	8	5	7	7	6	9	8
G. Total number pasturings	11	4	18	14	5	5	11	8
H. Animal days per acre per pasturing	117	71	54	55	82	49	76	53
I. Steer days* feed obtained per pasturing	71	66	46	52	75	45	62	52
J. Average daily† gains (pounds)	1	1	1.2	1.4	1.7	1.9	0.2	1.9
K. Average number of days per pasturing	14	9	10	8	12	8	8	7
L. Interval in days between pasturings	....	30	32	27	37	21	27	25
M. Interval in days from beginning pasturing	....	39	42	35	49	28	35	32

*Compared on the basis of total digestible nutrients requiredfor a 1,000-pound rapidly growing steer (Morrison's Feeding Standards, Table III).

†Expressed to nearest one-tenth. All other figures are to nearest whole number.

differences in total digestible nutrients (T.D.N.) removed at each pasturing. This difference has been partially corrected in line I, where the animal days feed obtained from each pasturing has been reduced to common terms, steer days feed obtained per acre per pasturing. One steer day's feed is computed on the basis of T.D.N. required for a 1,000-pound steer fed so as to make rapid growth (Morrison's Feeding Standards, Table III). Carrying capacity figures obtained from pasturing calves at Casa Grande during 1941-42 when thus converted furnishes an interesting comparison.

Rates of gain are shown in line J.

By using the figures given in line H or I and line M, an estimate may be obtained of the carrying capacity in animal units per acre for the grazing season. For example, between April 5 and September 27, 1945, the grass-legume mixture carried an average of 1.3 head of 782-pound steers to the acre and during the period of March 28 to August 26 of 1946 carried around 1.6 head of 911-pound steers to the acre.

Extreme variations occurred in carrying capacity and in rate of gain throughout the season. Greatest gains were obtained during periods of favorable weather of the spring and fall. Poorest gains and even loss of weight occurred during the summer months and during periods of rainy weather.

The intervals for regrowth (line M) for the various pasture crops depend on factors affecting plant growth-growing weather, irrigation and fertilization. The lapse of time from the day of beginning pasturing a given crop to the day when it will be ready to graze again has varied from twenty-one days average during the warm growing season to over sixty days during unfavorable weather in the winter.

In order that a more complete picture may be seen of the use that has been attained from these pastures to date and to avoid the drawing of wrong conclusions the following summary is given:

1. The alfalfa pastures have not been pastured sufficiently to furnish reliable data on its pasturing value at the Salt River Valley Farm. It was not grazed the first year to avoid injury to the stand. During the second season, inability to provide sufficient steers when needed made it necessary to make hay of most of the forage.

2. The grass-legume mixture has received the most use of any of the pasture crops. The mixture was slow in getting esablished during the first year. The alfalfa and perennial rye were the only plants that made satisfactory production during 1945. During the spring of 1946 the alfalfa formed a dense coverage with the grasses showing some evidence of beginning to make a stand. After some grazing, perennial rye and orchard grass furnished a fair amount of forage along with the alfalfa. By the middle of the summer, Dallis grass became well established and toward the end of the summer and early fall was furnishing practically all the forage for grazing. What little alfalfa was evident was held back by grasshoppers. With the coming of cool weather in the fall, the

Dallis grass is making little growth. The alfalfa stand is rather thin. The remaining grasses show up merely as traces. Either these cool weather grasses died out during the summer from the heat or from insufficient frequent irrigations or were crowded out by competition from the more vigorous summer growing plants.

3. The temporary pasture crops, barley and Sudan, have furnished good pasturing when in production. The need for seedbed preparation and time to establish stands of these crops limits their use as pasture crops.

ANIMAL PATHOLOGY

PASTURE DISEASE LOSSES

After considerable investigation approximately thirty large bands of ewes and lambs were tested with 1-9 phenothiazine and salt to control stomach worms. Constant checks were made on these bands and a very definite reduction in ova was noted after seven to ten days' treatment. There was a rapid reduction in death losses and approximately 85 to 90 per cent of lambs were marketed in March and April as fat lambs in contrast to 34 to 40 per cent in previous years. Analyses of feed and management were made. This work will be tabulated after another year of study.

Death losses in feeder pasture calves were investigated. It was noted that a high percentage of these animals were affected with round worms. Work is being done to control these in cattle with individual treatments of salt and phenothiazine mixture of 12 to 1.

Studies are being continued with adult cattle on pastures. Death losses result from rapid pasture changes and the use of young barley or alfalfa fields. The daily use of dry feed in addition to the green pasture has reduced these losses materially. Bacteriological and blood studies have failed to show any infection. Mineral and vitamin studies are being continued but no definite indication of deficiencies have been seen.

EXTERNAL PARASITE CONTROL

The major part of the control work with parasites has been taken over by spray outfits. Study is being made on the differences in the residual action of D.D.T. as compared with other sections of the United States.

Analyses for D.D.T. are being made to determine the amounts left on hay or straw treated for field insects.

POISONOUS PLANTS

Severe death losses occured in two areas in southern Arizona with cattle and goats grazing on *Acacia Constricta* (catclaw). Analysis showed that this plant contained from 71.3 to 120 mgm. HCN per 100 grams of dried plant material. Analysis of waters used in these areas showed from 850 to 1,900 ppm. sodium nitrate concentration which is unusually high.

FEEDER CALVES

The co-operative work on hormone injections and the feeding of Thiouracil is being reported by the Animal Husbandry Department.

DIAGNOSTIC LABORATORY

There was a large increase in pullorum testing of turkeys. Check tests were made for parathyroid on all samples. Approximately 5,000 duplicate tests were made. Over 1,900 specimens of poultry, cattle, sheep, and hogs were diagnosed.

BOTANY AND RANGE ECOLOGY

DESTRUCTION OF RANGE FORAGE BY RABBITS AND RODENTS

Studies have been continued on the kinds and amounts of forage plants consumed by rodents and rabbits on semiarid ranges. Work has been concentrated mainly upon Merriam's kangaroo rat and young Arizona jack rabbits.

Kangaroo rats

A technique for rapidly determining numbers of Merriam's kangaroo rats per unit area has been devised. Animal numbers in the mesquite-burroweed vegetative type averaged about six rodents per acre from March to August. Since an individual rat consumes nearly 4 pounds of seed per year for maintenance, such populations could destroy 24 pounds of seed per acre in a year. This amount is in excess of that produced by perennial grasses in a favorable year on the area of study. Perennial grasses, though making up only about 18 per cent of the diet, are preferred, due mostly to large seed size, as shown by a comparison of plant composition with food preferences (Table 16). Increase in density of perennial grass, however, discourages kangaroo rat numbers. Under comparable conditions, greatest numbers of animals occurred where perennial grass density was lowest (Fig. 3). Impeded movement of animals and less favorable food supply

TABLE 16.—FOOD PREFERENCES OF MERRIAM'S KANGAROO RAT COMPARED WITH PLANT COMPOSITION[1]

	Composition (per cent)			Use (per cent)			Preference[2]
	Spring	Fall	Year	Spring	Fall	Year	Year
Annual grasses	15.8	37.7	35.0	37.4	36.5	37.1	1.0
Perennial grasses	.....	6.5	5.3	11.6	26.7	17.8	3.4
Annual weeds	76.0	32.0	38.8	23.0	16.8	20.5	0.5
Perennial weeds	0.9	17.1	15.1	15.5	14.4	15.0	1.0
Shrubs	7.3	6.7	5.8	12.0	5.6	9.3	1.6
Unidentified	.....	.....	.....	.5	.....	.3	....
Totals	100.0	100.0	100.0	100.0	100.0	100.0	

[1]Composition on number of plants basis.
[2]Use divided by composition.

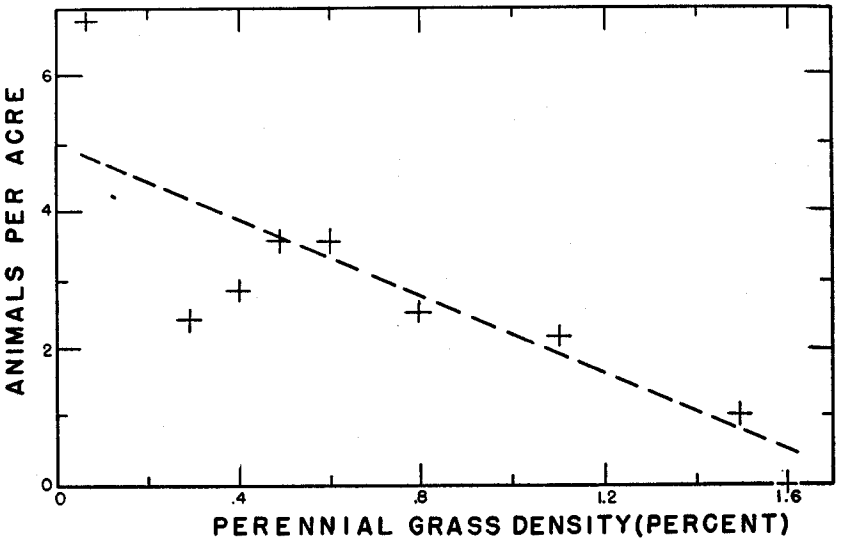

Figure 3.—Relationship between Merriam's kangaroo rat populations and density of perennial grass.

probably explain this relationship. Accordingly, the effect of these rodents, with respect to large-seeded perennial grasses, varies inversely as the density of grass.

Plots simulating artificial reseeding showed these rodents to cause four times as much damage to seed sowed on the surface as compared to seed drilled into the soil. Amount of damage also decreased with size of seed, those below the size of one million to the pound rarely being discovered.

The characteristics of this rodent and its relationship to plants, the soil, and range management practices are now being summarized for publication.

Jack rabbits

A treatise on the food requirements, growth, and breeding potential of the Arizona jack rabbit has been accepted for publication in the *Journal of Mammalogy*. A further paper dealing with the use of pellet counts as a possible means of estimating differential rabbit grazing pressure is in the preliminary stage of completion.

BURROWEED INVESTIGATIONS

Control with herbicides

The effectiveness of 2,4-D on burroweed (*Haplopappus tenuisectus*) was investigated* in July on a burroweed-infested area of the Santa Rita Experimental Range. Previous experiments show

*In co-operation with the Southwestern Forest and Range Experiment Station.

that June through August is the most effective period to carry on control investigations.

