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Technology can be more revolutionary than any "ism." Agricultural, more than industrial, technology is transforming the internal economies of developing countries and may soon be a source of critically needed foreign exchange.

A Green Revolution Yields a Golden Harvest

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GOLDEN HARVESTS, the product of a green revolution, are spreading across vast areas of Asia, particularly across Pakistan, India and the Philippines. This agricultural revolution is beginning to spread to other Asian countries as well as to Africa and is provoking rapid economic and social changes. It is generating enthusiasm and new hope for a better life among hundreds of millions of rural people in the hungry nations of the world, displacing an attitude of despair and apathy that permeated the entire social fabric of these countries only a few years ago.

The green revolution and its generated enthusiasm have caught most of the political leaders and economic planners unaware. They are ill-prepared to cope with the rapid changes now taking place. In the past they have been too conservative in their plans. Too frequently they have refused to listen or believe that such rapid change was possible. Consequently they have not revised their plans realistically to keep pace with, and add momentum to, the revolution that is taking place on the farms.

There is today a new urgency in dealing with the second-generation problems of development which have resulted from the breakthrough in production. Fortunately, government officials, scientists and educators in the awaking countries are now being infected belatedly with the farmers' enthusiasm. There have even been visible changes in the attitudes of some of the immutable bureaucrats.

The green revolution is increasing the Gross

National Product and has injected a new rhythm of business activity into the formerly stagnant economies of these countries. Although its current impact has been felt largely in the internal economies of the developing countries which have been caught up in the agricultural revolution, it will soon exert increasing effects on world trade.

The plan and strategy devised for feeding a hungry world, made as late as 1967 by the President's Science Advisory Committee, are no longer valid.[1] They should be revised drastically so as to encourage trade in agricultural products between developing countries and to avoid a glut of world cereal production caused by too rapid an expansion of production in developed exporting nations.

Moreover, the green revolution has many political implications. A potentially strong political pressure group—or "farm bloc"—is awakening and waiting for proper leadership. Governments, except for Mexico, have been slow to recognize the political-economic meaning of the green revolution, which they have sired. The rural sector represents 70% to 80% of the population in most developing countries, but government leaders have failed to guide the formation of an effective "farm bloc," which under responsible leadership could assist in bringing greater stability to government, thereby creating an environment which would permit balanced economic and social development for all sectors of the economy. Most of the social unrest in the developing countries is now being led by students and labor leaders, who represent only very small privileged urban sectors of the society. They are poor spokesmen for the long-neglected but now stirring agricultural sector.

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The golden harvest is the result of a spectacular breakthrough in wheat, rice and maize production. It has reached the economic pay-off stage in Pakistan, India, the Philippines and Turkey. It is in various stages of development in Afghanistan, Iran, Iraq, Tunisia, Indonesia and Malaysia.

The swift spread of the green revolution has shattered the hypothesis of economists and planners who believed that a revolution in agricultural production, characterized by rapidly rising per-acre yield, could only be achieved after a gradual improvement over several decades. It was, however, predicted, and the whole development is documented in a series of reports to the government of Pakistan by scientists and advisors of the Ford Foundation and the International Maize and Wheat Improvement Center (CIMMYT).[2]

The rapid changes in production now taking place in several countries were made possible by the introduction or "transplant" of high-yielding, fertilizer-responsive, day-length insensitive varieties (seed) of wheat and rice, together with a package of improved cultural practices which must be applied to permit these varieties to express their high yield potential. It was formerly believed such "transplants" were not technologically possible.

Recent experience has shown that transplants can be successfully made if they are guided in the early stages by scientists who are thoroughly familiar with the new varieties and with the interacting "ingredients," or factors, which have been formulated into a sound package of production practices. Simultaneously, while introducing the new varieties and technology, they must win the battle at top government-policy levels for attractive grain prices, while assuring availability at reasonable prices of such inputs as fertilizer, insecticides and water (pumps, motors, etc.). The so-called high-yielding Mexican wheat varieties, together with the new production technology, were largely developed through research done by CIMMYT in Mexico. They were introduced commercially into Pakistan, India and Turkey only after applied research carried out in those countries had established the feasibility of such action.

