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THE WHEAT IMPROVEMENT PROGRAM,

WEST PAKISTAN

A PROGRESS REPORT

by

Norman E. Borlaug

and

Ignacio Narvaez Morales

The Ford Foundation
Islamabad

ABOUT THE AUTHORS

Dr. Ignacio Narvaez Morales holds a Ph.D. degree from Purdue University in Plant Breeding and Pathology, and has been associated for the last 19 years with the Mexican program of wheat improvement, sponsored jointly by the Mexican Ministry of Agriculture and the Rockefeller Foundation.

In 1964 Dr. Narvaez visited 11 wheat-growing countries of Africa and Asia as a consultant for UN-FAO, advising on wheat improvement.

From November 1964 through June 1969 Dr. Narvaez was assigned by the International Maize and Wheat Improvement Center, Mexico City, as adviser to the West Pakistan Secretary of Agriculture, Lahore. In this capacity he worked with the Cereal Botanists and their staffs at Lyallpur, Tarnab, Tandojam, and Quetta on the accelerated wheat improvement program. For his work in Pakistan Dr. Narvaez was awarded the Sitara-i-Quaid-i-Azam in 1967.

In August 1969 Dr. Narvaez became Wheat Improvement and Production Specialist, Middle East Office, The Ford Foundation.

Dr. Norman E. Borlaug holds a Ph.D. degree from the University of Minnesota in plant breeding, and has spent 22 years in Mexico as a member of the Rockefeller Foundation, assisting the Mexican Government in wheat improvement.

Since 1962 Dr. Borlaug has been consultant to more than 20 countries which are introducing the dwarf wheats developed in Mexico. He first visited West Pakistan in 1957, and has been heavily involved since the beginning in the West Pakistan Wheat Improvement Program.

Dr. Borlaug is an Associate Director of the Rockefeller Foundation; a member of the National Academy of Science, U.S.A.; American Society of Agronomy; holds an honorary Doctor of Philosophy degree from the University of Punjab, India; he received the Sitara-i-Imtiaz of Pakistan in 1969.

SUMMARY

The 1969 Pakistan wheat harvest, although officially estimated to be at least the equal of last year's, has produced confusion and frustration for farmers, government officials, and scientists alike. Our recent visit has convinced us that farmers' confidence has been shaken and that the dissatisfaction with the past harvest is in large part the result of two factors: first, lower average yields than record-breaking 1968 due to unfavorable weather conditions and fertilizer-water inputs; second, lower incomes due to changes in wheat prices--which were announced after the crop was in the ground. Nevertheless, if one looks beyond the smoke of confusion, it becomes apparent that, province-wide, the past harvest was not disastrous but successful, considering the very adverse weather conditions under which it was produced. Our conclusion is that the Green Revolution is not dead; if infused with the right inputs and economic medicine, it will react favorably and go on to achieve Pakistan's production targets.

This report first gives an account of the facts, as we have understood them and discussed them in our recent tour through the Southern Region, the Central Region, and the North West. In giving the scientific reasons for these phenomena we largely concur with analyses already performed by Pakistani scientists: there was a scarcity of essential inputs at essential times, and weather was a dominant factor. Genetic deterioration of a fixed variety is simply a genetic impossibility.

The bulk of our report looks to the future. What is needed

to insure a continuation of the wheat revolution? The study submits most earnestly the following recommendations. In the immediate short term, farmer confidence must be restored. Prices must be announced before planting, probably for a one-year period, and defended at all cost. The Government must insure that the farmer can count on access to fertilizer, through building buffer stocks, and to water, through better planning. Pakistan desperately needs Nitrogen for the next wheat crop.

Second, although genetic structures of a variety do not change, disease organisms do. The only defence against the scourge of rust is a vigorous research and seed distribution program which insures that multiple varieties are constantly being introduced. We mention three specific needs: first, for a summer nursery to cut in half the time needed to identify a new variety; second a system of advancement and remuneration which encourages and frees the creativity of the new generation of young Government scientists; third, a system of pure seed multiplication and certification.

Finally, we note that Pakistan has definitely entered a new technological age in agriculture. Not all farmers can make use of the technology which has brought about the jump in wheat harvests. A special research effort must be made to develop improved varieties of those crops which are of unique importance to the barani farmer. In addition, although we are writing as production specialists, we observe that the absence of data and policy oriented research in Pakistan prevents it from effectively defining its agricultural policy options in terms of farm prices and incomes. We urge that a major effort be made to upgrade research in this vital area.

