Patterns of Cooperation In Sugar Beet Research

MARTIN G. WEISS[1]

Those of us in the federal-state network of agricultural research are well aware of the contribution of the sugar beet industry to the nation's wealth. It has been outstanding. It has increased the production of sugar in the United States by an average of 1.6 million tons annually. It insures a supply of an essential food in times of national emergency. It provides a stable market for the output of some 700,000 acres of farm land. And it adds around 300 million dollars each year to the farm income.

I believe it is fair to say that the technology which now characterizes this vigorous industry has been brought about by teamwork. It is the product of cooperation between the growers, private industry and public research.

Each member of the team has made important contributions. These began years ago under the leadership of the great chemist, Harvey W. Wiley, in studies by state experiment stations and industry to determine areas in the United States where the crop could be grown.

Scientists in public research, both the state agricultural experiment stations and the Department of Agriculture, can point with pride to, their work in devising economic methods for the production of sugar beet seed in this country. They took the leadership in developing varieties with resistance to curly top, leaf spot and other diseases which have threatened the crop.

Industry has made spectacular advances in the improvement of machinery for thinning and harvesting the crop.

The close working relationships between the growers and processors have helped to encourage the use of improved production practices at every step along the line.

Looking back over the past 15 vears, we can see many striking returns from the joint efforts. There has been a steady flow of new varieties. Each has represented superiority in disease resistance and other characters over the variety it was developed to replace. There have been dramatic improvements in the designs of machinery for thinning and harvesting of beets. The man hours required to produce a ton of beets have been reduced by half, from 7.5 in 1940 to less than 3.9 in 1950. A great deal of information has been compiled on the fertilizer and moisture requirements of the crops. This has made it possible to devise more effective methods for applying nutrient elements and irrigation. These improvements have been reflected by an increase in average yields of 26 percent.

The rate at which new techniques have been perfected has increased notably in the past decade. The stepped up tempo reflects a number of influences. One of these, of course, is the general advance of agricultural

[1] Chief of Field Crops Research Branch, United States Department of Agriculture, Washington, D. C.

science. New concepts, techniques and materials developed in fundamental research have been applied to problems in sugar beet production. One place we see this is in the use of new chemicals to control weeds.

Another influence of considerable importance, it seems to me, is that of organization. Modern research depends upon some unifying force to promote the rapid exchange of ideas. These can be made productive only when they are pooled and studied by scientists and engineers of many specialties. A strong organization facilitates the interchange of ideas. It promotes the development of new techniques. It hastens the correction of concepts which are in error. And it reduces the time lag between the perfection of a technique in the laboratory, its testing in the field, and its widespread acceptance by growers.

For this reason the American Society of Sugar Beet Technologists and similar groups can take a good measure of credit for the gains which have recently been made in the improvement of sugar beet production.

In these biennial sessions you have an opportunity to learn in considerable detail the progress of work along many highly specialized lines. The comprehensive program makes it possible for you to get a good idea of how the results from the various investigations may be fitted together for use on the farm or in the factory. The meetings and discussions stimulate new ideas.

Another organizational approach to crop improvement was established through the Research and Marketing Act of 1946. Under this legislation industry-wide advisory committees were set up to assist public research workers in evaluating work in progress and planning new research. It has proved an excellent measure for keeping those of us in government informed of your problems and thereby helping us to reshape research plans to gear them to the needs of the growers. It is generally agreed, I believe, that the advisory committee system also has given those of you in industry a better understanding of public research problems.

The Beet Sugar Development Foundation also has facilitated cooperation between private industry and public research.

In public research we are charged with developing new materials and methods for improving crop production. But our responsibility does not end there. We also have the task of seeing that these advances get to the farmer in the shortest possible time. Long experience has shown that this obligation can be met most effectively when public research has the backing and close cooperation of the industry concerned.

In public research we find it much easier to develop cooperative programs with an industry when there is an over-all group which can speak for all or nearly all of the participating companies. In setting up the Beet Sugar Development Foundation as a nonprofit organization to sponsor research and education programs, the industry has also provided an important link with public research.

One of the notable developments in our joint activities is a memorandum which applies to sugar beet improvement on a national scale. Here-

tofore the cooperative efforts were planned for growers east of the Continental Divide under one agreement and for those in the west under another. But the broad objectives are the same for all parts of the country. The work is governed by the same policies. And so the arrangement, nationwide in scope, marks a step forward in our cooperative relationships. This agreement is new. It was signed in February, 1953, but it is a sound basis for our joint effort.

