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IMPACT OF THE NEW PRODUCTION POSSIBILITIES ON THE STRUCTURE OF INTERNATIONAL TRADE IN AGRICULTURAL PRODUCTS†

INTRODUCTION

What are the new production possibilities that should be considered in this paper? The technological breakthroughs in cereals production that have taken place during the last five years in a number of developing countries will be given most attention, but to confine the analysis to these developments would be too simple an approach.

Fortunately, agricultural science has a long history. The more scientific methods of cereals production in tropical and subtropical countries may be new in the sense of their recent dramatic application in formerly stagnant agricultural systems, but most of them have been based on painstaking plant breeding and agronomic research programs that have been underway in Mexico on wheat and maize and in the Far East on rice since the last war. The Mexican and Asian research was essentially continuous with the application of science and technology which has transformed the agriculture of the industrialized countries through the last hundred years.

Although agricultural research itself may be relatively old, its concentration upon the problems of food production in tropical and subtropical areas with the intensity that we have seen in Mexico and the Philippines is certainly new. Most of the developing countries who ushered in a new farming era with the receipt of their first consignments of improved varieties of wheat seed from Mexico or rice seed from the Philippines have begun to establish or strengthen national agricultural research programs designed to consolidate the early gains.

The developments in the tropical and subtropical countries, however, are not the only new production possibilities in agriculture that have become apparent

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during the last five years. Over this period the march of agricultural science and technology has continued in its earlier homelands of Europe, North America, and Japan. In these areas, too, the farmers have been provided with improved cereal varieties, responsive to greater inputs from industry and to further advances in farming practice and adapted to a wider range of physical conditions. The continued increases in cereal yields obtained in the advanced countries in recent years have and will have a marked impact on the structure of agricultural trade, perhaps more marked than that resulting from changes in developing countries. They cannot, therefore, be excluded from this paper.

In fact, since the subject focusses on world trade, the only correct approach seems to be to regard the new production possibilities now being demonstrated and increasingly applied in the tropical and subtropical zones as the latest geographic extension of the rising capacity of mankind to wrest his requirements from the land. In the sphere of industry we have become familiar with the spread of manufacturing processes and investments from the original centers of innovation and concentration to the outlying regions of the world which formerly constituted the markets for manufactured goods. The application of industrial technology in new lands forced the adjustment of earlier production and trade patterns. Thus, as a conspicuous example, the structure of world trade in textiles was transformed during the first half of this century and is still experiencing the necessity for severe readjustments. The same principle holds true in world agriculture.

THE GREEN REVOLUTION

The recent advances in tropical and subtropical agriculture that have come to be known as "The Green Revolution" have been confined to the cereals, wheat, rice, maize, millet, and sorghums, and have been most successful and most widely adopted in the case of wheat. Revolutionary changes in the production of these crops have been based in all cases on the evolution and distribution of new high-yielding varieties, supported by the availability to farmers of modern inputs in the form of fertilizers, irrigation, pesticides, credit, and technical advice. For wheat and maize, the fundamental breeding work has been centered in Mexico at what is now called the International Maize and Wheat Improvement Center, and for rice at the International Rice Research Institute which was founded in 1962 in the Philippines. Progress has been highly dramatic because of the speed with which the new varieties have been spread from country to country, multiplied under national conditions and taken up by local farmers who had access to the supporting inputs needed.

Wheat

The intensive research on wheat in Mexico in the 1940s built upon earlier work in other countries. By the early 1960s new fertilizer-responsive, rust-resistant varieties had been developed, and were already taken up by Mexican wheat farmers and planted on more than 90 percent of the country's wheat land, doubling the national yield per hectare as compared with prewar. When the International Center began to conduct wheat varietal trials in many countries it was found that the Mexican semi-dwarf varieties were adapted to a wide range of conditions. In particular, under the Food and Agriculture Organization of the United Nations

(FAO) Near East Wheat and Barley Project coordinated yield performance trials on high-yielding varieties were conducted in about twenty countries of the Near East, India, Nepal, Turkey, and North Africa. It was in the crop year 1965/66 that the Governments of India and Pakistan began importing seed from Mexico. In the following season, India imported no less than 18,000 tons and, in 1967/68, Turkey obtained 22,000 tons from Mexico, and Pakistan the massive quantity of 42,000 tons. By this time smaller quantities of Mexican-type seed had already been imported by Afghanistan, Nepal, and Tunisia. During the last two years, new importers of Mexican seed included Iran, Iraq, Saudi Arabia, Syria, Algeria, Egypt, Morocco, Sudan, and Bolivia (*8*).

The results have generally been striking. In India, over the five seasons from 1966 to 1970, the area under new varieties of wheat increased from 3,000 to 6.1 million acres. The yields of the high-yielding varieties, grown with the recommended package of associated inputs, have been consistently from two to three times those obtained from the local varieties. Thus, over this five-year period, while the Indian total wheat acreage increased by about one-third, the national average yield per acre increased by about 50 percent. In 1970, 37 percent of the total Indian wheat acreage was planted with new high-yielding varieties which contributed 68 percent of the total output. The progress in Pakistan over the same period has been similar. By 1970, 45 percent of the Pakistan wheat acreage was planted with high-yielding varieties which contributed 59 percent of the total production, and national wheat yields had gained by at least 50 percent (*7*).