The so-called "miracle rice" variety, IR-8, devel-

oped by The International Rice Research Institute (IRRI) at Los Baños, the Philippines, together with a new production technology evolved in the Philippines, was subsequently introduced in much the same way as indicated for the Mexican wheats.

Implementation of Transplant

The tactics used to transplant the new wheat seeds and technology to Pakistan, India and Turkey followed a prescribed order:

(1) The introduction of small quantities of experimental wheat seeds from Mexico and their evaluation with the technology known to be highly effective in Mexico, where the practices were developed.

(2) The initiation of aggressive, adaptative research programs, largely carried out under farm conditions in both Pakistan and India, to check the applicability of the Mexican-developed technology to the new surroundings and to make whatever modifications were needed to increase efficiency. This automatically forced scientists from experimental stations and laboratories on to the farms where the battle of food production must be won.

(3) The formulation of specific recommendations based on practices designed to demonstrate large yield increases on many farms, i.e., to jump yields in one season from 700 kilos per hectare (11 bushels per acre) to 5,000 kilos per hectare (75 bushels per acre).

Such spectacular increases in yield destroy, in one stroke, the built-in conservatism or resistance to change that has been passed on from father to son for many generations in a system of traditional agriculture. Such news spreads fast. It is now clear that the rate of adoption of new technology into a traditional agriculture is directly proportionate to the magnitude of yield-change demonstrated, assuming a favorable price-cost relationship.

The importance of this psychological factor has been overlooked previously by scientists, economists, planners, extension specialists and top government officials. In the early stages of making the transplant the plant scientists were forced to justify before "economist-sociologists" the use of 120 pounds of nitrogen per acre on 400,000 acres rather than 40 pounds on 1,200,000 acres. This battle of resource allocation was won, and the strategy saved ten years in the spread of the new wheats and new technology.

(4) The importation by governments of large quantities (18,000 to 40,000 tons) of commercial seed from Mexico. This action saved the countries from three to five years of time compared with the usual practice of simply multiplying the small stocks of seed originally introduced for early experimental tests. All three countries have encouraged the spread of the new seed and new technology through government research and extension services, the public sector seed organizations, as well as from farmer to farmer.

(5) The governments made fertilizers available at favorable prices and promoted their sale, although credit is still in short supply.

(6) The governments established incentive prices for wheat grain, which made wheat farming profitable when the new production technology was properly applied.

Although the high-yielding, fertilizer-responsive varieties were the catalysts for igniting the green revolution, the rapid increase in the use of chemical fertilizers was the jet fuel that propelled it forward at unprecedented speed.

The tactics and strategy used in the introduction of the new, high-yielding wheat varieties have subsequently been equally effective in the introduction of high-yielding rice and maize varieties. It has become apparent that the experience gained by farmers, government officials and scientists with the transplant of the high-yielding Mexican wheats into Pakistan and India has had a multiplier effect. The rate of adoption of new technology to other crops may be very rapid once the farmer has gained experience and confidence from success with the first crop.

Spectacular Spread

The rate of diffusion of the high-yielding Mexican dwarf wheat varieties has been spectacular, as shown

Table 1: Diffusion of the High-Yielding, Semi-Dwarf, Mexican Wheat Varieties in West Pakistan, India, Turkey and Afghanistan

Country	Estimated Acreage Sown to Mexican Varieties 1964–65	1965–66	1966–67	1967–68	1968–69
W. Pakistan	10	11,000	600,000	3,000,000*	6,500,000
India	15	7,000	700,000**	6,000,000	11,000,000
Turkey	—	—	1,500	425,000***	1,600,000
Afghanistan	—	—	3,000	65,000	125,000

* 42,000 tons of seed imported from Mexico
** 18,000 tons of seed imported from Mexico
*** 22,500 tons of seed imported from Mexico

in Table 1.

