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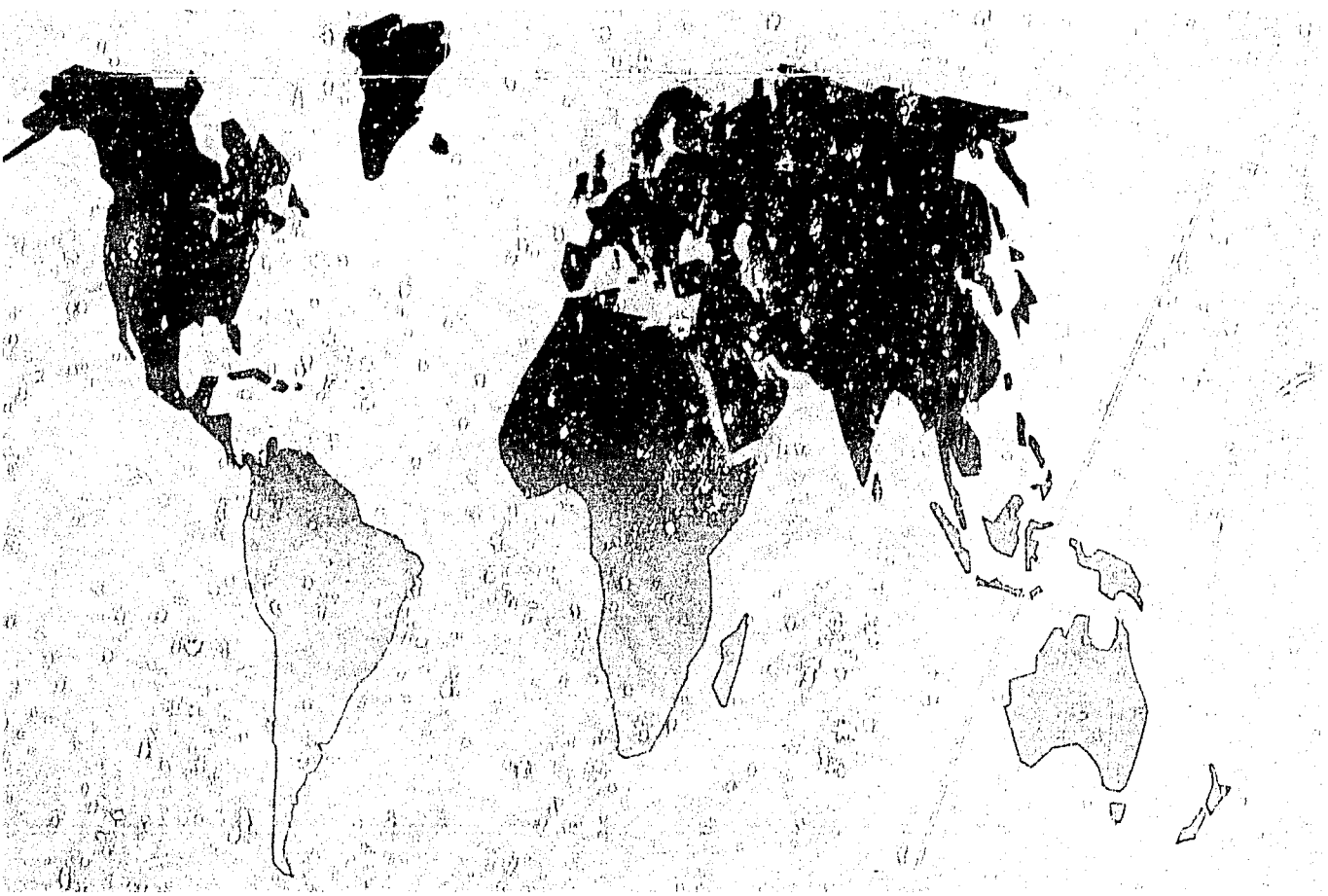

1987-88
CIMMYT World Wheat Facts and Trends

The Wheat Revolution Revisited: Recent Trends and Future Challenges

The International Maize and Wheat Improvement Center (CIMMYT) is an internationally funded, nonprofit scientific research and training organization. Headquartered in Mexico, the Center is engaged in a worldwide research program for maize, wheat, and triticale, with emphasis on food production in developing countries. It is one of 13 nonprofit international agricultural research and training centers supported by the Consultative Group on International Agricultural Research (CGIAR), which is sponsored by the Food and Agriculture Organization (FAO) of the United Nations, the International Bank for Reconstruction and Development (World Bank), and the United Nations Development Programme (UNDP). Donors to the CGIAR system are a combined group of 40 donor countries, international and regional organizations, and private foundations.

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Contents

Foreword

Previous issues of *World Wheat Facts and Trends* have explored rising Third World wheat imports and analyzed wheat marketing and pricing issues in developing countries. The scope of this issue is equally comprehensive. Our subject is the recent past and near future of technological change in wheat production, mostly in the developing countries of Asia. It is especially urgent for CIMMYT and other institutions to understand this process of change, popularly referred to as the "Green Revolution," so that we can establish future research priorities with greater certainty.