In Turkey progress has been slower. The Mexican semi-dwarf wheats are capable of producing at least three times as much per hectare as the local varieties, but in 1968 and 1969 they were seriously attacked by stripe rust and yields were disappointing. A change of varieties in 1970 improved the situation somewhat, but the danger of disease is still present. In 1970 high-yielding varieties were planted on 8 percent of the total wheat land and produced no less than 22 percent of total output. In 1971, with the aid of good weather, Turkey had a bumper crop.

In most of the other countries mentioned above, the new wheat varieties are doing correspondingly well. In Tunisia in 1970, 7 percent of the wheat area planted with new varieties is said to have produced 27 percent of the total production. This success points to the potential developments in the wheat-growing areas of North Africa, provided that the extreme susceptibility of the Mexican varieties to septoria disease in this region can be overcome. In other countries, the wheat development and improvement programs are still in the early stages of seed multiplication, testing, and early distribution.

Mexican varieties are suitable only for planting under climatic conditions not subject to frost, and are therefore not adapted to large areas of Turkey, Iran, Afghanistan, Argentina, and Chile. For such areas FAO, in collaboration with the United States Agency for International Development (USAID), has introduced a winter variety from Russia (called Bozostaya) which is very widely adapted and gives very good yield. Iran, Turkey, and Afghanistan have imported large quantities of seed of this variety from Russia, and nearly 200,000 hectares were under this variety in 1970/71[1]

[1] FAO sources.

Rice

Following the establishment of the International Rice Research Institute (IRRI) in the Philippines in 1962, it was possible to make much more rapid progress with work on high-yielding varieties of rice than had been the case with wheat. This was because the Rice Institute was able to profit from earlier work on rice in Taiwan and Japan and from various projects of the FAO-sponsored International Rice Commission such as Japonica-Indica hybridization and wide adaptability trials carried out during the 1950s.

During the latter part of the 1960s, small quantities of improved rice seed from the Institute were imported by most of the countries of Asia and the Far East, and also by a few countries as far away as North and West Africa, Panama, and Venezuela. The first new named variety issued from the Institute called "IR8" showed wide adaptability and gave very high yields. However, it proved to be susceptible to important rice diseases and had poor palatability and low milling quality.

The new rice varieties have caught on and have been successful with farmers in a number of countries, on paddy land subject to good water control. However, they have not been as successful on the whole as the new wheat varieties. Their adoption has been equally rapid in terms of total acreage planted, but not in terms of proportion of crop area. This reflects the fact that in Asia only 20 percent of total rice land is under controlled irrigation, compared with 65 percent for wheat land. It must also be noted that in India, Pakistan, and Thailand there are large areas of paddy land subject to deep flooding, where the new high-yielding rice varieties cannot be grown in replacement of the traditional types. In the great rice zone of East Pakistan about one-third of the rice area is so affected, and in Thailand almost 40 percent.

In some countries, nevertheless, their impact has been very significant. This is the case in the Philippines where about half of the rice acreage is currently reckoned to be planted with various of the new varieties. In this country, however, some of them have been seriously attacked in 1971 by virus disease. The increase in national average rice yield by 19 percent between 1967 and 1970 appears surprisingly small, given the large area under the new varieties and their known yield potential. In West Pakistan, where rice is grown under good water control, the new varieties had good success and about a quarter of the rice acreage is taken up by them. In India the acreage covered by the new rice varieties is very much larger (4.34 million hectares in 1969) but the proportion of total rice area is probably only about 11 percent. Countries such as Thailand, which depend to a large extent on export markets for high-quality rice, have shown a natural reluctance to adopt the new IRRI varieties, being unwilling to sacrifice or run the risk of sacrificing quality to high yields. However, the new varieties (e.g., IR20 and IR 22) that are steadily being developed at IRRI by further crossing possess better cooking and eating qualities, and the adoption of high-yielding varieties is bound to be extended further.

Ceylon and Malaysia have had a different type of experience. These countries have benefited over the last decade from new varieties developed under FAO-sponsored programs—H4 and H8 in Ceylon, and Malinja and Mahsuri in Malaysia—and only Malaysia has so far made much use of the IRRI varieties. In Cey-

lon some three-quarters of the paddy land in the main crop season of 1969 was planted with H4 and H8 varieties. The progress in these two countries has been particularly significant in that it has been based on the adoption of new varieties by smallholders, so that the benefits have been much more widely distributed than in India and Pakistan, where the main impact has been made on the larger farms (*2*).

Other Cereals

Hybrid maize, which originated in the United States in the 1930s, was successfully introduced in Mexico in the 1940s and subsequently in certain European and African countries.[2] Generally, however, its spread to developing countries has been slow, largely because of the complex problems of seed production and the need for annual renewal of hybrid seed. In developing countries, emphasis in maize breeding is shifting to open-pollinated synthetic varieties whose seed can be produced cheaply and needs to be replaced only every three or four years. The yield potential of these varieties is more than double that of local strains but slightly less than that of the hybrids.

Hybrid varieties of millet and sorghum have been developed in India and the United States. As with maize, the technology is more complex than with wheat and rice. The United States hybrid sorghums have not on the whole proved successful in developing countries because of disease and quality problems. Some of the Indian hybrids are being successfully planted over a substantial area in that country where they yield 60 to 80 percent more than the local varieties. They are, however, very susceptible to insect damage, but this problem is being tackled in further breeding programs.

Better Seed Is Not Enough

There is no easy gain from new seeds alone. The high-yield potential of the new cereal varieties can be achieved only if they are used in conjunction with adequate inputs of fertilizer and water, careful attention to crop protection, and generally high standards of farming. In particular, high levels of fertilizer application and full control of adequate supplies of water are needed. This in effect means good irrigation facilities.