The percentage of total rice acreage planted to the IR-8, high-yielding variety (ever increasing each year) was during the 1968–69 crop year:

West Pakistan	25.0%
Philippines	12.3
India	8.8
Malaysia (1967–68)	6.1
Indonesia	3.4
Vietnam (South)	1.8

The high-yielding, fertilizer-responsive varieties have already strongly influenced grain production in several Asian countries, especially Pakistan, the Philippines, India and Turkey. The Philippines and Pakistan became self-sufficient in cereal production for the first time during the 1967–68 crop year. India will most likely become self-sufficient in 1971 or 1972. Other countries such as Afghanistan, Tunisia and Indonesia will experience rapid increases in production within the next two years.

Wheat and Rice Production

The impact of the new technology on grain production is best illustrated by wheat in Pakistan and India. The 1967–68 wheat harvest in Pakistan was 7 million metric tons compared to a previous all-time high of 4.6 million metric tons harvested during the favorable 1964–65 crop season (Figure 1). Although the new seed and production technology were applied on only 20% of the total acreage sown to wheat in 1967–68, this area produced 42% of the total harvest. The increase in production represented an increase of 52% over the previous high. Similarly, Indian wheat production jumped from a previous all-time high of 12.4 million tons harvested during the 1964–65 season to 18 million tons during 1967–68, representing an increase of 46% (Figure 2). This huge increase was in large part attributable to the impact of the new varieties and technology, which were used on only 18% of the area but which produced 36% of the total harvest.

Despite the outstanding 1967–68 harvest, many skeptics in both countries attributed the large increase primarily to favorable weather, rather than to the new, high-yielding varieties and new production technology. The true value and contributions of the new technology are becoming unquestionably clear in the current harvest. The skeptics are now silent.

The current season (1968–69) has been unfavorable for wheat production in both Pakistan and India. The monsoon was cut short with below normal precipitation. Winter rains were virtually nonexistent. March temperatures, when the grain was filling, averaged 5° to 8° F. above normal. Nevertheless, the estimated Pakistan wheat harvest will reach 8 million metric tons, a million tons, or 14%, more than last year. The Indian crop is estimated at 19½ million tons, 1½ million tons, or 8%, more than last year. The year that should be one of famine because of unfavorable weather conditions is instead one of abundance.

Most of the increased production of wheat is attributable to increased yields per unit of cultivated area. The average yield in kilos per hectare increased in Pakistan from 865 (13 bushels/acre) in the record 1965 harvest to 1167 and 1382 kilos per hectare (17.5 and 20.7 bushels/acre) during 1968 and 1969 respectively. Similarly, Indian yields increased from 925 kilos per hectare (13.9 bushels/acre) in 1965 to 1286 and 1425 kilos per hectare (19.3 and 21.4 bushels/acre) during the 1968 and 1969 harvests. Most of the yield increase during the 1969 crop was attributable to the further spread of Mexican varieties to occupy a greater proportion of the total area sown to wheat.

The full impact of the new rice varieties and their technology on world production is still to be felt. The percentage of the area sown to the new varieties

CULTIVATED AREA, PRODUCTION AND YIELD OF WHEAT IN WEST PAKISTAN

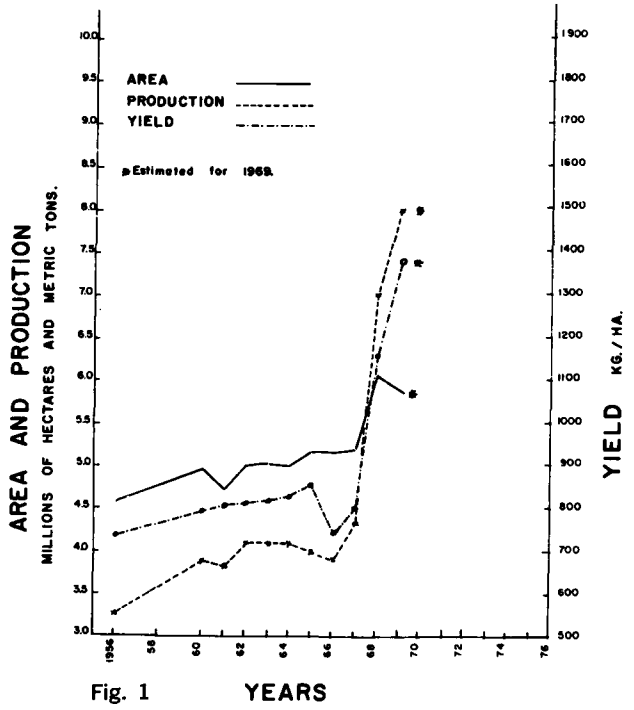

Fig. 1

TOTAL AREA, PRODUCTION AND YIELD OF WHEAT IN INDIA.