Results indicated that the per cent kill is related to the concentration of 2,4-D, 3,000 ppm, 2,000 ppm and 1,000 ppm gave respectively 93.8, 85.2 and 57.5 per cent kill. Spreaders and wetting agents such as calcium chloride, dreft, and turgitol, did not increase the percentage kill. Ammonium sulfamate used alone gave a kill of 98.6 per cent, and when mixed with 2,4-D, the kill was increased to 99.4 per cent. Sulfamic acid was also tested; alone it gave a kill of 84.6 per cent, with 2,4-D a kill of 91.5 per cent. A check plot, one in which none of the plants were sprayed, showed a 20 per cent loss in burroweed plants.

ARTIFICIAL REVEGETATION OF SEMIDESERT GRASSLAND RANGES

Widespread interest in artificial revegetation in the semidesert grassland of southern Arizona has been aroused through successful plantings of various native and introduced grasses, notably Lehman lovegrass. The need for accurate information on the behavior and resistance to grazing of these introduced grasses in mixture with native species is being met by a co-operative project on the Santa Rita Experimental Range in collaboration with the Southwestern Forest and Range Experiment Station and the Soil Conservation Service.

The project to test the adaptability of native and introduced species and to determine the resistance to grazing of compatible mixtures of introduced and native species was initiated in July, 1946, on a site representative of deteriorated semidesert grassland. A moderate stand of mesquite and cholla cacti was cleared and burroweed mowed on a 5½ acre plot fenced to exclude cattle and large rodents. Duplicate blocks of ½ acre were seeded to pure stands and mixtures of Boer and Lehman lovegrasses, Arizona cottongrass, and slender grama at various rates to determine compatible mixtures of introduced and native species. Half-acre plots, subject to controlled grazing, were seeded to mixtures of Lehman lovegrass—Arizona cottongrass and Lehman lovegrass-slender grama to determine the differential effects of seasonal grazing. Supplementary adaptation trials of sixty native and introduced grasses were made in row plantings, contour furrows, and mulched contour furrows.

Observations on emergence and survival were made at the close of the first growing season but definite results on the project will not be available until the end of the second growing season.

CLIMATIC AND GRAZING INFLUENCES IN DESERT GRASSLAND RANGE

Since 1931 yearly observations of vegetational density and abundance have been made on areas subject to (1) grazing by cattle and rodents; (2) grazing by rodents; and (3) total protection from grazing at Desert Grassland Station on the Santa Rita Experimental Range. This vegetational analysis has been correlated with a detailed study of climatic factors including precipi-

tation, evaporation, wind velocity, air and soil temperatures, and humidity.

Various phases of this project have been presented in previous annual reports. A summary covering the results of a fifteen-year study of desert grassland climate and vegetational analysis is in preparation and will be published in bulletin form.

ARIZONA'S RANGE RESOURCES AND THEIR UTILIZATION

The diversity of range vegetational types, topography, climate, and soils throughout Arizona creates many problems for the range manager of a regional or localized nature. As an aid to meeting these problems a project on the utilization of Arizona's range resources has been initiated which has emphasized the recognition of satisfactory and unsatisfactory range condition of range types. A resume of the range resources of Coconino County is now in preparation which will consider the regional problems in range and livestock management and the factors governing the use of this area of more than 11,000,000 acres.

DAIRY HUSBANDRY

BABCOCK VS. MOJONNIER TEST FOR HOMOGENIZED AND UNHOMOGENIZED MILK

Unhomogenized milk and milk homogenized at 150 degrees F. at 1,500, 2,000, 3,000 and 4,000 pounds pressure were tested in duplicate by the Babcock and Mojonnier methods. Variations in results of twenty-seven duplicate Babcock tests were 0.031 per cent for unhomogenized milk and 0.032 per cent for eighty-four samples of homogenized milk tested. The corresponding variations for the Mojonnier method were 0.013 and 0.014 per cent respectively. The unhomogenized milk tested 0.054 of a per cent higher by the Mojonnier method. Milk homogenized at 1,500, 2,000, 2,500, 3,000 and 4,000 pounds pressure tested 0.082, 0.105, 0.097, 0.103 and 0.119 of a per cent higher respectively by the Mojonnier method. The milk homogenized at 3,000 pounds pressure tested 0.084 of a per cent lower than the unhomogenized milk by the Babcock test. Less discrepancies were noted at the lower pressures.

Manuscript has been prepared for this work and it has been accepted for publication in the *Journal of Dairy Science.*

THE EFFECT OF COTTONSEED IN THE RATION ON PERCENTAGE OF FAT AND SERUM SOLIDS CONTENT OF MILK

Studies were conducted on the effect of substituting 2 pounds of whole cottonseed for 2 pounds of concentrates in the ration of dairy cows. The experiment was conducted for three twenty-eight day reversal periods using twelve cows. The digestible protein, 13.6 per cent in the basal ration, was increased to 14.16 to 14.93 per cent. The fat was increased from 5.6 per cent to 8.44 to 12.44 per cent; and the 73.7 per cent of T.D.N. was increased to 76.53 to 80.48 per cent. The fat test was 0.13 per cent higher for one group and 0.24 per cent higher for the second group with no

significant difference in milk yield. There was an increase in fat without a corresponding increase in serum solids. The feeding of 2 pounds of cottonseed increased fat during the first twenty-one days, but the fat content was approximately the same as the control for the last seven days. Palatability of cottonseed is a limiting factor when mixed with other concentrates.

Detailed report of this project will appear in an early number of the *Journal of Dairy Science.*

EFFECT OF IODINATED CASEIN ON THE VITAMIN CONTENT OF MILK

This is a co-operative project with the Nutrition Department. For a report on this work see the Nutrition Department report.

A progress report, prepared by the Nutrition Department, will appear in an early number of *Proceedings of the Society for Experimental Biology and Medicine.*

PERMANENT PASTURE

Fields, S, T, P, and Q, which were planted to permanent pasture in September, 1944 (*Fifty-sixth Annual Report*) were badly infested with Bermuda grass by July 1. The indications are that Bermuda grass will be very much in preponderance by fall.

Alfalfa represented some 65 per cent of the total forage of the planted plants, the balance being largely Dallis grass. There was a little rye grass with very little orchard grass or meadow fescue. Alfalfa and Dallis grass are evidently the only plants in this mixture which are satisfactory for summer pasture. The data so far indicate that light soil is not satisfactory for permanent pasture. It requires too frequent irrigation and the other plants cannot compete with Bermuda grass.

ENTOMOLOGY AND ECONOMIC ZOOLOGY

FURTHER EXPERIMENTS WITH DDT FOG

A report on the first application of DDT as an oil fog was given in the *Fifty-sixth Annual Report.*

On August 16 and 17, 1945, further observations were made on the effect of DDT in oil when applied as a fog to Thompson seedless grapes for the control of leafhoppers (*Erythroneura variabilis* and *Dikraneura cockerelli*) at Tal-wi-wi Ranch near Peoria, Arizona. Because of the large number of leafhoppers present and the density of the foliage it was not possible to make accurate counts of the insects present. However, before being treated many vines had an estimated population of 1,000 to 1,200 leafhoppers per vine or about ten to twenty-five adult leafhoppers per leaf. Many young leafhoppers were also present. On August 16, 1.2 per cent of DDT in oil was applied as a thin blue fog which did not rise to any great extent. This fog had caused an estimated kill of 75 per cent of the leafhoppers by 8:00 a.m. on August 17. Observations made at about 3:00 p.m., of the same day showed there had been a further reduction in the leafhopper population

on the treated vines. Only a few of these insects were active at that time and the residual effect of DDT seemed evident.

The following day a heavier oil containing 2.5 per cent DDT was applied as a dense fog. This fog completely enveloped the vines and seemed to give complete coverage. However the leafhopper population on the vines which were treated the second day was less dense than the previous day. Some vines had an estimated population of 500 adult leafhoppers per vine, or five to twelve adults per leaf. Other vines had an estimated population of fifty to one hundred leafhoppers per vine, or 0 to five adults per leaf.

MISCELLANEOUS PEST OCCURRENCES

In late July, 1945, the false chinch bug caused serious injury to young cauliflower plants near Sahuarita, Arizona. The nymphs killed the tender plants by puncturing and sucking at the soil surface.

The cotton boll worm (*Heliothis armigera*) was very injurious to cotton in the Santa Cruz Valley in August, 1945. This insect injures cotton by making a round hole in the boll through which it enters and feeds on the contents. Young bolls are killed, and the developing lint in large bolls is seriously damaged. Calcium arsenate dust was used to control this insect.

The cotton leaf perforator (*Bucculatrix thurberiella*) caused serious injury to stub cotton in the Eloy district in late July and early August, 1945. The larva of this insect first mines and later skeletonizes and eats holes in the leaves. Calcium arsenate dust was used at the rate of 32 pounds per acre for control of this insect.

The alfalfa caterpillar (*Colias eurytheme*) was exceedingly numerous and caused much damage to several acres of alfalfa near Tucson in September, 1945. Since dusting sulphur (325 mesh) applied at the rate of 75 pounds per acre had been reported as being very effective in warm areas elsewhere this material was recommended. It was used at the rate of only 35 to 40 pounds per acre. Very satisfactory control of the caterpillars was reported. Dusting sulphur leaves no poisonous residue, and there are other advantages in its use.

Assassin bugs (*Triatoma*) attracted some attention in August and September, 1945, which is unusually late. In a small test a 2.5 per cent solution of DDT in kerosene seemed more effective against *Triatoma protracta* than a 3A DDT (3 per cent) dust. The DDT in kerosene seemed to act slowly through the feet and finally resulted in the death of the insect. Assassin bugs caused considerable annoyance in June, 1946, because of their habit of sucking blood from sleeping persons.

Dusting lettuce with calcium arsenate for control of the cabbage looper (*Autographa brassicae*) and the beet armyworm (*Laphygma exigua*) caused the death of many colonies of bees in 1945.* The poison drifted on to other near-by plants which were visited by the bees in gathering pollen. One application of DDT was said

*E. A. McGregor, of the Bee Culture Division, Bureau of Entomology and Plant Quarantine estimated the losses at 15,000 colonies.

to be more effective for control of the cabbage looper and the beet armyworm than were two or more applications of calcium arsenate. DDT also controls *Lygus* and beet leafhopper (*Eutettix tenellus*) against which calcium arsenate is not effective.

