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The Importance of Seed In Agriculture and The Need for a Seed Program

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THE IMPORTANCE OF SEED IN AGRICULTURE AND THE NEED FOR A SEED PROGRAM [1/]

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This seminar on "Improved Rice Seed Production" is evidence that WARDA, as a organization, and you, as delegates from member countries, recognize the importance of seed production and supply in advancing rice production. The stated purposes of this meeting are to review rice seed programs in the region, identify major problems and constraints, and to develop recommendations for improvements in rice seed production and supply. These are good purposes or objectives but their accomplishment will have little effect on rice seed supplies in the region unless every delegate makes a committment to act positively, energetically and for as long as necessary on return to his country to implement the recommendations that will arise out of the deliberations here.

We very much appreciate the invitation to participate in this seminar, and the opportunity it provides for us to meet many of the rice workers in West Afica and to determine how we can best cooperate with WARDA in its important work. While the topic assigned to us is of a general nature, we hope our discussion will serve not only to establish

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an appropriate perspective for the more specific discussions that will follow but also to motivate you to make the committment that must be made to get on with the task of improving rice seed supplies.

The perspective we will try to establish for this seminar derives from the experiences of our group during 25 years of cooperative work with the U.S. Agency for International Development (USAID) on seed program/industry development projects in the less developed countries. Under terms of several contractual arrangements and cooperative agreements with USAID, our University has been privileged to assist in many different ways with seed program development efforts in more than 45 countries - including many of the countries represented here.

During the past 25 years we have learned many things about seed production, supply and usage in the less developed countries, but the most important lesson is that there is no single "formula" for seed program/industry development. Rather, it is our experience that the need for a "seed program" and its scope, composition, technological level and rate of development are determined by dynamic and interacting social, economic and technical factors, which vary among countries and within a country over time. As "change agents", we need to understand the more significant of these factors and how they interact so that our efforts can be directed toward changing them in ways most conducive to achievement of the goal of a progressive agriculture supported by an effective seed production and supply system.

The Importance of Seeds in Agriculture

Crop agriculture began more than 10,000 years ago on the flood plains of the great rivers of North Africa and the mid-East with man's discovery of the propagative function of seed. From the beginning of crop husbandry to our time, seeds have been the key ingredient in the establishment, expansion, diversification and improvement of crop production. Yet, seeds are such an integral part of agriculture we tend to take them for granted, or overlook their crucial roles in agricultural production and crop improvement.

Seeds are, first of all, a most efficient and effective means of crop propagation. They are the principal means by which plant populations have been and are distributed over both time and space. Compared to the vegetative propagules used for some crops, seed are smaller, hence very convenient to store and transport, hardier and longer-lived, easier to sow, relatively free of diseases, and a much smaller portion of the production is required for propagation. While seeds are marveleously adapted for propagation of plants, they have another function or role which is even more pivotal in crop improvement.

Sexual processes in plants continuously combine the heritable variability in the inter-breeding population in different ways in the progeny produced. Seed are the product of the sexual process in higher plants and the repository of the heritable traits of the progeny. Some of the plants propagated from seed exhibit traits or combinations of traits that make them "different" from other members of the population. For thousands of years man has slowly improved the crops he cultivates

by saving seed for propagation from plants exhibiting traits he perceived to be most useful. In this century, the process of crop improvement has been tremendously accelerated through systematic collection and preservation of the variability in crop species and exploitation of the science of genetics. The improvements genetically engineered in small populations of plants by modern plant breeders are most efficiently maintained, transmitted and multiplied by seeds. Seeds, therefore, are the principal means for extending improvements effected in crops, i.e., improved cultivars, from the breeding nursery to farmers' fields throughout the area of adaptation.

A third, relatively modern, and increasingly important role of seeds in agriculture is as a carrier of agricultural chemicals. Seeds are very convenient carriers of chemicals required in relatively small quantities for protection of the seed and developing plants against insects, diseases and weeds, regulating plant growth and development, and amending the nutrient status of the soil.