Thus the introduction and distribution of improved seed must be supported by a wide range of governmental policies and programs to establish efficient institutions and infrastructure to convey also to the farmers a wider range of services. These services must include technical advice; the supply of needed inputs, especially fertilizers, irrigation, and pesticides, at reasonable prices; credit for purchasing the new inputs; and price policies and adequate arrangements to ensure purchase and storage of bigger crops. In the long run, of equal if not greater importance, is the requirement for the continuation and expansion of local research, including further varietal improvements to adapt the imported strains progressively and continuously to the local conditions and requirements, especially resistance to changing disease factors. It is the fact that the national governments

[2] Maize hybrids were first produced in the United States by G. E. Shull in 1908/09 (*4*, p. 8), but successful commercial production of high-yielding hybrids came much later [ed.].

TABLE 1.—AVERAGE YIELDS OF WHEAT AND RICE (PADDY) IN SELECTED COUNTRIES, 1909–13 TO 1968–70*
(*Quintals per hectare*)

	1909–13	1923–27	1928–32	1934–38	1948–52	1953–57	1958–62	1963–67	1968–70
					WHEAT				
United Kingdom	21.2	22.0	21.9	23.1	27.2	30.9	36.4	40.5	38.2
France	13.1	14.0	14.8	15.5	18.3	22.6	25.4	31.2	35.6
United States	9.9	9.7	9.7	8.7	11.2	12.9	16.7	17.4	20.2
Algeria	6.7	5.3	5.4	5.6	6.2	6.9	6.6	6.1	6.2
Argentina	6.6	8.6	8.8	8.7	11.5	13.2	13.2	14.6	11.2
Brazil	—	13.1	9.7	8.3	7.4	8.4	5.7	7.6	9.6
Mexico	3.8	4.6	6.3	6.7	8.8	12.1	15.8	23.1	28.0
India	8.1	7.5	7.0	7.1	6.6	7.4	8.0	8.3	11.6
Pakistan					8.5	7.5	8.0	8.1	11.0
Tunisia	3.2	4.2	4.6	5.1	4.9	4.5	3.7	4.7	4.6
Turkey	—	6.5	7.8	9.9	10.0	10.0	10.5	11.7	11.8
					RICE				
United States	16.7	20.1	23.3	24.7	25.6	31.5	38.5	47.6	49.4
Japan	30.8	32.5	35.0	36.3	42.5	44.1	50.0	51.8	56.4
Burma, India, and Pakistan	16.5	14.3	14.5	13.9	12.0	13.2	14.8	15.3	16.7
Ceylon	8.0	7.7	8.6	9.9	14.2	15.8	18.6	19.4	24.0
Egypt	36.0	30.0	29.9	35.0	37.9	47.7	51.8	50.8	52.0
Malaysia	10.2	12.3	13.2	17.3	19.3	20.9	23.5	24.6	23.2
Philippines	7.4	11.7	12.0	10.9	11.8	11.6	11.7	13.2	15.7
Taiwan	17.0	20.1	22.3	24.7	22.1	28.5	32.9	39.0	41.5
Thailand	15.0	18.6	16.3	12.9	13.1	13.6	14.2	17.0	18.1

* Data from FAO, *The State of Food and Agriculture, 1968* (Rome); Annex Table 16, revised and extended, from unpublished FAO reports.

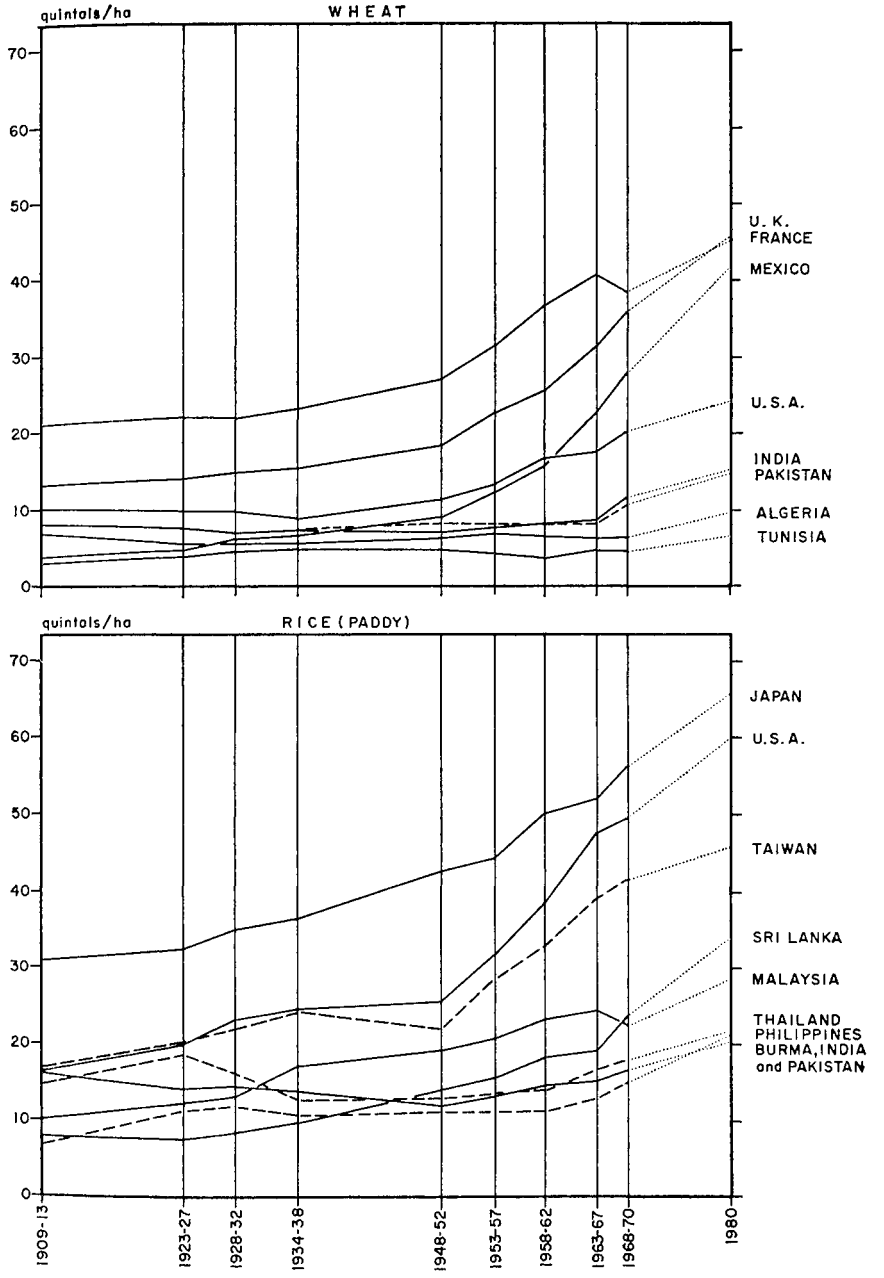
in countries such as India and Pakistan are going far to establish these services on a self-perpetuating basis that enables one to conclude that new production possibilities, as distinct from new seeds, are being effectively implanted in the developing world, at least in some parts. The impact, however, is still relatively small and confined to a fairly narrow front.