Patterns of cooperation like other aspects of research must continually be reexamined. They must be studied in the light of new findings and the appearance of new problems. And they must be revised to fit changing conditions.

That is what has been done in revamping the cooperative program for the improvement of sugar beets. The objectives stated in the agreement make this quite clear.

The first objective covers genetic investigations toward the isolation of genes which may be used in breeding superior strains and varieties. And under the new plan attention will be given to hybrid vigor, disease resistance, monogermness of the seedballs, nematode resistance, seedling vigor, superior biochemical attributes, and high keeping quality in storage.

The second objective is to establish means whereby new genetic material resulting from these studies may be brought into widespread use by breeders and growers. As soon as evaluation tests demonstrate the merits of this material it must be distributed promptly, efficiently and at reasonable cost.

The Beet Suagr Development Foundation is taking leadership in carrying out this part of the understanding. The Foundation also has accepted the responsibility for the production of adequate supplies of elite and stock seed of new varieties.

The Genetic Approach

You will notice that hybrid vigor heads the list of objectives in the new memorandum of understanding for sugar beet improvement. But hybrid vigor is not an isolated quality. Its value is realized when it is combined with other characters which are of special concern in sugar beet production.

Growers want monogerm hybrids which are resistant to leaf spot, black root, curly top, virus yellows and other diseases. In much of the west and particularly in California they need sugar beet hybrids with high resistance to nematode injury. Vigorous hybrids will be of greater interest to both the growers and the processors if they keep well in storage and are characterized by a high sugar content.

In other words, the plant breeders have a many-sided task in producing the hybrids needed to serve growers most effectively.

At Salt Lake City Dr. F. V. Owen has developed an ingenious technique for producing 100 percent hybrid sugar beets. He deals with two forms of

male sterility—Mendelian and cytoplasmic. With these forms he has accomplished genetically in sugar beets what the corn breeder has to do mechanically in the laborious detasseling of corn plants to furnish seed ears for corn hybrids.

In the 12 years since male sterility was discovered in sugar beets the scientists in this research have built up valuable stores of fundamental knowledge and plant material. They have a fairly good understanding of the character and how it can be used. They are mastering the knowhow for developing and maintaining male sterile lines. They now are selecting promising breeding material for use with the male steriles. They have developed a number of inbreds. These are being indexed and evaluated.

In association with Dr. Owen, Drs. V. F. and Helen Savitsky are concentrating on the incorporation of the monogerm character into basic breeding stocks in addition to many other lines of genetic research on beets. Their work is supported by funds contributed by the Beet Sugar Development Foundation. This is a particularly excellent example of close cooperation between industrial and public support of research.

In the east, Dewey Stewart and his coworkers have made encouraging progress in the development of monogerm hybrids with considerable resistance to black root rot and leaf spot. A new technique devised this past year for making crosses with a wild species appears highly promising as a means of tapping new sources of resistance to these and other diseases.

In the west, Dr. C. W. Bennett and the men associated with him have done an outstanding job in their studies on the nature of curly top and the variation in virulence of the numerous strains of this virus.

We believe that all this work in sugar beet improvement has reached a stage where it can be strengthened greatly by certain additional research. This past year at the request of leaders among sugar beet growers and in the industry, Congress appropriated funds which have enabled the Department of Agriculture to add two geneticists to the staff of sugar beet breeders.

We have been fortunate in obtaining the services of two outstanding scientists—Dr. Leroy Powers, principal plant geneticist of the U. S. Horticultural Field Station at Cheyenne, Wyo., and Dr. H. M. Tysdal, principal geneticist for the Department of Agriculture on guayule and other domestic rubber plants at Salinas, Calif.

Many of you know Dr. Powers and Dr. Tysdal. They will have an opportunity to become widely acquainted with sugar beet technologists in coming months as they visit the different areas of production. They plan to spend the next few months in detailed conferences with research men in the industry and at the state experiment stations.

Dr. Powers will make his headquarters at Fort Collins where he will work in close cooperation with the Colorado Experiment Station at Colorado A & M College. The increase in Department funds for sugar beet investigations this year is making it possible to set up a new greenhouse for the expanded program of work there.