The oleander and milkweed aphid (*Aphis nerii*) was numerous in the spring of 1946 and seemed to be most numerous about the last of April. This aphid is bright yellow in color, and both winged and wingless forms develop. The winged forms migrate to milkweeds when these plants appear on the desert in spring and their descendants return to oleander in the fall. It is found on the oleander leaves and tender terminal parts of stems and flower clusters. It does not cause serious injury to the plant although the flowers may be somewhat damaged when the insect is abundant.

The pea aphid (*Macrosiphum pisi*) was numerous on alfalfa in the spring of 1946.

Swarms of the white-spotted blister beetle (*Epicauta pardalis*) appeared suddenly from desert areas on June 3 and 4 and flew into fields of potatoes where they caused serious damage by eating the foliage. Damaged areas about 15 to 25 feet in diameter appeared as light colored, somewhat circular areas at a distance. Five per cent "Pyrocide" dust completely controlled these insects.

RANGE RODENT INVESTIGATIONS

Continued scarcity of cottontails has so handicapped field work on them for several years that it has been decided to close this work. Final reports are being prepared.

Collection of mammals has been continued actively, and birds are added as opportunity offers. No particularly notable species have been added this year, however.

HORTICULTURE

VEGETABLE CROP INVESTIGATIONS

Lettuce breeding and selection

Selection and breeding for strains more resistant to bolting under high temperatures continues; augmenting the established hybrid lines, selections have been made of slow bolting plants in commercial fields of No. 44 and No. 152.

The seed program of the Central Arizona Grower-Shipper Association has been expanded, and this year under the supervision of the Experiment Station some 25,000 pounds of seed were produced at Yuma and turned over to the association for distribution to its members. The strains grown were No. 44, 615, and 152. The seed program as it is now operating comprises the following points:

1. The production of foundation seed from single-head selections grown at the Vegetable Research Farm.
2. The increasing of the foundation seed on the Vegetable Research Farm under rigid roguing. (It should be emphasized that both of the above are carried out in the Salt River Valley under the climatic conditions where the crop is grown.)

Plate II.—Field of lettuce in Yuma Valley for seed production.

3. The increasing of seed to commercial quantities in the Yuma Valley where it is again rogued carefully.

This program would seem to assure uniform seed of well-adapted strains for the lettuce industry of the Salt River Valley.

The Experiment Station also increased seed stock of ten strains of lettuce for the Bureau of Plant Industry.

Trials of fifty-four strains of lettuce were made at Yuma during the 1945-1946 season.

Cantaloupe breeding and selection

Various hybrid and inbred strains of cantaloupes were tested during the 1945-46 season. These are of the same general character as those reported a year ago. An Arizona strain of Imperial 45 cantaloupe proved very good, and growers who have seen this strain are very much interested in it. Selections have been made from crosses between U.S.D.A. mildew resistant melon and Arizona 13.

Vegetable seed and herb seed production

Many of the irrigated areas in Arizona have been found suitable for production of vegetable seed, and much information has been obtained on the growing and handling of these seeds, both from the standpoint of commercial and experimental production. Vegetable seed crops which have been grown successfully on a commercial scale in Arizona are indicated in Table 17.

The following vegetable seeds are easily produced but have not been grown on a commercial scale in Arizona: Chinese cabbage, collards, Florence fennel, mustard, okra, and parsley.

The following vegetables have not produced satisfactorily yields of seeds in Arizona: Brussel sprouts, cabbage, cauliflower, Swiss chard, spinach, kale, chicory, rutabaga, kohlrabi, turnip, and radish.

TABLE 17.—VEGETABLE SEED CROPS GROWN COMMERCIALLY IN ARIZONA

Vegetable	Average yield (lb. per acre)	Best valleys
Red table beets	3,000	Salt River and Safford
Mangel beet	2,800	Salt River and Safford
Carrot	1,000	Salt River and Yuma
Onion	500	Salt River and Sulfur Springs
Lettuce	400	Yuma and Salt River
Endive	400	Yuma and Salt River
Salsify	1,700	Salt River and Safford
Broccoli	1,000	Salt River and Safford

Plate III.—Herbs in bloom for seed production: anise, corriander, and dill.

Herbs producing satisfactory seed yields in Arizona are: Anise, corriander, dill, French celery, summer savory, sweet fennel.

Reclamation vegetable research on Yuma Mesa

During the past year the University of Arizona and the U.S. Bureau of Reclamation have co-operated on a vegetable research project. Twenty acres of typical Yuma Mesa sandy soil have been planted in vegetables for the purpose of determining adaptability. Dates of planting and varieties of many kinds of vegetables were under experimentation with variations in types of irrigation furrows, fertilization, and cover crop system. Tomatoes and sweet corn have been most promising and therefore given the most attention. Tomatoes were found especially promising for both winter and spring production. Direct seeding of the Earliana strain of tomato (498) was very satisfactory, especially when

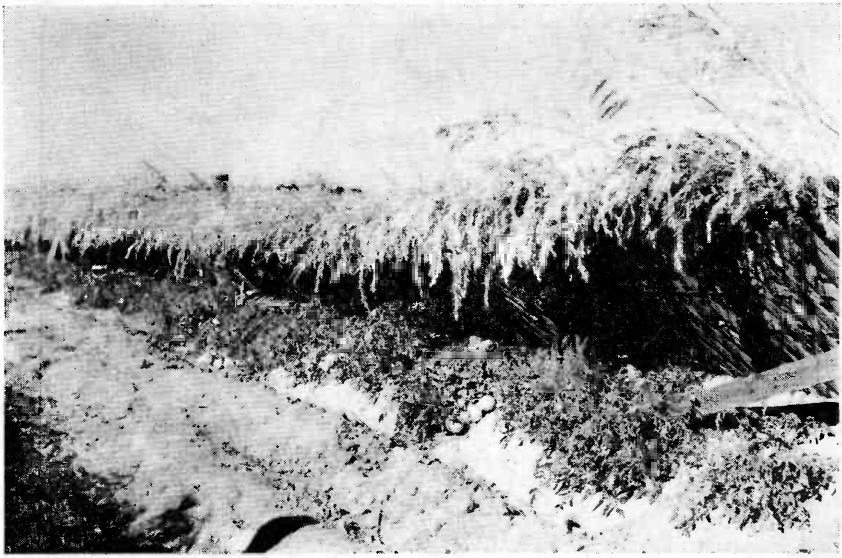

Plate IV.—Winter tomatoes grown on Yuma Mesa showing cold protection by brushing.

planted on the north slope of the bed. Evidence indicates that certain varieties of the English pea, such as the Giant Stride, were also very well adapted for winter production.

Young vegetable plantings for early spring production were seriously damaged by windblown sand during March. Windbreaks should be established to prevent such damage.

CITRUS INVESTIGATIONS

Nitrogen control in grapefruit orchards in the Salt River Valley

The cover crop system of nitrogen control for the purpose of improving the quality of fresh grapefruit has not been so effective under Salt River Valley conditions as that which was developed under conditions on the Yuma Mesa. The results of leaf analyses for nitrogen indicate that applications of nitrogen to grapefruit trees during the winter months are not readily absorbed by the trees until spring growth begins. It is known that adequate nitrogen and carbohydrates must be present throughout the tree before spring growth begins for the setting of a good fruit crop and to prevent excessive dropping of young fruit. One of the effects of a grass cover crop in grapefruit orchards is to decrease nitrogen intake by the trees during fruit enlargement and maturation throughout the summer period. Trees in the Salt River Valley, subjected to the grass cover crop system used successfully on the Yuma Mesa, go through the winter deficient in nitrogen, which is unfavorable because of (1) the limited amount of fruiting wood produced in the spring, and (2) limited fruit setting. This

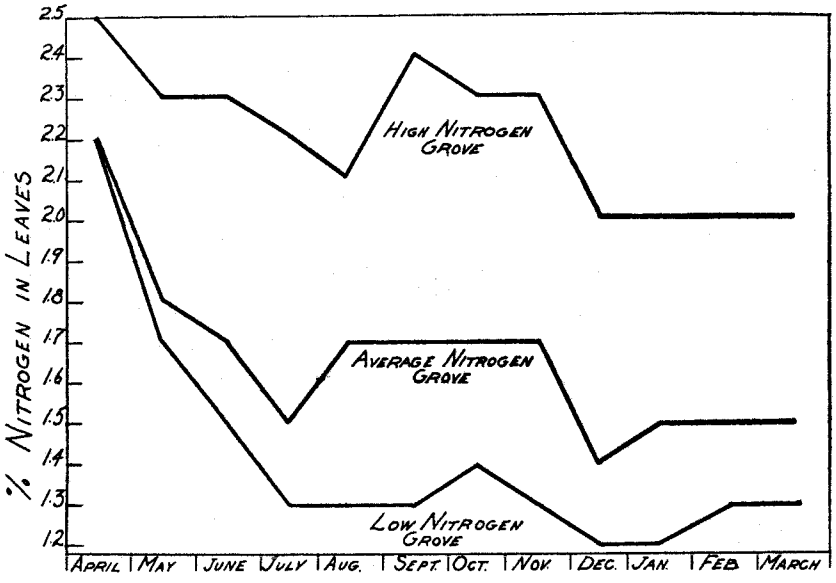

Figure 4.—Nitrogen content of grapefruit leaves sampled from twenty-five groves in Salt River Valley during the 1945-46 season. The low nitrogen grove is under a permanent grass cover system of management.

situation exists even though nitrogen applications are made during winter months.

Research is in progress at the Salt River Valley Citrus Farm on blocks of grapefruit trees to determine how early in November nitrogen applications can be made and yet prevent vegetativeness with the objective of getting nitrogen uptake by the tree during the late fall months prior to the low temperature season when nitrogen intake is retarded. Rhodes grass is the best grass cover crop yet tried for Salt River Valley conditions for the purpose of lowering the nitrogen level in grapefruit trees during the summer months.

Nitrogen status of grapefruit orchards in the Salt River Valley

During the 1945-1946 season the program of leaf analysis for nitrogen in twenty-five grapefruit groves was continued in cooperation with the Arizona Citrus Growers' Association. This study has shown the large variation in nitrogen nutrition of orchards in the Valley. Leaf samples are drawn from the respective groves once each month and nitrogen analyses made. The low, average, and high nitrogen levels in the leaves are shown for the respective months in Figure 4.