Our desire to establish the relative importance of different avenues of research is motivated by more than the usual pragmatism that should accompany the planning of any enterprise. We are acutely aware of the time lags inherent in the research-to-payoff continuum. Effective planning is thus a tool for minimizing time lags without sacrificing the quality of scientific investigation. A critical part of the planning process is gathering and analyzing information relevant to the decisions we must take: hence reports such as the *Facts and Trends*.

This report charts the progress of technological change in Third World wheat production over the past two decades and gives careful attention to the possibilities for future gains in productivity. Clearly, the rapid technological advances of the past two decades have been extraordinary and potential for additional progress remains. Even so, our study leads us to take a rather conservative view of the extent to which the main sources of yield increases in recent years—the spread of modern varieties, increased fertilizer use, and improved supplies of irrigation water—will help Third World farmers meet the growing demand for wheat in years to come.

The study suggests that over the next decade continued efforts in genetic improvement will certainly be necessary, especially as they relate to maintaining and improving resistance to biotic and abiotic stresses. Opportunity, however, appears to favor research in crop management, with greater attention to some of its subtler aspects. And we note that the more complex extension messages of the future will require a better developed system of transferring inputs and information to farmers.

The challenges of the future can be met, and national program efforts will be critical to meeting them. The time when wheat production could be increased significantly through opening new land to agriculture is essentially behind us. Rather, it is the productivity of resources committed to agriculture—including the productivity of the research system itself—that must receive our attention. These needs arise at a time when resources for agricultural research are less readily available. With more subtle demands on research and an increasingly limited supply of resources, it is important to take extra care in directing the work. We think that studies such as *Facts and Trends* help to show the way forward. We hope its readers will find it useful.

D.L. Winkelmann
Director General

Preface

This issue of *World Wheat Facts and Trends* is divided into three parts: a discussion of recent changes in Third World wheat production and their implications for the future; an overview of the current world wheat situation; and selected statistics on world wheat production.

Part 1 begins with a summary of major trends in cereal production in the postwar period, a time that saw a dramatic switch from increases in area to increases in yield as the primary source of growth in wheat production. We focus particularly on recent changes in Third World wheat production during the past decade, when yields and production in developing countries rose almost as rapidly as during the early years of the Green Revolution.

Part 1 gives special attention to trends in regions that are irrigated or where rainfall is good, for they characterize the major wheat-producing regions in the developing world. However, some reference is made to the drier areas in which wheat is grown, where the pace of change has been slowest. To study the relation of moisture regime to adoption of new varieties and the use of fertilizer, CIMMYT, in collaboration with national programs and other sources, assembled data covering almost all developing as well as many industrialized countries to obtain rough estimates of area, production, and yields of wheat grown under four moisture regimes: 1) irrigated; 2) rainfed with more than 500 mm annual rainfall; 3) rainfed with 300-500 mm annual rainfall; and 4) rainfed with less than 300 mm annual rainfall.† These data are used throughout the discussion in Part 1.

The analysis by moisture regime is followed by information on the sources of the impressive yield increases in wheat in developing countries over the past decade: the spread of semidwarf wheats and greater use of fertilizer on wheat (expansion in irrigated area has been a less significant factor in recent yield increases). We also discuss assessments of how breeding, compared to other factors, has helped raise the productivity of wheat. Two cases of recent changes in wheat production in the Punjab of Pakistan and in China follow to illustrate some of the trends presented in this report.

Part 1 concludes with an assessment of future increases in production and consumption. The evidence suggests that the major sources of growth in wheat production over the past two decades—improved varieties, fertilizer use, and irrigation—have now been largely exploited, and that to the year 2000 the rate of increase in wheat production will be considerably slower than in the past. Although wheat consumption will also increase more slowly, it is not certain whether current levels of self-sufficiency in Third World wheat production can be maintained.

Future gains in productivity therefore depend on adopting a strategy somewhat different from that followed in the past, which relied chiefly on the interaction of improved germplasm, fertilizer, and irrigation to raise the productivity of wheat. A new strategy, suited to both favored and marginal areas, would be to further exploit available technology by increasing the efficiency with which it is used. This approach suggests that improved crop and resource management will play a greater role relative to improved varieties in raising productivity in the future. Implementing this new strategy will require effective crop management research systems, strong extension systems, and well-developed input support systems.

Part 2 of this report is an overview of the current world wheat situation, covering production in developing and developed countries, wheat utilization, global trade and stocks of wheat (with a review of principal importers and exporters), and trends in wheat prices, freight rates, and fertilizer prices. The effect of the North American drought of 1988 on the world wheat economy is also discussed.

Finally, Part 3 of this report assembles statistics on the production, consumption, trade, and prices of wheat. Statistics related to themes developed in Part 1 are also provided, including information on moisture availability, variety, and fertilizer use in wheat production. This information is organized by region and covers the major wheat-producing and wheat-consuming nations of the developing world as well as most developed countries.