Dr. Tysdal will continue to make his headquarters at Salinas. When it became necessary to move the work from Riverside, we took advantage of an opportunity to make use of the laboratories and field plots formerly used by the Department for guayule. These have now been reassigned to sugar beet research. We believe the relocation of the virus studies at Salinas will be helpful in cooperative studies with the Calfiornia Experiment Station at Davis. The men there will assume the major responsibility for the research on cultural and agronomic problems and on mechanization to round out a well balanced cooperative program for that production area.

Other Aspects of the Disease Picture

The virus studies, which now will be centered at Salinas, are being expanded to include work on virus yellows. Although cooperative research in the United States to determine the damage from virus yellows was begun only two years ago, Dr. George H. Coons and his coworkers have found that the disease is widespread and a potential threat to the industry. We are still not certain of the extent of loss from the disease but it appears to be a serious threat to sugar beet production in certain parts of the country, notably California.

The evidence indicates that all of our presently grown commercial varieties of sugar beets are highly susceptible to virus yellows. But a few inbred lines appear to be resistant to the strains of virus present in the United States. In the preliminary tests these inbreds have shown evidence of being noticeably less affected by virus yellows than the commercial sorts. The situation may be like the one when the first faint evidences of curly top resistance were found in sugar beets.

The next step is to determine the genetic character of this resistance, to build up breeders' strains of those isolates which may confer yellows resistance, and to find ways to incorporate the resistant genes into hybrids. The road may be a long one. We believe we should move forward on it with all the facilities at our command.

Another matter of concern is that the curly top problem is still with us, as evidenced by the outbreaks in eastern Colorado and western Kansas. This means a new job for the curly top resistance breeding program.

Still another problem area to which we are giving increased attention is that of nematodes. Interest in these minute soilborne organisms is intense. They are causing enormous losses not only in sugar beets but in many other of our major crops.

Recent research demonstrates that plants suffer from the simultaneous attacks of different types of nematodes. It is not always easy to determine which of the attackers is most serious. The presence of mixed populations of nematodes in a field makes it difficult to set up control by rotation. A certain rotation crop suitable to reduce one species may provide a host for one or more of the others. It may therefore help to increase the other pests.

Another approach which holds considerable promise is that of breeding lines of sugar beets with resistance to various species of nematodes. This approach is being used effectively in other crops.

For example, lespedeza breeders in the southeast were able to transfer resistance to two species of nematodes to the highly productive new variety, Rowan.

Cotton breeders have recently discovered resistance to root knot nematode in certain primitive or wild types. They have established a close relationship between nematode damage and susceptibility to Fusarium wilt. A few of the varieties with resistance to Fusarium wilt show a high degree of tolerance to nematodes.

Sugar beet breeders are now screening wild species of the genus *Beta* for gene sources with resistance to various species of nematodes. They have found resistance in *Beta patellaris* to the sugar beet nematode. The search will be continued and we plan to intensify our efforts to transfer the resistance to commercial sugar beet lines.

We are moving forward on many fronts simultaneously. As we are all aware, the objectives of sugar beet improvement are not limited to disease resistance, increased yields, enhancement of quality. These are important. But if the grower is to realize the benefits of these and other improvements they must be associated with characters which will aid in mechanization of the crop.

The plant breeders have made progress along this line. They have developed varieties with roots which are smoother and rounder and which lend themselves to machine harvest. They have developed varieties with greater resistance to rot following machine harvest.

We realize that the long step toward mechanization will be made when seed for vigorous monogerm hybrids can be furnished growers. Meanwhile the research on machinery for thinning and weeding the crop is moving ahead. The results of this work have been of special value in suggesting designs which may be incorporated into commercial models and in stimulating further studies.

As the supply of farm labor is reduced we must develop machines and tools which can be handled by the fewest possible workers. We must perfect still further the harvesting and handling equipment, which has already done so much to reduce the hours of arduous labor required to produce an acre of sugar beets.

The control of weeds continues to be one of the main obstacles to mechanization. Research to find chemical controls may hold the key to this problem.

One of the chief objectives is to find selective chemicals by which wild oats and broadleaved species in the sugar beet crop may be controlled economically. In Minnesota, TCA applied as a pre-emergence spray is exceedingly effective, particularly with pigeon grass and foxtail.

