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PROGRESS REPORT ON RESEARCH AND RELATED SERVICE APPLICABLE TO SUGAR

Including Work in United States Department of Agriculture
and Cooperative Studies with
the State Experiment Stations

* * *

Prepared for Use in Connection with the
January 1957 Meeting of the
Sugar Research and Marketing Advisory Committee

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This Progress Report is a "tool" for: (1) Advisory committee use in formulation of recommendations in regard to present and future programs, (2) Administrative use in program development, coordination and evaluation. The material in this Report is not for publication. The Report includes research findings that have already been released. When mention is made of these findings, the publication containing the public release is also cited. Any reference to published findings should mention the publication in which the release was made, not this Progress Report. Included also are many tentative findings that have not been sufficiently tested for public release. When results are ready for release, the information will be made available through established channels.

For the reasons given, copies of the Report are available only to research administrators and workers directly concerned with the development and conduct of the program and to advisory committee members. Those receiving it are asked to observe strictly the limitation: "Administratively Confidential -- (Not to be Quoted or Copied)."

UNITED STATES DEPARTMENT OF AGRICULTURE
Washington, D. C.
December 1956

FUNCTIONS OF ADVISORY COMMITTEES

The Sugar Research and Marketing Advisory Committee is one of a number of committees authorized by Congress in 1946 to advise the Department of Agriculture with respect to specific research and service programs.

The Committees have been asked to consider all of the research and marketing service work of the Department in their respective fields. This is in recognition of the value the Department places upon the advice and counsel received and is in accord with suggestions of Congressional committee members who are directly concerned with the work.

These committees are performing an important function in advising with respect to the development of the Department's research and marketing service programs. However, it is recognized by members of Congress, committee members, and the Department that the implementing and administering of these programs are the responsibility of the Department.

The functions of the advisory committeemen include:

1. Acquainting themselves with the problems of consumers, producers, all segments of the industry and of other groups, and presenting them for committee consideration.

2. Reviewing and evaluating the current research and marketing service programs of the Department, including work under way at Federal laboratories and field stations.

3. Recommending adjustments in the Department's program, including priorities for new work and expansion of work underway.

4. Developing a better understanding of the nature and value of the agricultural research program, explaining it to interested persons, groups and organizations and encouraging the wider and more rapid application of the findings of research.

USDA AGENCY ABBREVIATIONS

AGRICULTURAL RESEARCH SERVICE - ARS

AE	Agricultural Engineering Research Branch
ENT	Entomology Research Branch
FC	Field Crops Research Branch
HC	Horticultural Crops Research Branch
NU	Northern Utilization Research Branch
SU	Southern Utilization Research Branch
SWC	Soil & Water Conservation Research Branch
WU	Western Utilization Research Branch
HHE	Household Economics Research Branch
EU	Eastern Utilization Research Branch

AGRICULTURAL MARKETING SERVICE - AMS

AEC	Agricultural Economics Division
AES	Agricultural Estimates Division
FV	Fruit and Vegetable Division
GR	Grain Division
MOC	Market Organization and Costs Branch
MD	Market Development Branch

FOREIGN AGRICULTURAL SERVICE - FAS

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Much of the research on sugar covered in this report, particularly that relating to production is conducted cooperatively by the USDA agencies and the State Agricultural Experiment stations. This cooperative effort usually begins with the inception of the need for a job from farmer and industry contacts and extends by joint planning of work programs, cooperation in doing the research job, and finally, making available the results on the joint effort. The detailed arrangements for the cooperative work vary considerably, depending upon the available facilities, financial support, and personnel and the State policies involved. In principal, the cooperative efforts by the USDA agencies and the State stations are planned so as to utilize to the best advantage the personnel and facilities of both agencies and to assure coordination of effort. In most of the report which follows, the detail required to explain specific cooperative relationship is omitted.

Most marketing service and education work covered in this report also involves varying degrees of cooperation between the USDA, State departments of agriculture and bureaus of markets, State Extension Service and industry groups.

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A. Progress on Work Under Way

PROGRESS REPORT
FOR
SUGAR RESEARCH AND MARKETING ADVISORY COMMITTEE
January 9-11, 1957

1. PRODUCTION RESEARCH

A. PROGRESS ON WORK UNDER WAY

1. SUGAR BEETS

a. Production and Management

(1) Weed Control FC-ARS

(a) Weeds Limit Mechanization Progress - Lack of suitable materials and techniques for the adequate control of weeds in sugar beets and sugarcane constitutes a barrier to complete mechanization of all phases of production. Weeds not only impede progress toward mechanization but they also raise cost of production. Research on the control of weeds in sugar beets is under way in Montana, North Dakota, Michigan, and Beltsville, Maryland. Cooperative research on the control of weeds in sugarcane grown for syrup and in sorgo has been conducted in Mississippi.

(b) Control of Wild Oats in Sugar Beets - Studies in North Dakota have shown that dalapon has much promise for the control of wild oats when applied after the oats have emerged. The safest stage of growth to treat with this compound appears to be at the 2- to 4-leaf stage. Applications of 4 to 6 pounds per acre have given satisfactory control without significant damage to the crop.

(c) Control of Other Grasses in Sugar Beets - In Michigan, good control of both broadleaf and grass weeds was obtained from pre-emergence applications of 3,6-endoxohexahydropthallic acid (endothal) at rates of 4 and 8 pounds per acre without injury to sugar beets. Other compounds that showed good promise as pre-emergence herbicides were sodium trichloroacetate (TCA), dichloral urea (DCU), and 2,2-dichloropropionic acid (dalapon).

Work in Montana showed that treatments with dalapon at the 2- to 4-leaf stage of sugar beets using 4 or 6 pounds per acre of dalapon controlled 84 to 100 percent of the annual grass weeds (mainly Setaria spp.). The material was less efficient when applied pre-emergence and gave only partial or no control of broadleaf weeds. Sugar beet yields following treatment at the 2- to 4-leaf stage averaged 5 percent higher than untreated but were slightly lower than yields from hand weeded beets. In Montana, dalapon appeared

more promising for grass weed control in sugar beets than 2-(2,4,5-trichlorophenoxy)-ethyl 2,2-dichloropropionate (erbon), 3-(p-chlorophenyl)-1,1-dimethylurea (monuron), or 3,6-endoxohexahydrophthallic acid (endothal), 3-chloro-N,N-diallylacetamide (CDAA), 2-chloro-N, N-diethylacetamide (CDEA) and 2-chloroallyldiethyldithiocarbamate (CDEC) at the dosages studied. In North Dakota, TCA continued to show value as a pre-emergence herbicide to control grasses in sugar beets under most conditions and gave some control of broadleaf weeds. Under dry conditions, TCA has given inconsistent results and has not controlled wild oats satisfactorily.

(2) Gibberellin, Potentially a Miracle Drug for the Sugar Beet FC-ARS

It has been demonstrated that gibberellin, a substance produced in culture by the fungus Gibberella fujikuroi, will induce elongation of plant tissue and bring about other growth responses not previously obtainable from chemical treatments. In cooperation with investigators in the Plant Hormone Project of Horticultural Crops Research Branch, applications of gibberellin were made to large sugar beets growing in the field, and crown elongation typical of seedstalks occurred within three weeks. This type of growth from the crown of the sugar beet has been obtained previously only as a result of exposures to cool temperatures for periods of 75 to 100 days--the requirements depending upon the bolting resistance of the variety. If field experiments now under way demonstrate that gibberellin can be used to reduce the natural requirements of thermal induction for seedstalk production, the substance could become truly a miracle drug and make available to growers varieties of sugar beets higher in bolting resistance than previously practicable.

In the northern areas and in cool mountain regions, early spring plantings which normally would give highest yields often result in high incidence of seedstalks, due to lack of bolting resistance in the varieties. In regions where the sugar beet is grown as a winter crop, extreme bolting resistance is required. Sugar beet breeders have been able to establish strains and varieties with extreme requirements of thermal induction. In fact, the requirements are so great for some strains that they remain vegetative from year to year in regions that have been favorable for sugar beet seed production by the overwintering method. If gibberellin can be used to initiate seedstalks in these highly resistant sorts, thereby reducing the requirements of thermal induction, seed crops should be obtainable as with other varieties.

Only experimental quantities of gibberellin have been available for trials. However, manufacturers of antibiotics have started small-scale productions and if future tests confirm the promise of preliminary trials, gibberellin should be available as a commercial product to the extent that the needs and the economics of its use create a demand.

(3) Preprocessing Losses in Stored Sugar Beets are Serious FC-ARS

Recent investigations have indicated that part of the heavy losses of sugar in stored sugar beets may be prevented by developing varieties with a lower rate of respiration. The best selections gave a respiration rate of 84.6 percent and the second best selections gave a respiration rate of 89.8 percent of the parental variety.

Another major cause of loss in stored beet roots is rot-inducing organisms. It has been reported previously that resistance to certain fungi involved in root deterioration can be established through breeding. It is now apparent, therefore, that preprocessing losses in stored beets can be reduced by breeding improved varieties. Much work, however, is required before these desirable characters can be incorporated in commercial varieties. No further progress can be reported on the use of gamma irradiation to reduce storage losses. As reported last year, irradiation actually increased the respiration rate of sugar beet roots during the first 40 days of storage.

Plans: The studies on breeding for rot resistance will be continued at about the same level; some irradiation studies will be continued.

(4) Seedballs may Carry Stimulus for Rapid Germination FC-ARS

It has been known for many years that some sugar beet seedballs contain substances that inhibit or delay germination. For some purposes it is a standard procedure to wash sugar beet seedballs before starting germination tests. The presence of inhibitory substances in the seedballs have been confirmed by recent tests, but it has also been discovered in recent cooperative work at Michigan that seedballs of some selections contain s substance that is stimulatory to germination.

Plans: This work will be followed up to determine its implications and feasibility of selection for this character.

(5) Bolting Resistant Varieties Show Promise in California FC-ARS

In field tests conducted in the Imperial Valley near Brawley, California, a new hybrid gave a yield of 17 percent above the best commercial variety. This hybrid combines resistance to bolting and to curly top. It has been given excellent performance in the central region of the state.

Using new varieties which are extremely resistant to bolting, it has been demonstrated that fall plantings are feasible in the San Joaquin Valley. Plantings made at Tulare and at Tracy during the first part of October did not give more than 2.3 percent of bolters in new resistant varieties, while in the standard variety, US 75, which has been considered one of the slow bolting varieties, 18.5 percent were bolters.

(6) Monogerm Character Continues to Show Much Promise For Greater Efficiency in Production FC-ARS

In strip plantings made with standard precision planters with a drilling rate of approximately 2-1/2 pounds of seed per acre, the monogerm hybrid produced prethinning stands that were very desirable. A large percentage of the seedlings grew as singles. Adjacent strips were planted with processed multigerm seed, using a precision planter. Thinning trials were made both by hand and by machine. In the strips of the monogerm hybrid there was no need for short-handled hoe work, and the thinning work could be done in half the time required for normal short-handled hoe thinning of the multigerm variety. Strips of monogerm hybrid thinned by machine yielded as well as the hand-thinned beets. The higher yield from the monogerm hybrid is attributed in part to better seedling vigor of the uniformly spaced plants and to the fact that the seedlings were disturbed less than the multigerm stands in the thinning operation.

(7) High Nitrogen Fertilization Brings Quality Problems FC-ARS

The willingness of farmers to give the sugar beet an increased fertilizer ration is in a large part tied in with the development of productive disease-resistant varieties that will respond to treatment. The trend to heavier application is obviously a step toward meeting the high cost of labor by increased acre yields. It is a matter of concern to the industry that some districts that are producing higher and higher acre yields of roots have shown a gradual reduction in sucrose percentage and purity and an increase in nitrogen content. In an attempt to fashion a sugar beet that will conform to the new trend in fertilization, varieties are being subjected to screening tests in which selections are made of those producing highest sucrose percentages under luxury levels of nutrition verified by tissue tests. It is the aim of the research to develop varieties capable of responding to high levels of fertility, with maximum root yields and without diminution in quality.

Plans: These studies will be continued.

(8) Effect of Nitrogen and Zinc on Yield of Sugar Beets SWC-ARS

At Prosser, Washington, the third year of a study of effect of nitrogen source, nitrogen rates and zinc application rate on growth and zinc uptake by crops showed that only nitrogen rate affected sugar beet yields. Zinc uptake and leaf concentration was greater where ammonium sulfate was the nitrogen carrier than when ammonium or calcium nitrates were used.

Plans: This work will be continued.

(9) Sugar Content, N-Status of Beets Affected by Over-Irrigation SWC-ARS

Effects of over-irrigation on yield of sugar beets have been reported. Application of more water than the soil would retain early in the season reduced yields. Reductions were greatest at low nitrogen rates and, as expected, were not incurred at high rates.

Sugar content of the beets and nitrate nitrogen analyses of the petioles confirmed that these yield reductions resulted from removal of nitrogen from the crop. Yields were lowered, sugar contents increased, and petiole nitrate levels reduced by the excess water applications. Reductions in petiole nitrate levels by late excess applications were noted and resulted in higher sugar contents without reducing yield. This effect occurred largely in the 360 lb. nitrogen rate. It should be noted that this rate was considerably beyond the responding range. No appreciable increase in sugar content was observed at rates within the yield response range as a result of late excess water applications.

Loss of nitrogen and perhaps other nutrients and the waste of water, soil and labor resulting from over-irrigation are only a part of the over-all picture involved in this problem. Of prime concern also is the contribution of the excess water used to drainage problems. Drainage waters from this source could be largely eliminated by proper irrigation methods and care in water application.

(10) Sweet Clover with Barley Increases Yield of Sugar Beets SWC-ARS

Sweet clover planted with barley in 1954 increased 1955 yields of sugar beets about 5 tons per acre at Huntley, Montana. Various methods of planting and row spacings of sweet clover and barley did not affect the sugar beet yields. Studies in years and stage of growth when sweet clover was turned under for beets had some

effect on beet yields, but the best yield increases were more than offset by no crop or reduced yield of barley.

Plans: This work will be discontinued after this year.

(11) Phosphate Benefits Sugar Beets on Reclaimed Soils SWC-ARS

A rotation experiment on a saline-alkaline soil reclaimed by leaching at Grand Junction, Colorado, is showing the benefits of alfalfa in reducing the nitrogen fertilizer requirements of corn and beets in the rotation. Large responses to phosphate are being obtained on sugar beets and alfalfa. This study has the objective of determining best fertilizer practices on a reclaimed soil for rotations with and without alfalfa.

Plans: This work will be continued.

(12) Pesticide Application Equipment AE, ENT-ARS

Work has been conducted at Toledo, Ohio, in cooperation with industry on construction materials for equipment for handling pesticides, liquid soil fumigants, and fertilizers. In the work with sprayers, comparisons were made between corrosion rates occurring during sprayer tank storage and those during actual use. Results of field tests completed to date show that for practically all metals and alloys, corrosion rates decreased during the storage period. A correlation of these results, together with others obtained previously, pin-points the time of greatest attack as occurring during brief periods between sprayer use when the tank is left empty but uncleaned and the metal surfaces still damp and exposed to the atmosphere.

Since the use of liquid fumigants for soil treatment has been rapidly increasing over the past few years, investigations were undertaken for determining suitably resistant construction materials. These studies show that for handling the commonly used materials such as ethylene dibromide and dicholor-propene-dichloropropane or other halogenated hycrocarbons, the use of mild steel should be avoided where possible. Resistant metals include copper alloys, Ni-Resist and stainless steel. Resistant rubber and plastic materials for hose, gasket, and diaphram use include good grades of neoprene, Buna N, polyethylene, Teflon, nylon, and certain others.

In order to augment presently known information on the corrosive effect of nitrogen solutions, laboratory investigations were undertaken for determining the relative resistance of a wide variety of metals and alloys. Data obtained show that the commonly used nitrogen bearing solutions have serious effect on copper, copper-base alloys, zinc, cast iron, and low alloy steels.

On the other hand, nickel, high nickel alloys, aluminum, and the austenitic and ferritic stainless steels appear to offer suitable resistance.

Experiments with low-gallonage spray equipment for control of diseases on truck crops were made at a number of locations in Ohio cooperatively with the Ohio Agricultural Experiment Station. (While these experiments were made on crops other than sugar beets, they are mentioned because the equipment has possibilities for use with this crop.) Practically all fungicides used up to date have been in wettable powder form making it difficult to apply at low gallonage rates because of nozzle clogging difficulties encountered with conventional sprayers. Hydraulic sprays applied at 20 to 160 gallons per acre but at the same chemical rate showed no significant difference in disease control or yields on potatoes and tomatoes. Applications at 30 and 40 gallons of spray per acre with air blast gave control of diseases equal to hydraulic sprays at 160 gallons per acre when the same amount of fungicide was used. Deposit pattern studies to determine the uniformity of spray across the swath showed a considerable higher deposit of fungicide on foliage than with high gallonage hydraulic spray. In all cases the air blast deposit was higher than the highest hydraulic and average of air blast deposit was 100 percent higher than the average of the high gallonage hydraulic spray treatment. Air blast concentrate sprayers offer much promise for reduction of labor and time but better control of air pattern is needed.

Study was initiated in Ohio on equipment requirements for applying soil treatments for control of nematodes and soil borne diseases. Two types of equipment were designed, constructed and field tested in cooperation with the Ohio Agricultural Experiment Station: 1) Sub-surface injector for handling liquid fumigant materials, and 2) Surface spray applicator in conjunction with a commercial soil mixing tractor attachment. Field applications were performed during the spring and fall for purposes of chemical screening. Some promising results were obtained in control of certain diseases such as potato scab, verticillium on eggplant and tomato anthracnose. Significant reductions of nematodes attacking carrots, celery, and onions were also obtained. Continued work on equipment requirements is needed as very little information on equipment is available at this time.

Plans: Investigations on equipment and methods for the application of pesticides to various crops will be continued along present lines so far as facilities permit.

b. Insects and Diseases

(1) Insect Investigations ENT-ARS

(b) Beet Leafhopper - Greenhouse tests in Arizona showed that sprays containing certain of the systemic insecticides gave good control of the beet leafhopper on sugar beet plants grown for seed that were actually covered by the sprays, but that the toxic effects of these materials were not translocated downward to the new leaves which grew from the crowns of the treated plants. The systemic insecticides, in the order of their effectiveness, were demeton, Bayer 17364, Bayer 19639, Am. Cyanamid 3911, Hercules AC-528 and Shell OS-2046. The residual effectiveness of these materials, as evidenced by the killing of the beet leafhopper, ranged from less than 5 days for Hercules AC-528 and Shell OS-2046, to 11 days for Bayer 19639 and Am. Cyanamid 3911, and 18 days for demeton and Bayer 17364.

The production of monogerm and hybrid sugar beet seed in northern and southern Utah has presented problems in the protection of sugar beet seedlings from curly top disease infection by the beet leafhopper. A side dressing of the systemic insecticide Am. Cyanamid 3911 at the rate of 1 pound per acre, mixed with 200 pounds of ammonium sulfate, was applied prior to the development of the seed stalk. Samples of seed from treated and untreated plots have been collected to determine if any benefits in terms of seed viability has occurred as a result of this treatment.

Plans: Experiments will be continued in Arizona and Utah with systemic insecticides for the control of the beet leafhopper on sugar beets grown for seed and experiments will be conducted for the control of this pest on sugar beets grown for sugar in Utah, Colorado, and Idaho if the intensity of the leafhopper infestation provides a favorable opportunity.