HISTORICAL PERSPECTIVES

Table 1 shows the trends in national average yields per hectare of wheat and rice for a selected number of developed and developing countries over the period 1909–13 to 1968–70. The same data are shown graphically in Chart 1 together with FAO yield projections for 1980. These long-period data make it possible to assess what is happening in the developing countries in the historical perspective of the application of science and technology to agriculture on a more global basis, as reflected in average yield of these crops.

The general picture that emerges, especially if one looks at data much earlier than 1909–13, is a gradual change from a flat or slowly rising curve of crop yield per unit area towards a progressively steeper acceleration. In Japan, for instance, it took eleven centuries for rice yields to double to attain the level of the mid-19th century but only one additional century to double again. Likewise, in the United

CHART 1.—TRENDS IN YIELDS OF WHEAT AND RICE (PADDY) IN SELECTED COUNTRIES, 1909–13 TO 1968–70 AVERAGES, AND PROJECTIONS FOR 1980*



* Averages from Table 1, projections from FAO, *Agricultural Commodity Projections, 1970–1980*, Vol. II, pp. 39–41.

Kingdom wheat yields doubled in three and one-half centuries between 1550 and 1900, but subsequently doubled again in some sixty years (*6*). In some countries during certain periods when the area cropped was expanding, crop yields trended downwards. This seems to have occurred for wheat in the United States in the first four decades of this century and in the great rice zone of South Asia (Burma, India, and Pakistan) during the first half of this century. Conversely, the rise in United States wheat yields since World War II, though certainly based on science and technology, has also been greatly facilitated by the reduction of one-third in the area planted to this crop over the same period, the lands retired being those least well adapted to wheat.

Looking to the future of the developing countries the perspective is one of great promise. It is true that the so-called green revolution in wheat in India and Pakistan appears as the first marked upturn of the curve after a long flat period, and one cannot say whether it is the beginning of a continuing steep rise or whether it will turn into a much more gradual increase. The experience in Mexico, where the national wheat yield has more than trebled during the two decades of the 1950s and 1960s, is a most encouraging feature. This advance in Mexico was made possible by a strong concentration of research power financed by the Rockefeller Foundation, a concentration which no developing country would be able to make unaided. At the level of national average yields per hectare, the impact of the new varieties is not yet evident in other developing countries where programs have begun, namely Algeria, Tunisia, and Turkey.

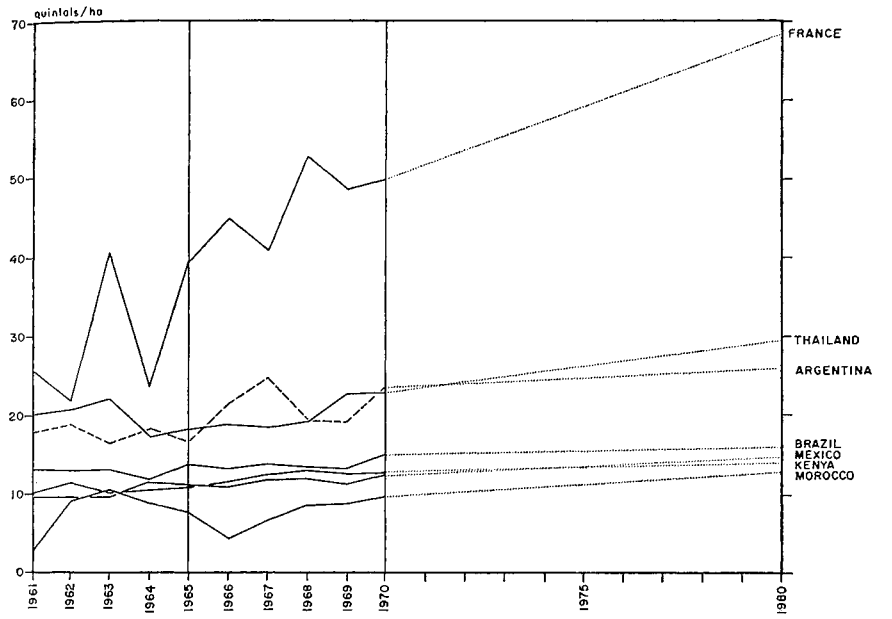
In the case of rice, the green revolution may be said to have made a positive appearance on the chart of national averages, in the form of an acceleration in the rise of yield since 1963/64 in the Philippines, where a significantly large proportion of the national acreage is under the new varieties. However, the shape of the Philippines curve will be spoiled by setbacks in 1971, when some of the new varieties were affected by virus disease, and typhoons were also unusually bad. New strains are being selected for resistance to the virus. Ceylon and Malaysia have enjoyed a rising trend of national rice yields for the last forty years or so, with, at least in Ceylon, an acceleration in the 1950s and 1960s.