Some of you are familiar with the studies in which we are evaluating compounds of potential use as herbicides. In the past three years more than 400 compounds have been studied for the control of weeds in 30 different

crops. The research has begun to pay off in knowledge that certain of the compounds have high toxicity to weeds and are remarkably selective in their activity.

It seemed advisable to concentrate federal-state resources on one group of compounds at a time. This permits intensive study of specific groups of compounds known to possess herbicidal properties.

The first evaluation studies have been conducted with the carbamates because the action on plants is generally converse to that of the phenoxy compounds. The type of selectivity exhibited by the carbamates is greatly needed for weed control in sugar beets, cotton, soybeans, peanuts, and lima beans and other legumes.

When the Department of Agriculture was reorganized a few months ago, the research on the control of insects in crop plants was combined with other work and crop improvement and production. This is making it possible to tie the studies on the control of insects of special concern in a crop more closely with the research on other phases of production.

Soil Fertility

While sugar beet growers are steadily increasing the consumption of fertilizer, it is regrettable that some farmers still apply the nutrients so sparingly that little or no benefit is obtained.

In crops and soils research we are keenly aware of the need to give greater precision to our recommendations. But much work is required before this can be done.

Increased efficiency depends upon a number of factors. This has been demonstrated quite strikingly in the Great Basin by Dr. Jay L. Haddock and the men working with him. They have found that sugar beets have a yield potential of more than 20 tons per acre when good cultural practices are combined with a recommended program of fertilization and irrigation. The highest yields were obtained when the sugar beets were planted in rows 20 to 22 inches apart and thinned to leave plants 10 to 15 inches apart in the row; from 60 to 100 pounds of nitrogen per acre were applied; and irrigations were light and frequent.

We recognize the need for a better understanding of the influence of nitrogen—both the rate and time of application—on sugar beet quality.

There is no standard procedure for appraising the nitrogen-supplying power of soils in this area. Until this procedure is devised, recommendations for applying nitrogen can be only rough approximations.

Within the past year a technique has been perfected for measuring phosphate fertility on a wide range of soils. It is a comparatively simple test which uses ordinary baking soda as the phosphate solvent.

The new test was developed in public research by Dr. Sterling R. Olsen and a group of coworkers at the Colorado Agricultural Experiment Station. It is a product of the vigorous research which was begun shortly after the

war when radioactive phosphorus became available in sufficient amounts for field experiments. With this new tool the soil scientists have gained a large store of information about the role of phosphorus in the growth of major crop plants. One of the important gains is a technique for calibrating tests for phosphorus fertility. Dr. Olsen and his colleagues used this calibration to determine the accuracy of the baking soda test.

The new test is of special interest to the sugar beet industry in the west. It offers the first dependable measure of avilable phosphorus in calcareous soils. It provides a basis for predicting yield responses from specific applications of phosphorus.

And this is the kind of information we need all along the crop production line. In agriculture we are engaged in a gigantic task of synthesis, of bringing together our scientific advances. For the sugar beet it may well begin in the breeders' plans for vigorous, monogerm hybrids which are adapted to definite areas of production, which are suitable for mechanization, which are efficient feeders on plant nutrients, which carry high resistance to diseases and insects and other crop pests of the area, and which give high yields of beets with high sugar content and good keeping quality.

We need to put under review all of our current information for every step in production practices—in seedbed preparation, planting techniques, cultivation, the application of fertilizers—and irrigation procedures to see that these are abreast of the tide of research development. We need to augment our knowledge on the effectiveness of chemicals to control weeds, plant diseases and insects in the sugar beet crop. We need a better understanding of the role of crop rotation in stabilizing sugar beet production, and in building a sound soil fertility program.

This audience is well aware that there is a research job ahead. This work must be done if sugar beet growers are to take full advantage of the gains that have come in the recent past. Much additional work will be required to perfect the new materials, machines, and techniques which now hold great promise. And all of these improvements are essential if the grower is to have a stable crop that he can produce efficiently and at a reasonable profit.

There is so much work to be done that there can be no question about whether it should be done by private industry or public research. But of this we are sure. In the future as in the past, our best and fastest progress along the road to improvement of sugar beet production will be made through the joint efforts of all the individuals and organizations concerned with this important agricultural crop.