(b) Lygus Bugs - In large-scale field tests for the control of lygus bugs on sugar beets grown for seed in Arizona, a single application of dusts containing 10 percent of DDT; 2 percent of dieldrin; 15 or 20 percent of toxaphene; or 2 or 3 percent of the gamma isomer of BHC, applied by aircraft at the rate of 30 pounds per acre, all failed to give satisfactory results. In most cases the initial kill with these insecticides was satisfactory but no substantial residual effect was obtained. A second application of each of these materials was required to reduce the lygus bug populations satisfactorily in most fields and in some fields a third application

was required. In these instances dusts containing 2 percent of parathion, or 4 or 5 percent of malathion was applied by aircraft at the same rate per acre mentioned previously. Prior to 1954 a single application of 5 percent DDT dust was sufficient to control lygus bugs on sugar beets grown for seed in Arizona.

In an experiment for the control of lygus bugs on monogerm and hybrid sugar beets seed plants in northern and southern Utah, a mixture of 1 pound of Am. Cyanamid 3911 and 200 pounds of ammonium sulfate, applied as a side dressing at the rate of 200 pounds per acre prior to the development of the seed stalk, did not reduce the population of lygus bug adults or nymphs on the plants at the flowering stage. Samples of seed from treated and untreated plots have been collected to determine whether or not the insecticide treatment had a beneficial effect on seed viability.

Plans: Experiments for the control of lygus bugs on sugar beets grown for seed in Arizona and in Utah will be continued in 1957.

(c) Sugar-Beet Root Maggot - Experiments for the control of the sugar-beet root maggot in northern Utah were designed to determine the effect of insecticide seed treatment and side dressing applications as reflected in stand and yield of sugar beets. The seed was treated in a commercial seed treater, using ½ pound of aldrin, dieldrin, heptachlor, or Am. Cyanamid 3911 to each 100 pounds of seed. The side dressing of heptachlor or Am. Cyanamid 3911 was applied at the rate of 1 pound per acre just prior to thinning while the sugar beets were in 4- to 6- leaf stage. Despite an observed low sugar-beet root maggot population in the two sugar beet fields where the experiments were staged, the stand of thinned beets in the plots where the seed was treated with aldrin, dieldrin and heptachlor averaged 86 percent compared to 66 percent in the untreated plots. The side dressing treatments were ineffective.

The insecticides that have given effective commercial control of the sugar-beet root maggot in southern Idaho are being tested during 1956 in a maggot-free field to determine their effects upon yields of sugar beets but the results are not yet available.

Plans: Studies will continue on the sugar-beet root maggot in Utah and in Idaho during 1957.

(d) Red Spider Mites - In experimental plot tests with systemic insecticides in Arizona, on sugar beets grown for seed, the population of a species of red spider mite was reduced greatly by a single application of sprays containing Am. Cyanimid 3911 or Bayer 19639. Sprays containing demeton were not as effective as those just mentioned but seemed to have a longer residual effect. Hercules AC-528 was not as effective as the other three materials tested. A marked increase in the mite populations occurred 11 to 19 days after the spray applications on the plants in the plots treated with Am. Cyanamid 3911 or Bayer 19639, while during this same period mites decreased 38 percent on the untreated plots. This decrease of mites on the untreated plots was attributed to the beneficial activities of the predators known as pirate bugs (*Orius* sp.) and indicates that Am. Cyanamid 3911 and Bayer 19639 were toxic not only to the noxiuos mites but also to their predators.

Plans: These studies will be continued in 1957 or whenever red spider mites become numerous on sugar beet plants grown for seed.

(e) Red-Backed Cutworm - Experiments for the control of the red-backed cutworm in Idaho during 1956 showed that dusts or sprays containing toxaphene applied to the soil surface of sugar beet fields at the rate of 3 pounds per acre were generally effective when applied before severe damage was inflicted to the small plants. These studies will be continued.

(f) Beet Webworm - Field experiments for the control of the beet webworm infesting sugar beets in Idaho during 1956 demonstrated that emulsion sprays containing endrin, parathion, toxaphene alone or a toxaphene-methoxychlor combination were effective. Less effective results were obtained with sprays containing isodrin, methoxychlor alone or malathion. Comparative tests with ground equipment versus aircraft indicated that dosages of toxaphene should be increased about one fourth, for equally good results, when applying sprays by aircraft for beet webworm control. In small cage tests, sprays containing DDT or parathion were more effective in killing the webworm than sprays containing aldrin, chlordane, dieldrin, endrin, heptachlor, isodrin, lindane, malathion, or methoxychlor.

Plans: These studies will be continued.

(g) Beet-Leafhopper Surveys - Surveys early in 1956, in the beet leafhopper breeding areas of southern Utah, southern Nevada, southeastern California and in Arizona showed that the overwintering population of the insect was very light and that the acreage of its spring host plants in the desert areas was smaller than at any time during the last 10 years. Similar surveys in northern and eastern Utah showed that leafhopper populations in these areas were also very low. The leafhoppers from the southern breeding areas started to move northward into the cultivated districts of southern Nevada and southern Utah in late March, which is about the usual time for this initial movement and did not reach northern and central Utah and western Colorado until May 18 which is later than usual. The initial movement from the northern and eastern Utah breeding areas into the adjacent cultivated districts did not occur until June 7, also later than usual. Surveys in the sugar beet fields of Utah, adjacent Colorado, Nevada, and Arizona during the summer of 1956 showed that less than one percent of the plants were infected with curly top disease, which was much lower than during average years. It is planned to continue these surveys in 1957.

Surveys in southern Idaho and adjacent eastern Oregon showed that the highest population of the beet leafhopper recorded since 1949 entered the winter of 1955-56. The winter was very favorable for leafhopper survival. Studies in the spring of 1956 showed that the leafhopper host plants were abundant and widely distributed in the burned-over and otherwise disturbed breeding areas of the insect and were in good condition for producing a large spring brood. Later studies showed an average of 131 leafhoppers per 100 square feet in these host plant areas as compared to an average of 14 for the last 14 years. Timely rains during the spring maintained the weed host plants in a succulent condition until late June and further contributed to the prevailing favorable condition for best leafhopper breeding. Laboratory tests indicated that an average of about 20 percent of the leafhoppers were carrying the curly top virus, as compared to about 15 percent during most years. The movement of the leafhoppers from their wild host breeding areas to sugar beets and other susceptible crops began and reached their maximum magnitude about 5 days later than usual. The peak population recorded in sugar beet fields during this movement was 233 leafhoppers per 100 square feet, as compared to an average of 730 during the past 20 years. These surveys will be continued in 1957.

Two statements were issued to the sugar beet and cannery industries of Idaho, Utah, Colorado, and Nevada giving a timely summary of the beet leafhopper conditions, as revealed by these surveys. These statements enabled the growers of sugar beets and other susceptible crops to adjust their planting schedules and cultural practices to escape severe curly top infection. It is planned to continue this research.

Studies during February and March 1956 revealed low populations of the beet leafhopper in the southern Great Plains and adjacent areas, including the territory extending from the Rio Grande in New Mexico and Texas east to the 98th meridian and north to the Arkansas River Valley of Colorado and Kansas. Because of the drought the spring weed hosts of the leafhopper were sparse or absent in much of this area. It is planned to continue these surveys.

Plans: These surveys will be continued.

(2) Disease Investigations FC-ARS

(a) Combination of Virus Yellows and Curly Top Causes Damage to Sugar Beet Seed Crop - A serious disease problem has developed in a major area of sugar beet seed production in Arizona. In 1955, and again in 1956, the acre-yield of seed has been far below the average, and the low quality of the seed produced has been of greater concern. Although there has been some curly top in the area, sugar beet seed production here by the overwintering method has been the highest of any region in the country.

It was reported last year that virus yellows was prevalent in the seed fields in the Phoenix, Arizona, area. It was also given in the Progress Report that plants with virus yellows were more susceptible to infection and injury by curly top than yellows-free plants. Seed harvested from plants infected with both virus yellows and curly top germinated only 35 percent, while seed produced by healthy plants gave a test for 95 percent. From these preliminary tests it is indicated that the combination of the two diseases is much more serious than the additive effects of the diseases if present separately in the plants.

Plans: Cooperative investigations are under way to develop methods of combating the disease problems that have arisen in this major area of sugar beet seed production.

(b) Strains of the Virus as Factors in Yellows Damage - The test conducted at Riverside, California, using a virulent strain and a mild strain of the virus, indicated a reduction in yield of 28 to 36 percent of the virulent strain and about 14 to 22 percent for the mild strain. This test indicates clearly that the amount of damage from this disease is influenced by the strain, or strains, in a locality as well as by the time of actual infection. In these tests there was a reduction in sucrose percentage as a result of virus yellows. The widespread occurrence and serious losses caused by this disease point up the need for breeding resistant varieties or developing other means to overcome these losses.

Damage appraisal tests to determine the loss from virus yellows were conducted in cooperation with the entomologists of the Colorado Experiment Station. The over-all average loss in gross sugar yield in plots infested with viruliferous aphids, as compared to the uninfested plots, was 12.6 percent--a highly significant difference attributable to virus yellows.

(c) Evaluation of Sugar Beet Strains for Virus Yellows Resistance - Field tests have been conducted with a large number of inbred strains and varieties as well as different species of wild beets, in an effort to find resistant types. In 1956 at Salinas, California, 56 inbreds obtained through The Beet Sugar Development Foundation, 46 selections made in Colorado, and 859 selections made in Oregon, have been evaluated for virus yellows resistance. Some of the selections appear to be considerably more susceptible to injury by the virus than US 75 used as a standard of performance, while others appear to have considerably more resistance. The highlight of the test is the occurrence of five or six selections in which the inoculated plants are hardly distinguishable from the uninoculated ones. If this indication of resistance is confirmed in harvest records, these selections will be of great value in breeding for resistance to the virus.

(d) Influence of Curly Top on the Physiology of the Sugar Beet - Methods have been perfected during the past year to determine the changes in the concentration of certain amino acids in leaves of susceptible sugar beet plants affected with severe strains of the curly top virus. It was found that all of the amino acids, except cystine, accumulate in the leaves of sugar beets showing severe symptoms of curly top. As a whole, the amino

acids tend to accumulate in diseased leaves to about double the concentration found in comparable healthy leaves. The most striking difference attributable to disease is the accumulation of basic amino acids argenine, histidine, and lysine in leaves of curly top infected plants. The mean ratio of argenine in 11 samples from curly top infected plants to the mean concentration in the leaves of healthy plants was 3.3

Plans: These investigations are being continued to determine the basic properties of the curly top virus and its influence on the physiology of the sugar beet.

(e) Disease Resistant Varieties Necessary for Stable Production - In regions west of the Rocky Mountains, the leafhopper, *Circulifer tennellus*, migrates each spring from the range lands, where it overwinters, to the irrigated districts. The insect feeds on sugar beets, tomatoes, and other cultivated plants and, in feeding, transmits to susceptible hosts a virus which is capable of causing great damage. In the sugar beet the disease caused by the virus is known as curly top. Before there was a concerted effort at resistance breeding in this country and when only imported seed of susceptible varieties was availalbe, sugar beet production was not possible in irrigated districts near the overwintering areas of the leafhopper or in the major paths of its migration. In most other regions of the West where the growing of sugar beets was undertaken, curly top presented an ever-present hazard and prevented stabilization of production. In some districts the disease resulted in the abandonment of the industry after it had been established.

Breeding for resistance has given a succession of curly-top-resistant varieties such as US 1, US 33, US 22, and, more recently, hybrids. The damage by curly top has been reduced with each stage of varietal improvement. However, the tremendous losses occurring two or three decades ago would occur again if the breeders in the development of new types and hybrids did not maintain constant vigilance and prevent the reversion to less resistant sorts. It seems to be worth while to point out the extent to which the sugar beet growers, through resistance breeding, have freedom from the hazards of this disease.

Probably the outstanding record of the benefit derived from breeding for curly top resistance was obtained in a field test conducted with eight varieties of sugar beets at the New Mexico Agricultural Experiment Station in 1955.

A susceptible variety of European origin was a total loss due to curly top. In the same test, a curly-top-resistant hybrid gave a yield of over 49 tons per acre. This is the first indication that sugar beet production may now be possible in the lower Rio Grande Valley and in other districts where, in the past, epidemics of curly top have been unusually severe.

In a number of sugar beet growing areas it has become increasingly evident that combined resistance to several diseases is necessary. This is particularly true of such diseases as curly top, black root, and leaf spot. Research under way for several years, cooperative between the Plant Industry Station and the New Mexico Experiment Station, has developed a variety high in curly top resistance and moderate in leaf spot resistance. This variety has been released as US 104. More recently the hybridization of CT 9, highly resistant to curly top, and US 201 B, highly resistant to leaf spot, has resulted in a hybrid variety outstanding in yield. Another cross in which SP 5350-01, resistant to curly top, and US 400, resistant to leaf spot and black root, were used as parents, the hybrid exceeded the yield of the curly-top-resistant variety US 22/4 by 40 percent when grown under leaf spot exposure at Fort Collins, Colorado.

Plans: This work will be continued.

(f) Preliminary Studies on Rhizoctonia Root Rot - The need for research on Rhizoctonia root rot was discussed in the Progress Report of 1955. Studies pertaining to this disease have been initiated in cooperation with the Colorado Agricultural Experiment Station. The chief long-range objectives are the development of field and greenhouse techniques for selection and testing, and the development of resistant strains.

Preliminary tests with seeding populations of US 401 and a local variety of sugar beets when grown under severe exposure to Rhizoctonia solani showed a significantly lower percentage loss of seedlings for US 401. It is of interest to note that US 401, which is resistant to leaf spot and to black root, was recently released for use in the Great Lakes Region where these diseases are factors in sugar beet production.

Plans: This work will be continued.

(3) Nematode Investigations FC-ARS

(a) First Discovery of Nematode Resistance in the Sugar Beet - Screening tests in which more than 75,000 sugar beet plants of various sources have been grown in the greenhouse under control conditions of nematode exposure and examined individually for nematode resistance have brought to light only a few plants classed as showing any degree of resistance. The progenies of these plants have shown only slight improvement in resistance over the parental variety. The new discovery to be reported in nematode resistance in the sugar beet is the finding in some selections of a reduced number of nematodes in roots, as well as resistance to wilting. The original selections were made by the American Crystal Sugar Company, a cooperator through The Beet Sugar Development Foundation, in a leaf-spot-resistant variety, US 215 X US 216.

It should also be reported that screening results conducted by the Instituut voor Rationele Suikerproductie, Bergen op Soom, The Netherlands, with which there is an informal cooperation for exchange of results and material, have indicated that some sugar beets do not wilt when attacked by the nematode, even though the roots of the plants are heavily infested by the organism. This may represent a different type of resistance and requires further study.

Interspecific hybridization looking toward nematode resistance is being continued. Rooted cuttings of F_1 hybrids between Swiss Chard and Beta webbiana were found to be entirely free of nematodes when grown for two months in heavily infested soil in California experiments. Since Swiss Chard is highly susceptible, this indicates that resistance as it occurs in the Beta webbiana species may be dominant. Some promise is indicated for resistance in commercial beets which, together with the possibility of using interspecific crosses with the immune species Beta patellaris, B. procumbens, and B. webbiana, makes it appear a very worthwhile project.

Plans: This work will be continued.

(b) Contract with the Beet Sugar Development Foundation HC-ARS

On July 1, a contract was signed with the Beet Sugar Development Foundation for a study of nematodes associated with sugar beet production. This contract will be in force for about 15 months. During this time, the nematodes associated with sugar beets in selected areas of California, Colorado, and Michigan will be studied

with the object of determining what kinds of nematodes in addition to the sugar beet nematode (Heterodera schachtii) are of importance in beet production in those states. Several thousand subsamples were collected, processed and preserved during the summer and the nematodes will be extracted from these and identified as soon as possible. Additional collections will be made in the summer of 1957, and a report will be delivered in the fall of 1957. Preliminary results indicate that root-knot nematodes are very common on sugar beets in parts of California. In Colorado, damage very similar to root knot is caused by a nematode so newly discovered that it has no common name, but only the scientific name, Nacobbus batatiformis.

Samples from sugar cane fields have shown that stylet nematodes, spiral nematodes, stubby root nematodes and meadow nematodes are very common in Louisiana. Experiments designed to demonstrate damage by these nematodes are in progress.

Plans: Work will continue substantially as at present.

c. Breeding and Testing

(1) Hybrids of Outstanding Performances Require High Quality Inbreds FC-ARS

The outstanding performance of hybrid sugar beets have emphasized the importance of good parental lines. Some of the new and promising curly-top-resistant lines are worthy of note. The new CT 9 line has shown improvement in curly top resistance, high sucrose percentage, and better pollen production than the original CT 9. Inbred line 158 is high in purity and low in amino nitrogen, indicating superior processing qualities.

The excellent performance of hybrid sugar beets in comparison with those developed by mass selection continues to indicate a new level of performance and clearly points the way for the future type of commercial varieties. One of the highest-yielding hybrids developed in curly top resistance breeding in tests of 1955 was F 54-4H7, a 4-way combination in which cytoplasmic male sterility and Mendelian male sterility were used as tools to bring about hybridizations in the production of the F_1 hybrids and the double cross. In spite of the fact that one parent in the double cross was curly top susceptible, the 4-way hybrid in tests conducted under severe curly top exposure was more resistant than the old commercial variety, US 33.

A new nonbolting inbred has been developed that is extremely resistant to bolting, possesses good mildew and curly top resistance, and has excellent vigor. This inbred is now being tested in hybrid combinations. Other inbred lines show a high degree of mildew resistance. Hybrids developed in the breeding program have produced from 15 to 30 percent more sugar per acre than the best commercial varieties in cooperative field tests conducted in California. Some of these hybrids have been equal in bolting resistance to US 75, which is the most resistant USDA variety now in commercial use. Several of the best inbred lines have been made available to industry breeders for the production of commercial hybrids through The Beet Sugar Development Foundation.

Additional evidence was obtained that resistance to downy mildew, Peronospora schachtii, is at least partially dominant over susceptibility. This means that hybrid varieties of sugar beets can be produced with good mildew resistance, even though one of the parents is only moderately resistant.

(2) Methods of Partitioning Variance Reveal Superior Breeding Material FC-ARS

Methods have been developed for the partitioning of variance into its components and for genetic analysis that will reveal superior individuals in sugar beet populations in studies in Colorado.

In starting and in pursuing breeding programs, it is desirable to evaluate different materials that become available. The application of methods and formulas which have been developed should provide information concerning the extent of genetic variability, the proportion in the population of superior individuals, genetic gains possible, and the relation between the characters in breeding material. Such information makes possible the selection of superior stocks with which to start the breeding program. The methods and formulas which have been developed are equally as valuable throughout the pursuance of the breeding program as they are in evaluating initial stocks. They may be used to evaluate the progress being made when employing well-known breeding methods such as mass selection, polycross breeding, recurrent selection, reciprocal recurrent selection, and production and hybridization of inbred lines.