Introduction

The so-called Green Revolution was born of the heady optimism of the record-breaking wheat crop of 1967-68. That crop, produced under near ideal climatic conditions, resulted in a bumper harvest of 6.5 million metric tons, which was an increase of nearly 50 per cent over the previous all-time high. The harvest far surpassed the original estimates and expectations of farmers, planners, government officials, and most scientists. The spectacular performance of the dwarf variety Mexipak in large part was responsible for the record crop. "Mexipak" became a household word as it shattered all previous yield records across the breadth of the wheat producing areas of Pakistan. Not all but many farmers experienced yields of two to three times their previous highs with desi varieties. Mexipak clearly established that it was a very efficient user of fertilizer, and irrigation water, and responded spectacularly when properly grown. Mexipak's record-shattering yield performances were highly publicized in the press and over the radio. Within this wave of enthusiasm the seeds of unrealistic expectations with built-in potential disappointments, appeared. Unfortunately, the name Mexipak in the minds of many became an elixir for all agricultural ills, rather than being properly tagged as a very potent catalyst for revolutionizing wheat production if properly grown and exploited.

An Analysis of the 1968-69 Disappointment

It is a paradox that, despite having achieved a crop equal to last season's record, the general impression has been conveyed that the harvest was a disaster. This is clearly not the case. Many farmers who produced spectacular yields of Mexipak in 1967-68 did indeed harvest lower, but nevertheless good, yields in the 1968-69 crop season. Moreover, vast numbers of farmers experienced higher yields than ever before. Why then all the confusion?

Unlike the 1967-68 crop, that of 1968-69 was produced under highly unfavorable climatic conditions. This resulted in somewhat lower yields--but, nevertheless, good yields by pre-Mexipak standards. Moreover, when harvest was just beginning the support price for wheat was lowered from 17 to 15 rupees per maund. This resulted in farmer disenchantment and he has reacted in several ways which have confused the whole wheat production picture for the 1969 harvest. The result is that the government planners, officials and scientists who are now finalizing plans for the 1969-70 crop cycle must now base their plans on confused data and information.

It is not clear how much wheat from the 1969 harvest is still in the hands of the growers, nor how much is held by traders. Nor is it clear how much of the total grain now being

withdrawn from stocks is currently being milled and how much is being handled by interests speculating on an increase in wheat prices within the next few months. To make matters worse, erroneous explanations are being offered for the "reductions" in yield of Mexipak. Among the most widespread, persistent, and unfounded rumors is the one implying that Mexipak has genetically degenerated--or suffered a great genetic reduction in yield potential. Such rumors, founded on ignorance, honest confusion and, in some cases, malice, simply have added more confusion to the already murky picture. This is a poor foundation on which to build wheat production plans for the 1969-70 crop season. What then are the facts?

The Facts

The lower yields of Mexipak reported for 1968-69 have been represented by many as genetic deterioration. As evidence, they have stated that Mexipak was taller, plants were of uneven height, heads were smaller and tillers on the same plant were of different heights. While all of these phenomena were no doubt in various places observed, the reason was not genetic deterioration. Genetically, a variety of a self-pollinated crop does not change once it has been selected to uniformity and has been fixed. Before being released for sale to Pakistan

the variety had been fixed, for no breeder would ever permit release before this was achieved. Pakistani scientists themselves traveled to Mexico and selected with scrupulous care the fields from which the 42,000-ton shipment was harvested. Why then were these other conditions observed? The reason for lower yields will be discussed in some detail. The observed characteristics can be considered here.

(a) Average height. Some farmers may have felt that Mexipak was taller simply because frequently there were no adjacent fields of tall desi varieties with which it could be compared. Assuming, however, there was an actual difference, this could well have been caused by an incorrect nitrogen to phosphorus fertilizer ratio.

(b) Field mixtures. Admixtures with other varieties no doubt accounted for most of the unevenness of height. Such mixtures are particularly striking when seed of a tall variety is mixed with that of a dwarf. Field observations indicated that the locally tall "off types" were of Pakistani desi origin, either volunteers from previous crops in the same field or admixtures in purchased seed. Although the field may look very ragged, mixtures of up to ten per cent will have little effect on yield, since stiff-strawed dwarf varieties inhibit lodging.

(c) Smaller heads. Smaller heads result when temperatures

are above normal or the plant has been under water stress during the early part of the growing season, as was the case during 1968-69 for much wheat acreage.