It is heartening to note that in the rice bowl of South Asia (curves for Burma, India, and Pakistan combined and Thailand) during a period of expanding cultivation since the last war, rice yields have slowly recovered from a low point to reach the levels attained in the early part of this century. The steep acceleration in rice yields that has been gained in Taiwan since the war and in the Republic of Egypt throughout the last forty years is most encouraging as regards prospects for Asia, but it has to be remembered that the practice of controlled irrigation is much more widespread in these countries than in India and Pakistan or in other Asian rice-producing areas.

As regards maize, the annual yields per hectare for selected countries through the 1960s are shown in Chart 2, with FAO projections to 1980. These data show rather flat curves over the last ten years for the main developing exporting countries Argentina, Thailand, Brazil, Mexico, Kenya, and Morocco, reflecting the technical difficulties in securing the adoption of high-yielding hybrid varieties of this cereal.

A striking feature of Table 1 and Charts 1 and 2 is the rapid increase in yields

CHART 2.—TRENDS IN YIELDS OF MAIZE IN SELECTED COUNTRIES, 1961–70 ANNUAL, AND PROJECTIONS FOR 1980*



* Data from FAO, *Production Yearbook*, various issues, and its *Agricultural Commodity Projections, 1970–1980*, Vol. II, pp. 43–44, supplemented from FAO files.

per hectare that is still being attained in the developed countries for the three main cereals wheat, rice, and maize, beyond the relatively high levels currently reached. The limited but potential breakthroughs in developing countries have diverted attention from the major gains still being achieved in North America, Europe, and Japan from the continued application of the scientific method to cereals production in these regions. Agricultural science develops its own momentum, and this is the hopeful factor in the new world.

The experience of Mexico and the promising beginnings made in Ceylon and Malaysia, India, Pakistan, and the Philippines suggest that in the developing countries where the curves of yields are still basically flat, cereal yields can potentially be doubled even more quickly than in the developed countries. This is because of the very low present levels of yields in the developing regions and the accumulation of improved planting material and technological advances available for local research and application. It is evident that enormous gains lie ahead not only for wheat and rice but also for maize, millet, and sorghum—very important food and feed grains for which the yield trends are still generally flat. These gains will be realized only if there is a firm and continuing commitment by governments to ensure adequate investment in the essential supporting institutions and services.

Another key question is the intensity of the research effort that can be mounted in the developing countries from their own resources and with the aid of outside agencies. In this connection, it is a most hopeful portent that taking note of the success resulting from concentrated research in Mexico and the Philippines, the

International Bank, FAO, and the United Nations Development Program have joined forces with the Rockefeller and Ford Foundations and a number of important donor governments to establish a new international agricultural research program. This program aims not only to continue and broaden the support for wheat and rice research, but also to initiate comparable research and development programs for other important tropical and subtropical crops which so far have not yet received adequate attention.

To fulfill the purpose of this paper, namely to assess the potential impact on the structure of trade, the attempt must now be made to foresee on certain assumptions how supply will develop in the future in relation to demand, as regards the agricultural products affected by the new production possibilities.

POTENTIAL IMPACT ON TRADE

Trade aspects will be examined only for wheat, coarse grains, and rice. Since trade is a derived value, it is necessary as a first step to project separately demand for and production of each cereal for each of the countries affected, both importers and exporters, for a specific period ahead. The projections of production must then be confronted with those of demand for each country and for each cereal. The residual balances at a national level show the implied export availabilities or import requirements for the specified future period, on the assumptions adopted. The aggregation of these series gives a measure of the changes in volume and pattern of trade for each cereal implied by the projections. Fortunately, the basic analytical and statistical work, in accordance with this approach, has just been completed for cereals by the Food and Agriculture Organization of the United Nations in its new *Agricultural Commodity Projections, 1970–1980*, covering with a uniform methodology 132 countries and some 60 commodities for demand, and 40 commodities on the production side. For the purpose of this paper I propose to draw upon the results, as regards cereals, of this major FAO study (*1*).

To interpret the FAO findings, it is necessary to know the assumptions on which they were based. These are unchanged national policies as known in early 1971, constant 1970 prices, continuing improvement in technology and its application, a continuation of recent trends in the growth of gross national product by individual countries, and a continuation of population growth at the same rate as in the 1960s but with a small acceleration in the developing countries. The FAO results are thus essentially trend-oriented projections, not forecasts or targets. Although the assumptions are rather unrealistic in the real world, some such standard assumptions are necessary for methodological reasons. The projected imbalances that emerge from the calculations will not, of course, occur in practice. They reflect rather imprecisely the order of magnitude of the disequilibria between demand and supply which would arise if the observable trends continued unchanged until 1980, with the underlying assumptions.