(3) Breeding for High Quality FC-ARS

In the development of the sugar beet, major emphasis has been given to the development of varieties high in sucrose

percentage, with relatively little consideration given to other chemical constituents. Certain chemical components of the sugar beet are known to have a high melassigenic effect. If these undesirable constituents could be reduced without loss of sugar percentage, it would greatly reduce the cost of recovery of sucrose from the sugar beet. Approximately 2,000 chemical and physiological determinations were made on plot samples at the Salt Lake City field station, taken from extensive variety tests conducted in Utah, Idaho, and California. In eight field tests, differences among varieties in amino nitrogen, sodium, and potassium were found to be statistically significant. This demonstrates that among the established varieties of sugar beets there are at present marked differences in quality. In line with the results of these variety tests, purposeful selections were made toward a desired composition with respect to chemical constituents including sucrose percentage. It was found that the progenies conformed to the direction of selection. The sugar beet is amenable to breeding for specific quality requirements. There is a lack of knowledge concerning the chemical constituents determining quality.

(4) Symptom Expression Complicates Breeding for Virus Yellows Resistance FC-ARS

The losses for 9 inbreds inoculated with yellows virus ranged from 0.9 percent for C-3502 to 24.5 percent for the highly susceptible strain SP 461020-0, indicating a wide range in disease reaction. The correlation of yellows reading with the depression of gross sugar yield was not significant when based on the performance of 12 diverse strains of sugar beets. Therefore, some of the strains showing only slight yellowing nevertheless were severely damaged by the virus.

Applications of nitrogen gave subsequently larger and darker foliage than two other fertilizer treatments. The virus yellows symptoms were obviously less pronounced with the high applications of nitrogen. Statistical analyses of the data indicate that the nitrogen levels had essentially no effect on the disease reaction as measured by reduction in yield.

These findings concerning symptom expression and the reduction in yield are in line with the reports of European workers that the degree of yellowing induced by the virus is not a true index of the damage done to the plants. The lack of a readily observable symptom indicating the severity of virus damage other than reduction in growth greatly complicates breeding for virus yellows resistance.

It has been reported by European investigators that the presence of the yellows virus in the sugar beet could be detected by

by chemical methods using colometric tests. However, it has been found that the test is positive for yellow leaves and, unfortunately, it does not discriminate between the yellowing due to the virus and yellowing resulting from attack of downy mildew or from other factors.

(5) Significant Progress with Monogerm Sugar Beets FC-ARS

Encouraging progress has been made in the development of monogerm hybrids which are resistant to curly top. In replicated tests in Utah and Idaho, the monogerm hybrid F 54-4H21 was superior to the commercial variety US 41 in root yield and in gross sugar per acre.

Monogerm strains showing great advance in leaf spot and in black root resistance over those available previously have been developed. Some of these strains are as disease resistant as US 400 and only slightly below this variety in yield. The polycross method of breeding is being applied to further improvement in productivity.

The first extensive commercial production of monogerm seed is now in progress. This seed will be available for grower use in 1957. This will be the first time monogerm varieties have been available for grower plantings. The original single monogerm plant was found in 1948.

(6) Further Progress in Breeding for Resistance to Leaf Spot and Black Root FC-ARS

Agronomic tests to evaluate new leaf-spot- and black-root-resistant varieties in the Great Lakes area were conducted in cooperation with State Experiment Stations and the Farmers' & Manufacturers' Beet Sugar Assoc. The outstanding performance of US 400 in all tests where leaf spot and black root were factors in production confirms previous tests in 1954 with this variety. Commercial seed has become available and US 400 will be used estensively in the Great Lakes region in 1956.

A related variety, US 401, which has shown improvement over US 400, has been released. Extensive commercial seed production of this variety is under way and it should be generally available for grower use in 1958.

New synthetic varieties developed by the polycross method of breeding show great promise in higher sucrose and yield of roots, as well as a higher level of disease resistance.

(7) Induced Mutations FC-ARS

In cooperation with the Brookhaven National Laboratory, work is continuing to obtain mutant types from seeds exposed to X-ray and gamma ray. According to the original plan of research, irradiated individuals were selfed and the progeny examined for recessive mutations, which are the type usually produced. However, since some characters are inherited as a dominant or intermediate, the irradiated seeds are being planted directly for exposure to reveal the character sought. This makes it possible to screen much larger quantities of irradiated material.

Plans: All studies under breeding and testing will be continued at about the same level.

2. SUGARCANE

a. Production and management

(1) Cultural practices FC-ARS

A modified method of off-barring sugarcane in Louisiana that rebuilds the row immediately was equal to the conventional method that leaves a trench or furrow on each side of the line of cane, based on yields of cane and sugar per acre. The modified method of off-barring is particularly useful when applying anhydrous or aqueous ammonia, and it provides better drainage for the land.

Slumping or slacking of the soil was not influenced by additions of organic matter from soybeans or cane trash at Houma, Louisiana, during 1955. Accumulated residual influence of organic material added to the soil may influence the water stability after a period of years. After several years, there appears to be a favorable yield response in plots where soybeans were turned under in the rotation.

Soybeans planted broadcast at Houma had as high nitrogen content on a dry-weight basis as when the crop was planted in double rows in drills. However, yields of green material from the broadcast planting were approximately 30 percent higher than from the double row planting. This larger yield of green material increased the pounds of nitrogen per acre by 35 percent. Sunn hemp (Crotelaria juncea) was equal to soybeans as a green-manure crop when both crops were planted broadcast.

The erect-growing variety, C.P. 36-105, produced 400 more pounds of sugar per acre in rows spaced 44 inches apart, than in rows spaced 72 inches apart at Houma, La. There was

essentially no difference between the yields from narrow- and wide-spaced rows with a good shading variety like C.P. 44-155.

In Georgia, there was no difference between yields obtained from sugarcane planted on October 15 and that planted the following spring on March 15. The same response was obtained at Brewton, Ala. It is more economical to plant sugarcane in the fall in Alabama and Georgia.

(2) Weed-control Studies FC-ARS

Dalapon showed excellent promise for controlling Bermuda grass in sugarcane in Mississippi when applied to the growing grass either before or after emergence of the sugarcane. TCA and monuron applied prior to the emergence of the weeds and the sugarcane shoots at dosages of 20 and 3 pounds per acre, respectively, and the usage of 2,4-D at 1/2 pound per acre as a post-emergence spray gave good annual grass and broadleaf weed control without apparent damage to sugarcane.

(3) Fertilizers FC-ARS

The use of 80 pounds of nitrogen per acre, compared to 40 pounds, had no significant effect on yield of sugar per acre from plant cane in four out of five tests in Louisiana. In one test, there was a slight but significant increase from the 80-pound application. Sucrose content of the juice was slightly reduced in each case where 80 pounds of nitrogen were applied. Varieties used in these tests were not treated for the ratoon stunting disease. In another series of tests on stubble cane at three locations in Louisiana, 120 pounds of nitrogen increased the yield of cane and sugar per acre over the yield from 80 pounds of nitrogen at one location and reduced the yield at another. In other tests there was no difference between the yields from 80 and 120 pounds of nitrogen per acre. There were no significant difference in yields from applications of phosphate and potash. Significant variety-nitrogen interactions were obtained in a plant-cane experiment at Houma.

Applications of sodium molybdate did not influence the yield of cane under Louisiana conditions. Calcium peroxide applied to heavy silty clay loam soil in Louisiana to increase the amount of oxygen in the root zone area increased the yield of sugar per acre by 1,250 pounds. This significant increase in yield of sugar per acre is thought to be associated with improved aeration of the soil. Applications of 500, 1,000, and 2,000 pounds of Krillium per acre and Poly-ac at 45 and 225 gallons per acre did not have a significant influence on yields of cane or sugar per acre in Louisiana.

Plans: Studies on problems under Production and Management will be continued at about the same level.

(4) Drainage Studies for Sugarcane Production SWC-ARS

In 1955, near Baton Rouge, Louisiana, emphasis was placed on a study of flat-planted cane vs. conventional high (16" - 18") row-planted sugarcane. In flat-planted cane, quarter drains installed at planting required no further maintenance during the plant cane season. However, in row-planted cane, maintenance costs of quarter drains averaged approximately $2.50 per acre. Cultivation costs were $1.00 per acre for flat-planted cane and $2.00 per acre on row-planted. Harvest operations and equipment management also were less difficult on flat-planted. Stubble cane yields from flat-plantings showed an increase of 7.41 net field tons and 12.19 net standard tons over row-planted cane.

Plans: This work on land-forming or grading to improve surface drainage and reduce drainage costs on sugarcane lands will be continued in areas where diversified farming demands a cane culture that can use cotton farming equipment.

b. Insects and Diseases

(1) Insect Investigations ENT-ARS

(a) Soil Pests - Research conducted in Louisiana indicated that soil arthropods in sugarcane can be effectively controlled with several insecticides. Endrin, isodrin, and heptachlor at ½ pound per acre or aldrin at 1 pound gave as good control as chlordane at 2 pounds, which is now recommended. There was no difference between formulations of the insecticides, but application on the seed pieces in the open planting furrow was more effective than that made in the open forrow before the cane was planted, or on top of the row after the cane was planted and covered with soil. The insecticides, aldrin, endrin, dieldrin, isodrin, heptachlor, and chlordane gave promising control of the sugarcane beetle. There was no significant difference between spray, granular or dust formulations. Insecticide application on the seed pieces at the time of planting was better than that made on the young plants just before the beetles invaded the cane fields.

In large field tests in Florida 4 pounds per acre of heptachlor gave effective control of white grubs and wireworms in sugarcane. The cane yield was increased more than one ton per acre by the treatment.

Plans: These investigations will be continued.

(b) Sugarcane Borer: Tests to determine the possibility of economic control of the sugarcane borer by imported parasites have been encouraging. The Cuban fly introduced from Trinidad has become established in Louisiana, and it has been recovered from recent releases in Florida. Average borer parasitization was 19 percent in 1955 on plantations in Louisiana where the parasite had become established. A marked reduction in dead hearts caused by first-generation borers was noted in the spring of 1956 in fields where parasitization was high in 1955.

Plans: This work will be continued.

(2) Disease Investigations FC-ARS

(a) Ratoon Stunting Disease - The ratoon stunting disease (R.S.D.), considered to have an important part in the deterioration of commercial varieties of sugarcane, caused heavy losses in Louisiana, Florida, and Puerto Rico. Based on data from plant cane experiments in Louisiana, the yield of C.P. 44-101 was reduced from 12 to 20 percent by the disease. Treatment of seed cane with hot water at 50°C. for two hours definitely reduced losses from R.S.D. in this leading commercial variety. Symptoms of R.S.D. appeared in a small percentage of the progeny from cuttings treated with hot water at 50°C. for two hours, as well as for 2-1/2 hours, and in the progeny from cuttings treated with hot air at 54°C. for 8 hours. No symptoms appeared when the cuttings were treated with hot air at 56°C. for 8 hours. The more severe treatments required to completely eradicate the disease caused severe damage to the cuttings.

The ratoon stunting disease was transmitted from diseased to healthy stalks of sugarcane in Louisiana by dipping the cut ends of stalks into infected juice, by cutting the stalks with an infected knife, and by introducing the inoculum into holes punched in the stalks. These three methods of inoculation are about equal in efficiency in transmitting the disease, and they are superior to inoculating with a hypodermic needle.

It was demonstrated at Houma that juice from leaves of infected plants is effective in transmitting R.S.D. This first successful transmission of the disease by inoculation with juice from leaves, indicates the possibility of insect transmission under field conditions.

Dilution of R.S.D.-infected juice 1 : 100,000, reduced infection in susceptible disease-free plants from 100 to

10 percent. R.S.D. symptoms were eliminated to a greater extent from smaller-stalked varieties than from large-stalked varieties when given the standard hot-air treatment, 54°C. for 8 hours. There is an apparent though unconfirmed relationship between the size of the stalks and the effectiveness of the heat treatment.

Progenies from heat-treated seed cane in 9 of 10 current or former commercial varieties in Louisiana gave increases in yield averaging 21 percent. Yields of 8 of the 10 varieties were increased from 4 to 47 percent as a result of heat treatment. It is apparent from these tests that varieties differ greatly in losses due to R.S.D. When inoculated with R.S.D.-infected juice, yields of C.P. 29-116 were reduced 44 percent.

In Florida, R.S.D. inoculations show that three varieties, N.C. 116, Lataria, and Agoule No. 1 are symptomless carriers of the disease. The response of B. 39246, Ba. 11569, and Cl. 41-70 ranged from an apparent resistance to what appeared to be immunity, while in C.P. 1, immunity to the ratoon stunting disease was strongly indicated. Indications of resistance were observed in Louisiana in C.P. 29-103, C.P. 52-37, and C.P. 52-68.

There was no evidence that R.S.D. was spread from diseased to healthy stalks of sugarcane by the feeding of rats at Canal Point, Fla. Further observations in the stubble crop may indicate that rats are a factor in transmitting the disease. There was no clear-cut evidence of transmission of R.S.D. from diseased to disease-free plants by discs used in the cultivation of sugarcane in Florida.

Comparisons of R.S.D.-infected and R.S.D.-free cane in Florida show that the disease reduces yields of C.P. 34-79 by 39 percent, and F. 31-962 by 31 percent. In both varieties, reductions in yields were associated with shorter stalks of smaller diameters. Inoculation studies with 401 varieties of Noble cane that had been given the long hot-water treatment, 50°C. for 2 hours, at Canal Point, show that after treatment 66 percent gave negative reactions to R.S.D. Eighteen percent of the varieties did not survive the long hot-water treatment. Six percent of the varieties survived the hot-water treatment but gave positive reactions to R.S.D. It is interesting to note that susceptibility to damage from the L.H.W.T. was apparently influenced by factors other than the size of the stalks in this group of noble varieties.

Temperary control of the ratoon stunting disease by heat treatment is expensive and limited in efficiency, since the disease is transmitted by knives, harvesters, and probably cultivating tools. In the long run it appears that the most economical control of the disease will be by producing resistant varieties.

(b) Red Rot - The effect of red rot caused by Colletotrichum falcatum and by Fusarium moniliforme was not influenced by the presence of R.S.D. in Florida. There appears to be a difference in the virulence of C. falcatum when F. moniliforme is also present in the stalks. Losses from red rot and other seed-rotting diseases in Louisiana during 1955 were very light.

(c) Mosaic - There was an important spread of mosaic into commercial plantings of N. Co. 310 in areas of Louisiana where this variety is grown in the vicinity of mosaic-infected Co. 290. In Puerto Rico the mosaic disease continues to be a serious problem in susceptible varieties such as B. 34-104, M. 336, and B. 37161. B. 34-104 serves as a dangerous source of inoculum for the other commercial varieties used to replace it. Mosaic has been observed in H. 32-8560, P.R. 980, B. 41327, and P. R. 902.

(d) Chlorotic Streak - The chlorotic streak disease is widely distributed throughout the northern and western parts of Puerto Rico. It is especially prevalent in P.O.J. 2878. At this time, P.O.J. 2878 occupies about 200,000 acres. Its susceptibility to this disease presents a serious problem. Results from experiments conducted in Puerto Rico show that losses in yields of cane per acre in P.O.J. 2878 ranged from 24 to 28 percent. Losses in yields of sugar per acre ranged from 31 to 45 percent. The long hot-water treatment, 50°C. for 2 hours, for the control of the ratoon stunting disease, will also control chlorotic streak. This two-fold advantage from the L.H.W.T. is being given favorable consideration by sugarcane producers in Puerto Rico; however, there is an important need to develop disease-resistant varieties.

Plans: All studies under Disease Investigations will be continued.

c. Breeding

(1) Breeding Program

FC-ARS

The sugarcane breeding program at Canal Point, Fla., during the 1955 season was highly successful, though weather conditions during the last half of the season were unfavorable for the normal development of pollen. More than 500 important crosses were completed. The new greenhouse and controlled temperature facilities available this fall, should make it possible to cross many desired clones, despite unfavorable weather conditions. In Puerto Rico, the breeding program was also highly successful, as shown by the completion of 374 crosses involving parental combinations to give high-yielding disease-resistant seedlings. Some of the crosses completed in Puerto Rico were made by utilizing the favorable influence of low and high elevations for synchronizing floral initiation and pollen development of several desirable parental varieties.

The combined search for mosaic-resistant varieties of sugarcane in 1956 involved more than 300,000 seedlings. Loss of mosaic-susceptible seedlings ranged from 13 percent in Louisiana to more than 30 percent in Florida. In Louisiana, approximately 115,000 seedlings were transplanted to the field, after eliminating those infected with the mosaic disease and the weak plants. A large part of the seedlings transplanted to the field in Louisiana were from crosses in which one or both parents were high in sucrose. A total of 13,600 seedlings were transplanted to the field in Florida. Of these seedlings, approximately 10,000 were planted in the spring and 3,600 were planted in August for primary selections in the fall of 1957. In Puerto Rico, more than 86,000 seedlings were transplanted to the field in cooperation with the Puerto Rico Agricultural Experiment Station at three locations, Rio Piedras, Corozal, and Guaraba. These seedlings are being grown under widely different conditions, in order to make selections adapted to the different sugarcane-growing regions of the island. In the sirup area, approximately 5,000 seedlings were tested for mosaic. Of these, 1,257 mosaic-free seedlings were grown at Meridian, Miss., 1,705 at Cairo, Ga., and 1,756 at Poplarville, Miss.

The combined search for mosaic-resistant varieties of sugarcane is closely coordinated with specific tests to determine the commercial value of the varieties. A good disease-resistant variety of sugarcane must also possess a high sugar content, high yielding ability, resistance to lodging, and agronimic characters adapted for machine harvesting. The testing of large numbers of seedlings is conducted in cooperation with State Experiment Stations in Louisiana, Florida, and Mississippi,

and with the Puerto Rico Agricultural Experiment Station.

(2) Cytological Investigations FC-ARS

Basic cytological information needed in the breeding program is being obtained from special studies at Beltsville conducted in cooperation with the Hawaiian Sugar Planters Association. A total of 141 clones were studied, including 4 species of Saccharum: S. officinarum, S. robustum, S. sinense, and S. spontaneum, interspecific hybrids, and species of genera related to Saccharum. Twenty-one special crosses for studying interspecific hybrids were made in Hawaii to provide material for cytological studies at Beltsville. Abnormal pre-meiotic fusion of pollen mother cells was observed in specimens of Saccharum and Erianthus. Forty-five lots of seed-bearing fuzz were imported and germinated under quarantine conditions at Beltsville. Seedlings produced from this fuzz are now being studied cytologically.

(3) Inheritance Studies FC-ARS

Inheritance studies at Houma, La., involving 950 clones from 7 crosses show a close association for stalk diameter of single stools and stalk diameter in line tests (r = .619). The correlation for stalk diameter of plant cane and first-stubble line tests was even higher (r = .733). There was a statistically significant correlation of Brix in single stools and Brix in line tests of the same strains (r = .392). A highly significant correlation was obtained for sucrose in plant cane and the same strains in first-stubble line tests with an r value of .589. There was some degree of association for erectness of stalks and number of stalks per stool for single stools and line tests, but this was of a lower order than for Brix, sucrose, and stalk diameter. These findings will be valuable in selecting for high-yielding varieties that possess useful agronomic characters.

(4) Promising Varieties FC-ARS

C.P. 48-103, released to growers during 1955, has the highest sugar content early in the season of any variety ever made available for commercial culture in Louisiana. This variety consistently provides cane of high milling quality in early October. Recent tests show that the yield of sugar per ton of cane from C.P. 48-103 on September 29 was equal to that from C.P. 44-101 on November 1, and to that from C.P. 36-105 and N. Co. 310 on November 15, and, of course, much higher on September 29. Yields of sugar per acre at the time of harvest in November was approximately the same for C.P. 48-103 and the leading commercial variety, C.P. 44-101; however, the yield of sugar per ton of cane from the former was about 20 percent higher.