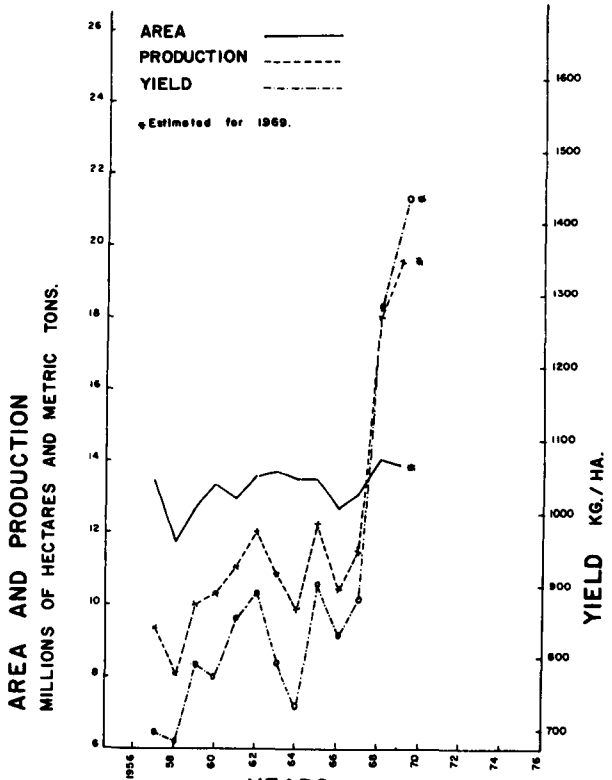

Fig. 2

under new production technology has been too small in most countries up to the present to produce an impact on production, except for the Philippines and West Pakistan. There in the 1968 season, 12.3% and 25% respectively of the total rice acreage was sown to new varieties. The Philippines, as a result, has attained self-sufficiency and become an exporter of rice. The rice production of West Pakistan rose spectacularly from 1.4 million tons during the 1967 harvest to 2.1 million tons during the fall 1968 harvest, largely as a result of increasing the area sown to the IR-8 variety from 10,000 acres to 850,000 acres. This increase in production in West Pakistan is more than adequate to make up the deficit in East Pakistan and to make the country, as a whole, self-sufficient in all cereal production.

West Pakistan, employing the new technology, has the potential production capacity to become one of the world's large exporters of rice.[3] It can produce rice at a cost which will make it highly competitive in international markets once the second-generation problems of storage, milling, transport and marketing are solved.

Skeptics insist that India will not make the same breakthrough with rice production that it did with wheat because of the lack of adequate control of irrigation water. Those associated with the program disagree and believe that rice production will increase greatly within the next two or three years. Similarly, although Indonesia, currently a large importer, has not shown any appreciable increase in rice production so far, it is introducing and accepting the new seed and technology. Large increases in production are expected within the next two years.

The recent introduction of high-yielding wheat, rice and maize varieties (and the new technology) are not cure-alls for stagnant agricultures. In the areas where they fit, they have produced tremendous

benefits: increases of from 12 to 25 tons of additional grain per nutrient ton of fertilizer applied, compared to increases of 6 to 10 tons from traditional varieties. The new varieties lend themselves to more intensive agriculture because the yield responses are maintained with increased per-acre fertilizer applications up to levels that are double or triple those feasible with other varieties.