A good understanding of the primal and catalytic roles of seed in crop agriculture is essential for the formulation of effective strategies for agricultural and rural development. Seed - improved seeds - must be recognized both as a key component in the package of inputs required to improve crop production, and as a catalyst for exploitation of other technological improvements in crop production. As an input, seed have several advantages over other inputs such as fertilizer, pesticides, and improved water management. They are required in rel-

atively small quantities, multiplied rather than consumed in the production process, familiar to all cultivars, and their use does not require any change in farming practices per se, although some change is usually desirable. On the other hand, seed as compared to most other inputs have two disadvantages which are often overlooked: they are alive and must be maintained in a living condition to fulfill their propagative function; and the production of seed has to be planned well in advance of the time they are to be used - they are not a "shelf" item like fertilizer and pesticides.

The Need for a Seed Program

The first "seed program" was established by the first cultivator. Thereafter, every serious farmer has taken steps to assure adequate seed supplies for the crops he cultivates, i.e., developed a "seed program." Steps taken by farmers to assure seed supplies range from the traditional saving of a portion of the production for propagation, through various barter arrangements with other farmers or village merchants, to the "booking" of all seed needs with a seed supply company in advance of the planting season. 3/

Several factors influence the specific seed supply arrangemments made by farmers: production objectives (subsistence or marketing);

3/ We recognize that availability of the range of seed supply alternatives considered assumes the existence of some sort of seed production and supply system. It is our thesis, however, that until farmers seek or can be persuaded to seek alternatives to traditional "seed saving", there is no sound basis for establishment of a seed program/industry.

kinds of crops and area cultivated for each kind; level of production technology employed for each crop kind; availability of superior cultivars; availability of other inputs such as fertilizer, pesticides, water; commodity prices; climatic conditions - long term trends and seasonal variations; and the availability of cash or credit. The importance of these factors varies among farmers and among the crop kinds cultivated by a single farmer. Subsistence farmers are usually as interested in yield stability (risk aversion), the consumption qualities of the produce (taste preference), and secondary uses of the crop (straw, stalks) as in "potentially" high yield. They often perceive that the desired crop qualities are more certain in traditional varieties, and follow traditional seed saving practices. Large scale, market-oriented farmers, on the other hand, often feel it is most cost effective to purchase seed every season from a reputable supplier than to take the time and make the effort to save seed. Many farmers make "mixed" arrangements for their seed supplies. Thus, a West African farmer might save seed for his sorghum crop, but buys or is supplied with groundnut and cotton seed, while an American farmer might purchase seed every season for his corn crop (hybrid), only periodically for his soybean crop, and very infrequently for his wheat crop.

Our purpose in reviewing the seed supply arrangement made by farmers is to establish two premises:

1. Seed production and supply systems (or a seed industry) for a village, district, country, or even a region, develop in

response to opportunities that arise out of the choices among seed supply arrangements farmers perceive to be best for the crops they cultivate.

2. The scale, composition and technological levels of a seed program/industry are, therefore, ultimately determined by the same factors which influence the seed supply arrangements farmers make, would prefer to make, or can be persuaded to make.

The manner in which these premises have acted to determine the make-up of national seed industries can be illustrated with many examples. A few examples in both developed and less developed countries follow:

- In the 1930s U.S. farmers perceived that use of hybrid corn varieties was advantageous but on-farm production and saving of seed was too complex. A large scale, highly sophisticated hybrid corn seed industry developed to supply the hybrid seed needed. Many U.S. wheat farmers, on the other hand, still save seed for planting (wheat is self-pollinated) except when they want to replace the variety or varieties they cultivate with new varieties. As a consequence of these seed supply arrangements, the wheat seed industry in the U.S. is small scale and not well developed, although wheat is a major crop.
- The small (in area cultivated) farmers in the Kenya highlands were persuaded in the 1960s by excellent demonstrations and an effective extension service that hybrid corn varieties were highly beneficial, and a very efficient hybrid seed service has been

established to supply their seed needs. In contrast, most corn farmers in the lowlands of Kenya still do not perceive that the hybrid corn varieties available are superior to traditional varieties and continue to save seed.

- Farmers in Thailand started producing soybeans during the rainy season for the market in the early 1970s and experienced great difficulty in saving seed of good enough quality to plant. The government responded by establishing a soybean seed program based on production of the seed during the "dry season." It has been reasonably successful.
- Indonesia established a rice seed program in the 1960s, but it progressed very slowly until different biotypes of the brown plant hopper (an insect) began to evolve. Since varietal resistance is the best means of control, the rice seed program had to rapidly develop to supply seed of new, resistant varieties to replace varieties as they become susceptible.
- A substantial hybrid cotton seed industry has developed in India because farmers perceive that hybrid cotton varieties are superior despite the relatively high cost of seed laboriously produced by hand pollination.

