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THE GREEN REVOLUTION IN PAKISTAN IS NOT DEAD!

By

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4. Instructor, The University of Minnesota, 1940-41.

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HONORS AND AWARDS

1. Outstanding Achievement Award, University of Minnesota, 1958.
2. E.C. Stakman Award (Cereal Research), University of Minnesota, 1959
3. Honorary Diploma for Wheat Research, State of Queretaro, Mexico, 1959
4. Honorary Diploma for Wheat Production, State of Puebla, Mexico, 1958
5. Golden Spike of Wheat, Wheat Producers, State of Sonora, Mexico, 1963
6. National Academy of Science, U.S.A., 1968
7. The City of Ciudad Obregon, Sonora, Mexico -- Named street in honor of Dr. Norman E. Borlaug, 1968
8. Pakistan Government Award, Sitara-i-Imtiaz, 1969
9. Honorary Director of Philosophy degree, University of the Punjab, Ludhiana, India, 1969
10. American Agronomy Society, International Service Award, 1969
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TRAINING AND PROFESSIONAL EXPERIENCE

School:	Escuela Superior De Agricultura	Years: 1942-46
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University or College:	Purdue University	Years: 1954-57
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1946	Research Assistant, Ministry of Agriculture, Mexico.	
1947	Special Studies - Wheat Improvement, The Rockefeller Foundation, Mexico.	
1949-51	Kansas University - M.Sc. Program.	
1951-54	Special Studies - Wheat Improvement, Mexico.	
1954-57	Purdue University - Ph.D. Studies.	
1957-61	Head of Mexican Improvement Program.	
1961-64	Head of Wheat Division, National Research Institute.	
1964-65	Special Consultant, Wheat Improvement, FAO.	
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AWARDS AND HONORS

1. Awarded with the Grain of Gold by the Mexican Wheat Producers - Co. Obregon, Son., Mexico - 1965.

2. S.Q.A. - Pakistan, 1967.

3. Honorary Doctor's Degree, Purdue University for outstanding service - 1969.

4. Gold Medal, Ministry of Agriculture, Mexico - 1969.

THE GREEN REVOLUTION IS NOT DEAD

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 percent 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, was born. 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.

The 1969 Pakistani wheat harvest despite being larger than that of 1968 - and in fact an all-time record - has produced both confusion and frustration for farmers, government officials and scientists alike. In a large part the dissatisfaction with the past harvest is the result of unfavorable weather coupled with very untimely changes in wheat prices and other economic policies. Compounded with this were the unrealistic expectations on the part of the producers who harvested bumper crops in 1967-68. This whole question is dealt with in more detail below. Nevertheless, if one looks beyond the smoke of confusion, it becomes apparent that the past harvest was not disastrous - but rather it was successful - considering the very adverse weather conditions under which it was produced. It clearly indicates that the green revolution is not dead. It may be sick, but if treated with the right inputs and economic medicine it will react favorably and go on to achieve the production targets.

An Analysis of the 1968-69 Disappointment

It is a paradox that despite having achieved an all time record wheat crop during the past season 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. As a result the national average yield per acre reached an all time high. 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 rumor is the one implying that Mexipak has genetically degenerated - or suffered a great genetic reduction in yield potential. Such vicious rumors, through all-founded, simply have added much 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?

<u>The Facts</u>

The lower yields of Mexipak reported for 1968-69 have been represented by many as genetic deterioration. As evidence, they have stated that it 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 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. Why then were these other conditions observed? The reason for lower yields will be discussed in some detail. The other factors can be considered here.

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. Mixtures with other varieties no doubt accounted for most of the unevenness of height. Such mixtures are particularly striking when seed [illegible] tall variety is mixed with that of a dwarf. Field observations indicated that the tall "off types" were of Pakistani desi origin. Although the field may look very ragged, mixtures of up to ten percent will have little effect on yield.

Smaller heads result when temperatures are above normal or the plant has been under water stress during the early part of the growing season. 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.

This was not a [illegible] disease in general had little effect on yield. 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.

A number of factors were previously responsible for reduced yields. These factors are concerned with the environment either natural or man-made. The following list includes some of the reasons thus far 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. [illegible]

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 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 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 temperatures hit the crop when the seeds are 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 was 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 [illegible] 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

The record-breaking crops of wheat harvested during the last two seasons have been attained under almost disease free conditions. However, this fortunate event does not indicate that the conditions will be the same every year. 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 (1968-69) 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, the 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 safe 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.

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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 about 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 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 progress, several other advantages accrue. There may be disease organisms present which are not found in the regular season nursery but are a problem in certain areas; there may be other races of rust and severe epidemics can be created; the climatic conditions are 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 adoption 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 foolhardy, unnecessary delay in the varietal improvement program and should be corrected immediately.

The Basic Long Range Problems in Research

Pakistan spent about [illegible] 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 percent of the crop value is put into research. In many countries, the figure is ten times this amount. The type of research data and materials that is 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 percent increase in output under the present conditions of available staff and the research administrative structure. As a consequence, it becomes imperative that reforms be introduced in the methods used in selection and advancement of scientists within the research establishment. Research [illegible] of poorly-trained, [illegible], poorly-motivated scientists. If this is so, it is evident that such people should not be selected, and conditions must be such that strong motivation is encouraged.

Selection breaks down when it is made on <u>any terms</u> other than scientific excellence, vision and motivation. Too many times nepotism and friendship ties are the criteria used. Currently, advancement is made on the basis of seniority. Such a system leads to 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 so that outstanding young scientists can 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 approahc 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 remuneration levels 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 has also, however, become apparent that the whole system is so stifling that much of their initiative is lost and many 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.

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 with corresponding scientists at all three Institutes is established and maintained. The crop coordinator must work out with the Directors of the three Research 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 building in flexibility of operation. This has been done by placing a modest flexible budget directly under the control of the Wheat Coordinator. The use of these funds provides the opportunity to avoid time-consuming bottlenecks and increases program efficiency.

Tactics for the 1969-70 Wheat Production Campaign to Make it Go

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. In order to remove these barriers and restore the forward thrust the following steps should be taken immediately:

1. The government must announce a support price for wheat within the next two weeks. 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. Is the target of 7.5 million tons for 1969-70 wheat production realistic? 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

should be raised. Fertilizer availability and stable prices are absolutely necessary to achieve the target.

4. 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. Planning for arrivals has been both inadequate and unrealistic. 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.

5. 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.

6. [illegible] as Pakistan approaches total food self-sufficiency. Unwise use of PL-480 imports can stop 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. In Asia, another prime example is the effect of PL-480 grain on rice production in Indonesia.