(d) Uneven height of tillers on same plant. Uneven height of tillers is normally the result of delayed irrigation. Mexipak normally sends all its tillers up at the same time and each has approximately the same size of head. However, if water is not applied at the correct time, the plant sends up one or two tillers, it waits until water is applied and then sends up the additional tillers. These "late" tillers have short heads and often short stems. Variations such as this, caused by technical errors in management, lead to reduced yields.

Reduced Yields

A number of factors were responsible for reduced yields; they relate to the environment, either natural or man-made. The following list includes some of the reasons we have identified:

1. Adverse Climatic Factors

(a) Abnormally high temperatures in the first two weeks of March and again in the month of April. The high temperatures of early to mid-March (85-97°) occurred at the time much of the crop was setting seed, resulting in lower

numbers of seeds per head. The later high temperatures of April were even more important. The effective result was a hastening of maturity causing the seeds to be less well-filled.

(b) Inadequate water supply. Winter rains were almost non-existent, and this was coupled with a shortage of irrigation water in February and March. During this period water supply in the canals was low, and there was a general failure in electrical supply to tubewells on which much of the crop is dependent. This occurred in the period of flowering and post-flowering which is considered one of the most critical periods in which water stress should be avoided.

2. Improper and Inadequate Fertilization

(a) Incorrect nitrogen/phosphate ratio. The farmers of West Pakistan have become quite convinced of the value of nitrogen fertilizers. The same is not yet generally true for true for the use of phosphate. Many are not using any. However, both are known to be necessary and inter-dependent, if maximum returns are to be realized; the use of nitrogen, accelerating the exhaustion of phosphates naturally in the soil, requires phosphate replenishment. The recommended ratio in general terms is 2 N : 1 P_2O_5. The actual ratio based on sales was about 6 N : 1 P_2O_5 in the past

season. The net effect of excessive N in relation to phosphorus is later maturity. Thus the high March temperatures hit the crop when the seeds were not fully developed.

(b) Improper application. Fertilizer was, in many cases, not available at the time of sowing. It has been shown that fertilizers must be applied to the crop before or during early plant growth for proper response. Little effect on yield is achieved if the nitrogen is put on later than the first six weeks of the plant's life. When nitrogen is applied late, e.g. at heading, only a small yield increase is obtained. Its magnitude is measured in slightly higher grain weight, but the number of tillers and number of grains is established very early and cannot be changed.

(3) The Dilution Effect of Increased Acreage

The first farmers taking up new seed and technology are normally the most progressive. As the acreage increases, production is moved to those with less technical competence, those who are unable for economic reasons to apply recommended levels of fertility and those living on marginal lands with salt or other soil problems. Such farmers, for obvious reasons, have lower yields and this is reflected in its effect on the average for acreage under the new techniques.

(4) Late Sowing

With the desi wheats, their general longer maturity precluded the possibility of sowing them after the late harvest of a previous crop. The present dwarf varieties with somewhat earlier maturity can be sown later so that two crops can be harvested, e.g. cotton or rice followed by wheat. However, when late sowing is adopted, the cultivator must expect to have lower yields even though he uses an early maturing variety. Mexipak is medium late in maturity but has been used widely for late sowing. In normal years, a reasonably good crop could be expected from mid to late December sowings. In the present year, however, late sowing of this variety resulted in premature ripening under the heat stress mentioned above.

The Rust Hazard

This was not a rust year, and disease in general had little effect on yield. The record-breaking crops of wheat harvested during the last two seasons have, in fact, been attained under almost disease-free conditions. However, this fortunate event does not indicate that the conditions will be the same every year. A variety can, however, become susceptible to a disease and this is often wrongly attributed to genetic deterioration

of the seed. Actually, when this happens, the organism responsible for the disease has changed, not the variety. The pathogens that attack the wheat plant, particularly the rusts, are continuously mutating or producing new types with different degrees of virulence (aggressiveness). For this reason the varieties now under cultivation (resistant to rust) may eventually become susceptible.

No one scientist is capable of predicting where or when a change in the rust pathogen will occur which permits attack on a given variety. Mexipak 65, now considered resistant to stem rust, may suddenly become susceptible. An improved model must be developed promptly.

The high yield potential of Mexipak 65 attracted the attention of almost all wheat growers of West Pakistan resulting in a rapid spread of this variety throughout the country. Last year (1968-89) Mexipak 65 occupied more than 60% of the irrigated wheat acreage, and the grain harvested from Mexipak alone represented almost 70% of the total wheat harvested last season. The self-generated success of Mexipak has placed Pakistan wheat production in a dangerous position. If Mexipak 65 becomes susceptible because of changes in the rust organism, wheat production is vulnerable to suffer drastic losses that may bring about disastrous economic repercussions in the economy of the nation.