It should be evident from the foregoing discussion that the matter we need to address here is much more complicated than the question of whether or not a seed program is needed, more specifically a rice seed program. The more appropriate question is: what scale, composition and

technological level of rice seed production and supply is required in the various countries to permit rice farmers to make the seed supply arrangements they presently make, would prefer to make, or can be persuaded to make?

WARDA's activities have been quite successful in promoting and improving rice production in West Africa. We can assume, therefore, that developments have reached the stage where adequate supplies of seed of the superior rice varieties are essential for continued progress. Futhermore, it is quite likely that the stage of seed program/industry development and the demand for rice seed vary widely among the different countries. In view of the probable situation in West Africa, some discussions of the requisites for a seed program/industry, "lessons" leaned from experience, and the components of a seed program would appear to be appropriate before considering some of the general characteristics of rice seed programs.

Requisites for a Successful Seed Program

A seed program can be defined as those activities conducted and the measures implemented to achieve the desired levels of production and supply of seeds of superior varieties and the use of these seeds by a high percentage of the farmers.

Considering the countries that are making rather rapid advances in agricultural productivity as well as those that are only approaching the "take off" point for substantial and sustained progress, certain requisites for the effective organization, implementation and subsequent

development of a seed program/industry are clearly indicated. Many of the problems associated with the establishment of seed programs and most of the failures or near-failures can be attributed to failures either in recognizing these requisites or in providing for their proper development.

High-Level Support: Desire and determination within the decision-making level of government to improve agriculture and the supply of essential inputs in the first requisite. Determination and desire alone, however, are not sufficient. They must be tempered with an understanding and appreciation of the needs of agriculture and their priority, alternative avenues to progress and their relative accessibility, and the human and material resources that can be committed to the task. A proper balance among development programs is most important.

To assure the proper balance among development programs, it is most often necessary for the Ministers to establish a definitive agricultural development policy. This policy must establish priorities for the total development of the agricultural sector, not just for seed, research or extension. If seed is among the priority programs, then a national seed policy and a plan for its implementation should be developed. In the absence of high level support to assure a continuous supply of personnel, finance and land a seed program simply cannot develop beyond its current level.

Productive Plant Research Program: An active and productive plant breeding, introduction and varietal testing program is the corner-stone

and second requisite for a seed program/industry. Structuring a seed program on traditional or "unimproved" varieties can seldom be justified. Sporadic yield increases might result from improved seed production and processing practices, but the overall and long term effect is usually disappointing. Cultivators have worked out successful methods for saving seed of self-pollinated varieties over hundreds of years. Elaborate schemes and facilities, no matter how well intentioned, are unlikely to improve seed usage very much. Most cultivators need only a small quantity of seed, a few kilograms, for their own plantings. Once they obtain seeds of a new variety, they rarely obtain additional seed until a better variety is developed and tested at the farm level.

Rarely have breeders developed a variety that is truly superior in the absence of other improvements in production practices. Development of these associated practices are also a responsibility of the research program.

Cultivator Demand: The production of a large quantity of quality seed of a superior variety for which there is no demand, or which cannot be effectively distributed, is a futile as creating a strong demand for improved seed without provision for adequate production. Either situation can wreck the developing seed program and stifle development. In the first case, the waste of resources and effort is obvious, while in the second case, the cultivators simply consider that the situation is just another in a long series of government misadventures, and they will become even more distrustful of non-traditional schemes for agricultural improvement.

Getting good seeds used is probably the most difficult task encountered in a developing seed program. Developing an awareness among the cultivators of the potential of improved seed - or any input to the point where they will demand it - is usually a function of the agricultural extension service. On the other hand, failure of the extension service to keep pace with developments and to persuade the cultivators to adopt improved practices or varieties, is one of the problems most frequently related to us by seed specialists in developing programs. It is certain, however, the success of a seed program/industry should be judged in terms of how much seed produced are distributed and planted, and not solely on the quantity produced.