In some areas, however, the new varieties have been unsuccessful. For example, IR-8 rice is poorly adapted to areas of heavy rainfall with heavy cloud covers where diseases, such as bacterial blight and blast, become limiting factors, i.e., East Pakistan. Moreover, better grain types are preferred. Similarly, wheats with superior grain types and a broader spectrum of rust and Septoria resistance are now seeded. These improvements and others will soon be forthcoming from revitalized national breeding and agronomic research programs being conducted in Pakistan, India, Tunisia, Turkey and Indonesia, backed up by and linked to strong research programs at IRRI and CIMMYT. Indeed, there are excellent possibilities of developing even higher yielding and better varieties of wheat, rice and maize than those that are now available. The green revolution need not be a "Pandora's Box." [4]

Moreover, there are good reasons to believe that the revolution in wheat, rice and maize production will continue to spread. The estimated total acreage sown to the new varieties in 1968 was 20 million acres. It is believed that it will reach the level of 35 million acres during 1969. It may surpass 40 million acres by 1970.

The rate of expansion of the new technology will depend upon continuation of a policy to maintain adequate price/cost benefits for farmers, combined with a rapid increase in the volume of available inputs, especially fertilizers and pesticides, as well as the maintenance of a stable price for grains. Greater volumes of credit for purchase of inputs will also be needed as production increases.

It is almost certain that within the next three years there will also be a rapid increase in production of grain sorghum and millets. The high-yielding varieties are already available and the development of the technology which will make these varieties highly productive is now being finalized. In the past both sorghum and millets have been used primarly as coarse food grains in the subcontinent, especially in years when rice and wheat were in short supply. With self-sufficiency rapidly becoming a reality in wheat, rice and maize, it is likely that sorghum and millets will be used increasingly as feed grains for livestock production, especially for poultry. More animal proteins, i.e., milk, eggs and meat, are badly needed to improve the nutrition of the people of the developing countries. For the first time in recent history this goal now becomes a definite possibility.

Intensity of Cropping

Double-cropping, that is, growing two crops on the same land in the same year, is not a new practice in the irrigated lands of the subtropics. In the past, however, grain yields of both crops in such a system were extremely low, primarily because of the low level of soil fertility. The availability of cheap chemical fertilizers and high-yielding, early-maturing crop varieties are revolutionizing multiple cropping. Large numbers of farmers are now changing their management in order to produce high yields of two or more crops each year on the same land. The new objective, therefore, becomes one of producing the maximum number of kilos of grain per hectare per year, rather than from a single crop.

Many farmers now harvest 10 to 15 tons of grain per hectare per year by using such double-cropping patterns as wheat during winter followed by a summer crop of rice or maize. This can be contrasted with a total production of 3 tons per hectare for the two crops before the new technology was introduced. In the more tropical areas a few talented farmers are now harvesting two, or even three, crops of rice during the same year. A few others use triple cropping involving wheat-moong bean-rice or wheat-rice-potato rotations. These and other combinations of multiple cropping with greatly increased yields per hectare in each crop have vastly changed the outlook of world food production for the next two to three

decades.

Mechanization is the key to expansion of successful multiple cropping, now that chemical fertilizers and early-maturing crop varieties are available. Machines will facilitate rapid plowing, seedbed preparation and sowing following each harvest. This cannot be achieved with bullock power as has been used almost exclusively in the past. Small tractors will become an absolute necessity if this potential is to be realized. The shift to tractor power will also gradually release large areas of land for food production that now are used for production of bullock feed.

Effect on Business

The golden harvests have already greatly influenced the GNP in both Pakistan and India and expanded business activity.

It is estimated that the 1968 wheat crop increased the GNP of Pakistan and India by the equivalent of $200.3 million and $497.6 million respectively over that of the record 1965 crop. The current (1969) wheat crop will add another $250.3 million and $628.5 million respectively to the GNP of the two countries. During the current harvest a total increase of $878.8 million will be added to the GNP of the two countries.

The full impact of the revolution in rice production has yet to be felt, especially in India. Nevertheless, it is estimated that the increase in rice production during 1968 in West Pakistan added $76.5 million to the GNP.