The data indicate that grapefruit trees do not absorb adequate amounts of nitrogen during the winter months under Salt River conditions. The excessively high nitrogen in many groves suggests that the application of nitrogen in these cases is wasteful and may result in fruit with coarse thick peel of poor quality and

late maturing. This study has revealed that the common practice of applying nitrogen fertilizers on the arbitrary basis of pounds per tree is subject to serious question.

Inadequate irrigation associated with coarse grapefruit

A study of orchard conditions associated with the production of good and poor grapefruit was conducted at the request of the growers. There is good correlation between high quality fruit and more frequent irrigations and larger amount of water applied. The survey showed no correlation between quality of fruit and nitrogen nutrition of the trees. The Department of Agricultural Chemistry and Soils has co-operated in this survey in connection with minor element relationships.

Oil spray program for weed control in orange groves

At the Salt River Valley Citrus Research Farm blocks of Washington navel and Valencia oranges have been managed under a system of spraying the soil surface with diesel oil to kill all weeds. These blocks have not been disced or otherwise cultivated during the two year period of oil spraying. During this period soil porosity and water penetration have been decidedly improved. The cost of maintaining orange groves under an oil spray system of management is less than with discing. Besides the greater expense of discing, hard impervious soil layers are developed in many of the groves of the Salt River Valley just under the disced portion of the soil resulting in poor aeration and very slow water penetration.

From the standpoint of efficient cultural management of orange groves, good production and high fruit quality, the oil spray system has proven superior to other grove management systems tried.

Alfalfa in relation to citrus orchard management

Alfalfa plantings have been established in orange and grapefruit blocks of trees on the Salt River Valley Research Farm. Some of the advantages of alfalfa as a cover crop in citrus groves are: (1) Improves physical characteristics of soil and increases water penetration. (2) Operation costs are offset by the value of the hay removed. (3) Superior to grass cover crops in case of oranges, since grasses compete too much with the trees for available nitrogen. Orange trees require more nitrogen during summer than grapefruit.

One of the major disadvantages of alfalfa as a cover crop is that alfalfa gives rise to destructive populations of grasshoppers which move onto citrus trees and devour much of the foliage. The Salt River Valley Citrus Research Farm is completely surrounded by alfalfa fields. During the summer each time a field of alfalfa was cut a wave of grasshoppers moved into the grove causing damage to foliage. Arsenates are partially effective as grasshopper insecticides, whereas zinc arsenite sprayed on citrus foliage was completely effective. On the other hand repeated applica-

tions of zinc arsenite sprayed on citrus resulted in toxicity as evidenced by mottled chlorosis, tip burn of leaves, and defoliation. This condition was serious only in nitrogen deficient trees. It was observed that none of the grasshoppers invaded the oil spray blocks which suggests that diesel oil acts as an effective repellent to grasshoppers.

Low winter temperatures in the Salt River Valley citrus groves

During the last winter data on minimum nightly temperatures were collected from thirty citrus groves distributed throughout the citrus areas of the Salt River Valley. The 1945-46 winter season proved to be the coldest since 1937-38 when this temperature survey was started. The average minimum temperature for the fifteen coldest nights was 22.0 degrees F. in the coldest grove, 31.0 degrees F. in the warmest grove, and 24.0 degrees F. at the Salt River Valley Citrus Research Farm.

Stratified nightly minimum temperatures were determined at the Salt River Valley Citrus Research Farm for the months of November, December, January, February, and March. The minimum temperatures averaged 37, 41, and 45 degrees F. at the 5, 20, and 50-foot levels respectively.

Citrus fruit counting machine

A citrus fruit counting machine was developed at the Yuma Mesa Citrus Research Farm during the 1945-46 season. The counting machine is attached to a Farmall tractor and is power driven by the tractor. The equipment counts the number of fruit harvested from each of six separate trees in rapid succession, and loads the fruit into a standard citrus hauling truck. It will handle rapidly all the fruit harvested by six or twelve pickers from six rows at one drive through the orchard.

MISCELLANEOUS STUDIES

Yuma Valley Date Research Orchard

The Yuma Valley Date Research Orchard was again fruited commercially during the 1946 season. This orchard is a variety planting of soft sugar dates, predominately Khadrawi. Very little rain occurred during fruit ripening and fruit of superior quality was produced. Additional evidence was obtained regarding the superiority of the lower Colorado River Valley over other desert areas for date production. The Maktoom variety produced a low yield due probably to high salt content of the soil, as evidenced by typical salt injury, tip burn of leaflets.

Pecans

Because of rising water table in the Yuma Valley Pecan Research Orchard, growth of pecan trees was somewhat retarded. There was a definite tendency toward alternate bearing of pecans. It is again apparent that many of the newer varieties have superior yielding performance as compared to the older varieties which were extensively planted during the period 1920-30.

NUTRITION

NATIONAL CO-OPERATIVE RESEARCH PROJECT

During the year 1945-46 the Western Regional Group of the National Co-operative Project formulated a new plan of work which was more fundamental in its concept than it had been during the war years. The following five broad projects were outlined: (1) The physiological availability of food nutrients and factors affecting this availability, (2) the interrelationship of food nutrients, (3) the amino acid contents of foods, (4) the effect of soil composition and environmental factors upon the nutritive value of foods, and (5) the fortification of foods in canning and freezing.

Physiological availability of carotene (vitamin A) in fresh cantaloupe

Previous reports (Mimeographed Report No. 67) have shown that cantaloupe is a rich source of carotene. However, recent research has shown that carotene or provitamin A content is not always synonymous with physiological availability. Therefore, the storage of vitamin A in the livers of rats was compared with cantaloupe, alfalfa, and pure carotene in Wesson oil supplied the vitamin A in equivalent amounts. Considering the availability of pure carotene in oil as 100 the availability of the carotene in three different samples of Imperial cantaloupes were 84, 88, and 105. On the same basis alfalfa showed availability of 53. Like experiments done at the Texas Agricultural Experiment Station (Food Research 10, 187, 1945) gave apricots an availability of 16, carrots 37, sweet potatoes 16, turnip greens 19, and spinach 47. Imperial cantaloupes then contain a high amount of carotene in a highly available state.

Effect of the type of carbohydrate in the diet upon the utilization of riboflavin and thiamin

A study with rats on the effect of the kind of carbohydrate in the diet on the storage of riboflavin and thiamin in the liver was begun. Preliminary results indicate that a dextrin diet results in slightly higher liver storage of riboflavin than does a sucrose diet. The feeding of sulfasuxidine, a bacteriostatic sulfonamide, appeared to have a slight inhibitory effect on the storage of thiamin in the liver, in the case of the dextrin diet, but was without effect in the case of the sucrose diet.

Effect of iodinated casein upon the vitamin content of milk (Co-operation with Department of Dairy Husbandry)

In the past few years a number of reports have shown that iodinated casein (synthetic thyroprotein) will increase the production of milk when it is fed to dairy cows. Experiments were devised to determine the effect of iodinated casein upon the vitamin content of milk. Fifteen grams of iodinated casein fed daily to Guernsey and Holstein cows caused a rise in milk production which lessened during the latter part of the period of iodinated

casein feeding. The concentration of niacin was increased from approximately 60 micograms per 100 ml. of milk to approximately 100 micrograms per 100 ml. of milk. Thiamin was only slightly increased and riboflavin was reduced from approximately 50 micrograms per 100 ml. to approximately 5. These differences were lessened in the latter part of the iodinated casein feeding. The vitamin A and carotene contents were not affected. Taken as a whole the results indicate that very little is gained from the feeding of iodinated casein and therefore its feeding is not recommended.

Effect of variety upon the vitamin content of lettuce (Co-operation with Department of Horticulture)

Twenty-three varieties of lettuce grown on the Tempe Research Farm were analyzed for carotene (vitamin A), ascorbic acid (vitamin C), riboflavin, and niacin. No correlation between variety and the content of these vitamins was observed. There was an indication that the niacin content of lettuce gathered in January was higher than the niacin content of lettuce gathered in March. However, more work is needed before this fact can be established.

Effect of nitrogen upon the nutritive value of citrus (Co-operation with the Department of Horticulture)

In previous reports from the Department of Horticulture it has been established that grapefruit grown under declining nitrogen conditions were of higher quality from the standpoint of texture, thickness of rind, sweetness, flavor, color, percentage of juice, and content of vitamin C than grapefruit grown under high nitrogen conditions. Grapefruit from relatively high nitrogen plots, medium nitrogen plots, and low nitrogen plots were collected from the Citrus Farm at Tempe. The previous findings of the Horticulture Department were confirmed. In addition the grapefruit were assayed for the B complex vitamins, niacin and riboflavin. The niacin varied from 2.3 micrograms per ml. juice to 4.6 micrograms per ml. and the riboflavin from 0.16 micrograms per ml. to 0.30 micrograms per ml. There was no correlation between the nitrogen content of these fruit and the content of these vitamins. Nor was there any correlation with the date of picking. Fruits were picked in December, February, and April.

Valencia oranges from high, medium, and low nitrogen plots on the Tempe Farm were picked in April shortly after a heavy frost. Approximately 75 per cent of the fruit from the low nitrogen plot were woody, 50 per cent from the medium nitrogen plot and none from the high nitrogen plot were woody. Since these fruit had been damaged no analyses were made.

Collaborative work for the Association of Official Agricultural Chemists

Methods for carotene and riboflavin with several improvements over accepted procedures were studied collaboratively. Good agreement was obtained by the various collaborators for both of the methods. These reports are given in detail in the *Journal of*

the Association of Official Agricultural Chemists, Vol. 29, pages 18-24, and pages 25-29.

PLANT BREEDING DEPARTMENT

ALFALFA

The alfalfa hay growers in Arizona are shifting from the more or less winter-dormant Chilean type of alfalfa to non-winter-dormant, or southern type. This latter type gives a greater yield of hay and a more abundant winter grazing. The two most promising varieties of the southern type which are being increasingly grown in Arizona are the Indian and the African. Since there is considerable variation within each of these two varieties, an attempt is being made to determine the extent of variation with regard to the more important economic characters of alfalfa, yield of hay, seed setting, and extent of winter growth. An attempt is also being made to isolate a disease resistant strain, especially resistance to bacterial wilt.

