SUMMARY - PANEL REVIEW

The workshop was concluded with a panel review and discussion of each of the subject areas. In order to tie together the individual reports from the several production areas (West Coast, Intermountain, Eastern Rockies, Red River Valley, and Eastern), the summaries are focused around the USDA goals and ARS's specific missions. The reviews delineated important accomplishments and opportunities for the future.

GOAL I: Insure a Stable and Productive Agriculture for the Future Through Wise Management of Natural Resources

Reviewer: Marvin E. Jensen

A. Research Accomplishments

Only a portion of the recent soil and water research program was summarized at this conference because many ARS scientists in this subject area devote only a portion of their time to sugarbeets. Briefly, research over the past several decades has accomplished the following:

1. Water Management

   a. Consumptive water use from planting to harvest has been delineated for major sugarbeet growing areas.

   b. The expected range in peak water use rates over 10-20 day periods has also been delineated for current varieties.

   c. The relative rate of evapotranspiration as compared to a well-watered reference crop has been adequately defined for approximating irrigation schedules.

   d. Although leaf area can be influenced substantially by irrigation and nitrogen management, sugar yield is not strongly influenced by the level of soil water depletion between irrigations.

   e. The timing of the first irrigation is still important, and the quantity of water applied during the first few irrigations significantly influences N management.

   f. Computer models are essentially complete to enable accurately estimating daily soil water loss from meteorological data for management purposes.

2. Nitrogen Management

   a. Fundamental relationships have been developed and tested for predicting the quantity of N needed to produce a crop and the amount present in the soil, including that expected to be mineralized during the season, and the amount of fertilizer needed to maximize sugar production.

b. Nitrogen management equations still need calibration for various climate-soil-variety regimes. Good N management is just beginning in some areas.

c. Sucrose content of beet roots has been found to be very closely related to the integrated average nitrate nitrogen content of the petioles from midseason to near harvest during individual growing seasons, but year-to-year variations have not been resolved.

d. Largest sugar yields are obtained with high N early in the year and low N late in the season. Largest yields are obtained when N is supplied from manure.

3. Phosphorus Management

a. Yield response from P can be adequately predicted using a standard soil test for soluble soil phosphorus. However, these tests do not indicate the total amount of P available in the soil.

b. Field studies show that P fertilizer is being applied even though soil tests show adequate P. Some studies indicate a possible adverse effect on sugar production under high rates of P.

4. Other Nutrients

a. Deficiencies in minor nutrients have been found and usually are very specific for a given soil and water supply. Studies have enabled predicting these deficiencies.

b. Deficiencies in other plant nutrients have usually been determined as their symptoms appeared.

B. Opportunities for the Future

1. Growth, Quality, and Plant Nutrients

a. More plant breeding needs to be directed toward increasing sugarbeet yields and quality.

b. Plant breeding for seedling vigor in cool spring weather, rapid development of leaf area, early development of the beet, and cessation of leaf development and transfer and storage of photosynthate earlier in the season is needed.

c. A combination of irrigation, plant nutrition, and cultural practices is needed to improve the establishment and maintenance of uniform stands in most sugarbeet growing areas.

d. Factors that influence early season growth and their effects on yield need to be identified and quantified.

2. Diseases and Soil and Water Management

a. An evaluation of the relative decrease in disease incidence and severity in high yielding, good quality varieties as influenced

by soil, water, and plant nutrient management seems to have consistently played a secondary role to developing new disease resistant varieties that may not have as good or no better production characteristics.

3. Soil-Water-Plant Relationships

   a. Plant water stress as caused by either high evaporative demands and/or a deficit of soil water influences plant growth. The nature of this stress at various stages of growth and quantitative relationships must be known to optimize soil and water management for optimum sugar production.

   b. A concerted effort is needed to develop new varieties that will take advantage of the potential growth period without sacrificing yield and quality. The time now required from planting to produce the first unit of beet roots limits yield potentials.

   c. Growth analyses coupled with a range in water and plant nutrient levels should be considered when evaluating disease resistant varieties.

   d. Practical techniques are needed to control soil crusts that form in high silt soils after spring rains or sprinkler irrigation. Poor stands caused by crusts and other factors probably account for the largest reduction in sugar production except for major disease outbreaks.

GOAL II: Protect Forests, Crops, and Livestock from Insects, Diseases, and Other Hazards

RPA 207 - Control of Insects, Mites, Snails, and Slugs Affecting Field Crops and Range

Reviewer: C. C. Blickenstaff

A. Research Accomplishments

Research on insect pests of sugarbeets is being carried out by ARS in only two of the production areas: eastern Washington (1 SMY) and Utah-Idaho area (1 SMY). The objectives of both programs are to develop knowledge on the biology, ecology, life-history alternate host plants, and natural enemies of insects and mites attacking sugarbeets, and to develop methods of control with the aim of increasing sugarbeet production. Accomplishments are difficult to assess because they relate to both the actual damage caused by the pests themselves and damage caused by diseases for which some insects are vectors. Some of the accomplishments reported are:

1. The biology, ecology, life cycle, etc., for most of the major sugarbeet insect pests are fairly well understood.

2. Insecticide spray programs have been worked out for many of the insects and they contribute to yield increases.

3. Some information is available on predators that could lead to biological control programs.

4. Traps have been used successfully to determine the root maggot life cycle in relation to beet development which leads to more efficient chemical control and some assessment of losses.

