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CIMMYT'S MAIZE PROGRAM OVERVIEW

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Introduction

I will first give you a brief overview of the maize program as it is now and then indicate some of the areas in our research program that are likely to change in the future.

The objective of our maize program is to facilitate maize research in Third World countries. We do so by providing national maize programs with improved germplasm and other products and services such as research procedures, training, and technical information. These are developed and delivered by some 15 scientists working at our stations in Mexico and by an equal number of maize researchers involved in regional and bilateral programs outside of Mexico. The ultimate aim of our research is to increase the options available to farmers for raising the productivity of resources that they commit to maize production. In working toward that goal, we give the highest priority to our relations with national programs. We also take an active interest in the work of other organizations such as universities and private seed companies whose research results in products that can help farmers increase the efficiency of their maize production.

One extremely important part of the CIMMYT maize program is our variety development scheme. Our system has a funnel-shaped structure very similar to that of any other large breeding program for a major crop. At the top of the funnel is the area of the greatest genetic diversity. As you move down the funnel, genetic diversity is decreased and uniformity is increased. You would find this to be true whether you are breeding for a hybrid program or, in this case, a variety development program. At the wide end of the funnel is our germplasm bank in which we maintain a little over 10,000 accessions.

Drawing on these genetic resources from the germplasm bank, the program formed a large number of gene pools or germplasm complexes. Each gene pool is adapted to one of several broad regions we refer to as megaenvironments. An example is the lowland tropics. Megaenvironments encompass many smaller growing areas that are distinct from one another in some respects but similar in elevation, climate, and other features that affect the maize germplasm requirements. The gene pool subdivided by maturity, grain color, and grain type is improved in our backup unit by means of half sib family selection procedure.

Corresponding more or less to these pools are a number of more elite germplasm material. Within our advanced unit, those materials are placed under more intense selection pressure in a modified full sib family selection scheme that includes international testing. Selected families of full sib progenies are evaluated at up to six different locations in the first testing stage. Based on these test results, we form an experimental variety which is then distributed to national maize researchers for evaluations at 30-50 strategically chosen locations. The best performers in these trials, which we term elite varieties, are then tested at 60-80 other sites.

One of the attractive parts about our program is that the national programs take a great deal of pride in forming these varieties. They consider it their work if they are involved in forming varieties. They do not take nearly as much pride in releasing varieties that have been selected by others straight out of the variety trials. The varieties emerging from our breeding program are by and large intermediate rather than finished products. They generally

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are not adapted to a particular ecological niche but rather to a megaenvironment. For that reason, they must undergo a certain amount of adaptive testing before they can be released to farmers.

In the development and delivery of intermediate research products, using the most appropriate techniques can be almost as important as the best available germplasm. For that reason, we devoted a large portion of our time and resources to developing improved research techniques. This makes our program more efficient and also helps national programs in conducting their research and applying their research more effectively to meet farmers needs. Some examples are techniques for mass rearing, artificial infestation with insect pests for resistance screening, and breeding methodologies for developing improved varieties.

The set of techniques that have proven especially useful to national program are ones CIMMYT scientists developed for onfarm research. National scientists examine farmers' circumstances, identify production problems, and carry out experiments to resolve those problems under conditions of the representative farmer. At CIMMYT, we convey ideas about onfarm research through our in-service and in-country training programs. The majority of maize program trainees participate in one of our 5- to 6-month, in-service training courses. The courses cover production agronomy, maize improvement, protein evaluation, and experiment station management, and are held at CIMMYT's headquarters in Mexico.

Other trainees come to the center for a week to several months as a visiting scientist to familiarize themselves with our breeding and other programs. A smaller number of predoctoral fellows who have finished their university coursework may conduct their thesis research under supervision of CIMMYT scientists. We also have positions for post doctoral fellows who become more closely involved in the research program while still working independently on a problem of special interest to them. Training is not provided indiscriminately but in a very deliberate manner. It is based largely on the information that we receive from our regional programs. We recently gave a lot of thought to those programs and tried to clarify and describe their functions with greater precision. One important point that has come out of this effort is the tremendous value of the regional program as an information link between our international client countries and CIMMYT headquarters staff in Mexico.

Our regional programs also enable us to provide stronger support for research planning in national maize programs. The planning approach we promote in our regional programs resembles that used in private seed companies. We first encourage national researchers and administrators to identify specific product needs. Since onfarm research is the best way to identify those immediate needs, we will continue to spend a lot of time helping maize scientists make this type of work a permanent feature of their research program.

Once product needs are identified, we work with the national scientists in planning research and allocating resources for products that nation's farmers need. It would hardly be appropriate for maize program staff to preach such a doctrine without following it to the letter. That is why we are now engaged in a priority-setting and planning process. I would like to further develop our effort to gather more detailed information on the germplasm requirements of maize-growing environments in the third world.

For selected countries such as Ghana, we are delineating megaenvironments by compiling general information about maize production around the country. Our regional staff and their colleagues in national programs supply most of this information. They determine demand for maize farmland, time for maize to mature on that land, and so forth. In addition to recording the general features of maize production in a given environment, we are trying to learn more about the extent and severity of specific problems as disease and insect pests.

Our ultimate goal is to gain a clear idea of germplasm needs throughout the developing world. The next step would be to improve our capacity to meet those germplasm needs with greater

accuracy. The exact details are now under consideration, but we do have a general idea of some expected changes in the following five areas: the germplasm bank, the backup unit, the advanced unit, the new hybrid maize program, and the maize physiology program.