A varietal census of the 1956 crop in Louisiana shows that C.P. 44-101 is the leading commercial variety, occupying more than 50 percent of the acreage. It is equally popular in the three principal areas of the "sugar belt." No other variety produced at Canal Point, Fla., has ever attained this general popularity, nor has any variety occupied such a large percentage of the acreage during the past 25 years. Results of variety tests throughout the sugar belt show that C.P. 44-101 is still the best all-purpose variety available to the Louisiana industry.

C.P. 50-28 has consistently produced high yields of cane and sugar per acre at Fellsmere, Fla. It makes a vigorous growth, appears to have some cold resistance, remains erect throughout the growing season, and produces higher yields of sugar per acre than the standard commercial variety, C.P. 34-79. This variety may be considered for release for limited culture in the Fellsmere area of Florida.

In Puerto Rico, P.R. 980 produces high yields of sugar per acre under a wide range of conditions. Stalks of P.R. 980 are not as large in diameter as some of the commercial varieties in Puerto Rico; however, it strips easily, produces good ratoon crops, and should be considered for culture under some conditions on the island. P.R. 981 and P.R. 1013 are promising new varieties now being tested in Puerto Rico.

(5) Physiological Investigations FC-ARS

Special physiological studies conducted in Hawaii in cooperation with the Hawaiian Sugar Planters Association to determine the effect of different climatic conditions on the tasseling of sugarcane, indicate that floral initiation can be accomplished in some varieties of sugarcane with a fixed photoperiod of 12 hours and 25 minutes. It was found in these studies that climatic conditions after September 1 in Hawaii may be responsible for the flowering differences between two contrasting regions classified as sparse flowering and abundant flowering. These flowering differences are shown in a greater percentage of floral initiation and a more rapid development of the flowers in the abundant flowering region. There is an indication in these studies that exposure of sugarcane plants to warmer night temperatures (3° to 8°F.) during April may induce flowering under Hawaii conditions. Excessive exposure of one of the principal Hawaiian varieties, H. 37-1933, to infra-red irradiation is apparently inhibitory to flower initiation.

The rate of inversion of sucrose in stored cane is associated with dehydration and permeability of stalk tissue, according to studies conducted at Houma, La. Preliminary laboratory tests

indicate that the use of anti-auxins to reduce permeability of the tissue may decrease the rate of inversion. Further studies are needed to evaluate the feasibility of using anti-auxins commercially for this purpose. Large-scale storage tests at Houma show that five new promising varieties are equal to Co. 281 (standard) in resisting inversion of sucrose.

(6) Morphological Studies FC-ARS

Morphological studies at Mesilla Park, New Mexico, show that vascular bundles of sugarcane stalks infected with the ratoon stunting disease are heavily infiltrated with a homogeneous red staining substance. The chemical nature of the red staining substance has not been determined. Walls of sieve tubes in R.S.D.-infected stalks gradually become lignified and lose much of their efficiency in transmitting nutrient material. Symptoms of R.S.D. appear first in primary leaf traces. Evidence of sieve tube infiltration have been observed in the region just below the nodes, even when R.S.D. infection is slight. Further morphological studies may prove useful in devising accurate means for identifying the presence of the disease in sugarcane stalks.

Structural changes in the tissue of sugarcane stalks damaged by borers consist, first, in the thickening and lignification of parenchyma cells, and, second, in the infiltration of the zylem part of the vascular bundles with a red staining, gummy deposit. These changes influence the efficiency of the plant in performing metabolic processes. Preliminary studies involving soft tissue of the upper stem region of Saccharum show that representatives of the Spontaneum species usually possess the greatest amount of borer resistance.

Plans: All breeding studies will be continued.

(7) World Reference Collection FC-ARS

Plans have been completed for establishing a second planting of the World Reference Collection of sugarcane varieties in India. The first major shipment of varieties to India will be made in October 1956 in accordance with plans approved by the International Society of Sugar Cane Technologists in January 1956.

The World Reference Collection that is now being maintained at Canal Point, Fla., was increased during the year by importation of 772 varieties from 10 countries. All of the varieties received during the year are now growing in the quarantine greenhouse at Beltsville. When sufficient growth

has been made, the varieties will be given the L.H.W.T. for control of the ratoon stunting disease and they will then be sent to the secondary quarantine station at Ft. Lauderdale, Fla. A total of 127 varieties were exported to 17 countries during the year.

d. Sugarcane Production and Harvesting Machinery AE, ENT - ARS

The main objective of the sugarcane machinery project is the development of a commercially acceptable sugarcane harvester that will reduce the loss of recoverable sugar caused by trash and delayed milling. The harvester is being developed for Louisiana conditions in cooperation with the American Sugar Cane League. The current emphasis has been on improving the gathering and detrashing components. A conical helix type of screw conveyor was developed and adapted as a lower gatherer on the experimental harvester to overcome the speed limitation of the chain-type gatherer and to improve gathering of the canes. The screw-type gatherer picked up canes satisfactorily when they were lodged at right angles to the row, but was found unsatisfactory for canes lodged lengthwise of the row.

Field tests showed that satisfactory operation of the upper stripping unit depends upon proper patterning of the canes as they are fed into the stripper. Maintaining the canes in a vertical position during detrashing increases the effectiveness of the stripping unit and decreases ground loss of milable cane caused by breakage. The amount of trash left on the harvested canes was reduced from 6.32 to 2.92 percent by the adaptation of a rubber snap-in type of stripping finger developed by a rubber tire manufacturer. The amount of trash on individual loads of cane varied from 0.79 to 9.73 percent. Trash samples in excess of 5 percent contained suckers. The effectiveness of the finger was satisfactory. Its useful life of approximately 150 tons of harvested cane was an improvement over that of the belt-fabricated finger, however, even this is not considered satisfactory for commercial operation. Commercial acceptability of the present USDA experimental sugarcane harvester depends upon the development of a satisfactory stripping finger. Continued work on this part of the harvester will have high priority.

The development of a sugarcane top cutter, for use in the control of sugarcane borers that would otherwise overwinter in cane tops left in the field after harvest, was continued in cooperation with ENT and the American Sugar Cane League. The cylinder-type cutter used during 1953 and 1954 was installed on a commercial cane cutting machiner. Field tests showed that (1) 30 to 35 horsepower are required to operate the cutter satisfactorily at a ground speed of 4 mph, (2) the reverse gears should be

made of steel and the drives enclosed, (3) anti-friction bearings should be provided on all the feed rolls to simplify lubrication, and (4) the size of the feed throat of the cutter should be increased to reduce choking. In field counts made on February 28 and 29, 1956, the entomologists found 73 live borer stages per acre in all material left in fields where the top cutter had been used and 1,016 live borer stages per acre in all material left in the check fields. Further development work is to be conducted to correct mechanical weaknesses of the cutter and to evaluate further the effectiveness of this method of sugarcane borer control.

Field tests of the two-row mechanical sugarcane planter developed in cooperation with the American Sugar Cane League showed that (1) the combination of opening and planting provided a more accurate control of the depth of planting than could be obtained with the present hand planting method, (2) the seed hoppers did not have sufficient capacity to accommodate the wide variation in bundle sizes, (3) the use of a winch truck for transferring the seed cane from the transport cart to the planter was satisfactory, (4) the adhering trash on the seed canes frequently retarded the dropping of the canes, causing an uneven rate of planting with gaps that had to be filled by hand, (5) a capacity of 4 acres per 9-hour day was obtained with two feeders. The capacity of the planter depended to a large extent on the condition of the seed cane. Adhering trash, tie vines, broken canes, and mixed bundles (as to direction of the tops) hamper the efficient operation of the planter. Development work is being continued to correct mechanical weaknesses and to increase the capacity and uniformity of planting rate.

Plans: Continue studies at about the same level on the sugarcane machinery investigations with emphasis on the harvester, planter, and the cane top cutting device.

3. SUGAR SORGHUM (SORGO)

a. Production and Management

(1) Cultural practices FC-ARS

Spacing studies at Holly Springs, State College, and Meridian, Mississippi, show that maturity of the new sirup variety Wiley is delayed about one week when plants are spaced 1 and 3 inches in drills compared to spacings of 6, 9, and 12 inches and three plants in hills every 24 inches. Also, plants spaced 1 and 3 inches lodged readily early in the season. Lodging in close spacings is a serious handicap in harvesting the crop mechanically for sirup production and for other purposes. Preliminary studies at Meridian show that Tracy and Sart respond to close spacings as described above for Wiley; however, there was less lodging in Sart than in the other two varieties.

In southern Georgia, Tracy gave approximately the same yield of sirup per acre in rows spaced 24, 30, 36, and 42 inches apart; however, there were fewer weeds in the narrow rows at the time of harvest. Two drills per row reduced the yields in the 24- and 30-inch rows.

(2) Fertilizers FC-ARS

High applications of phosphate fertilizers hastened maturity of sorgo at Meridian and Poplarville when the crop was planted the first week in April. Phosphate fertilizers had no apparent influence on maturity in later plantings.

Applications of nitrogen as a side dressing late in the season impaired the quality of the sirup from Tracy in a test at Holly Springs, Miss. These preliminary data indicate that applications of nitrogen after the plants are 30 inches tall may impair the quality of the sirup.

(3) Weed-Control Studies FC-ARS

Cooperative studies in Mississippi showed that 4,6-dinitro ortho secondary butylphenol (DNBP) and 3-(3,4-dichlorophenyl)-1, 1-dimethylurea (diuron) have promise as pre-emergence herbicides for controlling annual weeds in sorgo when used at rates of 9 and 1 pound per acre, respectively. Herbicides studied under the same conditions that were unsatisfactory either from the standpoint of failure to control weeds and/or injury to the crop were 2-chloroethyl N-(2-methyl-5-chlorophenyl) carbamate, sec. butyl N-(3-chlorophenyl) carbamate, 2-(1-chloropropyl) N-(3-chlorophenyl) carbamate, CIPC, and dichloral urea.

Plans: Studies will be continued under Production and Management of Sugar Sorghum.

b. Insects and Diseases

(1) Disease Investigations FC-ARS

(a) Smut - Sart sorgo is susceptible to the strain of loose kernel smut, *Sphacelotheca holci* Jackson, commonly found on Johnson grass in Mississippi. Smut commonly found on sorgo can usually be controlled by seed treatment with an effective fungicide; however, none of the fungicides tested have been effective in controlling smut in Sart in tests at State College, Miss. The occurrence of smutted seed heads in fields of Sart has become a very important problem for seed certification authorities. It has been established in preliminary inoculation experiments at Meridian, Miss., that Johnson grass smut is pathogenic on Sart sorgo.

(b) Zonate Leaf Spot - Artificial inoculation of sorgo with zonate leaf spot (*Gloeocercospora sorghi*) has given erratic infection at Meridian, Miss. A preliminary experiment to determine the effects of temperature on infection has been carried out at Meridian using controlled-temperature rooms. In this experiment infection did not occur at 60°F.; it was very light at 70°F.; and heavy at 80°F. There are indications that the infection-temperature curve closely approximates the growth-temperature curve of the fungus in culture. More extensive tests are planned to establish the conditions necessary for consistent infections.

In tests at Meridian, 10 isolates of the zonate leaf spot fungus collected from widely different parts of the Southeast gave approximately the same reaction on several varieties of sorgo. Based on hundreds of inoculation studies, it appears that six varieties of sorgo in the World Reference Collection are partially resistant to zonate leaf spot. Complete resistance to the disease has not been found.

(c) Rust - A total of 89 selections (hybrid varieties) from superior parents were tested at Houma, Louisiana, for resistance to sorgo rust (*Puccinia purpurea* Cke.). Six of these have a higher degree of resistance to rust than commercial varieties previously used in that area; however, most of the resistant hybrids are susceptible to some damage from zonate leaf spot. Studies will be continued in an attempt to incorporate resistance to rust and zonate leaf spot in the same hybrid. The availability of parent varieties highly resistant to both of these diseases should make it possible to develop commercial varieties suitable for production in southern Louisiana and other humid areas of the South.

(d) Mosaic - Since sorgo is now planted in parts of the sugarcane area, susceptibility of commercial varieties to the mosaic disease presents an important problem. Results from inoculation studies at Meridian show that most of the varieties commonly used as parents or for commercial culture are susceptible to sugarcane mosaic. Of 71 varieties inoculated with sugarcane mosaic, 19 were very susceptible, 44 susceptible, and 8 resistant. Damage to sorgo from sugarcane mosaic ranged from the type of mottling of the leaves found on sugarcane to extensive leaf necrosis and death of the plants.

Plans: These studies will be continued at about the same level.

c. Breeding

(1) Breeding Program FC-ARS

A new sorghum variety released - Wiley, a new variety of sorgo for sirup production in southeastern United States, developed in the sugar sorghum breeding program at Meridian, Mississippi, was released to growers on July 18, 1956. Seed supplies are being increased in cooperation with State experimental stations in Mississippi, Louisiana, Alabama, Georgia, South Carolina, Tennessee, and Arkansas. Wiley, tested as selection Mer. 52-1, produced a sirup of excellent quality in more than 20 experiments in six States during 1955. It is resistant to the common sorgo diseases; it matures about 10 days earlier than Sart, the present most important late-maturing variety; and it is not sensitive to minor changes in photoperiod and temperature conditions. Stalks of Wiley are almost free of wax; they strip easily and resist lodging under normal field conditions. This outstanding sirup variety should have an important influence on sirup production in the Southeastern States.

C-041, developed in the breeding program at Brawley, California, produced 17.56 percent sucrose and a yield of 2.72 tons of sugar per acre. Three new selections (49-119-2, 14-118-2-1, 52-139) developed in the breeding program at Meridian, Mississippi, produced 13.73, 14.87, and 14.80 percent sucrose and 3.18, 3.54, and 3.47 tons of sugar per acre, respectively, at Brawley. The average yield of the latter three selections was approximately 30 percent higher than from Rex, the standard variety in the Brawley area.

Fifteen promising hybrids (F_5, F_6, and F_7 generations) for sirup and sugar production were selected at Meridian for exacting field trials in 1956. These outstanding selections are disease resistant, and they produce high yields of stalks and sirup per acre. They are being tested for sirup production in cooperation with State experiment stations in Mississippi, Alabama, Georgia, South Carolina, Kentucky, Tennessee, Louisiana, and Arkansas. A total of 23 experiment stations cooperate in this research work. Results of all experiments are summarized annually in a single report that is furnished to each of the cooperating State stations.

A total of 66 new crosses was made at Beltsville during the year. Segregating generations from these crosses will be grown in Mississippi and other Southern States during 1957. Most of these crosses were made between F_1 populations of superior hybrids.

Seed of Sart, Tracy, and Wiley were irradiated with two X-ray treatments (30,000 r and 40,000 r) and three thermal-neutron treatments (12, 15, and 18 hours) in 1956. The irradiation treatments did not influence germination; however, none of the plants from X-rayed seed survived. The root system did not develop in plants from the X-rayed seed. Though germination was not influenced by the thermal-neutron treatments, there was a tremendous varietal difference in survival. Tracy plants from all the treatments survived; however, growth from the 15- and 18-hour treatments was considerably less than from the 12-hour treatment. Most of the plants of Sart and Wiley from seed irradiated 18 hours died in the seedling stage; however, several plants were obtained from the 15-hour treatment in both varieties. The 12-hour treatment did not influence Sart and Wiley to a great extent. Several mutations have been observed in the irradiated material. These mutations involve deformity of leaf and stalk tissues, the loss of chlorophyll, and possibly other characteristics of significance in the varietal improvement program.

Plans: The study will be continued.

(2) World Reference Collection FC-ARS

Seed were produced at Beltsville from 607 varieties of the World Reference Collection. Since some of these varieties do not produce seed under normal growing conditions in this country, 368 varieties were grown in the greenhouse during the winter. A total of 3,978 varieties of sugar sorghum are now maintained in the World Reference Collection. Most of these varieties were obtained by exploration in isolated areas of Africa and other countries. Additional varieties are added to the collection annually through exchange arrangements with other countries. One hundred and thirty-nine new varieties were added to the World Reference Collection during the current year.

B. PUBLICATIONS

AE, ENT-ARS

"Development of a Sugarcane Harvester for Louisiana," by R. M. Ramp. Presented at annual meeting of the American Society of Agricultural Engineers, June 1956 and to be published in Agricultural Engineering, the Journal of ASAE.

"Sugarcane Planter Progress Report for 1955," R. M. Ramp, paper presented at Annual Meeting of the American Society of Sugar Cane Technologists, February 28, 1956.

"Root-knot Nematodes," by J. D. Wilson and Donald T. Black. Ohio Farm and Home Research, May-June 1956. p. 40-42.

"Effects of Pesticides on Application Equipment," Progress Report to Pesticide and Application Equipment Committee, No. 5, D. T. Black, March 15, 1956.

"Corrosive Solvent Action of Agricultural Chemicals on Application Equipment," D. T. Black, presented at the Ohio-Indiana Agricultural Aviation Conference, Columbus, Ohio, February 24, 1956.

ENT

"Treatments of Sugar Beets with Systemic Insecticides for Control of the Beet Leafhopper," O. A. Hills, F. H. Harries and A. C. Valcarce. 1956 Proc. Amer. Soc. Sugar Beet Tech. (In press)

"Resistance of Lygus Bugs to DDT on Sugar Beets Grown for Seed," O. A. Hills, E. A. Taylor and A. C. Valcarce. Jour. Econ. Ent., Vol. 49, No. 1, pp. 94-95, Feb. 1956.

"Beet Leafhopper and Curly Top Conditions in the Southern Great Plains and Adjacent Areas," J. R. Douglass, W. E. Peay and J. I. Cowger. Jour. Econ. Ent., Vol. 49, No. 1, pp. 95-99, Feb. 1956.

"Borers Surviving the Winter and Prospects for the 1956 Infestation in Louisiana," W. E. Haley, W. J. McCormick, L. J. Charpentier, A. L. Dugas and E. J. Conciene. The Sugar Bulletin 34 (13), p. 190. 1956.

"Systemic Insecticide Studies for Control of Vectors and Sugarcane Mosaic in Louisiana," Leon J. Charpentier. Jour. Econ. Ent., 49 (3), pp. 413-414. 1956.

"1954 Studies of Parasites for Sugarcane Borer Control in Louisiana," Leon J. Charpentier. Jour. Econ. Ent. 49 (2), 267-268. 1956.

FC-ARS

Sugar Beet Publications

"Characterization of Sugar Beet Varieties on the Basis of Their Internal Structure Together with the Effect of Environment on the Variability of Diagnostic Characters in Inbred Lines," Ernst Artschwager, Proc. Amer. Soc. Sugar Beet Tech. 8(2): 118-124, 1954.

"Correlation Studies of Chemical and Morphological Characters of Sugar Beet Variety GW 413," Ernst Artschwager and H. E. Brewbaker, Submitted for publication in Jour. of Amer. Soc. of Sugar Beet Tech. (Presented at 9th General Meeting, 1956)

"Biological Relations of Viruses to Plants," C. W. Bennett, Annual Review of Pl. Physiol. of Stanford Univ. 7: 143-170, 1956.

"A Mutant of the Sugar Beet Curly-top Virus," C. W. Bennett, Submitted for publication in Virology.