As a first step in this work, approximately 500 individual plant selections were made from a field of African alfalfa, and about 200 individual plant selections from a field of Indian alfalfa. This was done by stripping the seed from a single stem of the plant selected. The seed from each selected plant was planted in a 10-foot row. The selections of each variety were planted adjacent in order that a study might be made of the differences between individual plant progenies. This will permit the determination of the dominant type in each variety, and also the selection and propagation of the more productive types. As a basis of comparison, about 500 individual plant selections of the highly uniform 21-5 alfalfa were planted in an adjoining plot. All of these plantings were made the latter part of October, 1946, on the Yuma Valley Experimental Farm, and studies of the progenies will begin in the 1947 growing season.

LONG STAPLE COTTON

One hundred and ninety-five progenies of multiple crosses consisting of about 5,000 plants were grown in 1946. The parents of these crosses consist of Pima, SxP, Tanguis Sea Island, and Upland. The crosses and backcrosses have been made in various ways, but selection is being made in the direction of a farba-dense type with reduced size of plant, and a larger boll having lint of the length and character of the Egyptian type. Considerable progress has been made toward this goal and selfed seeds were taken from several hundred plants in 1946. These selfed plants will be the origin of the progenies grown in 1947.

WHEAT

The crosses and backcrosses of Baart 38 on Timopheevi derivatives were grown in bulk for an additional generation at the Yuma Experiment Farm in 1946. (See Arizona Agricultural Experiment Station Report for 1945, pp. 64 and 65.) Three backcrosses

have been made, Baart 38 being the recurring parents. The first generation of the third, the second generation of the second, and the third generation of the first backcross were grown in 1946. Also the fourth generation of the original cross was grown. These crosses were grown, as in previous years, under conditions where heavy rust infection is expected to occur when a rust epidemic appears. Several hundred head selections will be made from each cross when it reaches the fifth generation, since a considerable portion of the plants will be homozygous for both the Hope and the Timopheevi factors for rust resistance by that time.

UPLAND COTTON BREEDING

The breeding work with Santan (Shafter type Acala) was carried on in co-operation with the U.S. Field Station at Sacaton. Mass selections were made from the best progeny rows grown in 1945. Laboratory studies of boll size, percentage of lint, lint index, seed index, number of seeds per boll, and length and strength of lint reduced the number of progenies to twenty-five. These were planted in the Casa Grande Valley in the spring of 1946.

Work with hybrids

Fourth generation progenies of crosses between Santan (Shafter type Acala) and 1517 (New Mexico Acala), Santan and Stoneville 2B, and Santan and Wilds No. 13 were grown on the Mesa Experiment Farm in 1945. Third generation progenies of the backcrosses Santan x (Santan x 1517), 1517 x (Santan x 1517), Santan x (Santan x Wilds No. 13), and Wilds No. 13 x (Santan x Wilds No. 13) were also grown. Selfing was carried on during the summer of 1945.

In the fall of 1945 plants were selected from these progeny rows as shown in Table 18.

TABLE 18.—PROGENIES SELECTED IN THE FALL OF 1945

	Plants and progenies	
Santan x 1517	218	27
Santan x Stoneville 2B	293	31
Santan x Wilds No. 13	55	7
Santan x (Santan x 1517)	149	20
1517 x (Santan x 1517)	0	0
Santan x (Santan x Wilds No. 13)	82	13
Wilds No. 13 (Santan x Wilds No. 13)	0	0
Total for all crosses	797	98

TABLE 19.—SELECTED PLANTS FROM CROSSES AND BACKCROSSES

Cross or backcross	No. of plants selected
Santan x 1517	96
Santan x Stoneville 2B	18
Santan x Wilds No. 13	12
Santan x (Santan x 1517)	26
Santan x (Santan x Wilds No. 13)	7
Number of progenies planted	159

TABLE 20.—RESULTS FROM 1945 PRELIMINARY STRAIN TEST

	Strain or variety	Lint per acre	Lint (per cent)	Weight per boll (grams)	Lint index	Seed index	Strength index
Santan x 1517	X1-26	591	35.3	6.92	7.02	12.8	10.00*
	X1-39	473	36.9	6.52	7.22	13.7	10.07*
	X1-44	665	36.0	7.27*	8.42*	14.4	8.95*
	X1-47	747*	38.0	7.48*	8.31*	13.6	10.12*
	X1-113	517	34.1	7.08	7.52	14.5	10.52*
Santan x Sto 2B	X11-110	661	34.3	7.49*	7.54	14.3	8.92*
	X11-123	572	35.1	7.26*	7.68	14.2	8.78*
Santan x Wilds 13	X15-19	757*	34.2	6.38	6.74	14.2	8.75*
	X15-36	582	33.3	6.19	6.61	13.3	8.76*
	X15-178	601	35.0	7.10	7.34	13.6	9.07*
	X15-187	589	36.7	7.00	7.73	13.3	9.24*
Other strains and varieties	Sto 2B	669	34.0	6.64	6.37	12.3	9.01*
	Santan	495	35.9	6.86	7.23	12.9	7.77
	Shafter	533	37.8	6.94	7.78	12.8	7.73
	1517 NM	504	32.8	6.33	6.83	14.0	10.45*
	1517 RB	617	33.6	6.90	7.20	14.2	9.72*

Differences necessary for significance at 1 per cent and 5 per cent levels

Lint per acre	154 and 204 pounds
Percentage of lint	1.60 and 2.13 per cent
Weight of bolls	0.31 and 0.41 grams
Lint index	0.53 and 0.70 grams
Seed index	0.40 and 0.53 grams
Strength index	0.26 and 0.35 pounds

*Indicates superiority to Shafter Acala at the 5 per cent level of significance.

No plants were selected from the backcrosses 1517 x (Santan x 1517) and Wilds No. 13 x (Santan x Wilds No. 13) due to their poor appearance in the field.

An open pollinated sample from each selected plant was brought into the laboratory for study. Determinations were made on plant and progeny yields, weight of bolls, percentage of lint, lint index, seed index, number of seeds per boll, percentage of lint over 1 inch in height, and strength of lint. On the basis of these determinations 638 of the 797 selected plants were discarded, and 159 were planted in progeny rows in April of 1946.

These selected plants were distributed between the various crosses and backcrosses as shown in Table 19.

In addition to the regular progeny row tests a preliminary strain test was conducted on the Mesa Farm in 1945. Fourth generation plants of eleven hybrid strains were grown in comparison with a number of standard varieties and strains from other stations. Each strain and variety was replicated four times. Table 20 shows some of the results from this test.

Three strains from the cross Santan x 1517 were tested for spinning quality in the fall of 1945. One sample of Santan was included in the test as a check. Table 21 shows some of the results of these tests.

TABLE 21.—RESULTS OF SPINNING TESTS

Strain	Picker and card waste	Neps per 100 sq. in. of card web	Staple classers	Length equivalent	Yarn 22's	Strength 36's	Yarn 22's	Grade 36's
X1-26 Santan x 1517	9.0	18	1 1/32	1 9/32	140	76	B	C+
X1-44 Santan x 1517	8.6	24	1 1/32	1 5/32	128	69	B	C+
X1-47 Santan x 1517	9.1	22	1 1/32	1 7/32	130	72	B	C+
Santan	8.5	25	1 1/32	1 3/32	119	64	C+	C+

Santan had slightly less waste than the three hybrid strains. The classer's staple was the same in each case. In all other respects, however, the hybrid strains were superior to Santan. This is particularly true for yarn strength.

PLANT PATHOLOGY

ALFALFA BACTERIAL WILT

Fifty alfalfa plants from the original field-test plot which survived artificial inoculations with the alfalfa bacterial wilt organism, *Corynebacterium insidiosum* (McCul.) Jensen and the

inroads of the root-rot fungus were removed to more secure localities near the University. The crowns of several plants were divided into small units (using sterilized instruments) so that this source of material now affords some seventy-five plants. Of these, some are being held in the greenhouses and some out-of-doors. Mass seed samples from all of these plants were taken during the summer, 1946, and are being used as a source of future test plants. Eight isolations of *C. insidiosum* from various parts of the country, collected by Dr. F. R. Jones, University of Wisconsin, are being carried along as inoculum for the various greenhouse tests. Infected root material received from Dr. J. D. Menzies (Irrigation Branch Experiment Station, Prosser, Washington) is being used as a source of isolations and for the infestation of sterilized soil in pots in the greenhouse and in plots out-of-doors.

Due to difficulty in securing materials the establishment of the new field experimental plot at the North Campbell Avenue Farm has not been completed. As a result, all inoculated plants have, to date, been held in the greenhouse in pots.

Seeds from several new strains of alfalfa have been secured from several sources and these are being utilized as rapidly as facilities permit. The first variety of alfalfa (collected by Dr. L. C. Curtis in North Africa in 1944) tested in the greenhouse has shown promise of being adaptable to this climate and also satisfactory from the wilt resistance viewpoint. Although tops tend to die down in the greenhouse, root development of this strain remains apparently normal. It is too early to determine with certainty how this variety will act under field conditions.

The single surviving cutting from a plant of F.C. No. 19, 316, inoculated with *C. insidiosum* in March, 1942, continues to show promise of resistance to wilt. Under the conditions in which this strain has been grown to date, the seeding qualities are rather poor and sufficient material for future tests has not been obtained.

Several mass seed samples from already established fields of alfalfa in the vicinity of Litchfield Park and Glendale, Arizona, have been collected and are serving as a source of plants for future inoculations.

ANTIBIOTICS

Budwood of a hybrid of Japanese plum contributed by Stark Brothers Nurseries was freed of infection with the black spot and rot bacterium, *Phytomonas pruni*, by treatment in partial vacuum with streptomycin. Both crude streptomycin produced in the phytopathological laboratory of the Station and the commercial product (supplied by Schenley Laboratories) were satisfactory agents.

Stem galls on Bryophyllum and other plants were cured with applications of penicillin and streptomycin. On galls of Bryophyllum streptomycin worked even faster than penicillin. This appears to be the first announcement of cure of crown gall by applications of the former antibiotic.

Bacterial ring rot of seed potatoes, caused by *Corynebacterium sepedonicum*, probably can be controlled by using penicillin. Tests on the bacterium in vitro have been successful. The treatment has been applied to potato seed pieces in limited experiments without apparent injury to the seed.