The increase in GNP is already visibly affecting the economy. Farmers are ahead of the planners. In both countries farmers are clamoring for more fertilizer. Despite herculean efforts by both governments to supply increasing amounts of fertilizers, the black markets have flourished. In India 200,000 new tube-wells, mostly privately financed, have been installed by farmers during each of the past two years, bringing eight million additional acres under irrigation. Pakistani farmers are also expanding tube-well installations as quickly as possible. Tractor production in India in 1967 was far ahead of demand. Large numbers of units were accumulating at factories, and buyers were few. Currently, not a single tractor is available for sale anywhere in the country, and the demand is so great that the total programmed production for the next two years has already been committed. The great increase in wheat production is forcing farmers in both countries to abandon threshing by the timeless method of treading out the grain with bullocks, followed by winnowing. Hundreds of small machine shops are now fabricating thousands of simple threshers to handle the threshing of the wheat harvest, which also releases bullocks for plowing for the next crop.

The farmers are buying more consumer items: transistor radios, bicycles and a whole list of other goods. In the awakening there is a growing demand for more and better schools, better housing, more warehouses, improved rural roads and transportation, more electricity to drive the motors on wells and to light the houses.

If the rhythm of increased agricultural production can be sustained and uncontrolled inflation avoided, the general activity of the entire economy will continue to increase in tempo.[5] Many millions of rural people, who formerly lived outside the general economy of the country—at a subsistence level—are becoming active participants in the economy. Millions of others desire to enter. If they are denied this opportunity, then the new upsurge will lead to increasing political unrest and political upheaval.

New Problems

Pakistan, having achieved self-sufficiency in cereal production at the present level of effective demand, is now being confronted with a series of challenges and second-generation problems. It currently has the potential ability to produce more than 10 million metric tons of wheat on the area now grown to this cereal, which is approximately 2½ million tons more than domestic effective demand. It must therefore either rapidly divert 3 to 4 million acres of irrigated wheat to other winter crops or prepare to export large quantities of wheat. The possibilities of substitute

winter crops are limited.

The country is short of both oilseeds and pulse (legume) crops. The latter are especially vital to improving nutrition. Part of the area no longer needed for wheat production can be used to grow rape seed, which is the most important winter oilseed. Safflower, perhaps, can also be successfully introduced as a new winter oilseed once mechanized combine harvesting becomes available. It is estimated that through the introduction of improved technology, which would make these oilseed crops economically attractive to farmers, an increase of 1 to 1½ million acres would result in meeting the oilseed needs of the country. Although there is a great need for expanding the production of winter pulses, i.e., gram, lentils and pidgeonpeas, there is little pertinent new technology available either within or outside of Pakistan that can be mobilized to increase yields from these crops.

The best possibility for expanding the production of pulses is through the introduction of soybeans as a summer crop. The technology for making soybeans an effective summer crop following winter wheat is available in Mexico. The double crop rotation of wheat and soybeans has become important to the economy of Mexico during the past five years.

Part of the surplus grains now available can be used to develop poultry production, since both chicken and eggs are highly valued as food by Pakistanis, and both are in short supply. This, however, is an industry that can be developed only gradually as the effective market demand is expanded by higher incomes for the general public.

Not all aspects of the green revolution have been favorable to the economies of the developing countries. West Pakistan has always been an exporter of cotton, a product that has been second only to jute as an earner of foreign exchange in the over-all economy of Pakistan. The yield of cotton is stagnant and unless aggressive government action is taken soon, rice, because of its rapidly rising yields based on the new seed and technology, will rapidly displace cotton. The seed and technology which can prevent such a disastrous shift and which can rapidly increase cotton yields, is available in some countries, Mexico and the United States. The Pakistani cotton farmer, without an effective government program to guide him, cannot, however, successfully make the needed changes in production technology. The introduction of new high-yielding, fertilizer-responsive varieties, coupled with the establishment of an effective insect-control program to protect the larger investments would be required to increase cotton yields. It is highly probable that a successful transplant of modern cotton production technology can be made in Pakistan in a three-year period if such a program is given adequate government support, and competent cotton scientists are assigned responsibility for the transplant.

After examining alternative crops and both actual and anticipated further increases in crop yields, it becomes obvious that Pakistan must begin to look for export markets for agricultural products, if it is to expand its economy.