How the Rust Hazards are Counteracted

The only protection against rust attack for any country is the planting of five or more varieties with different genetic constitution for resistance. If one variety becomes susceptible, the others will minimize the losses.

It is for this reason that the wheat scientists must maintain a dynamic breeding program to develop new varieties. The best ones identified should be rapidly multiplied and distributed widely among the farmers.

In the future a better system of supplying pure seed to the farmer must be developed. The current system of multiplying foundation seed on the district Agriculture Department farms and then passing it on to A.D.C. for further multiplication and sale to farmers, is cumbersome and permits accidental or intentional mixing of varieties. As a first step, it would appear useful to move some of the foundation seed directly from the breeder to the A.D.C. for further multiplication. In the longer run, a system of seed certification which involves impartial inspection of private growers' fields should be established.

The Summer Nursery -- A Short-Cut in Breeding

In breeding a new wheat variety the elapsed time between making a cross between two parents and the eventual

release of the new variety is 8 - 10 years. It is a long, slow process. If, however, especially in the early generations following the cross, a suitable cool summer nursery site can be found, a second crop or generation can be grown each year reducing the time required to produce a new variety by one half. This procedure is followed in a number of countries such as Mexico where dynamic breeding programs are maintained. In addition to speeding up the plant breeding process, several other advantages accrue. There may be disease organisms naturally present in the summer nursery which are not found in the regular season nursery but <u>are</u> a problem in certain areas; in addition, epidemics can be induced in an isolated nursery in the off-season, without jeopardizing the main crop; the climatic conditions are also different. All of these factors exert a strong selection pressure against the plants. When plants are selected which withstand the rigors both of the normal season and the off-season, they are almost automatically adapted to conditions over a wide area. Similarly, they are likely to yield well in spite of changes from year to year at the same location. Mexipak itself is a variety selected under such pressures and its wide adaptation is almost legendary.

In 1965-66 when the Accelerated Program for Wheat Improvement was undertaken in Pakistan, it was suggested that a

suitable site be located in the north at higher elevation where a satisfactory summer nursery could be grown. Subsequent to this, several locations were evaluated and on the basis of performance a site in Kaghan Valley was chosen three years ago. A proposal was presented to Government of West Pakistan to purchase 50 acres for establishing this nursery. Although this modest (Rs. 7 lakh) but vital scheme has been approved, the land has not yet been purchased. This year, as last, we have been assured that sufficient funds will be made available to purchase the land and that all efforts would be made to actually acquire possession. As of today, however, Pakistan does not have even one acre of permanent summer nursery. This represents, in our opinion, a dangerous and unnecessary delay in the varietal improvement program.

The Basic Long Range Problems in Research

Pakistan spent about 5 lakh rupees on wheat research last year. The value of the harvest has been conservatively estimated to exceed 280 crore rupees. Reduced to a percentage this means that less than .02 of one per cent of the crop value (.02%) is put into research. In many countries, the figure is ten times this amount. The type of research data and materials needed to improve the efficiency of Pakistani agriculture is

unlikely to come from such projects as sophisticated mutation breeding based on the use of atomic energy. Rather it will come from a carefully considered gradual expansion of the budget for conventional research, as additional well-trained scientists become available.

Doubling the agricultural research budget of Pakistan might bring only a very small per cent increase in output under the present conditions of available staff and the research administrative structure. Effective utilization of this budget is entirely dependent upon the selection and freedom of creative scientists. It becomes therefore imperative that reforms be introduced in the methods used in selection and advancement of scientists within the agricultural research establishment. Research problems are not solved by numbers of poorly-trained, incompetent, poorly-motivated scientists.

Selection breaks down when it is made on <u>any terms</u> other that scientific excellence, vision and motivation. If nepotism and friendship are the criteria of selection, and advancement is made on the basis of seniority, the result can only be an accumulation of "dead wood" and frustration which is fatal to research organizations. It is absolutely essential that flexibility be incorporated in order that excellence can be recognized in the form of merit promotions. Only in this way can outstanding

young scientists be advanced in their own field rather than shuttled off to a vacancy in another crop or discipline for which they are poorly qualified. In searching for a satisfactory approach it must be recognized that research and administration are of equal worth, but a different system of advancement is needed for each. A good research scientist is not necessarily a good administrator and more often is not. He should be allowed, however, to aspire to the same levels of remuneration and status as the administrator.