For cereals, the demand projections cover both food and feed uses. In this new study a special effort was made to integrate the feed demand with the assessed requirements for the livestock production as projected in other parts of the study. The 1980 production estimates in each country were based on projected changes in area and yield of individual grains, taking account of total grain area

as well. Statistical extrapolations from the past were amended where necessary to take account of recent and prospective progress in the use of high-yielding varieties and related agricultural techniques, expected improvements in water management, availability of needed inputs, and other relevant developments.

The 1970–80 projections of yields per hectare of wheat, rice, and maize made by FAO commodity specialists in this study are shown for a selected number of developing and developed countries in Charts 1 and 2, linked to the historical trends since 1909–13 in the cases of wheat and rice. For the developing countries that have made a beginning with high-yielding varieties of wheat and rice, FAO has projected further significant increases in yields, especially for rice in Ceylon, where remarkable progress has occurred recently. For maize in developing countries, no basis has been found for projecting anything more than a slight rise in yields. In a number of developed countries, however, further steep rises in yields of wheat, rice, and maize above present high levels have been projected.

It would grossly overburden this paper to present the underlying projections of demand and production for individual cereals, country by country. These data, along with full details of the methodology adopted, are available in the basic FAO publication referred to above (*1*). For the current purpose, the results of the work are brought into focus in terms of the estimated export availabilities and import requirements for wheat, coarse grains, and rice in 1980, linked with historical trade in the period 1964–66 and a preliminary estimate of 1970 trade. It is somewhat artificial to treat these three groups of cereals separately because of the possible but limited substitution among them in feed uses, which are projected to increase faster than food uses in developing as well as developed countries. Implications affecting all cereals will be considered later.

Wheat

The results for wheat are shown in Table 2. The main general feature is that, on the assumptions made, world import requirements in 1980 would be about the same as actual net imports in 1970. Annual world export availabilities would be considerably larger, thus indicating that adjustments in production policies will have to be continued in order to avoid accumulation of excessive stocks. The tendency to overcapacity in world wheat production is nothing new. In fact, in these projections the tendency may be less pronounced than in previous FAO projections, partly because of the trend among developed country wheat growers, both exporters and importers, to shift acreage from wheat to coarse grains.

The only firm, though slight, increases in import demand in developed countries would be those of the United Kingdom and Japan. For the United Kingdom as a member of the European Economic Community (EEC), the projected increase in imports may not materialize.[3] The effect of the green revolution is seen in the projected disappearance of India and Pakistan as importers well before 1980. However, other developing countries would have larger import requirements, much of which would become actual imports only if supplies were available on concessional terms. Additional export availabilities above the growth of domestic demand are projected for the major traditional exporters—the United

[3] The projections were completed before the United Kingdom decided to join the EEC.

TABLE 2.—WHEAT: INTERNATIONAL TRADE, 1964–66 AVERAGE, 1970, AND PROJECTIONS FOR 1980*
(*Thousand metric tons*)

	1964–66 Average	1970	1980 Implied balance[a]
	NET IMPORTS		
World totals[b]	50,698	48,260	48,640
USSR	5,233	1,846	—
India	6,680	3,000	—
China (Mainland)	5,651	5,200	6,000
United Kingdom	4,202	4,950	6,000
Japan	3,624	4,685	7,075
EEC (except France)	2,168	2,950	2,946
Egypt	2,061	1,270	3,391
Brazil	2,000	1,993	3,188
Pakistan	1,377	1,031	—
Venezuela	546	714	1,030
Korea, Rep. of	509	1,216	1,482
	NET EXPORTS		
World totals[c]	52,854	51,170	66,653
United States	22,578	19,096	24,269
Canada	13,606	11,487	12,787
Australia	6,936	8,160	10,992
France	3,485	4,446	5,717
Argentina	5,161	2,402	4,203
USSR	—	4,700	5,000

* Data, including grain equivalent of flour, from FAO, *Agricultural Commodity Projections 1970–1980* (Rome), Vol. I, Table 8, p. 100; 1970 data revised on the basis of latest available unpublished information.

[a] Based on the assumptions of prices and national policies remaining constant as in 1970.

[b] Net imports of net importing countries.

[c] Net exports of net exporting countries.

States, Canada, Australia, Argentina and France—but in practice production is likely to be restricted by government policies.

Coarse Grains

Table 3 summarizes the findings as regards this group of cereals.[4] In previous commodity projections prepared in 1967, FAO was commending these crops to developing countries suitably placed for the expansion of export production. The new projections have not amended this view, although there is greater need for caution in view of the stiffer competition expected. The trends and policies which can now be observed affecting supply and demand for these grains in individual countries would, if continued to 1980, lead to a considerable expansion in import requirements to about 50 million tons, or one-quarter more than actual net imports in 1970. However, they would also lead to a very much larger expansion in export availabilities. Although in practice export availabilities are unlikely to diverge greatly from import demand, the projections certainly confirm the indica-

[4] Maize, barley, oats, millet, sorghum.