Export Potential

Obviously, Pakistan must increase its foreign exchange earnings in order to reduce its dependence on foreign aid and avoid an unmanageable future foreign debt, while simultaneously trying to expand its industrial base. The first question for the economic planners to answer is one common to all of the developing countries—what are the best alternatives for export? The answer hinges on the question of comparative advantage. It appears that wheat and certainly rice exports are good alternatives, even though at first glance West Pakistan may be a less efficient wheat producer than the traditional exporting countries.

One way of ranking the various alternatives for export seems to be to calculate the marginal resources cost for the total economy per unit of foreign exchange earned. The marginal cost for the total economy will often be different from the marginal costs for the individual farmer, since some costs would be variable for the farmer but may be fixed for the total economy.

The marginal resource cost per dollar earned by

industrial and agricultural exports has recently been studied.[6] The report indicates that the marginal resource costs for Pakistan's manufactured exports is very high, of the level of 18 rupees or more per dollar of earned foreign exchange. Foreign exchange saved through industrial import substitution may have nearly the same cost. These costs substantially exceed the marginal resource cost of foreign exchange through increased agricultural exports, which were estimated to be about 5 rupees per dollar earned, or approximately one-third of the marginal resource costs for industrial exports (Table 2).

Increased exports of grains, perhaps under a bonus-voucher arrangement, must be considered as a favorable alternative compared with an increase of most industrial exports. In the case of wheat the domestic floor price, which is now very high when calculated at the official rate of exchange, can be reduced by 33% and still be remunerative to farmers. The question of whether or not to export wheat is, to a large degree, a question of the use of resources which otherwise may be more or less unused, since there are few alternative winter crops which could replace wheat on substantial acreage. At the present time there is no possibility of exporting any other winter crop. One obvious potential market for Pakistani wheat is China.

In the case of rice exports, West Pakistan is in an excellent position to compete in the world market. It can produce rice at a price competitive with any other exporter.[7] Its yields per acre are rising spectacularly.

West Pakistan in the past has exported annually from 150,000 to 200,000 tons of scented besmati rice, a specialty type. This rice is highly valued in the limited markets of the Near East countries. Pakistan is now, however, poised to invade the larger, more general rice markets of Southeast Asia.

Before Pakistan can effectively establish itself in the highly competitive international wheat and rice markets, it must drastically change its grain purchasing, storage, transport, milling and port facilities. The first step must begin with the establishment of an effective grading system for wheat, paddy and rice, so as to encourage the production of good quality grain. In the case of rice, modern driers and mills are needed to improve the yield and quality of milled rice. The construction of mechanized terminal elevators and the development of deep-water berths at Karachi, which can accommodate large modern bulk grain freighters, are essential to reduce costs of handling and shipping, both of which are necessary if Pakistan is to become an important exporter of grain.

Table 2: Implied Marginal Resource Costs of Foreign Exchange for Pakistan Exports

Export Products	Rupees per dollar (earned)
West Pakistan Exports	
01—Rice	5.1
02—Wheat	4.8
04—Cotton	5.1
11—Cotton textiles	(a)
15—Leather, leather products (b)	35.0
22—Machinery	20.9
28—Miscellaneous Manufactures	18.1
East Pakistan Exports	
03—Jute	9.9
12—Jute manufactures	27.7

(a) Data indicate negative net foreign exchange earnings, hence infinitely high resource costs per net marginal dollar of foreign exchange.
(b) In these calculations it is assumed that the inputs from the leather goods sector to the leather products sector largely takes the form of hides and skins, the internal prices of which are the same as for the international price.

Data by Dr. G. C. Hufbauer [6]

As other less developed countries struggle toward self-sufficiency and possible export, they also will require large investments to solve second generation problems of bottlenecks resulting from expanded production.