BROWN ROT OF STONE FRUITS

Following the first recorded outbreak of brown rot in a 40-acre peach orchard in August, 1944, no ascospore or conidial production or blossom infection was detected in March, 1945. A few weeks later a severe frost resulted in the almost total loss of the 1945 crop. Observations during 1946 revealed no trace of brown rot in the orchard although moisture conditions were favorable for its development in midseason and on late varieties maturing in July, August, and September. Rhizopus rot, however, was present both in the orchard and in harvested fruit.

CELERY DISEASES

Celery troubles mentioned in the last Annual Report (p. 65) later became more extensive. One large planting infested with virus was also attacked by the watery brown rot fungus (*Sclerotinia sclerotiorum*) and became a total loss.

CERTIFIED SEED POTATOES

The aid to commercial potato growers mentioned last year has been continued. In February a field inspection was made of the 40-acre trial plots of certified seed from all the western states. Most of the seed purchased this year was from fields and growers judged to have the best available stock.

DISEASES OF CHILI PEPPERS

Chili peppers have been grown in Arizona ever since agriculture began here, but mostly on a small scale. About five years ago plantings were greatly increased in one district to produce chili powder for the wholesale market. In 1946 the acreage planted to chili peppers had increased to 1,300.

Chili wilt, caused by *Fusarium annuum*, was present in many of the fields in 1945, but this year the loss of plants was much greater, and the growers, more concerned, appealed for aid in combating the disease which now began to threaten the new industry.

Members of the department made three field inspection trips at two-weeks intervals and found not one but four root-invading parasites and a number of fruit and foliage diseases. Wilt was the most prevalent and destructive disease, losses varying from 5 to 15 per cent in the average field; some fields showing heavy losses of 25 per cent and above; parts of one large field showed over 90 per cent dead plants. Under normal conditions losses will increase until the yields obtained are no longer profitable.

Other root parasites causing severe damage in some fields were: *Phymatotrichum omnivorum* causing cotton or Texas root rot, the root-knot nematode (*Heterodera marioni*), and a species of

Phytophthora which also causes a fruit rot of green and red chili fruits resulting in appreciable losses in seasons like the one just past.

The foliage diseases observed were curly top and mosaic (virus diseases), and sunscaled and Macrosporium rot of the fruit.

A project on the control of wilt and related diseases has been proposed.

CITRUS DRY ROOT ROT

Soil treatments using manure, sulphur, and ammonium sulphate applied to the soil surface around diseased trees and disced into the soil are proving successful in treating dry root rot. No recurrence of dry root rot has been noted on bearing trees in commercial orchards treated in 1938 (tangerines); 1939 (navel oranges); and 1940 (Valencia oranges). Some new cases have appeared in untreated trees.

DATE FRUIT ROTS

Losses much above average, although not unusual for a season in which the ripening fruit was exposed to greater than normal rainfall, were experienced in Maricopa County date orchards this summer and fall. Spoilage for the county averaged 50 to 60 per cent and one packing plant reported a reduction of 300,000 pounds in the expected pack, and a reduction in grade of part of the dates processed.

PHYMATOTRICHUM (TEXAS OR COTTON) ROOT ROT

Pecan experiments

All experiments on pecan reported last year are being continued, and there are no significant changes in the results observed.

Rotation experiments

A new series of rotation experiments designed to explore the possibilities of profitable use of root-rot-infested land was initiated in the fall of 1943. Five rotations based on cotton as the cash crop, and three based on flax are under way at the Mesa farm. Three rotations including alfalfa, and four including horticultural crops have been tried at Tucson. Only three years' results (with cotton yields incomplete for 1946) are available. No definite conclusions can be drawn but several interesting facts have become evident:

(1) Seasonal variations make the interpretation of results more difficult; 1944 was a very good crop year, 1945 was only fair, and 1946 was fairly good, as shown by the effect on all yields.

(2) The difference in yield of cotton between the untreated control plots and treated plots has become progressively larger in the second and third years of the experiment.

(3) The per cent of dead plants in the various plots on September 1 is a better index of their yield than the per cent of dead plants at the end of the season (November 1). Plants in the

treated plots are lost much later in the season and many have already matured their crop.

(4) *Susceptibility of guar to root rot*: The strains of guar ordinarily grown in Arizona are apparently quite resistant to root rot. An early maturing strain grown in 1945 and 1946, however, appears to be moderately susceptible to root rot. This strain is predominantly unbranched with single stems 24 to 36 inches high maturing as much as six weeks earlier than ordinary strains. This would permit a seed crop of guar followed by a winter crop such as flax.

WATERY BROWN ROT

In outdoor plots, soil which had been infested with sclerotia of *Sclerotinia sclerotiorum* for a period of 2 years (Border No. 2) and 3 years (Border No. 3) plus the addition of 5 sclerotia around the bases of plants in one row out of six of Border No. 3, was treated with granular "Aero" Calcium Cyanamide at the rate of 900 pounds per acre. Check plots were used in connection with both borders. The percentages of lettuce plants (New Improved No. 615) showing symptoms of Watery Brown Rot in each instance were as follows:

Border No.	Treatment	Per cent diseased plants
2	Check	83.1
	Treated	55.1
3	Check	75.2
	Treated	45.2

Laboratory tests disclosed that sclerotia were killed within two to three weeks after contact for that period of time with distilled water "solutions" of "Aero" Calcium Cyanamide. The chemical was dissolved at an equivalent rate of 900 pounds per acre. In distilled water alone the sclerotia were not affected.

POULTRY HUSBANDRY

BREEDING INHERITANCE STUDIES

Developing a high egg-producing strain

Feed shortage necessitated a drastic reduction in poultry stock. Only the best families were kept intact, thus leaving a limited population from which to draw conclusions on the year's work.

White Leghorns

Of fifty progeny raised from the *foundation* mating, fourteen were saved to complete the year. Within the fourteen birds saved were two of the best families, four individuals in each family, the average productions of which were 229 and 220 eggs respectively.

Twenty-three progeny were raised from the *family* mating, and but ten were carried over to finish the year's record. In these were included three families of three individuals each, with the average productions of 265, 243, and 234.

A study of the pedigree records furnishes a clue as to the reasons why the family mating produced heavier than the foundation mating. Back seven generations outcrosses of two outstanding blood lines were made in the foundation mating. The following generations although continuing the same original blood lines did not lay as well as expected. The best foundation families in the last generation produced almost fifty eggs less during the past year than did the best families in the family mating.

The current "B" progenies are half brother and sister. A mating of these bloods may furnish a link necessary for increasing egg production of these groups above the present level.

Rhode Island Reds

The opposite result was obtained with Rhode Island Reds as compared with the White Leghorns. A family background with lower egg production produced a higher average egg production in the current progeny.

In the case of the *family* progeny background the immediate dam had a first year production of 183 eggs; her dam, 205; and her dam, 278 eggs.

In the *foundation* progeny background the immediate dam had a first year production of 226 eggs; her dam, 238; and her dam was a hen of unknown production. In both family and foundation matings the sires were full brothers.

Barred Rocks

Over a period of years, notwithstanding the use of some of the best blood obtainable from outside sources, the egg production of our Barred Rocks has been at a low point. From the two families saved over from last year's work, one family, five in number, averaged 230 eggs, while the other, two in number, averaged 231 eggs. In tracing back the pedigrees it was noted that five generations back an outcross mating of two high producing stocks was made on both the sire's and dam's side of the sire responsible for the current progeny. In the fourth generation a brother and sister mating was made on the sire's side with the dam involved of relatively low egg production. The third generation involved relatively low production on both sides of the mating. In the second generation the male came from relatively low egg production and consisted of 5/8 and 3/8 blood of the original stocks. This sire was mated to a female of low egg production, 179 eggs, from another line unrelated to the two lines of breeding involved in the sire, making an outcross mating. The progeny from this mating laid 203, 270, 217, 256, and 203 eggs respectively.

Close breeding was resorted to in the fifth and fourth generations out of which came relatively low egg production, 168 eggs

and 207 eggs from the progeny of the fourth and third generations. The mating to an outcross bird involving only 179 eggs, increased the average egg production in a family of five birds to 230 eggs. If it takes five generations of breeding to bring about this increase in production it is a rather slow process. Whether this increase in egg production can be maintained or increased by the use of close breeding in the future remains to be determined. Apparently outcrossing and then close breeding was responsible for these results, although the change did not become apparent until five generations later.

Developing a low egg-producing strain

In 1945-46 a family of six progeny was obtained with an average production of 102 eggs. The range was from 15 to 190 eggs. Notwithstanding the rather high limit of the range, this is the lowest producing family yet obtained.

The pedigree of the immediate sire indicates a foundation of high egg production back four generations. Since then it was possible to select for low egg production the dam of the immediate sire having laid in successive years 87, 87, and 159 eggs.

There was the same level of production back of the immediate dam, being 87, 87, and 159 eggs.

The mating from which this low production on a family basis was obtained was a brother and sister mating. Inasmuch as there was the same proportionate blood in the progeny as in the mating, it would seem that any mating of this kind should give the same approximate result, which has not occurred in the past.

A dam with a low first year production, 120 eggs, but coming from a background of high egg production was placed with the low producing mating, and mated to the same sire as used with the previous family mentioned. This sire's dam laid 87, 87, and 159 eggs in three successive years. The result was a family of six progeny with an average production of 223 eggs and a range of from 205 to 246 eggs.

The thought behind the use of this one bird in this way was that the low production of 120 eggs out of a background of high production might indicate quite a degree of purity for low production. The second years' production of this bird, 250 eggs, and the production obtained from her progeny even when she was mated to a sire with a background of low production definitely indicates our supposition was wrong.

Prolonged economic production

At the end of this year's work one family was outstanding. Of five progeny carried over after their first year's production, three had exceedingly good second years records. The egg production for the first and second years for the five birds were 236-270; 216-245; 251-252; 228-193; and 222-139. This last bird died before completing the record.

In tracing back the pedigrees it was found that back five generations an outcross of two outstanding blood lines was made. In the

fourth and third generations other outcrosses were made with a combination of previous blood lines involved. The second generation from which the present progeny was obtained was a half brother and sister mating.