B. Opportunities for the Future

1. More work is needed on the importance of parasites and predators and their role in a biological control program.

2. There is an apparent need for information on the role of pheromones in the control of certain sugarbeet insects.

3. It would be helpful to have more data on the economic threshold levels for the root maggot and peach aphid to make better judgments about when it would pay to apply controls.

4. There would be benefits from an integrated multidisciplinary approach to the whole sugarbeet pest problem, including pathology, virology, entomology, weeds, nematodes, and ecology of vectors, to develop a pest management program.

RPA 208 - Control of Diseases and Nematodes of Field Crops and Range

Reviewers: J. E. Duffus, Virology
E. G. Ruppel, Fungus Diseases

A. Research Accomplishments

The pathology research on sugarbeet diseases is a broad program with scientists centering their research on the unique problems of each production area. The pathology work is done at Salinas, East Lansing, Fort Collins, Logan, and Fargo. At Fargo the emphasis is on storage rotting organisms. The work at Salinas also includes virological studies and studies on the interactions of nematodes and fungus diseases. All of the work covers four distinct phases: (1) Identification of diseases -- This covers discovery, description, transmission, epidemiology, and host parasite relations. (2) Evaluation of diseases -- Research in progress determines the potential and actual damage caused by disease. Attempts are made to establish the relative importance or priority of the various diseases, taking into consideration the resistance or tolerance of varieties. (3) Manipulation of disease -- This research involves the control of diseases through breeding for resistant varieties and the screening of large numbers of selected varieties for resistance to specific diseases. (4) Control of diseases -- A portion

of the pathology research centers on the development of control procedures. These include such cultural practices as rotation and epidemiology. Other control measures include the breeding work, the use of chemicals and other therapeutic treatments. Mention was made that virus research often falls in the category of basic research and thus it is often difficult to get support. More detailed accomplishments in plant pathology are shown in the individual reports.

Good information has been developed from host-range studies of nematodes to provide a basis for cultural control practices. Basic information is being developed on nematode biotypes and hatch factors. The work on chemical control of nematodes in Utah has led to practical control measures that greatly reduce losses.

B. Opportunities for the Future

1. The need for an integrated approach with a pathologist and a physiologist studying the nature of resistance for several major diseases was indicated.

2. Efforts to identify the causal agent of yellow wilt and to develop resistant breeding lines need to be intensified. So far, work on yellow wilt has only been done by collaborators--we can't do this work in the USA.

3. The possibilities of bacteria and fungi other than Phoma contributing to storage rot problems should be pursued.

4. More information is needed on seedling diseases and the impact these have on production.

5. More information needs to be developed on the insects and diseases associated with seed production.

6. Pathologists felt the need to visit other production areas at a strategic time to observe and study the different disease situations.

7. There was a great deal of interest among the pathologists working on Rhizoctonia for a workshop with other pathologists working on Rhizoctonia of other crops.

8. A great deal more can be done on nematode control by broadening the work on biotypes, sources of resistance, the biochemistry of resistance and the hatching factor and more efficient chemical controls.

RPA 209 - Control of Weeds and Other Hazards of Field Crops

Reviewer: E. E. Schweizer

A. Research Accomplishments

Sugarbeet weed research in ARS depends on 1.5 SMY's, one scientist at Fort Collins and 0.5 SMY at Prosser, Washington. The programs are aimed at the development of principles, methods, and practices of weed control. In many instances the sugarbeet industry must rely on herbicides developed for other crops. In spite of these limitations, a great deal of progress has been made. Growers now have a good number of safe, registered herbicides; control costs have been reduced and the need for hand labor has generally been eliminated. Basic information has been developed on:

1. How to prevent or minimize injury to sugarbeets from herbicides by applying herbicides properly.

2. Understanding the competitive relationships between specific weeds and sugarbeets.

3. Recognizing that the weed control problems during the season can be separated into four separate and distinct periods.

4. Developing effective weed control systems that will control 95 percent or more of total weeds that emerge during the season.

B. Opportunities for the Future

1. Considerable research needs to be conducted on the absorption and translocation of herbicides in weeds and sugarbeets and on the mode of action of herbicides in weeds and sugarbeets. This will require additional manpower or the involvement of other ARS scientists who are working in this area. This work possibly could be coordinated with work at the Metabolism and Radiation Research Lab at Fargo, North Dakota.

2. Need to increase sugarbeet seedling vigor by discovering more selective herbicides, or tolerant varieties, finding effective antidotes, or using effective plant growth regulators.

3. Need to develop more effective cooperative investigations between agronomists and plant protection scientists to utilize each discipline's expertise to increase sugarbeet production.

4. Need to work more closely with agricultural engineers to develop more efficient and better equipment to apply herbicides.