"Sugar Beet Yellow Vein Disease," C. W. Bennett, Pl. Disease Reptr. Vol. 40(7): 611-614, July 15, 1956.

"Recovery of Water Pimpernel from Curly Top and the Reactions of Recovered Plants to Reinoculation with Different Virus Strains," C. W. Bennett, Phytopath. 45(10): 531-536, Oct. 1955.

"Incidence of Savoy in Relation to the Variety of Sugar Beets and to the Proximity of Wintering Habitat of the Vector, Piesma Cinerea," G. H. Coons, Dewey Stewart, H. W. Bockstahler, and C. L. Schneider, Submitted for Publication in Jour. Amer. Soc. of Sugar Beet Tech. (Presented at 9th General Meeting, 1956)

"Changes in the Concentration of Amino Acids in the Leaves of Sugar Beet Plants Affected With Curly Top," J. M. Fife, Submitted for Publication in Jour. Amer. Soc. of Sugar Beet Tech. (Presented at 9th General Meeting, 1956)

"The Control of Annual Grass Weeds in Sugar Beets by Sodium, 2,2-dichloropropionate (Dalapon)," Jess L. Fultz, R. Blough, and J. O. Gaskill, Res. Prog. Rept. Res. Committee, Western Weed Control Conference, p. 78, Feb. 14-17, 1956.

"An Annual Backcross to a Nonbolting Inbred Line of Sugar Beets," F. V. Owen and J. S. McFarlane, Submitted for publication in Jour. Amer. Soc. Sugar Beet Tech. (Presented at 9th General Meeting, 1956)

"Size, Shape, and Replication of Field Plots of Sugar Beets Grown for Seed," R. A. Pendleton, Submitted for Publication in Jour. Amer. Soc. Sugar Beet Tech. (Presented at 9th General Meeting, 1956)

"Components of Variance Method and Partitioning Method of Genetic Analysis Applied to a Genetic Study of Weight per Fruit of Tomato Hybrid and Parental Populations," LeRoy Powers, USDA Tech. Bul. 1131, 1955.

"Sugar Beet Studies - Imperial Valley, California," Charles Price, Submitted for publication in the California Sugar Beet.

"A Cytological Study of F_1Hybrids Between Swiss Chard and Beta webbiana," Helen Savitsky and John O. Gaskill, Submitted for publication inJour. Amer. Soc. Sugar Beet Tech. (Presented at 9th General Meeting, 1956)

"Inheritance of Chlorophyll Deficiencies in Beta vulgaris L.," V. F. Savitsky, Submitted for publication in Jour. Amer. Soc. Sugar Beet Tech. (Presented at 9th General Meeting, 1956)

"Inter-relation Between Weight of Seed and Fruit and Utilitarian Characters of Inbred Lines and Hybrids of Monogerm Sugar Beets," V. F. Savitsky, et al., Proc. Amer. Soc. Sugar Beet Tech. 8(2): 399-403, 1954.

"Effect of Moisture and Fertilization on Emergence of Sugar Beet Seedlings," F. W. Snyder, Submitted for publication in Jour. Amer. Soc. Sugar Beet Tech. (Presented at 9th General Meeting, 1956)

"Influence of Selected Treatments of Seedballs on Rapidity of Germination of Sugar Beets," F. W. Snyder, Submitted for publication in Jour. Amer. Soc. Sugar Beet Tech. (Presented at 9th General Meeting, 1956)

"The Effect of Soil Moisture and Compaction on Sugar Beet Emergence," B. A. Stout, F. W. Snyder,and W. M. Carleton, Submitted for publication in Jour. Amer. Soc. Sugar Beet Tech. (Presented at 9th General Meeting, 1956)

"Respiratory Losses from Sugar Beets Soon After Harvest," Myron Stout, Submitted for publication in Jour. Amer. Soc. Sugar Beet Tech. (Presented at 9th General Meeting, 1956)

"Sugar Beet Evaluation: Determining Respiration Rate and Sampling for Chemical Analysis of sugar Beets," Myron Stout, Agri. and Food Chem. 2(26): 1324-1328, Dec. 22, 1954.

Sugarcane and Sugar Sorghum Publications FC-ARS

"Some Observations on the Sugar Industry in Taiwan," E. V. Abbott, The Sugar Bul. 34 (15), May 1, 1956.

"Fertilizer Investigations on Sugarcane in 1955," L. G. Davidson, The Sugar Bul. 34 (22), August 15, 1956.

"The Sugarcane Variety Census for 1956," Leo P. Hebert, The Sugar Bul. 34 (22), August 15, 1956.

"Breeding Behavior of Certain Agronomic Characters in Progenies of Sugarcane Crosses," Leo P. Hebert, The Sugar Bul. (In Press)

"Comparison of the Usual Off-barring with a modified Method of Off-barring on yields of Sugarcane in Louisiana," Leo P. Hebert and R. J. Matherne, The Sugar Bul. (In press)

"Results of Sugarcane Variety Tests in Louisiana During 1955," R. J. Matherne and Leo P. Hebert, The Sugar Bul. 34 (22), August 15, 1956.

"The Effect of Stunting Disease of Sugarcane on Yields of Cane and Sugar in Louisiana, and the Use of Heat Treatment for Control," C. A. Schexnayder, The Sugar Bul. 34 (22), August 15, 1956.

"The Morphology of the Grass Spikelet with Special Reference to Saccharum," C. O. Grassl, Proc. 9th Congress, I.S.S.C.T., 1956.

"Apparent Resistance to Ratoon Stunting Disease," E. H. Todd, Proc. 9th Congress, I.S.S.C.T., 1956.

"Tests of Sugarcane Varietal Milling Qualities," L. P. Hebert and George Arceneaux, The Sugar Bul. 34 (5), December 1, 1955.

"Cytological Studies in Saccharum and Allied Genera, I. Synctyes in Certain Clones of Saccharum and Erianthus," Samuel Price, Cytologia, Vol. 21, No. 1, March 1956.

"A Leaf Squash Technique For Studies of Somatic Chromosomes in Saccharum," Samuel Price, Proc. 9th Congress, I.S.S.C.T., 1956.

"Some Aspects of Testing Sugarcane Varieties for Red Rot Resistance," E. V. Abbott, Proc. 9th Congress, I.S.S.C.T., 1956.

"A Preliminary Report of Soil Compaction Studies in Louisiana Cane Soil," L. G. Davidson, Proc. 9th Congress, I.S.S.C.T., 1956.

"Effect of Seed Piece Size and Rate of Planting on Yields of Sugarcane and of Nitrogen Fertilization on Yield of Seed Cane in Louisiana," L. P. Hebert, Proc. 9th Congress, I.S.S.C.T., 1956.

"The Ratoon Stunting Disease of Sugarcane in Louisiana with Notes on its Control," C. A. Schexnayder, Proc. 9th Congress, I.S.S.C.T., 1956.

"Agronomic Practices Influence Stubble Deterioration of Sugarcane," I. E. Stokes and T. E. Ashley, Proc. 9th Congress, I.S.S.C.T., 1956.

"Promising New Procedures in Sugarcane Breeding," H. M. Tysdal, Proc. 9th Congress, I.S.S.C.T., 1956.

"The Occurrence and Description of a Dry Segregate in Honey Sorgo," O. H. Coleman, Agronomy Journal. (In press)

"New Variety of Sorgo Developed, Named Wiley," O. H. Coleman et al., Mississippi Farm Research, August 1956.

"Wiley, a New Variety of Sorgo for Sirup Production in Alabama," O.H. Coleman et al., Alabama Agr. Expt. Sta. publication. (In press)

"1955 Cooperative Sorgo Variety Tests in Southeastern United States," O. H. Coleman and Kelly C. Freeman, Mimeo. progress report to cooperating agencies.

"Spacing Experiments with Sorgo Grown for Sirup Production in Southwestern Georgia," E. S. Lyons, ARS 31-2.

"Red rot Resistance in Rex Sorgo," O. H. Coleman, Proc. Assoc. Southern Agricultural Workers, 1956. (Abstract)

"A Preliminary Report on the Reactions of Sorghum Varieties to Infection by Sugarcane Mosaic," J. L. Dean and O. H. Coleman, Proc. Assoc. Southern Agricultural Workers, 1956. (Abstract)

"Effect of Soil Fumigation for the control of Nematodes on Sorgo Production at Meridian, Mississippi," J. L. Dean et al., Proc. Assoc. Southern Agricultural Workers 1956. (Abstract)

"The Ninth Congress of the International Society of Sugar Cane Technologists, India, January 1956," H. M. Tysdal, The Sugar Bul. 34 (23). September 1, 1956.

"Laboratory Studies of Methods of Extraction of Sucrose from Sorgo," Charles Price and J. M. Fife, Jour. Agr. and Food Chem. (In press)

Publications on Weed Control in Sugar Beets FC-ARS

"Pre-emergence Applications of Herbicides to Weed Free Sugar Beets," Robert N. Andersen and E. A. Helgeson, NCWCC Res. Report 12: 125-126, 1955.

"Post-emergence Applications of Herbicides to Weed Free Sugar Beets," Robert N. Andersen and E. A. Helgeson, NCWCC Res. Report 12: 126, 1955.

"The Evaluation of pre- and Post-Emergent Chemical Treatments for Weed Control in Sugar Beets," Jesse M. Hodgson, WWCC Res. Progress Report: 74-76, 1956.

"The Effect of Aquatic Herbicides Effluent of TCB and Rada on Sugar Beets and Corn," Jesse M. Hodgson, WWCC Res. Progress Report: 74, 1955.

HC-ARS

"Effects of Sugar Beet Root Diffusates and Extracts and Other Substances on the Hatching of Eggs from the Cysts of the Sugar Beet Nematode, *Heterodera schachtii* Schmidt," Thorne, G., 1956. J. American Soc. of Sugar Beet Technologists IX (2):139-145.

"*Nacobbus batatiformis*, n.sp. (Nematoda: Tylenchidae), Producing Galls on the Roots of Sugar Beets and Other Plants," Thorne, G., and M. L. Schuster, 1956. Proc. Helminth. Soc. Washington 23 (2):128-134.

"Occurrence of Plant Parasitic Nematodes in Louisiana Soils," Fielding,M.J., and J. P. Hollis, 1956. Plant Disease Reporter 40(5):403-405.

"Certain Aspects, Including Relation of Weeds and Pathological Histology, of the root Galling of Sugar Beets Caused by Nacobbus batatiformis, Thorne and Schuster." Schuster, M. L. and G. Thorne (In press)

SWC-ARS

"1954 Irrigation and Nitrogen Fertilization Experiments on Sugar Beets in the Columbia Basin," J. S. Robins, C. E. Nelson and C. E. Domingo. Washington Exp. Sta. Circ. 278, 1956.

"Some Effects of Excess Water Application on Utilization of Applied Nitrogen by Sugar Beets," J. S. Robins, C. E. Nelson, and C. E. Domingo. ASSBT 1956. (In press)

PROPOSALS FOR COMMITTEE CONSIDERATION
(Order of listing has no priority significance)

PRODUCTION RESEARCH

a. Breeding and Testing for Improved Sugarcane and Sugar Beets

Expand the breeding and testing programs, including basic studies, to develop varieties of sugarcane and sugar beets resistant to diseases and insects; with higher quality and sucrose content; with resistance to cold, nematodes, and other hazards; with better processing and keeping qualities;and more suitable for mechanized operations.

Disease and harmful insects continue to take a tremendous toll from the production of sugar crops. The ratoon stunting virus disease of sugarcane causes commercial losses ranging from 15 to 40 percent in sugar production per acre. The virus yellows disease of sugar beets not only causes a reduction in yield of sugar, but during the past year became a serious threat to seed production in one of the most productive areas in the U. S.

The root rots including Rhizoctonia also are serious in many areas. It is becoming more evident that combined resistance to several diseases is necessary for the profitable and efficient production of these crops. The sugarcane borer exacts a tremendous toll in the domestic sugarcane industry.

Preliminary results on breeding for resistance to the sugar beet nematode continue to be encouraging, but much work is still necessary. In order to make rapid progress and provide growers with desirable resistant strains of sugar beets, much more work is required than can be applied to this problem at the present time.

Mechanization in both sugar beets and sugarcane is a must for economical and efficient production. It is becoming evident that the monogerm sugar beet seed will materially expedite progress toward mechanized production of sugar beets, but this character must be introduced into the desirable commercial varieties. In addition, greater seedling vigor and many other desirable characters must be included. In order to provide for maximum mechanization in sugarcane, non-lodging varieties adapted in other respects must be provided. While progress is being made along a number of these lines, it is slow and the effort should be increased if these improvements are to take place within the present generation.

b. Physiology of Sugar Crops

Expand research on the physiology of the sugar crops.

This would include the effect of photoperiod, temperature, other environmental factors, and hormones, such as may be involved in gibberellin, on floral initiation, seed production, and maturity of plants; causes and control of preprocessing losses; factors that influence quality, cold resistance, and disease resistance; the feeding habits of these crops; the physiology of bolting in sugar beets; the possible use of chemical defoliants; and the mechanisms of inversion.

c. Reduction in Crop Handling Losses

Expand studies on control measures to reduce crop handling losses in sugar crops, including development of sugarcane harvesting equipment.

The tremendous losses amounting to more than 10 million dollars annually sustained by growers of sugar beets and sugarcane between the period of harvesting and processing is extremely serious. An intensive cooperative research program conducted by production and utilization groups would do much to reduce these losses.

Production and utilization studies show a loss of approximately $5 per acre for each day sugarcane remains on the ground in the field. Harvester development has reached a point where there is a possibility of cutting, de-trashing, and loading sugarcane for delivery to the factory in one operation. Additional research is urgently needed to develop engineering principles applicable to the commercial production of an improved harvester for farm use. Such research can be more efficiently advanced by construction of a second pilot model which incorporates the improvements resulting from past research and provides flexibility for prospective research. The successful construction of such a machine would greatly aid the efficiency of harvesting sugarcane. Since sugarcane varieties differ in their rate of inversion, the breeding program should be expanded to develop varieties with lower rates of inversion to reduce grower losses.

It is conservatively estimated that there is a 5 million dollar annual loss in stored sugar beets. It has been shown that this loss can be reduced by developing sugar beets more resistant to rotting and with lower respiration. Research on this project should be expanded to develop commercial varieties with these characteristics.

d. Weed Control

Expand research on weed control including the development and evaluation of new and existing herbicides for the control of annual and perennial weeds in sugar beets and sugarcane and the effect of these chemicals on the products of these crops.

There is an urgent need for strengthening research on developing improved herbicides and herbicide-cultural practices for the control of Johnson grass and the annual and broadleaf weeds occurring in sugarcane. The fate of the herbicides in soil as well as in the sugarcane needs study to determine the possible effects of herbicidal usage on the soil as well as on the yield and quality of sugarcane products.

Increased effort should be directed toward a search for more selective herbicides to use in controlling weeds in sugar beets. Research on current herbicides needs expansion in attempts to utilize them more efficiently as pre-planting, pre-emergence, or post-emergence treatments. Basic investigations are needed to gain a better understanding of the variations in weed control efficiency obtained by different herbicides as influenced by soils, crop development, and weather. Special attention should be given to the development of controls for broadleaf weeds that appear following usage of currently promising herbicides. The effects of herbicides on the quality of sugar beets and the importance of herbicidal residues in the crop and in soils merit increased attention.

e. Equipment for Pest Control

Expand work on the development and improvement of equipment and methods for air and ground application of pesticides to sugar beets and sugarcane and on attachments to harvesting equipment for sugarcane borer control.

f. Improved Agronomic Practices

Expand studies on varietal response to fertility levels, cultural treatments, time and method of planting and harvesting, rotations, effects of crop residues, and other factors as related to yield and quality of sugarcane and sugar beets.

This research should include studies on rapidity of germination, seedling vigor, and disease resistance as factors in obtaining and maintaining stands coordinated with chemical weed control; evaluation of current and improved cultural practices; time and method of planting; effects of rotations, crop residues, and soil compaction; and the evaluation of introduced varieties under different climatic conditions. These and other agronomic factors would be studied as related to the efficiency of production, and the yield and quality of sugar beets and sugarcane. The studies would include tissue tests to determine the reliability of this method for fertilization recommendation and for soil management. Phases of these studies will be cooperative with Utilization Research branches.

g. Water and Soil Management Practices

Expand research on methods and techniques to improve soils, soil management systems, and the utilization of moisture and irrigation water, including brackish water, more efficiently for maximum production of high quality sugar beets and sugarcane in the important producing areas of the United States.

Studies are needed on the water requirements and consumptive use of water, optimum soil moisture levels and timing of irrigations to physiological stage of growth, best irrigation methods, drainage and salinity relationships, tillage methods and practices, soil fertility levels and balance in relation to commercial fertilizer requirements and the incorporation of the best combination of soil and water management practices into farming a system for maximum production of high quality sugar beets.

Studies on sugarcane should include: (1) determination of the drainage requirements of sugarcane through the use of field facilities that provide for precise water table control; and (2) the design and development of better drainage techniques and equipment for cane lands.

g. Improved Equipment for Sugar Beet Production

Initiate research on the development and improvement of equipment for sugar beet production with emphasis on equipment for weed control and precision planting of monogerm seed.

h. Insects as Vectors of Plant Diseases

Expand work to determine the role of insects as vectors of diseases of virus, fungous and bacterial origin affecting sugar beets and sugarcane with special reference to virus yellows of sugar beets and to ratoon stunting and mosaic of sugarcane. These studies should be conducted cooperatively with plant pathologists and entomologists.

i. Biological Control of Insect Pests

Expand work on biological methods for controlling insect pests of sugar beets and sugarcane. Efforts should be intensified to find and to develop methods for utilizing parasites, predators and insect pathogens of aphids, leafhoppers and other pests affecting these crops.

j. Basic Studies on Insect Physiology and Toxicology

Expand research to determine the cause of and to develop methods of overcoming the resistance of insects such as lygus bugs to insecticides. Research should also be expanded to determine the mode of action of systemic materials and other insecticides, the nature and action of attractants and repellents, and the nutritional requirements of insects as a basis for improving control measures.

k. Control of Field Diseases of Sugarcane and Sugar Beets

Expand basic research on the control of diseases of sugarcane and sugar beets by methods other than breeding, and including a foreign testing program on diseases not present in the U. S.

A thorough study of diseases including identification and life histories of causal agents, evaluation of effects on plants and possibilities of biological control could well lead to the development of control measures either through a more effective approach in the breeding program or by methods other than breeding. The relation of cultural methods, soil management, crop residues, and other crop practices should be included in such studies. In addition, a cooperative program should be developed for testing American and other varieties under exposure to diseases in the country where they occur. Such diseases would bring about serious losses to our sugar production if by chance they should gain entrance to the U. S. Examples of such serious diseases are virus wilt and the Argentine curly top of sugar beets in South America and Fiji disease and smut of sugarcane occurring in certain Pacific areas.

l. Basic Genetic Studies

Initiate and expand basic genetic studies on sugarcane, sugar beets, and sugar sorghum.

Information on the inheritance of disease resistance and other economic characters would greatly facilitate the breeding program. Genetic studies on cytoplasmic and Mendellian pollen sterility; interspecific hybrids in

both sugar beets and sugarcane; the advantages of polyploidy in sugar beets; the advantage and use of irradiation in a breeding program; and devising new techniques for the breeding program are highly essential for maximum progress.

m. Nematodes

Expand research on the nematode problem in both sugar beets and sugarcane.