Within three other families of identical background results in egg production the second year were spotted. The production of one family of five was 220-216 eggs; 241-255 eggs; 228-121 eggs to June 12, 1946; 213-193; and 204-D. In another family with two progenies, 249-253 eggs; and 201-208 eggs. In a third family of two progenies 248-116 eggs to June 12, 1946; and 245-130 eggs to June 12, 1946.

The general backgrounds of the forty-two families involved were similar to the best family mentioned, with the exception of the half brother and sister mating the second generation back.

It may be possible, assuming that the types of mating involved in the production of the outstanding family will continue to produce equally good results, to shorten the procedure by first outcrossing two good blood lines and then interjecting a half brother and sister mating. Future work will determine this.

Female stock resulting from the outcrossing of two good stocks, and the introduction of additional blood in the next generation was then mated as half brother and sister for three generations. The offspring were then mated to males from good stock of unrelated blood. From these matings, forty-nine progenies were obtained. Twenty-five or 51 per cent averaged 248 eggs. Fourteen were sold off in summer, because of feed shortage, as relatively low producers. One family of five averaged only seventy-six eggs. The productions of three were abnormal and not figured in the results. Two birds died.

Establishing a strain for large eggs

A half brother and sister mating produced five families with a total progeny of twenty-five, the eggs of which averaged 26 ounces to the dozen. The average egg size within the mating was 27.1 ounces to the dozen. This was a half brother and sister mating with large egg size behind both the immediate sire and dam. From a background and mating of this character one would expect a larger egg size than that found in the progeny.

Establishing a strain for small eggs

During the first five years of this project there was a tendency for the egg size in the progeny to be greater than that of the mating, and this tendency has been progressive. Since resorting to family selections and mating, the size of eggs in the progeny has been about that of the mating. This past year the progeny's eggs were slightly larger than that of the mating.

A family of six birds had an average egg size of 21.3 ounces to the dozen. The egg size of the mating was 20.8 ounces to the dozen. The original dam of the current sire five generations back had an egg size of 23.4 ounces, and the original dam of the current dam had an egg size of 21.3 ounces. The average egg size

of the twenty-two progenies from the 1944-45 mating was 21.9 ounces to the dozen. Some reduction in egg size has been obtained during the last five generations. And compared to the average egg size in the large egg selection, 25.3 ounces, there is a very definite difference. Commercially this difference would be five cents a dozen at current prices.

Pendulous crop as an inherited factor

Turkeys inherit pendulous crop and chickens have this condition. No work has been reported, although in some cases this abnormality is quite severe and frequent.

Barred Plymouth Rocks are being used in this series of tests. Birds showing severe pendulous crop condition were mated. Second and third generations have not shown severe abnormalities of the crop, but in all cases some pendulous condition was noted. This work is continuing.

APPENDIX

ANALYTICAL SERVICE

Table 22 gives a tabulation of the chemical analyses made in the Department of Agricultural Chemistry and Soils during the past fiscal year for citizens of the state. The analyses made in the Tucson and Phoenix laboratories are given separately.

TABLE 22.—COMPILATION OF ANALYSES MADE IN THE DEPARTMENT OF AGRICULTURAL CHEMISTRY AND SOILS

Type of sample	Tucson	Phoenix
Water	555	1,106
Soil	677	899
Manure	4	27
Poison	13	150
Gypsum	12	12
Feeds and hay	93	.....
Plants	24	.....
Miscellaneous	15	35
Total	1,393	2,229

ARIZONA EGG LAYING TEST

The twenty-fourth Arizona Egg Laying Test was made up of forty-four entries from twelve states as follows: Arizona, 12; California, 5; Idaho, 2; Illinois, 1; Massachusetts, 1; Michigan, 4; Missouri, 5; Nebraska, 4; Oklahoma, 2; Pennsylvania, 1; and Texas, 7.

The following breeds were represented: White Leghorns, 27 entries; Barred Rocks, 2; New Hampshires, 3; White Rocks, 2; and Island Reds, 10 entries.

A White Leghorn entry owned by Foreman Poultry Farm of Lowell, Michigan, laid the greater number of eggs in the fifty-one

week period, with 3,297 eggs and 3,385 points to their credit, for the thirteen-bird entry. This same farm owned the sixth place pen.

Second place was taken by a White Leghorn pen owned by Nelson Leghorn Breeding Farm of Kingsburg, California, with a credit of 3,256 eggs and 3,309 points.

The Del Rio Farm of Mesa, Arizona, made a very consistent showing, three of their four pens finishing in eighth, ninth, and tenth places.

A Del Rio Farm Rhode Island Red hen was the highest producing individual having produced 305 eggs with a point value of 324. This represented an 85 per cent production for 357 days' period, and an egg weight of better than 25 ounces to the dozen. This entry also contained the ninth and eleventh high individuals.

A Foreman Poultry Farm White Leghorn finished in second place with 288 eggs and a point value of 305.

The entire test, for the 357 days, laid at a rate of 56.1 per cent.

The mortality of 17.8 per cent was just below the average of all previous tests.

The average egg production per bird for fifty-one weeks, by breeds was: Rhode Island Reds, 226 eggs; White Leghorns, 218; Barred Rocks, 214; New Hampshires, 192; and White Rocks, 166 eggs.

Two individuals laid 300 eggs or more. Forty-two, or 9 per cent of the 470 birds to finish, laid between 276 and 299 eggs. Ninety-nine, or 21 per cent, laid between 251 and 275 eggs. Three hundred and forty-eight, or 74 per cent, exceeded a production of 200 eggs.

SOIL SURVEY (CO-OPERATIVE WITH U.S.D.A.)

Soil survey work in Arizona has progressed steadily during the past year. At a conference in Fort Collins in January, 1946, and at subsequent meetings with U.S.D.A. officials a new working agreement between the state and the Department of Agriculture was developed. The S.C.S. is to make only farm to farm surveys for farm planning. As far as possible, soil series and types will be identified on the maps. The Bureau of Plant Industry personnel will be responsible for properly identifying and correlating soil series on these surveys, for mapping uncompleted portions of a district, and for making a survey conform to the standards of basic surveys. They will also be responsible for writing the final reports of the areas. The Experiment Station is to co-operate in inspections and to take the responsibility of studying the more important soils found in each area, in the laboratory, field, and greenhouse.

During the past year laboratory studies have been conducted on the soils of Casa Grande and Sulfur Springs Valley areas. This study is in preparation for a technical bulletin on the soils of Arizona.

Inspections were carried out in the Queen Creek area, the Sulfur Springs Valley area, and in part of the Enlarged Silver

Creek area. As a result it has been recommended that some revision be made of the Sulfur Springs area before publication, that the Enlarged Silver Creek area be split into several units, that the more important ones be checked and be prepared for publication as basic surveys.

The soils of the Duncan area have been correlated and the report prepared for publication. The Experiment Station has revised the report of the Queen Creek area and has prepared it for publication as a technical bulletin from the Experiment Station. This is a new departure in the publication of soil surveys. If successful it may be used in the future to speed up the publication of survey reports.

During the past year several new conservation districts have been formed. The officials of these districts have requested soil surveys of their districts. The University has approved surveys for Agua Fria, Big Sandy, Bridgeport, Chino Valley, Florence-Coolidge, Oak Creek, Pipe Springs, Selma, Seven-Eight, Sitgreaves Mountain, South Side, Triangle, and West Coolidge districts. In those areas already covered by modern basic surveys only conservation surveys will be made, but in new areas the University will co-operate in making basic surveys.

WEATHER

The final compilation of data for Bulletin 197, *The Climate of Arizona*, was completed and the bulletin published during the fiscal year. It contains weather data from all Arizona weather stations from the time of their establishment through 1944.

Regular weather observations have been made at the University this year as has been the case since 1892 when the University was established. The year as a whole was 0.8 degrees cooler than the seventy-seven-year average. The rainfall was only about two-thirds normal in amount. There were 266 clear days, sixty-six partly cloudy days, and seventy-three cloudy days. The yearly evaporation was 71.4 inches. The highest temperature, 110 degrees, recorded during the year, occurred in September. The lowest, 19 degrees, occurred in December. The length of the growing season was 219 days as compared with an average of 248 days.

TABLE 23.—CLIMATALOGICAL SUMMARY FOR THE UNIVERSITY OF ARIZONA WEATHER STATION—1945-46

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Highest temperature	75	78	85	98	97	105	106	106	110	92	87	72	110
Lowest temperature	27	28	31	29	47	51	66	67	44	34	26	19	19
Mean temperature	49.4	52.8	55.3	64.7	74	78.6	87.0	84.9	79.4	68.8	55.4	48.2	66.5
Mean temperature 67 years	49.2	55.3	57.7	64.4	73.2	82.5	86.4	84.1	79.6	68.7	57.7	50.7	67.3
Total precipitation (inches)	0.65	0.41	0.62	0.08	0.0	0.0	1.22	2.95	0.12	1.42	0.0	0.16	7.63
Mean precipitation 77 years	0.82	0.98	0.74	0.33	0.18	0.27	2.23	2.36	1.19	0.54	0.81	1.02	11.47
No. days with 0.01 inches or more precipitation	3	3	4	1	0	0	11	12	1	5	0	3	43
No. clear days	15	20	17	25	27	28	7	11	17	17	22	20	226
No. partly cloudy days	5	6	7	2	4	2	13	6	9	6	3	3	66
No. cloudy days	11	2	7	3	0	0	11	14	4	8	5	8	73
Av. ground velocity of wind (m.p.h.)	1.6	1.21	1.36	1.34	1.51	1.0	1.09	0.74	0.72	0.62	0.39	0.59	1.01
Av. velocity of wind, roof of Agr. Bldg.	4.0	5.0	5.6	6.1	5.8	5.5	5.6	4.9	5.2	4.9	4.3	4.6	5.1
Evaporation (inches)	1.055	1.790	3.543	8.193	11.218	12.681	11.525	8.647	7.066	3.008	1.531	1.139	71.400
Relative humidity													
12 M.	43	33	33	17	16	15	33	43	32	40	30	38	31
5 P.M.	44	31	28	18	15	13	30	38	29	42	31	41	30
Length of growing season (days)	....	....	....	....	....	....	....	....	....	....	....	....	219

SUMMARY OF STATION PUBLICATIONS

TECHNICAL BULLETINS

No. 108.—*Rubber Content of Native Plants of the Southwestern Desert*, by T. F. Buehrer and Lyman Benson, 31 pages. This bulletin presents the results of a survey of the rubber bearing plants of the southwestern desert. A total of 183 individual samples representing ninety-three genera were collected and analyzed for rubber content.