Germplasm Bank

The first thing we would like to do is to better store the germplasm resources that we have. We have built better long-term storage facilities so that the seed can be stored longer. Thus, less regeneration time will be required. We are also trying to set up a computerized data storage and retrieval system that will enable us to efficiently store and retrieve information quickly when people make requests. We are also developing training materials so that people are better aware of what is available in the germplasm bank and how it can be used. In addition, we are trying to set up a maize germplasm network of individuals who would preserve maize germplasm.

Mexico is the center of maize origination. One of the services that we would like to provide, in conjunction with the Mexican national program and some of our U.S. collaborators, is monitoring of these wild populations. We will make annual visits to determine whether or not significant changes are occurring in the wild population. We know that there is one race of maize around the Mexico City Valley that is almost extinct. We want to make sure that this does not happen to other races. We would also like to do research on some of the land races. We know from earlier research that there are certain heterotic patterns that develop among some of these superior land races. We would like to try to reconstruct them. In this way, we can obtain some new and different germplasm for our breeding programs.

Backup Units

The original objective of the backup unit was to be a next step beyond the germplasm bank. We wanted to have complexes containing broadly adapted germplasm that would have great genetic diversity. We also had the objective of providing superior germplasm for our more advanced populations. We are finding that those two objectives are somewhat juxtaposed. It appears that high degree of genetic diversity cannot be maintained while simultaneously providing elite germplasm from that pool. Thus, we are redefining what we do in the backup unit. We will continue to generate and maintain widely adapted germplasm pools as sources of genetic diversity.

We plan to identify germplasm needs for specific traits. We will generate a pool that, for example, has resistance to a specific disease or insect. We call these special-purpose pools. We are moving in this direction because in the past we tried unsuccessfully to generate pools with specific resistance by taking into consideration selection for insect pests as well as yield, disease resistance, logging, and grain quality and characteristics.

Advanced Unit

Many similar opportunities for improving efficiency have arisen in the advanced unit. To take advantage of them, we are considering an approach roughly parallel to that of the backup unit. A large number of populations are now being improved in the advanced unit. Experimental varieties are developed from each population and tested internationally. Populations are given equal emphasis and are handled according to the same breeding methodology.

The new approach being considered is to reduce the total number of populations and divide them into two groups, infinite-life and finite-life populations. The infinite-life populations, of which there would be one for each ecology/grain type and color/maturity category, would include populations already in existence and perhaps some new ones. As their name implies, these populations would be open-ended. For the next 10 years or so, or until better materials were found to replace them, they would continue to receive new germplasm. They would be improved by the same modified full-sib recurrent selection scheme now in use and would be tested internationally under the International Progeny Testing Trial (IPTT) system. By working with a smaller number of the infinite-life populations, we can devote more attention to solving problems as disease and insect pests that are specific to particular regions of the world.

The finite-life populations would primarily be used to focus on these problems. The original development and improvement of the finite-life materials could be carried out by national program scientists, regional maize staff, the backup unit, or other CIMMYT maize program units. These groups could use whatever methodology seemed most appropriate to solve the region-specific problems at hand. If the materials they produced showed enough promise, they could be proposed as finite-life populations, and, if accepted, would enter the IPTT system. These populations would be improved within the IPTT system for no more than two cycles and then be returned to their originators. This approach's chief advantages is that it would sharpen the focus on region-specific problems, allow researchers to use a variety of breeding methodologies, involve national scientists more fully in developing better germplasm, and improve the mechanism for delivering that germplasm to national programs.

The New Hybrid Maize Program

All of the changes I have described involve modifying systems already in progress at the CIMMYT maize program. The last topic to be covered is an entirely new effort at headquarters to serve national researchers interested in the development of maize hybrids.

In the past, the maize program had no systematic means of helping those researchers. But for a number of reasons, it is considered appropriate and necessary to expand CIMMYT's capacity to support hybrid work. Foremost among those reasons is that a growing number of national programs are interested in and have the capacity to develop maize hybrid. In cases where hybrid development is considered potentially successful, our aim is to help national programs go about this task in an efficient and cost-effective way.

CIMMYT has now established its own hybrid program, which will cater to the needs of national hybrid development efforts in several ways. It will compile information about inbreeding depression and heterotic patterns for both gene pools and populations. It will also select superior materials from improved pools and populations. They will be taken through several generations of inbreeding and then be made available to national programs. Plans are also underway to provide national researchers with detailed information and training in various techniques of developing hybrids.

Much of CIMMYT's effort in this area will be devoted to the so-called nonconventional hybrids for two reasons. First, there is little published material on how to develop family, topcross, and variety hybrids, and it would be worthwhile to try to fill this information gap. Second, because these types of hybrids are much easier to produce than the conventional ones, they should provide better options for many developing countries that have started or expect to start hybrid programs.

Maize Physiology Program

We think that there will be an increased role and emphasis on our maize physiology program. The major areas that program staff will address are with general stress tolerance, efficiency of nitrogen use, and tolerance to aluminum toxicity. The major role that physiology plays is to help us identify selection criteria that would make our breeding more efficient. For example, it could help us isolate a particular trait that increases the rate of genetic gain. One of the major constraints in developing countries is drought. For example, many areas of West Africa get up to 1,200-1,300 millimeters of rain during growing season yet report yields of only 1-2 tons. The major problem is the rainfall distribution. Drought associated with stand establishment is a very serious constraint in many of these areas.

Conclusion

This overview reflects current operations, but is not necessarily the description CIMMYT staff members would have given 10 years ago. Nor is it likely to be the one they give several years from now.

The CIMMYT Maize Program has made important adjustment. It will continue to respond to changing circumstances and new opportunities for achieving greater efficiency. Thus, what we now contemplate is not a different program, but only the next step in its development. Among the important developments of its 20-year history were the initiation of the international testing network and the creation of the regional program in 1974. It is hoped that the changes we are now considering will be just as beneficial to agricultural progress in the developing world.