A Sound Plan and Organized Effort: Accomplishment of the mission of a seed program requires planning and organization. Planning outlines the program, establishes its goals and scope, allocates necessary resources, and provides for continuity. After planning, organization is then necessary for successful implementation and attainment of goals. Effective cooperation has to be established among the various governmental agencies involved in crop improvement, research, extension, education, agricultural credit, supply, and with cultivators and other parties in the private sector. In the long run, the latter will or should evolve into a "seed industry."

The organization of a seed program does not follow a rigid pattern. There is no one formula for success. The biological characteristics of plants and seed do impose some limitations on what can and what cannot be done. Aside from these limitations, however, the only criteria are

that the plan and organization should foster a maximum of effectiveness and efficiency, a minimum of unnecessary procedures and irrelevant regulations, and should provide for and encourage - from the beginning - the participation of farmers (as contract seed producers) and other private persons and institutions.

A Cadre of Trained Personnel: General familarity with seed production, processing, storage, or marketing might suffice for broad planning of seed programs, establishment of goals and the outlining of an organization. But, implementation of the plan and the conduct of operations are quite different things. Acquaintance with the general principles of drying is simply not sufficient to equip a person to deal with the immediate problem of drying rice seed during the wet season in Sierra Leone when the humidity is near 100% and temperature near 40C. Seed operations in areas characterized by a seasonal division between rainy and dry periods, high temperatures and humidities, poorly developed transportation and communications are outside the experience of most seed specialists from Western Europe or the U.S. On the other hand, only a limited number of seed specialists from West Africa have received sufficient needed technical training, and persons with the experience to direct a comprehensive seed program are even more limited.

Opportunities for comprehensive training in seed technology are greatly restricted. Even in the so called developed countries, the training is too often directed toward specialization, e.g., as seed analysts or seed pathologists, rather than developing a comprehensive knowledge of both the technical and managerial skills required by the leaders of a developing seed program.

It may appear that we are over-emphasizing these"requisites" for seed program development, or that they are so obvious that they can be taken for granted. We have found, however, that ignorance of the bases for a seed program has been responsible for many seed program failures.

Lessons from Experience

Since 1958 our staff has had the opportunity to work with seed technologists and administrators in many developing and developed countries, participating in essentially every aspect of seed program development from the design and implementation of comprehensive seed programs to the proper techniques for cleaning equipment and facilities between varieties. From this broad experience we have learned several "lessons" concerning the development of seed programs, regardless of their "stage" of development. These five lessons are as follow:

(1) Skilled, knowledgeable manpower was basic. The initial efforts in the seed program should be scaled to developing manpower resources. Conversely, manpower resource development must be accorded high priority in the time frame of overall development. Since skilled, knowledgeable manpower will be limited if not non-existent in most countries, initial implementation must also be limited.

(2) Early development efforts were concentrated. Diffusion of effort, fragmentation of resources, and dispersion of operations are not ways to build a program. Initial efforts and available resources must be concentrated, centrally managed

and closely coordinated until the program attains the "critical mass" stage and becomes self-sustaining. Only then can the program be broadened rapidly in an orderly, efficient, and successful manner.

(3) The quality of inputs into the program was more important than their quantity. If a program is built with makeshift, piecemeal and haphazard inputs then its outputs are unlikely to be different. The "bandwagon" approach to seed program development has not succeeded, although, it has often been tried. Construct the program with quality inputs - good workers, good equipment, good organization, good support. Should resources be insufficient to support more than a very modest but good effort, then settle for a modest program.

(4) The time-frame was realistic. The "crash program" approach to building a seed program-industry also has not succeeded. Ample time for development must be alloted. A modest base solidly constructed a few years in advance of the anticipated urgent need for large volume seed production is the best approach.

(5) Planning, evaluation and implementation were continuous. One evaluation, one plan and a single implementation effort do not build a program. They can only start one. The "plan" must be revised, expanded, contracted, redirected, on the basis of periodic assessments of progress. Even after the

program/industry becomes "on-going" there will still be a need for further evaluation, planning and implementation to increase its efficiency, versatility, and scope, or just to keep up with the times.