TABLE 3.—COARSE GRAINS: INTERNATIONAL TRADE, 1964–66 AVERAGE, 1970, AND PROJECTIONS FOR 1980*
(*Thousand metric tons*)

	1964–66 Average	1970	1980 Implied balance[a]
	NET IMPORTS		
World totals[b]	34,632	43,215	53,927
EEC (except France)	13,846	14,267	14,388
Japan	6,185	10,210	16,000
United Kingdom	3,642	4,443	8,543
Spain	2,336	2,170	1,479
India	753	—	—
Taiwan	49	600	1,109
	NET EXPORTS		
World totals[c]	37,125	46,390	95,027
United States	21,748	19,040	46,462
Argentina	4,783	7,704	11,249
France	2,733	5,812	10,173
Thailand	1,144	1,541	2,896
Mexico	731	1,000	1,909
Australia	717	940	1,273
South Africa	611	1,297	4,833
Brazil	359	1,480	2,808
Morocco	85	240	1,014

* Data from FAO, *Agricultural Commodity Projections 1970–1980* (Rome), Vol. I, p. 101; 1970 data revised on the basis of latest available unpublished information.

[a] Based on the assumptions of prices and national policies remaining constant as in 1970.

[b] Net imports of net importing countries.

[c] Net exports of net exporting countries.

tions that world trade in coarse grains will become increasingly competitive throughout the decade of the 1970s.

The only two important contributors to the expansion of import demand would be again Japan and the United Kingdom for their growing livestock industries.[5] Taiwan also is projected to increase her coarse grains for livestock feeding by some additional half million tons of imports. The importing members of the original six-country European Economic Community—i.e., all except France—are projected to expand their production in line with the increase of their domestic demand, leading to no increase in imports above their 1970 requirements.

The green revolution in the developing world could play a part, but a relatively minor one, in changing the international trade prospects for coarse grains. India, which imported some three-quarters of a million tons in 1964–66, has already disappeared from the import market. Developing exporting countries—Argentina, Thailand, Mexico, Brazil and Morocco—are expected to expand their production faster than their domestic demand for these grains, leading to an additional export availability of some 8 million tons by 1980. But the projected deterioration in the world market situation for coarse grains would be due pre-

[5] This may not hold for the United Kingdom as a member of the EEC.

dominantly to the pressure of developments that can be identified in the developed countries.

In these countries the main factors that are at work are the stabilization or reduction of the wheat acreage in some major exporters under the influence of oversupply and low prices, the rapid expansion of area planted with coarse grains, particularly barley and maize, plus, in many cases, an unexpectedly fast continuation of the rise in grain yields from already high levels. This recent upsurge in yields in developed countries is due basically to the same kind of elements as are beginning to be more effective in the developing countries, namely, plant breeding and better cultural practices. A case in point is the sharp rise in maize cultivation in Western Europe, a development which is projected to continue, resulting from the appearance of new early-maturing varieties which can be grown outside the traditional maize-producing areas. General economic, social, and political pressures, including protectionist policies, also contribute to the expansionary momentum of agriculture in developed countries.

Rice

This commodity differs somewhat from the other cereals in that the total world trade is relatively small—7 million tons altogether in 1970. The trade is also a much smaller proportion of total production. However, developing countries are much more prominent in the trade both as importers and exporters. The results of FAO's Projections to 1980 are presented in Table 4.

Although the magnitudes are smaller, FAO sees the same basic trade situation as in the case of the other cereals. The present surplus situation in world rice markets is projected to continue through the 1970s. By 1980 total world import requirements, which have fallen by some 200,000 tons since 1965, are projected to fall by another 1 million tons to 6 million tons in 1980. On the other hand, export availabilities could expand, but the margin would be very small in relation to total production and consumption.

For this commodity, the green revolution is affecting both the importing and exporting sides of the trade. For the developing countries of the Asia and Far East region, the main zone concerned, total rice production is projected to increase markedly from 101 million tons in 1970 to 135 million tons in 1980 (excluding Mainland China). However, because of the increasing self-sufficiency of the importing countries, total imports are projected to decline from the actual level of 4 million tons in 1970 to 2.8 million tons in 1980. India, South Viet Nam, and Malaysia will require reduced or nil imports at the end of the decade. On the other hand, total export availabilities from the region are projected to rise from 2.2 million tons of actual exports in 1970 to almost 4 million tons in 1980. On current trends, Burma and Thailand and, notably, the Arab Republic of Egypt, could all have larger surpluses available for export in a contracting overall market.

However, technological advance will also be at work in the developed countries. The import requirements of Western Europe are not projected to increase by any significant amount and the export availabilities of the United States, on the basis of current trends and policies, would continue to increase slightly. The United States would remain in 1980, as it is now, the world's largest exporter of

TABLE 4.—RICE: INTERNATIONAL TRADE, 1964–66 AVERAGE, 1970, AND PROJECTIONS FOR 1980*
(*Thousand metric tons, milled equivalent*)

	1964–66 Average	1970	1980 Implied balance[a]
	NET IMPORTS		
World totals[b]	7,142	6,952	6,008
Japan	764	—	—
Ceylon	664	545	480
India	734	179	—
Indonesia	491	956	885
Korea	—	521	575
Malaysia	384	364	50
Pakistan	—	85	—
Viet Nam, Rep. of	185	553	—
	NET EXPORTS		
World totals[c]	7,043	7,204	8,630
United States	1,397	1,740	1,810
Italy	72	343	320
Japan	—	599	—
Australia	69	109	140
China (Mainland)	854	929	870
Burma	1,290	630	1,460
Taiwan	175	5	220
Khmer Republic	377	222	370
India	—	—	50
Pakistan	62	—	125
Thailand	1,737	1,060	1,610
Egypt	401	654	1,000
Madagascar	—	65	140

* Data from FAO, *Agricultural Commodity Projections 1970–1980* (Rome), Vol. I, p. 110; 1970 data revised on the basis of latest available unpublished information.