No. 109.—*A Study of Performance in Hereford Cattle. I. Progeny Testing of Hereford Sires. II. Type as an Indicator of Performance*, by E. B. Stanley and Ralph McCall, 19 pages. Weight records were revealed as being a dependable criterion of animal performance. Greater gains were obtained from steers weighing heavy in relation to height. Since the appearance of a steer is not a reliable indication of its growth rate, selection should be based on weight-for-age, and feeder qualities associated with carcass quality, such as thickness of body, weight for height, quality, size of bone, and quiet disposition.

No. 110.—*Studies in Soil Structure VI. Water Bound by Individual Soil Constituents as Influenced by Puddling*, T. F. Buehrer and D. G. Aldrich, Jr., 37 pages. This bulletin presents the results of a study of the effect of various soil constituents on the binding of water in soils. Simple salts hold only a small amount of water in a form that fails to freeze, this being water of hydration. Organic gels in dilute concentrations hold the water entirely in the unbound form. Sands affect the available water to a very slight degree through ordinary absorption. Of the clay minerals, kaolinite was found to bind water to an extent of less than 10 per cent similar to silica powdered to the same degree of fineness. This is due to sorption on the surfaces of the tetrahedral silica sheets. Montmorillonite by reason of its expanding lattice binds water spontaneously to an extent of 97 per cent at a total moisture content of 85 per cent. As the moisture content increases beyond this point the gel suddenly changes to a sol binding only 10 per cent of the water. Organic matter present as ground alfalfa added to a puddled soil reduces the amount of water bound by way of producing an aggregated condition. Evaporation from a puddled soil is greater than from normal soil. The chief constituents of soils responsible for water binding are the expanding lattice minerals of the colloidal clay fraction. Any amendments which tend to promote aggregation will reduce the amount of water bound and render it free.

No. 11.—*Pathogenicity and Pathological Histology of Phymatotrichum Omnivorum (the fungus causing Cotton or Texas Root Rot) in a Woody Perennial—The Pecan*, by Lloyd A. Brinkerhoff and R. B. Streets, 24 pages. The pecan as grown under irrigation in Arizona is quite susceptible to root rot, especially when orchards are intercropped with a closely planted susceptible host plant like alfalfa. Trees which had apparently escaped root rot were successfully inoculated. Infection was secured readily on roots

of all sizes ¼ inch to 10 inches in diameter, but not on smaller roots.

The casual fungus makes its most rapid growth as a mantle of mycelium and strands on the surface of the roots, apparently deriving nutrients from numerous independent new lesions developing in its wake. The lesions enlarge, coalesce, and rapidly encompass the cortex, penetrating the xylem tissues but slowly. The rate of growth averaged about ⅓ inch per day. Although above ground tissues are not normally affected, they were readily invaded when covered with moist soil.

Penetration of pecan roots is through lenticels, partial breaks in the periderm, and points of emergence of lateral roots. Both chemical and mechanical action occur in initial penetration. Compact chemical and mechanical action occur in initial penetration. Compact hyphal masses were observed at point of initial penetration. Following infection individual hyphae penetrate the phloem, cambial, and xylem regions intracellularly, passing lignified walls through pits. Definite zones of discoloration extended several layers of cells in advance of the invading hyphae. Starch disappeared rapidly from the invaded tissues.

GENERAL BULLETIN

No. 197.—*The Climate of Arizona*, by H. V. Smith.

No. 198.—*Rations for Fattening Cattle in Arizona*, by E. B. Stanley.

No. 199.—*Further Studies on the Response of Lettuce to Fertilization*, by A. E. Griffiths and A. H. Finch.

No. 200.—*Gypsum, A Soil Corrective and Soil Builder*, by W. T. McGeorge.

No. 201.—*Sulphur, A Soil Corrective and Soil Builder*, by W. T. McGeorge.

No. 202.—*Arizona Agriculture, 1946*, by George W. Barr.

No. 203.—*Pest Problems of the Small Garden*, by Charles T. Vorhies and Lawrence P. Wehrle.

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No. 78.—*Lettuce Variety Trials*, by A. E. Griffiths, Robert Keswick, C. W. Van Horn, and A. H. Finch.

No. 79.—*Excessive Field Exposure Coupled with Dryness of Lint May Be Responsible for Difficulties with Irrigated Cotton*, by R. S. Hawkins.

No. 80.—*Crown Gall*, by J. G. Brown.

No. 81.—*Index to "The Grasshoppers and other Orthoptera of Arizona,"* by Lawrence P. Wehrle.

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TABLE 24, FINANCIAL STATEMENT, 1945-46, UNIVERSITY OF ARIZONA, AGRICULTURAL EXPERIMENT STATION

	Hatch	Adams	Purnell	Bankhead-Jones	Balance & receipts	State funds	Total
		RECEIPTS					
Received from the Treasurer of the U.S.	$15,000.00	$15,000.00	$60,000.00	$14,392.24	.....	.....	$104.392.24
State appropriations	.....	.....	.....				
Main station	.....	.....	.....		.....	82,406.36	82,406.36
Substations	.....	.....	.....		.....	57,211.12	57,211.12
Balance and receipts from sales	.....	.....	.....		73,190.19	.....	73,190.19
Total receipts	$15,000.00	$15,000.00	$60,000.00	$14,392.24	$73,190.19	$139,617.48	$317,199.91
		DISBURSMENTS					
Salaries	13,941.28	9,787.71	34,918.83	6,726.84	3,572.65	74,995.79	143,943.10
Other wages	150.00	1,666.37	7,038.45	2,378.80	11,868.78	21,565.39	44,667.79
Student wages	.....	323.38	1,134.78	120.65	216.75	2,258.57	4,054.13
Office supplies and expense	.....	6.84	35.56	32.61	5.39	1,351.55	1,431.95
Postage	.....	.33	.....	13.00	1.00	144.62	158.95
Telephone, telegraph and messenger	.....	37.30	73.34	125.89	76.94	1,133.30	1,446.77
Freight and express	.....	18.96	44.06	15.46	96.49	371.42	546.39
Laboratory supplies	.....	1,530.34	3,604.57	1,427.18	785.85	677.39	8,025.33
Janitor supplies	.....	.....	5.81	.....	.....	.25	6.06
Misc. supplies and expense	.....	21.15	213.07	.....	664.15	474.09	1,372.46
Fuel	.....	.....	76.77	.....	.....	173.89	250.66
Power and lights	.....	.....	8.99	.....	61.64	379.89	450.52
Laundry	.....	6.45	2.92	.....	.....	12.42	21.79
Medical supplies	.....	.....	53.26	20.10	1.27	21.33	95.96
Irrigation and water expense	.....	.....	201.88	.....	502.80	2,881.31	3,585.99
Photo supplies, developing and printing	.....	55.58	75.91	6.46	7.47	123.94	269.36
Fertilizer	.....	23.23	65.47	.....	1,719.02	791.53	2,599.25
Publications	.....	39.50	1,566.14	202.60	.....	4,848.17	6,656.41
Forage and supplies for animals	.....	15.80	1,744.40	385.09	4,380.27	4,818.35	11,343.91
Food	.....	.....	41.20	.....	.....	.....	41.20
Rebinding	.....	.....	27.90	.....	.....	15.06	42.96

TABLE 24.—FINANCIAL STATEMENT, 1945-46, UNIVERSITY OF ARIZONA, AGRICULTURAL EXPERIMENT STATION (Continued)

	Hatch	Adams	Purnell	Bankhead-Jones	Balance & receipts	State funds	Total
	DISBURSEMENTS (*Continued*)						
Motor vehicle expense	.....	2.00	1,280.83	236.92	1,040.19	2,002.34	4,562.28
Grounds and services supplies	.....	.....	10.10	.....	11.35	29.38	50.83
Repairs: Furniture, fixtures and equipment	62.16	96.61	294.70	34.02	634.37	359.47	1,481.33
Repairs: Buildings	.....	.....	57.85	.....	18.04	1,585.77	1,661.66
Repairs: Grounds maintenance	.....	.....	3.97	.....	30.30	23.66	57.93
Repairs: Motor vehicles	.....	.....	51.92	25.79	121.40	344.30	543.41
Repairs: Pipe and power line maintenance	.....	.....	.....	.....	325.95	110.12	436.07
Repairs: Machinery and farm equipment	.....	.....	16.00	25.00	771.77	823.48	1,636.25
Farm expenses	.....	.....	67.76	25.12	1,531.80	1,481.25	3,105.93
Seeds and plants	.....	9.60	.....	37.43	1,414.55	1,202.93	2,664.51
Organization dues and subscriptions	.....	.....	.....	28.00	.....	34.00	62.00
Grounds	.....	.....	.....	.....	.....	90.00	90.00
Furniture, fixtures and equipment	742.31	57.20	5,111.68	1,489.61	749.92	528.72	8,679.44
Buildings	.....	.....	.....	.....	.....	8,311.85	8,311.85
Pipe and power lines	.....	.....	160.50	.....	6,624.21	2,115.74	8,900.45
Machinery and farm equipment	.....	.....	.....	104.95	1,722.99	966.12	2,794.06
Books and periodicals	.....	.....	.....	.....	4.10	.....	4.10
Livestock	.....	.....	.....	.....	12,117.69	.....	12,117.69
Motor vehicles	.....	.....	.....	.....	2,937.73	37.56	2,975.29
Field work (traveling)	104.25	1,301.65	1,920.81	898.89	1,762.78	1,796.84	7,785.22
Miscellaneous travel	.....	.....	90.57	.....	521.05	23.80	635.42
Rent - Buildings	.....	.....	.....	1.40	.....	20.00	21.40
Publicity	.....	.....	.....	30.43	.....	.50	30.93
Insurance and taxes	.....	.....	.....	.....	155.85	596.37	752.22
Building maintenance supplies	.....	.....	.....	.....	.....	95.02	95.02
Unexpended balance	.....	.....	.....	.....	16,733.68	.....	16,733.68
	$15,000.00	$15,000.00	$60,000.00	$14,392.24	$73,190.19	$139,617.48	$317,199.91