This would include studies for the improvement of preventive measures, factors related to the life history of the nematodes, as well as host relationships, and a more intensive breeding program for resistance.

n. Breeding Improved Sugar Sorghum

Expand breeding studies to improve sugar sorghum varieties high in sugar content resistant to diseases and lodging, and that are adapted to a wide range of environmental conditions.

This work should include basic studies on quality factors that influence sirup production.

o. Tillage Equipment and Methods Relating to Soil Compaction

Expand research on the soil compaction problem, particularly as it relates to tillage equipment and methods.

Many compacted soil areas are associated with intensive cultivation and machine traffic on cultivated soils. The compacted layers interfere with the movement of air and water in the soil and with proper root development. It is important to determine the factors affecting and the mechanisms involved in the formulation of compacted layers. Practices and equipment should be developed for improving those soils where compacted soil layers exist and for preventing the formation of compacted layers in other soils. In this connection, the value of rough tillage, deep plowing, and subsoiling to alleviate compaction, retard wind and water erosion, and conserve water should be studied.

p. Electric Energy Radiating Devices for Attracting or Repelling Insect Which Effect Sugarcane and Sugar Beets

Expand work on basic characteristics of electric energy radiating devices for attracting or repelling insects.

Numerous adult economic insects are attracted to electric radiation chiefly in the flue end of the visible spectrum and the near-ultraviolet of the ultraviolet region. There are evidences of substantial differences in attracting insects with radiant energy by as narrow a wavelength band as 50 Angstroms. The combined efforts of engineers and entomologists are needed in detailed basic research to determine the attraction of important economic insects to radiant energy.

II. UTILIZATION RESEARCH

A. PROGRESS ON WORK UNDER WAY

1. COMPOSITION AND QUALITY PRESERVATION

a. Losses of Sugar from Beets Prior to Processing WU-ARS

In accordance with this Committee's repeated recommendations, work has been initiated on the study of post harvest sugar losses from stored sugar beets. Beets from the same lot were stored under different conditions and diffusion juices prepared in the processing laboratory from them. Analysis of these juices is under way to determine the effects of different storage conditions on the composition of the resulting diffusion juices. The results of these analyses will give information about the nature and extent of the gross compositional changes caused by normal respiratory activity of the beets and also by microbiological activity leading to spoilage.

Plans: In this laboratory, a study of the actual mechanism and control of sucrose losses as a result of these two processes will be extended and implemented by contract research and by cooperative research whenever necessary. Successful results of research in this field will provide an excellent opportunity for decreasing sugar losses in the beet sugar industry. This work will continue and be expanded.

b. Composition of Sugar Beet Processing Liquors (Including Molasses and Marc) WU-ARS

As indicated in the previous progress report, most of the major compounds of sugar beets and of processing liquors have been isolated and identified, therefore, less composition work is in progress than in the past.

The studies of the nitrogenous compounds, purines and pyrimidines, were continued and quantitative procedures applied to the analysis of beet processing liquors.

Some of the purines and pyrimidines previously reported in European beet liquors were found in American processing liquors. In addition, four other related nitrogen-containing compounds previously unreported in beets were isolated. The concentration of these nitrogenous compounds in beet diffusion juice is low, but in general there is about a six-fold concentration (to 0.15%) of these compounds in molasses. These materials are not removed in the carbonation step and may be detrimental to sugar crystallization. Sugar beet molasses appears to be a potentially rich source for several of these nitrogen compounds if commercial uses are developed.

Studies on the water insoluble portion (marc) of sugar beets were continued. Beet marc consists principally of cellulose, pectin, hemi-celluloses, araban, and protein. Cellulose is the major water insoluble constituent, the others being insoluble only as long as they are associated together in the beet tissue. To conserve water in normal factory operation, ammonia water from the evaporators is returned to the diffusers. However, beet pulp extracted with ammonia water at pH 9.5, under time and temperature conditions similar to those used in a commercial diffusion battery, yielded 5 times the amount of colloidal material as pulp extracted with water alone. The mildly alkaline conditions solubilized araban and pectin and consequently more of these colloidal impurities dissolved than was the case when neutral or slightly acidic water was used. Such colloids adversely affect procedures used to purify diffusion juice. In addition, pulp extracted with ammonia water was soft, had poor pressing qualities, and was difficult to process into dried pulp. Work will be done to determine the extent of extraction of colloids and deterioration of pulp under various conditions.

Preliminary studies of the composition of alkali extracted colloidal material from beet pulp revealed that it was composed of about 65% araban, 30% galactan, and small amounts of an associated complex sugar and an organic acid. Some of this material has been prepared for use in the processing laboratory to evaluate its effect on carbonation and on sugar crystallization. Purified araban, essentially free of galactan, was prepared by fractionation of its acetate derivative on activated charcoal columns.

Plans: This work on composition is essential for planning processing studies and will be continued to determine the effects of the various constituents on extraction, purification, and crystallization of sugars from beets, and on pulp quality.

c. Examination of the Sach-Le Docte Method for the Determination of Sucrose in California Beets WU-ARS

The Sachs-Le Docte Method for the determination of sucrose in California beets was reexamined.

Experimental work and statistical evaluation of the data have been completed and a final report submitted to the Technical Committee on Analysis of California Sugar Beets for Sucrose.

Plans: No further work in this field is contemplated.

d. Solubilities and Phase Equilibria of Sugars at Low Temperatures WU-ARS

Work was continued on the nature of the crystalline solids which form when sugar solutions are frozen. Experiments on the beta form of glucose indicate that as with the alpha form glucose hydrate is the only crystalline glucose phase likely to appear in frozen storage. In the study of invert sugar solutions it was found

that ice crystallizes more readily from such mixtures than from solution of pure glucose, fructose, or sucrose.

Plans: No further work in this field is contemplated.

e. Processing Quality of Three Recently Released Canes SU-ARS

Increased returns from growing improved sugarcanes can be realized only if they can be milled and processed efficiently to recover the larger amounts of sugar produced per acre. This has been assured by contracting with Louisiana State University to determine the efficiency of milling of samples provided cooperatively by the American Sugar Cane League, and clarifying and processing the juices on a pilot plant scale at the Audubon Sugar Factory in Baton Rouge, La.

Three new canes introduced recently were shown to be generally as suitable or superior to the most widely grown commercial variety for milling and processing. One new variety, C.P. 48-103, is preferable to the others because clarification produces denser, less voluminous precipitate and it can be processed at higher rates. Clarity equal to that obtained with the widely used variety, C.P. 44-101, is obtained consistently by lime clarification of juices of this new cane. Its rate of grinding is lower and somewhat more power is required per ton of cane, but the high sugar content per ton of cane and ease of clarification compensate for this so that power required per ton of sugar recovered is less than with other canes. Another new variety, C.P. 47-193, can be ground at the same rate as the principal commercial variety, although more power is required per ton of cane and sugar obtained, and the very large volume of precipitate produced consistently in clarification will limit the capacity of factories processing this cane. The third new variety, N.Co. 310, equals standard variety C.P. 44-101 in milling qualities and is somewhat superior in clarification, but it cannot be clarified as readily as the preferred variety, C.P. 48-103.

Results of the pilot plant experiments were made available promptly after the close of the grinding season for consideration, together with agronomic data on the varieties, by the Contact Committee of the American Sugar Cane League in determining suitability of the new canes for introduction into the commercial crop.

Plans: The three new varieties will be evaluated in comparison with widely grown standard variety C.P. 44-101 by pilot plant scale milling and processing during the next two seasons to establish their relative merits under different seasonal and growing conditions more accurately as a guide for the industry in expanding production of the cane from which sugar can be produced most efficiently and profitably.

f. Organic Non-Sugars Related to Sugarcane Juice Clarification SU-ARS

Quantitative data on the concentrations of organic substances that affect clarification and interfere with crystallization of sugar are essential for the selection of new canes that can be processed efficiently as well as for the development of better methods of clarification. This information is being obtained systematically for the juices processed in the pilot plant to establish correlations of the amounts of particular organic non-sugars with results observed in continuous clarification and other processing operations. Samples of dry solids of the raw juices of sugarcanes processed during the last grinding season were analyzed to determine the concentrations of nine non-nitrogenous organic acids on which data had been obtained in previous seasons. Adaptation of accurate methods for determining amino acids made it possible to establish the amounts of sixteen of these important substances in the juice solids by a single analysis of each sample. In addition to proline and threonine, previously reported, phenylalanine was identified for the first time as a constituent of sugarcane juice. The most abundant substances of this class in sugarcane juice are asparagine and glutamine, which together constitute more than 0.5% of the solids. The fourteen other amino acids account for 0.3-0.5% of the solids, approximately one-third of this being aspartic acid. Approximately equal amounts of these acids are combined in the protein of the juice. Analysis of clarified juice by these methods showed that 80% of the protein was eliminated by lime clarification, but the uncombined amino acids are not eliminated to any appreciable extent and accumulate in the sirups from which sugar must be crystallized.

Progress was made at the Houma laboratory in identifying some of the organic phosphorous compounds present in sugarcane juice and developing methods for the quantitative determination of these complex substances.

Plans: It is planned to continue this work, and to expand the research on composition to include an investigation of the non-sugar carbohydrate substances that are also important in affecting clarification and the efficiency of processing and crystallization of sugar.

g. Deterioration of Sugarcane Between Harvesting and Grinding SU-ARS

Mechanically harvested sugarcane must be kept in heap rows in the field longer than hand-harvested cane to permit removal of leaves by burning, and the loss incurred by prolonging the time between cutting and grinding more than is absolutely necessary has not been fully appreciated. The American Sugar Cane League cooperated by growing sufficient quantities of cane at St. Gabriel Plantation and harvesting rows from which 2-ton samples were delivered at successively longer intervals after cutting to be ground under a research contract with Louisiana State University. Milling quality

determined by the University was supplemented by pilot plant processing experiments on the juices of progressively older cane, carried out by SURB at the Audubon Sugar Factory.

The practical experiments using 2-ton samples of cane handled under conditions comparable to commercial practice and milled and processed by the pilot plant methods established for comparison of new cane varieties, provided a striking demonstration of the magnitude of losses to growers as well as processors from any unnecessary delay in grinding harvested cane. Cane samples from each of eight lots were delivered at intervals of 2,3, 7, and 11 days after harvesting, a sub-sample being segregated to be weighed at each interval to establish weight losses. Twenty-five tons of cane, the average yield of one acre in Louisiana, that would have brought $165.70 when ground within 24 hours after cutting, was worth approximately $18 less to the grower after 3 days because of the loss of both weight of cane and recoverable sugar. The loss increased to approximately $40 after 7 days, and after 11 days it was almost $50 per acre on the basis of the average results of the eight experiments. Factories processing the deteriorated cane suffer additional losses because it is more difficult to grind and process such cane efficiently and the indicated recovery of sugar paid for in purchasing the cane is seldom actually obtained. Their major loss results from sharply increased overhead in processing cane from which less than 150 lbs. of sugar per ton is recovered and the longer grinding season necessary to produce the allotted quota without additional revenue.

Plans: Results of this research confirmed substantially those obtained in similar experiments during the previous (1954) grinding season; marked improvement was noted in the quality of cane delivered to the mills during the last season as a result of wide publicity given to the demonstration of profit to be obtained by delivering harvested cane promptly, and the work has been completed.

2. DEVELOPMENT OF NEW AND IMPROVED PRODUCTS AND PROCESSING

a. Determination of Sugar Beet Sample Size for Processing Studies

WU-ARS

The 1955 plots of beets planted under contract by the Utah State Agricultural College to obtain a statistically sound basis for proper sample sizes, have been harvested. Analyses are being made on 50 individual beets, selected randomly from each plot, for sucrose, marc, total nitrogen, amino nitrogen, total anions, malic, glutamic and oxalic acids, raffinose and galactinol. The analyses for the various constituents in the beets are nearly complete except for raffinose and galactinol. The statistical correlations will be made after all the analytical work is completed. Preliminary calculations indicate highly significant differences among individual beets from the California plot for all constituents.

Plans: The analysis of these samples will be continued and when completed, statistical correlations made according to the original plans.

b. Diffusion Studies WU-ARS

In accordance with the Committee's recommendations, experimental work utilizing pilot plant scale of equipment has been undertaken to investigate some of the diffusion (sugar extraction) problems.

Under a contract to the University of Michigan a continuous countercurrent diffuser was constructed and tested. It extracted 90% of the sugar, which is considerably lower than factory operations, but appeared to offer certain advantages in lower draft and the like. The desired information was obtained and consequently the investigation under this contract was terminated.

The pilot plant scale model of the Robert diffusion battery was tested and found satisfactory for preparation of standard beet diffusion juice. The apparatus must be charged cell by cell, an operation which requires excessive labor and is not, therefore, suited for studies on the continuous extraction of sugar.

The laboratory model Olsen continuous diffuser, with a capacity of 10 kilograms of beet cossettes per hour, was operated extensively and modified to obtain optimum operating conditions. The unit is now fairly satisfactory as a laboratory diffuser in regard to reproducibility of results and ease of operation. It is, however, less efficient for extraction of sugar than factory-scale continuous diffusers. A mechanical continuous feeder-preheater is being designed to improve operation still further. Further work will be carried out on the factors involved in the extraction of sugar from beets such as the blanching pretreatments, and flexing under different times, temperatures and water to beet ratios.

Plans: Future work on diffuser designs will be conducted when the effects of the various factors have been fully investigated.

c. Liming and Carbonation Studies WU-ARS

The laboratory scale model Dorr carbonator for juice purification studies was modified to reduce operating labor and increase experimental reproducibility. The unit is now fully satisfactory for experimental studies.

A total of 52 runs made during the past year in the Dorr carbonator show that the only critical variables are the alkalinity for filter ability, sedimentation rate, and soluble lime salts on the first carbonation juice. The alkalinity also affects color, lime salts, and purity of the standard thin juice treated with oxalic acid. The proportion of lime to juice used controls the total colloid content of the purified thin juice. Feed rate, recirculation rate, and temperature within the region of practical operation of the carbonator had only a minor influence in this operation.

Need for a uniform diffusion juice for carbonation studies required investigation of suitable conditions for juice preservation. Laboratory-produced diffusion juice, quick-frozen and stored at -10°F., maintains for at least three months the same filtration rate, sedimentation rate, and color properties after liming-carbonation as fresh unfrozen juice. The frozen juice lost half of its soluble proteinaceous colloids but this did not affect the quality of the juice for carbonation studies. Factory-produced juice deteriorated slightly in one month when similarly frozen and stored, while unfrozen juice with added preservatives was held three weeks at 34°F. without noticeable changes.

Plans: Studies on purification of diffusion juices will be continued, including consideration of colloidal constituents such as araban, protein, and others.

d. Equipment of the Beet Processing Laboratory WU-ARS

Equipment items were obtained for studies in connection with the allocation of funds from the Sugar Beet Development Foundation for a pilot scale processing laboratory located at the Western Utilization Research Branch, Albany, California. The facilities installed and in operating condition in the processing laboratory include:

(1) A beet washer.

(2) An ion exchange unit for water purification.

(3) A cossette mixing device.

(4) A cossette cutter.

(5) A combination cossette preheater and blancher.

(6) A Robert diffusion battery.

(7) A Brunische-Olsen continuous countercurrent diffuser.

(8) A heat exchanger for cooling diffusion juice.

(9) A Dorr continuous liming and carbonation unit patterned after a design by R. McGinnis, Spreckels Sugar Co., San Francisco, Calif.

(10) A Premier mill for preparation of lime slurries for purification.

(11) A vacuum system to be used in connection with the evaporator-cyrstallizer. The latter item is under construction.

(12) A vacuum freeze-drier for juice preservation.

(13) Various small items such as electronic temperature indicators, pH meters and the like.

All of these items have been installed, tested, and used in preliminary diffusion and purification studies of beets and beet processing liquors.

Plans: Purchase and installation of additional equipment will be continued to complete the beet processing laboratory according to the original plans. The pilot plant studies will be continued and expanded.

e. Direct Consumption Sugar Process Development SU-ARS

New ion-exchange resins and processes that avoid inversion of sugar and have been applied successfully as the last step in purifying liquid sugar can be used economically to produce grades of sugar directly from clarified cane juice that will be suitable for use in various industrial food products. Removal of ionic and colored impurities by this process in small pilot plant experiments made it possible to increase the recovery of sugar substantially, and improve the quality of the sugar sufficiently so that it can be marketed profitably for direct consumption without further refining. Larger scale pilot plant experiments were initiated at the Audubon Sugar Factory of Louisiana State University utilizing clarified juice from the sugarcane processing pilot plant, and were continued at the Puerto Rico Agricultural Experiment Station in Rio Piedras during the interval between Louisiana grinding seasons. A modification of the process in which the resins are combined for simultaneous removal of acidic and basic impurities and subsequently separated for regeneration was tried on this scale, but proved to be less effective than the procedure in which acidic and basic substances are removed by percolation through separate columns of the appropriate exchange resins. Equipment was designed and constructed for pilot plant development of the more efficient process on a larger scale at the Audubon Factory during the 1956 grinding season in Louisiana.

Plans: The technical feasibility of producing a satisfactory grade of direct consumption sugar by this process has been established, and it is now most important to determine costs accurately for economic evaluation of the process. The larger pilot plant will have sufficient capacity to provide reliable data on operating conditions, consumption of chemicals, water, and power, the practical increase in sugar recovery, and operating costs, as well as to produce sufficient quantities of sugar of uniform quality for evaluation in market surveys in which AMS will cooperate.

f. Expanded Uses of Sugar in Confectionery SU-ARS

Consumption of sugar as well as a variety of other agricultural products could be increased if per capita consumption of confectionery products were maintained or increased, rather than declining as it has in recent years, principally because quality is not maintained in storage and goods reaching consumers are inferior to freshly made candies. Improvement of storage or shelf life, as well as initial quality, to market better candies in volume paralleling the expansion of competitive food products, could increase domestic sugar consumption by as much as 100,000 tons per year. Basic research was initiated on formulation and processing various types of candy that are subject to deterioration by losing moisture so that the finished products will be more nearly in equilibrium with the humidities under which they must be stored and distributed. Availability of essential data on the mutual solubilities of combinations of sugars and their concentrations in saturated sirups, and of methods for determining the humidities with which candies are in equilibrium, have accelerated progress of this work. Storage stability of hard candies, which deteriorate by absorbing moisture, can be improved by reducing the content of invert sugar, which was found to be the principal factor in composition increasing the moisture absorption. Fundamental research was initiated independently at the University of California in informal cooperation through the National Confectioners' Association to study the causes of deterioration of starch gum candies that become tough in storage without losing moisture.

Plans: The National Confectioners' Association, who have been contributing the services of a Candymaker for this research, have tripled their contribution under the formal cooperative agreement for the next year; the research will be expanded to match the increased contribution by the industry and work on this project will be continued on a much broader scale.

g. Improved Production of Clinical Dextran NU-ARS

Work on dextran has been continued under a new line project at the request of the Department of the Army and by transfer of funds from the Office of the Surgeon General. The study has been directed toward perfection of improved methods for production of dextran of molecular size suitable for clinical use as a blood-plasma volume restorer. Two processes under investigation are the direct enzymic synthesis of clinical dextran, a process discovered at NU, and the production of clinical dextran by a special strain of microorganism which in whole culture fermentation produces dextran in the molecular weight range suitable for clinical use.