[a] Based on the assumption of prices and national policies remaining constant as in 1970.

[b] Net imports of net importing countries.

[c] Net exports of net exporting countries.

rice. A large proportion of United States rice exports is transferred on concessional terms. Trends suggest that there would still be scope for such transfers in 1980, as some developing countries would have slightly larger import deficits than today.

CONCLUSIONS FOR CEREALS TRADE AS A WHOLE

On the basis of stated assumptions, FAO projects total world demand for all cereals to increase at the rate of 2.3 percent per annum through the 1970s. The increase in demand would be most in the developing countries where consumption would rise by more than one-third, permitting an improvement in per capita levels.

On the same assumptions, world production of cereals would grow at 2.8 percent per annum. In developed countries the rate of increase would be slightly lower than in developing countries, and in Asia, the Far East, and Latin America

output would increase fastest reflecting the planting of high-yielding varieties over larger areas and increased use of associated inputs. Thus, the projections indicate a general tendency for world cereals output to be in excess of effective demand at current prices.

In these circumstances, the competition among exporters of cereals to find markets would tend to be intensified over the next decade. With the wider geographical distribution of exportable supplies, price and non-price competition in coarse grain markets is likely to increase considerably. At the same time, the competition between different types of cereals would be greater, particularly in the livestock feed use, as supplies of wheat and rice, as well as coarse grains, would tend to increase and their prices to weaken. Although the increase in export availabilities would be mostly concentrated in the developed countries, the developing countries could also have 16 million tons more of cereals to export—enough to take care theoretically of the total projected rise in world import requirements. Moreover, the further progress which can be expected in the development of high-yielding cereal varieties with wide ecological adaptability could lead to the emergence of new and potentially competitive exporters from the developing regions, even at relatively low world market prices.

Up to date, the two principal structural changes in the world cereals trade attributable to the new production possibilities in developing countries have been the gradual reduction of imports on the part of several developing countries, particularly India, Pakistan, and Brazil, and the gradual rise in exports of coarse grains, mainly maize, from a small number of developing countries, mainly Thailand, Brazil, Argentina, and Mexico. The most dramatic change concerns the cereals imports of India and Pakistan. At their peak in the period 1964–66 they averaged some 10 million tons. They are likely to be no more than 1 million tons on a normal season basis within three or four years (*3*). The cereals imports of some other developing countries will also decline through the 1970s and beyond, but the total magnitude will be relatively minor.

In assessing the impact of these structural changes several factors have to be borne in mind. As regards rice, while the ability of the traditional developing country exporters to compete in concessional sales with the United States and Japan in supplying the growing import deficits of a few other developing countries is very limited, recent trends indicate that they can successfully offer strong competition on the price front. On the other hand, with high domestic prices the developed exporting countries have to rely on increasingly high subsidies to exports. With technological progress projected to continue fairly rapidly in both developing and developed countries, the existing tensions in world rice trade are likely to develop further, thereby increasing the pressure for adjustments.

As regards wheat and coarse grains, a large part of the world's commercial trade is devoted to supplying the demand of the developed country importers, mainly the United Kingdom, some other countries of Western Europe and Japan. Main tensions in the grains trade are those among the developed country exporters and importers. These are being heightened by several factors. One is the continuing rapid momentum of advances in agricultural technology and productivity in these countries, which enable the importing countries to raise their self-suffi-

ciency ratios and the exporting countries to increase their exportable supplies. Another factor is the prevalence of agricultural protection which on the one side handicaps access to such import markets as remain and which in exporting countries takes the form of competitive export aids. Tension is currently being increased by fears that the enlargement of the European Economic Community will further restrict access to importing areas.

The Indo-Pakistan import deficits, especially for wheat, were not an important part of the commercial market, but provided outlets for the production or surpluses of the developed country exporters, which enabled the needed adjustment of their agricultural production and trade policies to be eased and postponed. With the elimination of these deficits and the growing strength of developing country exporters of maize, the pressures for adjustments in the developed countries will be further intensified.

Cereal-importing developing countries which manage to expand domestic production far enough to eliminate imports may be content to consolidate their self-sufficiency. A case in point is Malaysia, which has already scaled down its production goal for rice to 90 percent of domestic requirements, to avoid having exportable surpluses to dispose of in years of above-average harvests. If such countries take a policy decision to enter the export market on a regular basis, and succeed in doing so, a further potential change in the structure of international trade would ensue. So far, FAO has not made specific projections of this kind, bearing in mind the very great difficulties which former importers would face in entering the increasingly competitive world trade in cereals on a significant scale—difficulties in amending domestic price and marketing policies, in building internal and overseas export services, in establishing the international quality of their product, and in building and maintaining export contracts without being able to afford the competitive aids to exports which developed country exporters commonly practice (*5*).

However, some developing country importers may well become exporters in the longer run. As such developments gather momentum, the tendency to imbalances in the world cereals economy will become stronger. The location of the adjustments that will inevitably take place, as between developing and developed country exporters, and therefore the impact on the structure of trade, will be determined as much by the balance of political forces as of economic ones.

A much more broadly acceptable international framework for such adjustments, of which there is no sign at present, will have to be formulated and negotiated, if the benefits of agricultural science and technology are to be widely and equitably shared among the peoples of the world.

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