In our experience working with the young scientists of the Accelerated Wheat Improvement Program, we have been highly impressed by the talent of many of these young people. It must, however, be noted that even this strong program suffers sufficiently from the general advancement and rewards system that over the next few years many of its most promising scientists are likely to leave government service or sacrifice their training for promotion in other fields.

It has been shown that when a team is properly selected and led, as has been done in the Accelerated Wheat Program, an excellent "esprit de corps" can be developed. This is a spirit to be treasured. It must be injected into all of research at the three Institutes, but this is impossible under the present systems.

When the team approach is adopted where all disciplines are drawn together and moved toward a common goal the results have been spectacular. This has now been done in wheat, rice and maize. Progress in these crops has weakened the competitive position of other crops which have been neglected research-wise but are very important to the over-all economy. Presently, such crops include cotton, oil seeds, pulses, forages, and probably sugarcane.

Special attention should be given to crops of particular importance to the barani farmer. His inability to exploit the essential new inputs of water and fertilizer has minimized the value of the new seed varieties, and thus he--and he farms nearly one-third of Pakistan's wheat acreage--has not participated in the fruits of the wheat revolution. Although special credit (for tube wells, e.g.), tax, and training programs will be needed to prevent the barani farmers from becoming a depressed class, vigorous research in such important barani crops as oil seeds and maize, sorghum and millet should be pressed and extended to the farmer.

The necessary changes in administrative structure of research must be given the highest priority if Pakistan agriculture is to progress.

The establishment of a team approach, even though

organized on a crop basis but including the disciplines of breeding, agronomy, soil fertility, entomology and plant pathology, does not imply the need for establishing a new institute for each crop. Rather it implies working as a team as has been done in the Accelerated Wheat Program, where close collaboration among corresponding scientists at West Pakistan's three major Agricultural Research Institutes is established and maintained. The research coordinator of each crop improvement program must work out with the Directors of the Institutes the responsibilities of each of the Institute staff members affiliated with the Coordinated Crop Program. One of the keys to the success of the Accelerated Wheat Improvement Program has been flexibility of operation. This has been achieved by placing a modest budget directly under the control of the Wheat Coordinator. His use of these funds enables the program to avoid time-consuming bottlenecks and increases program efficiency.

Tactics for the 1969-70 Wheat Production Campaign

As indicated earlier in this report the progress in the "Green Revolution" in wheat production has been slowed down by several factors. Nevertheless, it is very much alive. Assuming the official figure for the 1968-69 harvest (6.5 million tons) is correct, it would appear that the 1969-70 target

of 7.5 million tons is low. If buffer stocks and additional supplies of food for East Pakistan are to be provided, the target could easily be raised. In order to remove these barriers and restore the forward thrust, the following steps should be taken immediately:

(1) The government should announce a support price for wheat within the next two weeks: i.e. before the next wheat crop is planted. Similar action must be taken for all important food crops at least one month before planting. The announced support price should cover only one crop season in order that necessary adjustments can be made annually.

(2) A vigorous press campaign must be undertaken to restore the confidence of the farmer. Once the support price has been announced, it must be defended at all costs. The publicity must reiterate the government's determination to meet this commitment.

(3) Fertilizer availability and stable prices are absolutely necessary to achieve the target. Immediate movement of nitrogenous fertilizer through Karachi port to the village level requires highest priority. Available information indicates that adequate stocks of phosphate fertilizers are in position at the village level. The

picture for nitrogenous fertilizers is unclear. Varying estimates are obtained from different agencies, but all are in accord that supplies are alarmingly low both within the country and at village level. At least half the nitrogenous fertilizer volume must be at the village level by mid-October at the latest, and the remaining half before the first of December, if the full benefits are to be realized. Deliveries late in December or in January will be of little or no value to the wheat crop. Planting season is here--fertilizer is not! The whole success or failure of the planned wheat program hinges on full availability of nitrogenous fertilizer delivered on schedule. It is absolutely imperative that every other product movement be subordinated to that of nitrogenous fertilizer from Karachi once it has arrived in port.

(4) The use of P_2O_5 must be popularized through a vigorous extension program. Nitrogen and phosphorus in correct ratio are required to maximize yields. The need for phosphorus is general.

(5) PL-480 imports must be used with care as Pakistan approaches total food self-sufficiency. Continued use of PL-480 imports to generate funds for development

programs, if allowed to depress prices received by farmers, can stall the agricultural production revolution. In our experience, agricultural production of food grains in four Latin American countries has been arrested by such short-sighted policies.

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