Pilot-plant-scale studies of the direct enzymic synthesis have been conducted using the enzyme produced by *Leuconostoc mesenteroides* NRRL B-512. The yields of 20 to 25 percent, based on total sucrose charged to the process, thus far obtained are significantly higher than those obtained by the present industrial processes used for

making clinical dextran. Further studies of operational variables and steps are needed to improve the procedure and place the process on a sound basis.

An alternative procedure of producing clinical dextran directly by whole culture fermentation employs an organism of a streptococcus strain, NRRL B-1351. Preliminary investigations of this organism were made in previous studies at NU. Methods have been developed for increasing the vigor of the organism and for improving the yield of dextran. Also, the fermentation period has been reduced to about 2 days, in contrast to 5 or 6 days required in earlier studies. Additional laboratory studies on methods of propagation, improved yield, and recovery of product are being conducted preparatory to pilot-plant investigations of the process.

The studies on both approaches to the improved production of clinical dextran will be continued with particular emphasis on the development of reliable processes and establishment of cost data on the processes.

h. Microbial Production of Fumaric Acid NU-ARS

Investigations on the microbiological production of fumaric acid have been directed toward improving the efficiency and economy of the fermentation. Reduced production costs would further increase the use of fumaric acid and provide a possible new outlet for surplus molasses. These studies have confirmed that Hi-test molasses, converted with enzymes, can be used in this fermentation in place of glucose. Also, several strains of fumaric acid-producing molds have been found in a survey of molds which ferment molasses without prior hydrolysis, whereas the mold initially used in the fermentation does not utilize sucrose. The method for preparing inocula for fermentations has been improved and the time for its production is thereby reduced from 44 hours to 8 hours.

Further studies will be made of factors which influence the rate of the fermentation and the yield of the acid; there is a particular need to shorten the time of the fermentation. Attention will be given to various strains of mold for the production of this acid, as well as to factors influencing mycelial growth in the production medium.

i. Maintenance of Culture Collection NU-ARS

The Northern Branch maintains a collection of microorganisms of industrial importance for production of antibiotics, vitamins, enzymes, organic acids, alcohols and related chemicals; for assays of amino acids, other growth factors, antibiotics, and fungicides; and for reference in the identification of unknown microorganisms. Thus, it serves as an invaluable source of bacteria, yeasts, molds and actinomycetes for scientists at this laboratory and elsewhere for conducting research on a wide variety of agricultural problems.

The Culture Collection has now 7,882 permanent cultures representing 2950 bacteria, 2390 yeasts and 2542 fungi. It also serves as a repository for cultures which have been deposited in connection with patent applications on fermentation processes. In the last year, 2199 cultures were distributed to industrial, agricultural, and university laboratories. Furthermore, 616 cultures coming from various parts of the world were identified. In the course of the identifications at least a dozen new organisms of interest in the laboratory program were acquired.

j. Investigations of Yeasts NU-ARS

Yeasts of the genus Hansenula and related forms are important in utilization research for their possible use as feed yeasts and as sources of enzymes. Several forms of this group are present during fermentation of pickles in brine. Knowledge of the genetics of the genus Hansenula has been expanded with emphasis on the production of diploids (2 X chromosomes) in species which are isolated from nature only in the haploid form (X chromosomes). The study of this genus has been directed towards the proper classification of its members for use in fermentations of agricultural products.

Knowledge of the genetics of the lactase-producing yeasts of Saccharomyces has been extended, with consideration of the industrial possibilities of enzyme production of these species. Techniques for doubling the number of chromosomes of the haploid species have been developed, and procedures for effecting hybridization and backcrossing have been successfully devised. Work on the taxonomy and hybridization of species of Hansenula and related yeast genera will be continued.

k. Investigations of Molds NU-ARS

The Mucorales are fungi which occur in soil, vegetables, stored grain, fermented foods, and in the air. They are capable of producing fumaric and lactic acids and of bringing about the oxidation of steroids. During this last year 373 mucoraceous fungi were obtained from our own isolations and from other culture collections. Taxonomic studies have been completed on four genera of the Mucorales--three of which contain species which grow at low temperatures. Such organisms are commonly found on cold stored meats and might play some role in the tenderization process. The sexual and zygosporic stage of two of the four genera has been found.

It has been confirmed that zygospores of some mucoraceous genera can be formed in submerged culture. In such a mating of plus and minus strains grown in synthetic mucor medium, growth is enhanced and an abundant yellow orange pigment is produced which is not found when either of the strains is grown alone. This pigment has been tentatively identified as β-carotene and the fungi which produce it are of considerable interest in a new program undertaken

here on microbiological production of vitamin A factor. Future taxonomic work on the Mucorales will be concentrated on the family Mucoraceae exclusive of Mucor and Rhizopus, especially under conditions favoring zygospore formation as it applies to classification.

1. Commercial Trial of Process for Separating Bagasse into Pith and Fiber NU-ARS

Pith present in sugarcane bagasse lowers its economic value for the production of papers, structural boards, and chemical pulps. Not only does the pith increase the amounts of processing chemicals required, but it also introduces dirt into pulps and adversely affects the physical properties in the products prepared. To eliminate these objectionable characteristics, the Northern Branch initiated research and successfully developed several methods for effectively separating and recovering the pith and fiber fractions of bagasse on a laboratory scale.

Under a research contract, our most promising method was evaluated by the U. S. Sugar Corporation, Clewiston, Florida, in a commercial-scale operation using bagasse directly from the sugar mill. The results of this trial run showed that the process was feasible from both economic and technical standpoints. The separated fiber was sold to a paper mill making fine grades of paper from bagasse. The pith fraction was retained in part for studies on its use as a carrier for feed molasses. Pelleting of pith-molasses mixtures has been studied on a laboratory scale at NU, and variations in pith fiber ratio, temperature of mixing and pelleting, particle sizes and moisture contents have been studied. Of these factors, moisture content of the mix was found to be the most critical variable in determining the firmness and density of the pellets.

Results of the commercial-scale trial pith-fiber separation were so encouraging that a major user of bagasse in Louisiana made an extensive economic study of the development, and has conducted extensive commercial-scale tests on the process. Savings effected in transportation of the separated fiber are sufficient to defray the expenses of the separation at bagasse baling stations.

Several well-established animal feed producers have expressed much interest in the separated pith for use as a molasses carrier. At least one firm has conducted tests involving more than 1,500 pounds of separated pith, and as a result is now seeking a continuing source of the pith for use in production operations.

Plans: This concludes our studies on the evaluation of processes for separating bagasse into pith and fiber.

m. Alpha-Cellulose Pulp from Bagasse for Rayon Manufacture NU-ARS

For many years production of high-grade alpha-cellulose pulp from sugarcane bagasse has been the objective of research conducted by both the cellulose-derivatives industry and the pulp and paper industry. The short-fiber character of bagasse, its relatively high pentosan content, and the characteristics and behavior of the pith made preparation of high-quality pulps difficult.

The Northern Branch in collaboration with a large industrial concern developed procedures on a laboratory scale (discussed in last year's report) for producing a high-quality alpha pulp from bagasse suitable for conversion to viscose rayon. To make possible commercial evaluation of the process and to encourage practical utilization of bagasse, experimental lots of alpha pulp were prepared for testing in a viscose rayon mill in Brazil. This work was conducted in cooperation with the above-mentioned collaborator. Although the Philippine bagasse was of inferior quality, alpha pulp was prepared with characteristics required for rayon production. As a result of the conversion of this pulp to rayon, spinning tests, and evaluation of the yarn in a commercial viscose plant, it was concluded that the NU pulping process can produce from sugarcane bagasse a dissolving pulp suitable for converting into good grade viscose rayon by a regular process of rayon manufacture.

Plans: This work has been completed.

3. UTILIZATION OF BYPRODUCTS AND DISPOSAL OF WASTES

a. Development of Feed Additives from Beets WU-ARS

Studies on an antibiotic aterrimin, produced by fermentation of sugar beet molasses, have been continued in accordance with the Committee's recommendation. The pure antibiotic has now been isolated and feeding tests on poultry conducted under a contract with Wisconsin Alumni Research Foundation on its effect on growth response. Preliminary results indicate that it effects growth but the statistical evaluation of these results have not been made.

Plans: The feeding contract has been terminated but evaluation of results have not been completed.

4. Utilization of Honey EU-ARS

Application of a new analytical procedure to the determination of the sugars of honey has shown that reducing disaccharide sugars are general constituents of honey. Since they make up five to fifteen per cent of the solids, their identity is of interest. Use of gradient elution charcoal chromatography and preparative paper chromatography has resulted in the isolation of eight disaccharides

from honey. Using infrared spectrophotometry, five of them have been identified as isomaltose, maltose, maltutose, turanose and nigerose. Work continues on the remainder.

An extensive analytical survey of the principal floral types and blends of honey in the United States, both commercially important and otherwise, has begun. A sample collection is now under way. This project is intended to provide basic composition information for the use of honey and food industries, supplanting the fifty-year old data now available.

Work on the organic acid fraction of honey has been suspended because of personnel shortages. Of the seventeen acids found in honey by chromatographic methods, four have been identified by X-ray diffraction. All four have previously been reported in honey.

Investigations on the role of honey in commercial cake production have resulted in cake formulations in which honey is the sole sweetening agent. Evaluation of the formulas is in progress. Under the same project, an investigation is being made of the browning reaction as it occurs in cakes containing reducing sugars.

Engineering studies are under way on the feasibility of producing a dry honey product. Successful runs have produced a product with no color or flavor damage. An exploratory study of the value of honey in pharmaceutical formulation is being undertaken by contract with the Philadelphia College of Pharmacy & Science. It is hoped that the flavor and sweetening power of honey will help it re-enter a field which it lost long ago.

B. PUBLICATIONS

SU-ARS

"Resumé of Milling and Processing Characteristics of Three New Sugarcane Varieties," by W. F. Guilbeau and C. W. Stewart. Sugar Bull. 34 (18), p. 276-277 (June 15, 1956).

"Processing Characteristics of Three Recently Released Sugarcanes," By W. F. Guilbeau, E. E. Coll, and L. F. Martin. Sugar J. 19 (2), pp. 37-40 (July 1956).

"Quantitative Determination of the Amino Acids of Sugar Cane Juice," by E. J. Roberts and L. F. Martin. Sugar 51, 1, pp. 32-33 (Jan. 1956)

"Distribution of Starch in (Vegetable Carbon) Refining of Cane Sugar," By R. T. Balch and J. J. Friloux. Sugar J. 18 (12), p. 79-80 (May 1956).

"Apparatus for Automatically Increasing Solvent Polarity in Partition Chromatography," By Earl J. Roberts and Austin Mason. Anal. Chem. 28 (6), pp. 1063-64 (June 1956).

"Some Characteristics of Louisiana Raw Sugars," By R. T. Balch and J. J. Friloux. Sugar Bull. 34 (17), pp. 254-258 (June 1, 1956); 34 (18), p. 274-5 (June 15, 1956).

"The Value of Fresher Sugarcane to Both Growers and Processors," by W. F. Guilbeau, E. E. Coll, and L. F. Martin. Sugar Bull. 34 (14), p. 205-212 (April 15, 1956).

13 Years of Candy Research: Accomplishments and Outlook for the Future. (Published under title "Martin Calls for More Research on Candy, Summarizes Results of Limited Studies".) By L. F. Martin. Confectionery - Ice Cream World 55, 24, pp. 34, 36 (June 11, 1956).

WU-ARS

"Sampling of Sugar Beets for the Processing Laboratory," Roy Teranishi, J. Amer. Soc. Sugar Beet. Techn. 9, 74 (1956).

NU-ARS

"Production of Dextranase," H. M. Tsuchiya, Allene R. Jeanes, Helen M. Bricker, and C. A. Wilham. U. S. Patent No. 2,742,399. April 17, 1956.

"Crystalline Methyl α-Isomaltoside and Its Homologs Obtained by Synthetic Action of Dextransucrase," R. W. Jones, Allene Jeanes, C. S. Stringer, and H. M. Tsuchiya. J. Am. Chem. Soc. 78 (11): 2499-2502. (1956).

"Fractionation of Dextran Products," Ivan A. Wolff and Russell L. Mellies. U. S. Patent No. 2,712,007. June 28, 1955.

"Thermal Modification of Dextran," Ivan A. Wolff, Paul R. Watson, and Carl E. Rist. U. S. Patent 2,719,147. September 27, 1955.

"A New Synthesis of 2,4-Di-O-Methyl-D-Glucose." J. W. Van Cleve and W. C. Schaefer. J. Am. Chem. Soc. 77(20): 5341-5343. (1955).

"Interpretation of Periodate Oxidation Data on Degraded Dextran," R. J. Dimler, I. A. Wolff, J. W. Sloan, and C. E. Rist. J. Am. Chem. Soc. 77 (24):6568-6573. (1955).

"Preparation of Methyl Glycosides of Homologous α-1,6'-Linked Gluco-oligosaccharides and the Optical Rotation of Their Cuprammonium Complexes," T. A. Scott, Jr., and F. R. Senti. J. Am. Chem. Soc. 77 (14): 3816-3821. (1955).

"Controlled Enzymatic Synthesis of Dextran. Conditions for Producing Clinically Suitable Molecular Weight," N. N. Hellman, H. M. Tsuchiya, S. P. Rogovin, B. L. Lamberts, Robert Tobin, C. A. Glass, C. S. Stringer, R. W. Jackson, and F. R. Senti. Ind. Eng. Chem. 47(8): 1593-1598. (1955).

"Viscosity, Sedimentation, and Light-Scattering Properties of Fractions of an Acid-Hydrolyzed Dextran," F. R. Senti, N. N. Hellman, N. H. Ludwig, G. E. Babcock, R. Tobin, C. A. Glass, and B. L. Lamberts. J. Polymer Science 17(86): 527-546. (1955).

"Synthesis of Dextran and Dextran Analogues of Predetermined Molecular Weight," Henry M. Tsuchiya, Nison N. Hellman, and Harold J. Koepsell. U. S. Patent No. 2,724,679. November 22, 1955.

"Modification of Dextran Synthesis by Means of Alternate Glycosyl Acceptors," Harold J. Koepsell, Nison N. Hellman, and Henry M. Tsuchiya. U. S. Patent No. 2,726,190. December 6, 1955.

"Symposium on the Maintenance of Cultures of Microorganisms," D. Perlman, S. E. Hartsell, R. H. Haskins, A. C. Blackwood, W. C. Haynes, L. J. Wickerham, C. W. Hesseltine, R. J. Heckley, M. N. Klumpp, S. H. Hutner, L. Provasoli, and H. R. Skeggs. Bact. Rev., 19(4):280-283. (1955)

"Maintenance of Cultures of Industrially Important Microorganisms," W. C. Haynes, L. J. Wickerham, and C. W. Hesseltine. Applied Microbiology 3(6): 361-368. (1955).

"A Scraper for Transferring Large Amounts of Microbial Growth," R. W. Kuehne. Chemist Analyst 45(1): 26. (1956).

"A Portable Rack for Staining Jars," R. W. Kuehne and Lenora J. Rhodes. Stain Tech. 30(4): 159-160. (1955).

"New Materials and Procedures for Genetic Studies of Yeats," L. J. Wickerham. Nature 176: 22. (1955).

"Hybridization Studies Involving Saccharomyces lactis and Zygosaccharomyces ashbyi. L. J. Wickerham and K. A. Burton. J. Bact. 71(3): 290-295. (1956).

Influence of Agglutination on Zygote Formation in Hansenula wingei, a New Species of Yeast." L. J. Wickerham. In volume of papers on genetics celetrating 70th birthday of Professor Winge on May 19, 1956.

"Controlled Enzymatic Synthesis of Dextran," N. N. Hellman, Henry M. Tsuchiya, S. Peter Rogovin, Richard W. Jackson, Frederic R. Senti. U. S. Patent No. 2,726,985. December 13, 1955.

"Hybridization Studies Involving Saccharomyces Fragilis and Zygosaccharomyces dobzhanskii." L. J. Wickerham and K. A. Burton. J. Bact. 71(3):296-302. (1956).

EU

"Sterilization of Honey for Bee Feeding," Jonathan W. White, Jr., and A. P. Sturtevant, Gleanings in Bee Culture 82, 658-61 (Nov. 1954)

"Honey Handling by the Commercial User," Jonathan W. White, Jr. In press, Federation News Letter, American Beekeeping Federation.

"The Browning Reaction in Baked Products. IV. Control of Browning in Cake Crumb," Donald Miller, Philip Nordin and John A. Johnson, In press, Cereal Chemistry.

"Progress in Honey Utilization Research," Jonathan W. White, Jr., Proceedings, Florida State Beekeepers Association 54-60 (1953).

"Research Develops New Outlets for Honey," R. E. Lothrop, Gleanings in Bee Culture 82, 594-99 (Oct. 1954).

"Browning Reaction Products of Cake Crumb" by Philip Nordin and John A. Johnson. In press, Cereal Chemistry.

"Glass Color Standards for Extracted Honey," B. A. Brice, A. Turner, Jr., and J. W. White, Jr., in press J. AOAC.

United States Patent 2,760,870, "Maple-Honey Spread," J. Naghski, C. O. Willits, W. L. Porter,and J. W. White, Jr.

PROPOSALS FOR COMMITTEE CONSIDERATION
(Order of listing has no priority significance)

UTILIZATION RESEARCH

a. Processing Quality of Sugar Beets and Sugarcane as Related to Composition

Expand research to complete the inventory of chemical constituents of sugar beets and sugarcane and their juices and to determine their relation to processing behavior and yield as a basis for more effective utilization and production research.

Acceleration of the work on isolating, identifying, and developing accurate methods for determining all of the non-sugar constituents will ensure greater progress in every phase of research on sugar. Complete knowledge of the chemical composition of juices will make it possible to correlate processing quality determined in pilot plant experiments with the concentrations of non-sugars that affect processing efficiency and quality of sugar. A rational approach to development of new and more efficient methods of clarification and sugar recovery depends upon establishing such correlations, and determining changes in composition throughout the manufacturing process. Raw and refined sugar qualities can be improved by research based upon knowledge of the chemical nature and concentrations of impurities in juices, sirups, and sugars. Genetic, pathological, and agronomic research can be expedited by applying the information and techniques developed in these studies in cooperative work,particularly with the Field Crops Research Branch.

b. Undetermined Losses in Sugar Manufacturing

Initiate studies to improve the present and develop new analytical methods for use in controlling the manufacture of sugar, including the determination of quality, magnitude of processing losses, and interferences by non-sugar substances.

Inaccuracies inherent in present analytical methods account for approximately 3% of "undetermined" losses of sugar in sugarcane. Some progress has been made with modern, qualitative chromatographic techniques in establishing the nature of some of the non-sugar reducing materials that interfere with the determination of sugars. Intensified work is needed to determine the precise nature and magnitude of interference by these and other impurities and to develop practical rapid methods, based upon the latest analytical techniques, giving precise data for factory and refinery control.

c. Industrial Utilization of Sucrose

Initiate studies on the use of sucrose available in refined raw and liquid sugars, sirups, and molasses,as a starting material for the production of industrial products by chemical and microbiological methods, and evaluate the economics and potential industrial utility of the processes and products so developed. Although refined sugar is one of the cheapest and purest

chemicals available in large quantity in the United States, only about 52,000 tons, or 0.7% of total consumption, are currently utilized for non-food purposes. Processes are already available for the synthesis of a wide variety of chemicals from sucrose, but much more product development work is required before non-food use of sucrose becomes widespread. The potential increase in the sugar market that could be created by the development of industrial outlets is so vast, however, that a vigorous research program should be initiated in this field.

d. Post-Harvest Losses of Sugar From Sugar Beets and Sugarcane Prior to Processing

Expand basic research and pilot scale processing studies on post-harvest losses of sugar in sugar beets and sugarcane, and devise procedures for reducing or eliminating these losses.