Components of a Seed Program/Industry

"A good seed program ... involves a number of components, each of which may be likened to the links in a chain. And, like a chain, if one of the links is weak the chain is also weak. some of the links are common to all of agriculture; others are peculiarly related to seed." 4/

Our experiences suggest that one of the most common problems in seed program development is an inadequate or incomplete understanding of just what is a seed program. In some countries a few components of a seed program have been actively promoted, supported and developed, (e.g., seed testing, seed legislation, breeder seed production), while others remain underdeveloped and relatively unpromoted. In other countries, the various components of the program are so unevenly developed that the "weak links" impede progress. While we do not have time here to consider the various components of a seed program in detail, a listing of the components with brief comments should be beneficial:

(1) Productive varietal testing, introduction and development research. This is the base of a seed program/industry.

4/ D. D. Hill. Seed and the World we live in. Foreign Agriculture. FAS, USDA, Washington, D. C. January, 1981.

(2) Varietal maintenance and breeder seed production. Released varieties must be maintained and periodic supplies of breeder seed produced.

(3) Basic seed production. Basic seed are the foundation of certified and/or commercial seed production.

(4) Seed production. Multiplication of basic seed up to the quantities needed has to be organized and adequately controlled.

(5) Seed conditioning. The quantities of seed produced in a seed program can not be handled by the traditional methods used by farmers for saving seed. Seed threshing, drying, cleaning, treating, packaging and storage facilities are required.

(6) Marketing and distribution. Seed have value only to the extent they are distributed to farmers and planted by them. Marketing, therefore, involves promotion of the seed produced so that it is demanded by farmers. Distribution involves the management and mechanics of positioning the seed desired by farmers at the proper time and place.

(7) Quality assurance and control. The quality of seed is very important. Therefore, a system is needed to assure and control the quality of the seed produced and marketed. Seed certification, seed testing, seed legislation are mechanisms for assuring and controlling the quality of seed.

Rice Seed Programs

The stage of development, scale, and technological level of rice seed programs vary widely among countries. One of the main determinants of the scale and technological level of a rice seed program/ industry appears to be farm size and end use of the rice production. In Central and South America where rice farms are relatively large and the production is all marketed, rice seed programs/industries are well developed and quite efficient. The "large" farmers producing rice adopt new varieties and production practices readily and tend to buy seed at least every 2nd or 3rd season.

In many Asian countries, on the other hand, rice is produced by small farmers and most of the production is consumed by the farm family. While Asian rice farmers have adopted the new varieties, they still save seed for planting and buy seed very infrequently - only when they perceive the need to change varieties because of the release of a new superior variety or need a variety with specific disease resistant characteristics. As a consequence of these situations, rice seed programs/ industries in most Asian countries are relatively small scale. there is just no consistent or predictably demand for rice seed. Nevertheless, a program of reasonable scale is needed to multiply seed of new varieties so that adequate quantities are available for farmers who wish to change to new varieties as they are released.

Technologically, rice seed are among the easiest kinds of seed to multiply and produce on a large scale. First, the multiplication ratio, of rice, i.e., kgs. produced by planting 1 kg of basic seed, is very

high - 1:100 or higher. Secondly, rice seed are relatively easy to harvest and thresh and small threshers are available. Thirdly, rice is self-pollinated so out-crossing is a very minor problem and maintenance of varietal purity is not difficult. Finally, rice is very well adapted to the humid tropics, and rice seed are among the most resistant seed kinds to field deterioration and the deteriorating effects of high temperature and humidity. If properly dried rice seed store very well.

The requirements for a rice seed program are not different from those for other kinds of seed: superior varieties accepted and demanded by farmers; varietal maintenance, breeder seed and basic seed production; seed production on government land or with contract farmers; facilities for threshing, drying, cleaning, packaging, and storage; good marketing and distribution; and quality assurance and control. Since the same general facilities needed for rice seed are suitable for other kinds of seed, the program can be most efficiently operated by including other seed kinds along with rice.

Summary

Seed have several crucial roles in agriculture. They are the most efficient means of propagating crops, and maintaining and transmitting genetic improvements made by plant breeders. Every cultivator has a seed program for selecting and saving the seed he needs for planting the next crop. This seed saving practice is adequate in traditional agriculture, but as research develops superior varieties and associated practices, a district or national seed program/industry is needed to multiply the seed of the new varieties up to the quantities needed for

distribution to farmers. Rice seed are among the most adaptable kinds of seed for large scale production and distribution. The benefits of a seed program based on superior varieties are very great. Thus, the investments needed to establish a seed program can usually be easily justified.