5. Need to develop long range systems of weed control in our crop rotation systems so we can reduce the inherent weed problems, thus reducing the total amount of herbicide applied per acre.

GOAL III: Produce an Adequate Supply of Farm and Forest Products at Decreasing Real Production Costs

RPA 307 - Improvement of Biological Efficiency of Field Crops

Reviewer: J. S. McFarlane

A. Research Accomplishments

It was evident from the reports of research in this problem area that the technology and knowledge are at hand to make significant gains in greater efficiency for the production of sugarbeets in all of the production areas. The work has emphasized the genetic and biological determinants of biological efficiency and included the identification of superior germplasm and breeding and selection of improved varieties. The breeding program has emphasized development of disease resistance, hybrid varieties, and monogerm seed. The program also includes an appropriate amount of basic breeding and inheritance studies. The individual reports give details of many accomplishments. Several highlights brought out in the panel review are listed.

1. Breeding lines with high resistance to bolting, curly top, virus yellows, black root, Cercospora, Rhizoctonia, and downy mildew have been developed. It is realized that greater resistance is needed for more virulent strains of curly top, improved combining of Cercospora and curly top resistance, greater Rhizoctonia resistance, and resistance to yellows other than through the pollen parent.

2. Sources for resistance to nematodes, Erwinia, and other root rots have been identified.

3. New techniques and breeding methods are being studied and used to speed up the incorporation of certain desired traits, improve selection, and identify selection criteria.

4. The genetics and breeding behavior of cytoplasmic male sterility have been studied and this information has helped overcome problems associated with hybrid production.

5. Significant progress has been made in the transferral of desirable characters such as nematode and curly top resistance from wild Beta species to the sugarbeet.

6. A fairly substantial proportion of the sugarbeet yield increase can be directly attributed to improved varieties or breeding lines developed in these programs.

B. Opportunities for the Future

1. There is a need for more information on the physiological or biochemical nature of disease and nematode resistance.

2. From the standpoint of genetic vulnerability, it would be important to broaden the genetic base for monogermness, male sterility, and other traits.

3. Now that good progress has been made toward improving disease resistance, there are opportunities to expand breeding for other traits such as root shape, improved quality (high sucrose and purity), better salt and herbicide tolerance, insect resistance, better storage qualities (low respiration, resistance to rot organisms), and better adaptability to short growing seasons (cold tolerance, seedling vigor, and early maturity). This would lead to a need to determine breeding priorities.

4. Many desirable characters occur in the wild relatives of the sugarbeet and a greater effort is needed to transfer these characters to the cultivated beet.

5. There are possibilities for using other breeding techniques involving polyploidy, apomixis, and mutation breeding. Chromosome mapping has been neglected and would be most helpful.

6. Interest was expressed in the possibilities of hybrid production from cell cultures, but it was thought that the tissue culture techniques for culturing sugarbeet cells might be worked out more efficiently in some central ARS laboratory.

GOAL IV: Expand the Demand for Farm and Forest Products by Developing New and Improved Products and Processes and Enhancing Product Quality

RPA 405 - Production of Field Crops with Improved Acceptability

Reviewer: R. Wyse

A. Research Accomplishments

With sugarbeet research we consider the harvested beets to be the principal product, so the goal is to improve the quality of beets as they are delivered to factories or if they are stored as they are finally conveyed to the slicers. ARS has not had a major effort in the area of quality improvement; therefore, the review focused on subjects that could be emphasized in the future and areas of cooperation where we might make further progress. Significant progress was reported in several areas.

1. Progress has been made in breeding and selecting new and improved varieties of beets that have characteristics that favor sucrose content and minimize non-sucrose constituents.

2. Techniques have been developed to evaluate beet quality and to accurately measure quality changes under controlled storage conditions.

3. Factors that significantly contribute to storage losses were identified and some shown to be genetically controlled, and an extensive program to screen breeding lines is under way.

4. Enzymes involved in sucrose degradation and the biosynthesis of raffinose and kestose were identified.

5. Growth analysis techniques to quantify seedling and developing growth patterns have been developed.

6. Some of the nitrogen metabolism factors essential in controlling quality were identified and can be used for screening selections and improving cultural practices.

7. The relationship of environmental conditions during seed production and subsequent seedling vigor has been determined.

8. New work is under way in the Red River Valley (Fargo) directed toward the physiology of storage losses.

B. Opportunities for the Future

1. Several areas were mentioned where cooperative work with physiologists could lead to quality improvement.

   a. Plant breeders need a selection test to help identify superior storing varieties.

   b. Plant breeders need a selection test for sucrose to help overcome the apparent sucrose plateau.

   c. Pathologists need to understand the mechanism of disease resistance.

   d. Basic information is needed on the biochemical mechanism of sucrose accumulation in the beet root.

2. Limited factory capacities and improved yields have made beet storage a major problem. More research is needed on:

   a. Factors determining the storability of varieties.

   b. The biochemistry of sucrose degradation.

   c. Effect of cultural practices on storage.

   d. The engineering aspects of harvesting and handling beets with a minimum of injury.

3. The need for continued coordination of USDA, industry, and Beet Sugar Development Foundation research on quality was emphasized.