The relative losses caused by metabolic activity of plant tissues and by invasive fungi and bacteria should be determined, and practices should be developed through applicable pilot plant investigations to decrease such losses. Studies of the metabolic losses will include isolation and characterization of the fungi and bacteria and enzyme systems responsible for the losses, and development of antimetabolic agents, irradiation, dehydration, or other treatments for their control. Cooperative studies, particularly with field Crops and Agricultural Engineering Research Branches should be undertaken when necessary.

e. Improved Processing Procedures

Expand fundamental research and applied pilot plant processing studies on the extraction of sugar from beets and cane, purification of juices, and crystallization of sugar from liquors, in order to achieve and maintain optimum and economic processing conditions in facilities now existent for the manufacture of sugar.

f. Sugar Beet Byproduct Utilization

Initiate studies for producing economically valuable non-food and non-feed byproducts from sugar beets and sugar beet processing residues such as: the floc-forming saponins as superior foaming agents for flotation and the like; certain nitrogen containing substances as biologically active compounds, waxes, and fatty substances as polishes; other chemical constituents as sources of vegetable gums; preparation of an antioxidant from the pectins of beet pulp preparation of a cheap material from beet pulp for use in water softening; industrial utilization of lime muds as a foam fire extinguishing agent for oil well fires and the like; and utilization of pulp press water for re-use in the factory.

g. Processed Feeds from Sugar Beets

Initiate studies on the direct utilization of sugar beets as processed feeds.

Although a considerable amount of information has accumulated on the use of beet pulp, molasses, beet tops and other byproducts as feeds or feed supplements

the use of the whole beet plant as feed has not been investigated. Preliminary data indicate that on the dry matter basis beets exceed alfalfa in total digestible nutrients. Researches should include procedures for processing the whole beet plant into a stable nutritious feed. While molasses and beet pulp have been shown to stimulate the growth of ruminants, dried beet tops apparently have a growth depressant effect on poultry probably similar to alfalfa. The use of whole beet plants offers a promising means of increasing efficiency of animal and perhaps poultry feeding provided sufficient researches furnish necessary information on processing and feed utilization. Attention should be given to the development of the most stable and widely acceptable form of the product so that no losses of potency during processing and storage occur. The newly developed feeds should be evaluated cooperatively with animal and poultry production groups. Successful development of such new feed outlets would permit means of increasing the efficiency of agricultural production of feeds from the available land.

h. Sugar for Specific Food Uses

Expand research on the qualities of sugar required for particular food uses and development of processes for more efficient and economical production of sugar with the desired qualities.

Research should be initiated to establish optimum qualities of sugar for economical improvement of sugar-containing food products, to determine the nature and importance of impurities in sugar affecting the processing and quality of such products, and to develop efficient, low-cost processes for producing sugar of the required qualities. Pilot plant development research should be accelerated to commercialize profitable application of ion-exchange purification for increased recovery of grades of sugar adequate for confectionery and other food uses. Use of sugar in foods requiring exceptionally pure grades will be expanded by developing economical methods of eliminating particular impurities, such as odorous substances and those causing floc in beverage sirups. Evaluation of the grades of sugar for various uses will be carried out in cooperation with appropriate food manufacturing industries and producers of sugar.

i. Increased Use of Honey by Industry

Expand research to develop new and improved uses for honey to include (a) composition of honey and its reputed biological activities, (b) investigations increasing the utilization of honey in food and other fields, and (c) investigations on the dehydration of honey.

III. MARKETING RESEARCH

A. PROGRESS ON WORK UNDER WAY

1. IMPROVEMENT IN MARKET ORGANIZATION AND FACILITIES

a. Industrial Molasses — MOC-AMS

A report titled Marketing Molasses for Livestock Feed, was issued, dated September 1956. A report on Transportation Facilities and Their Functions in Marketing Molasses to the Livestock Feeding Industry is now in process of publication.

Analysis has been completed on the third study of the series, The Mixed Feeds Industry as an Outlet for Molasses, and a report is now under review within the Department. It is expected to be published in the near future.

Findings in the three studies indicate that the use of liquid molasses in livestock feeding faces substantial problems. Important examples are the requirement and cost of molasses handling equipment on the farm, the efficient management of molasses feeding and the economical transportation of molasses to many inland feeding areas and delivery in small lots (to service 100 head of cattle or less) at prices competitive with other feeds. The conditions found in a survey suggest that with sympathetic interest and study these problems can be solved or the adverse conditions ameliorated to a great extent.

b. Sugarcane — MOC-AMS

Planning of a further step in the study of sampling of sugarcane has progressed to a point where active mechanical sampling and analysis can be carried out as soon as personnel is available. Because of the rapid mechanization of the handling of cane, it is planned to study machine sampling through several variations and to check results against milling tests of the samples and of the lots of cane from which they are drawn. Trustworthy results of such a project should be of increasing practical value as mechanization progresses.

c. Raw Sugar — MOC-AMS

The marketing of Puerto Rican sugar has been under study with emphasis on interrelations among variations in handling, storing, shipping and accounting methods in Puerto Rico, methods of ocean shipment, port of entry on the mainland, methods of sale and pricing and seasonality.

Partial analysis is indicating certain trends and relationships although to this point in the work they are little more than suggestions. It had previously been clear that there was a

loss in weight and a gain in polarity during shipment of raw sugar from Puerto Rico to the Mainland. It now appears, however, that the gain in polarity will usually represent a very slight change in value compared with the loss in weight experienced in shipment to northern ports. Weight loss has increased in each of the last three years. Shipments to southern and Gulf ports show less loss than those going further north, but still definitely more than an equivalent offset for increased polarity. Bulk shipments show less weight loss than do bag shipments, but this is accounted for to considerable extent by weighing bagged sugar at the mill and bulk sugar at the dock. There is a slight trend toward bulk shipment.

Proportions of the crop priced spot or average-for-a-period vary appreciably from year to year. Between the 1953 and 1955 seasons the portion of Puerto Rican sugar sold on an "average" price, increased from 35 percent to 85 percent. Little difference in average price shows for the two methods. A report will be made within the fiscal year.

d. Synthetic Sweeteners MOC-AMS

Routine analysis of available information has been made during the previous year. Data on the subject are so sparse, however, that further scrutiny and a search for additional facts seems necessary to develop sound judgment as to the importance of such sweeteners to the sugar market. Observations most frequently reported relate to experiences of chain groceries. These seem like very inadequate checks on a commodity of admittedly slight current demand and one until recently still considered a dietetic item. Scrutiny of advertising activity of producers of the synthetics suggests a brighter market outlook. Certain specific leads are still to be followed.

e. Refined Sugar Marketing MOC-AMS

Initial investigation of refined sugar marketing is being carried on in conjunction with study of the marketing of Puerto Rican raw sugar and from another angle in relation to the marketing of beet sugar. Further steps are planned and awaiting the availability of personnel. The work will include an appraisal of economic elements and marketing practices associated with (1) distribution of market risks, (2) buying and selling practices, (3) accumulation and maintenance of stocks, and (4) price change policies. In order to provide more detailed information on the organization of the sugar market and enable better understanding of demand forces, this work will also include the development of an analytical description of the market, including (1) the location of users by type and size; (2) area sugar use as affected by seasonality, population shifts, transportation media; and (3) other factors that contribute to variation of distribution pattern.

f. Sugar Price Spreads

MOC-AMS

Preliminary work is underway on the measurement of price spreads in the marketing of sugar. Such studies for all important agricultural commodities have been specifically requested by the Congress. Purpose of the work is to compare efficiencies between market channels, geographic areas, stages in distribution and commodities. Some parts of the market have been reviewed in the process of selecting appropriate points and correct methods for the measurements involved.

g. Bulk Handling of Raw and Refined Sugar

MOC-AMS

Bulk handling of raw sugar is receiving consideration as a minor aspect of the Puerto Rican sugar marketing analysis. Need for information on bulk handling of both raw and refined sugar is becoming increasingly obvious. There is need by all segments of the industry, particularly industrial users, for study of costs of handling refined sugar in bulk and for determination of the net economies that can be attained.

h. Marketing Sugar Beets

MOC-AMS

An analysis of the method of pricing sugar beets in the Central and Far West regions has been made and a preliminary report has been largely developed. Two points that require explicit consideration to present feasible alternatives to present pricing methods and their advantages and disadvantages are variation of economic advantage for growers and processors by geographic area and the economic implications of handling marketing risks in specific ways. A preliminary report, covering these aspects of sugar beet marketing will be published before the end of the calendar year.

i. Maple Sirup and Maple Sugar

MOC-AMS

We have been unable to recruit a qualified specialist to undertake a maple product study. Furthermore, no appropriate research contractor has been located to carry out a study of maple products marketing. As a result, the work is now held in abeyance.

j. Sugarcane Sirup Standards

F&V-AMS

Investigation required for the development of grade standards for sugarcane sirup has been completed. A proposal for revision of the current standard is now being developed. Along with this revision of standards, permanent glass color standards are being devised which should simplify the color grading of cane sirup.

k. Market Potentials for Low-Order and Non-Food Uses of Sugar

MD-AMS

The Department's facilities for work in the field of low-order and non-food uses have been so completely occupied with other projects already in progress that work on the marketing of sugar in these uses could not be initiated. The work should be done at the earliest opportunity.

l. Honey Standards Revision

F&V-AMS

A proposed revision of the grade standards for honey has been developed and considerable progress has been made on devising visual aids to illustrate color and defect requirements. The standards are scheduled to be released in final form shortly after the winter meeting of the honey producers.

2. Household Food Consumption

a. 1955 Food Consumption Survey

HHE-ARS
MD, SHR-AMS

The data on food consumption obtained from the 6,000 households included in the 1955 survey have been prepared for tabulation, and a preliminary report has been completed. This is the first nationwide study of food consumption since 1942 that covers rural as well as urban households.

The preliminary tables from this survey indicate that food expenditures of housekeeping families in the U. S. averaged $27 a week in the spring of 1955. About $22 of this was for food consumed at home. The remainder, $5, was spent for meals and between-meal food away from home. With average size of the household at 3.43 persons, average expenditure per person amounted to $7.89 a week for all food. Of this, $6.50 was spent for food to be prepared at home, and $1.39 for food consumed away from home. The tables included in this report also make possible comparison of rural and urban, regional, and income groups as to family food expenditures.

The food expenditure increase since the previous nationwide survey in 1942 indicates the effect of both higher food prices and the use of more expensive foods. In 1955, average food expenditure was about three times the average of $10 in 1942. A more precise comparison can be made for urban families of two or more persons. They spent $13 in 1942, $26 in 1948, and $32 in 1955. Retail food prices as measured by the Bureau of Labor Statistics index advanced only 6.5 percent between 1948 and 1955. The fact that family food expenditures increased about 25 percent indicates what is sometimes referred to as "up-grading" of the diet--either use of more expensive types of foods or inclusion of more services, such as precooking of foods, in the foods purchased.

Plans: Five sets of initial reports are to be prepared and all are to be included in one Department publication series. These five are Food Consumption of households; Dietary Levels; Home Food Preservation Practices; Home Food Production; and Home Baking Practices. Plans have been made for first releases in this series beginning late in 1956. In all reports, separate data will be shown for each region and the U. S. by income groups for rural farm, rural nonfarm, urban, nonfarm (rural nonfarm and urban), and all urbanization combined. In the processing of these data, the work has been planned to make the listings, punch cards, and tapes as useful as possible also for later research that will require additional tabulations. The reports will show separately the consumption of purchased granulated, confectioners, and brown sugar as well as total consumption of purchased sugar.

B. PUBLICATIONS

MOC-AMS

"Marketing Molasses for Livestock Feed," Frederick J. Poats. Marketing Research Report No. 132, September 1956.

"Wisconsin Maple Products, Production and Marketing," Peter Dale Weber. Wisconsin State Department of Agriculture and Federal-State Crop Reporting Service (Wisconsin State Department of Agriculture bulletin No. 333), June 1956.

PROPOSALS FOR COMMITTED CONSIDERATION
(Order of listing has no priority significance)

MARKETING RESEARCH

a. Feed Molasses Grades

Initiate studies of the feasibility and value of grades and standards for feed molasses.

The principal value of molasses to the feed trade is its sugar and protein value. At present, various other quality factors are used. Molasses users have indicated the need for greater knowledge of the products. Some of the things they would like to know are: (1) Total sugar content or the nutrient equivalency to permit accurate gauging of its use in a mixed feed or as a portion of the tation; (2) nature and extent of the dissolved mineral matter; (3) the density or weight per unit of volume; (4) water content or percent of dry solids; and (5) amount of dirt or undissolved foreign matter.

b. Dried Molasses Feed Products Statistics

Initiate a study of dried molasses feed products, including consideration of the feasibility and value of regular statistical reports of the volume involved.

The study would include analysis of variations in types of molasses, carriers and other additives such as protein supplements and in marketing methods and practices, each in relation to costs, efficiency, and other economic effects on feeders and the industry. Very little knowledge is available at present concerning the importance of these practices and other factors in the market for molasses and other important agricultural byproducts which are used as carriers.

c. Market Potentials for Direct Consumption Ion-Exchange Sugar

Initiate studies to determine the market potential for direct consumption sugar produced by ion-exchange purification.

This work will include the determination of the marketing area served by producers eligible to market this kind of sugar in the domestic market under existing Sugar Act regulations; sugar requirements within this area by industrial users; sugar usage in particular end products forwhich ion-exchange sugar is a suitable raw material; acceptability of this sugar by manufacturers whose products are adaptable to its use; and the comparable quality characteristics and prices at which this sugar will be competitive. The results of this work will indicate to prospective producers the economic feasibility of entering into production of this product; to users whether ion-exchange sugar affords to means to lower costs without sacrificing quality; and to the sugar industry the possibilities that ion-exchange sugar has for increasing total sugar consumption without decrease in returns to producers. This work will be carried out in close cooperation with the Southern Utilization Research Branch of the Agricultural Research Service.

d. Honey Marketing

Initiate studies of characteristics of the honey marketing process.

The honey industry has requested assistance in the analysis of marketing problems and recommendations for their solution. The first need is for an analytical description of the marketing process for more than a quarter of a billion pounds of honey produced in the American countryside. Such a study would include description and quantities of honey marketed, by types and qualities, by marketing channels, by uses and by size of purchase units (containers).

IV. MARKETING SERVICE AND EDUCATIONAL WORK

A. PROGRESS ON WORK UNDER WAY

1. FOREIGN MARKETING SERVICE AND RELATED RESEARCH

a. Scheduled Reports FAS

Regular world summaries of world sugar production are scheduled in November and May. A regular world summary of sugar beet production is scheduled for early October. During the fiscal year 1955-56, the following scheduled summaries were released in the publication Foreign Crops and Markets:

World Production of Sugar Beets Up in 1955 - released Oct. 17, 1955.

World Centrifugal Sugar Production Up About 600 Thousand Tons - released November 28, 1955.

World Centribugal Sugar Production in 1955-56 Larger than November 1955 Forecast - released May 7, 1956.

b. Unscheduled Reports FAS

A summary of international trade in sugar is published annually during the early summer. The article International Trade in Sugar Declines 1.2 Million Tons in 1954 was released in Foreign Crops and Markets, August 15, 1955.

c. Supplementary Work FAS

Statistical tables and articles are prepared annually for the following publications:

Agricultural Statistics: Tables covering world sugar production and trade were prepared in July and August, 1955, for the yearbook Ag. Stat.

World Agricultural Situation: A report on the current world sugar situation was prepared in December for publication in the Foreign Agriculture Circular, World Agricultural Situation, 1956, released in January 1956.

2. DOMESTIC MARKETING SERVICES OF U. S. DEPARTMENT OF AGRICULTURE

a. Sugar Statistics AEC-AMS

A part of the statistical work on sugar in the AMS centers around the publication once a year of the Sugar Situation. This report comprises a large number of tables and a descriptive text dealing with (1) domestic production, distribution, consumption, and prices of cane and beet sugar, (2) foreign sugar production, and (3) production, consumption, and prices of allied sweeteners.

Brief discussions of events of particular interest to the sugar industry are also included.

Other publications in which the results of the work on the Sugar Situation appear are: The National Food Situation, the Statistical Abstract of the United States, and Agricultural Statistics.

b. Statistics on Sugar Beets, Sugarcane, and Maple Products AES-AMS

Data on acreage, yield, and production are published monthly from July through December for sugar beets and sugarcane for sugar and seed, and annually in December for sugarcane for sirup. Data on trees tapped and production of maple sugar and maple sirup are published in May and December each year for maple product. Prices received by farmers and value of production are published for all of above sugar crops plus disposition and value of sales for maple products and sugarcane sirup. Final acreage, production, and prices for sugar beets, sugarcane for sugar, and sugarcane for seed are based on reports made by sugar companies to the Sugar Division of the Commodity Stabilization Service.

This work will be continued on about the same basis as in the past year. However, for maple products work has been started on converting the data on number of trees tapped to number of buckets or plastic bags hung. Survey data were collected in May 1956 obtaining information both on trees tapped and number of buckets hung which will prove useful in converting this series of estimates to a buckets hung basis.

c. Molasses Market News GR-AMS

The Molasses Market News reporting service was transferred from the Fruit and Vegetable Division of AMS to the Grain Division of AMS in August 1955. The move has resulted in an improved service and reduced costs, as the Grain market news field offices are being utilized to gather molasses market information. Molasses news has been included with other market reports issued by the Grain Division, thereby increasing the overall coverage. In addition, the molasses report continues to be published separately. The original title of "Weekly Molasses Market Report," has been changed to "Molasses Market News."

An attempt was made in certain quarters to have the service terminated. This question posed was answered by taking the issue directly to all recipients of the report.

As a result of the referendum taken in the Fall of 1955 we received a rather comprehensive breakdown on the various uses of which the report was being put. The majority opinion endorsed the continuing need for the market news disseminated under the current program. Many segments of the industry have become dependent upon this service in their daily transactions. Its particular service

has been in providing the smaller rancher and farmer with regular weekly price and market information. More organizations and feed users are receiving the report than any other group. This is a trend away from the initial preponderance of sugar producers and related industries. The shift from rail transportation to the barge-truck method of distribution has continued during the past year and there have been several rail freight reductions for molasses in an effort to recapture some of the lost business. Some of the railroads have increased their volume of molasses movement, following the reduction in freight rates at some of the major inland terminals.

Molasses prices have almost doubled since November 1955, and the upward price trend has continued through the summer when prices normally drop as demand falls off. Higher costs of Cuban molasses influenced U. S. domestic price increases in early 1956. During the past year molasses prices have increased percentagewise a great deal more than either prices for feed grains or feedstuffs.

The service was materially improved by reorganizing the manner of gathering molasses information in Puerto Rico. As a result, more complete information is being collected from the local Centrals and we have been able to obtain more representative prices and market conditions for Puerto Rico. Several new reporting points have been added during the past year which has made the report more complete with the inclusion of the major feed consuming areas.