Population Growth

Certainly, the 1967 report on the world food problem by the President's Science Advisory Committee is the most exhaustive and best study that has ever been made of the dual problems of world food needs projected against anticipated population growth. Yet, in light of the present breakthrough in wheat, rice and maize production in Asia, especially in Pakistan and India, which were used as two of

the case studies, the report appears to be far too pessimistic to guide the future expansion of agriculture in both the developed and developing countries. It is possible that the rapidly expanding production of wheat in a number of Near and Middle Eastern countries will result in sizeable exportable quantities of this cereal within five years. The quantities are likely to be of sufficient size to exert further downward pressures on prices of wheat moving in international trade. The availability of large quantities of exportable cheap wheat in South Asia, combined with the anticipated large increase in rice production, will also jointly exert a strong downward pressure on the price of rice.

The conclusions and recommendations of the President's Science Advisory Committee in light of these new developments need revision.

The anticipated specter of widespread famine by 1985 in many areas of the world could encourage too rapid an expansion of cereal production in developed countries such as Canada, Australia, the United States and the European Common Market countries, which would result in national gluts. These in turn could result in an expansion of concessional sales of food grains (i.e., PL 480-type) to developing countries. Such sales would consequently discourage agricultural development and stall the entire economic development process.

On the other hand, pessimism regarding the possibilities of expanding food production in Pakistan, India, etc., has discouraged investments in fertilizer, pesticide and machinery factories, warehousing, transport, and water resource development, all of which are vital to the continued expansion of agriculture in countries where the production breakthroughs are being made.

The fact that some countries, such as Pakistan and the Philippines, which have been plagued by food grain shortages, have now achieved self-sufficiency should not be interpreted as indicating that all people in these societies are now adequately fed. There is a vast difference between the supply of food needed to meet the effective (economic) demand and that required to meet the nutritional or physiological need. The next steps for these governments must be to expand the effective demand to increase consumption of food for a vast sector of the low income group.[8] Economic policies must be formulated which make every effort to:

(1) expand employment;

(2) generate production in ways that distribute income widely over the population;

(3) organize programs which contribute to the redistribution of the "ownership or stewardship" of the means of producing income, via expanded education, training and credit;

(4) establish food distribution programs from domestically produced foods for low-income groups.

At the same time government policy should strive to lower food production costs through expanding research and by providing or encouraging the development of efficient installations for the production of cheap fertilizer, insecticides and water.

A Monster Still

There is growing unrest among the people in the underdeveloped nations of the world, as well as among the underprivileged in the affluent societies. They want, and deserve, something better than survival. Increasing numbers aspire to the benefits of a life that is more enjoyable than is presently possible.

It is the moral obligation of governments around the world to improve the standard of living of their citizens. This is no simple task. The problem is far more complex than population and food. Simultaneously governments, societies and individuals must attack the octagonal problem of population growth, food, education, employment opportunities, health, housing, communications and recreation.

One of the great tragedies of our time is that a vast segment of the world's population, even among the privileged classes in the affluent societies, fails to realize the complexities of the population problem. Student unrest on campuses typifies this lack of comprehension. It is easy to destroy the productive capacity which has the potential to build a better life for many, but it is a difficult and slow process to construct or expand the same. Those who seek to redress

injustice and criticize the "establishment" for its failures do not recognize that the excessive rate of population growth is the greatest basic cause of the inability of governments to cope with the world's social problems.

Those who agitate for greater freedom for the individual fail to realize that the exploding world population will automatically result in less and less freedom for the individual, irrespective of the system of government. Love-ins, within or outside the age-old mandate to "be fruitful and multiply," will do nothing to solve the population problem or improve the standard of living of the miserable masses of the world. The unrelenting increase in human numbers, with no relief in sight, continues to be the greatest unsolved multifaceted problem confronting mankind in its quest for a better standard of living for the world's masses.

The seriousness or magnitude of the world food problem should not be underestimated. Recent success in expanding wheat, rice and maize production in Asian countries offers the possibility of buying 20 to 30 years of time—representing only a few seconds on the clock of human occupancy of the earth—in which to bring population growth into balance with food production. Nevertheless, the underlying social economic problem confronting mankind is greater than food. Indeed, it has now been demonstrated that food production need not be a problem for the next three decades.[9]

NOTES

1 President's Science Advisory Committee, *The World Food Problem,* Volumes 1–3, Washington, D. C.: Government Printing Office, 1967.

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