† Data on wheat area under each moisture regime are given in Part 3, by country.

Acknowledgements

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Part 1: The Wheat Revolution Revisited – Recent Trends and Future Challenges

An examination of trends in cereal production since World War II reveals that wheat continues to be the most dynamic sector in world grain production. Although world cereal production during the post-war period has increased at an unprecedented rate, averaging 2.8% yearly and surpassing the population growth rate (2.3%/yr), wheat has experienced the fastest growth rate of all cereals, averaging 3.5% per annum. Worldwide, increases in both area and yields of wheat were more rapid than for all other cereals combined.

The rate of change has been especially marked in developing countries. From 1948 to 1986, Third World wheat production grew at the surprising rate of 4.3% a year, quadrupling from less than 50 million tons in 1948-52 to 200 million tons in 1982-86. The share of the world's wheat produced in the Third World has risen from 27% to 41% in the post-war period and wheat has assumed increasing importance in Third World cereal economies.

Since 1950, the most striking change in wheat production (as in all cereal production) has been the dramatic switch from area increases to yield increases as the main source of growth in production. During the 1950s, the expansion of wheat area accounted for 59% of production increases; in the most recent decade, expanding wheat area was responsible for only 20% (Figure 1). Wheat yields have grown far more rapidly than area, accounting for 73% of the increase in world wheat production and almost 100% of the increase in developed countries. In developed countries wheat area has actually contracted since 1961-65, largely because wheat area declined in the USSR and, more recently, in major exporters such as the USA and Australia.

The relative contributions of rising yields and expanding area become even more evident when we look at production of all cereals combined. Expansion in area planted to cereal crops averaged only 0.38% per year in the most recent decade and accounted for only 11% of increased production. Given current trends, additional area sown to cereals will make a negligible contribution to future increases in world cereal production, although wheat area may expand slowly as wheat is substituted for other cereal crops.

A regional overview of changes in Third World wheat production during the past two decades (1961-65 to 1971-75 and 1971-75 to 1982-86) shows that in each decade production rose extremely rapidly in South and East Asia and, to a lesser extent, in Mexico.[1] Production increases in South and East Asia during the second decade slowed somewhat because rates of increase in area and yield fell slightly. Yield increases were by far the most important factor in raising production, especially in East Asia. Although the rate of yield gains dropped sharply in Mexico during the second decade, expanding area compensated for a levelling off in yield.

In North Africa and West Asia production increases have generally been slower over the past decade than in the previous one, largely because of diminishing wheat area. Wheat production in the Andean zone continued to fall. In the Southern

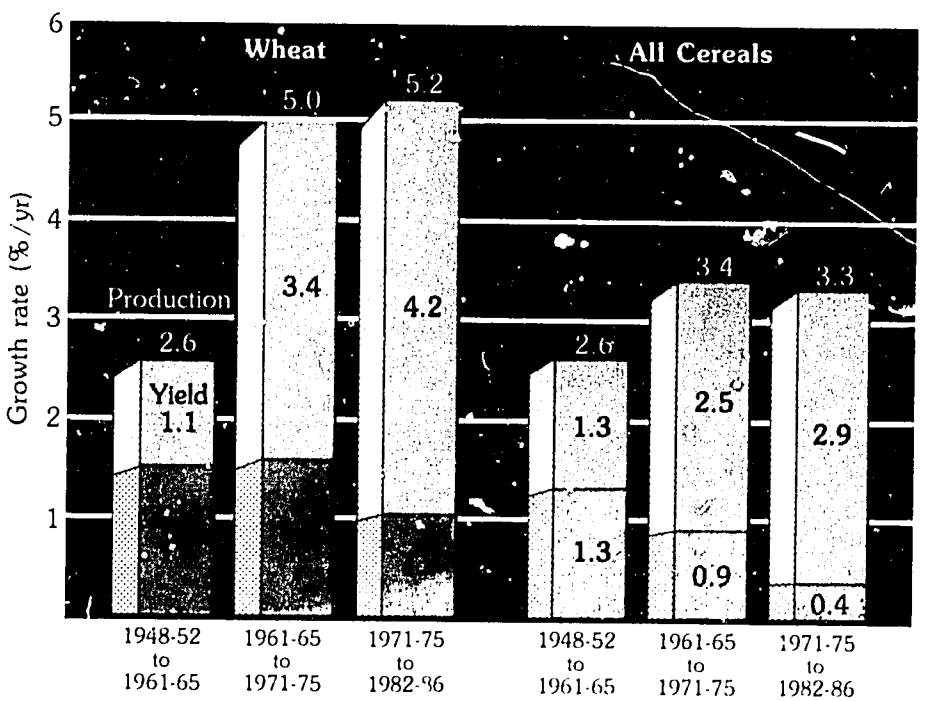


Figure 1. Growth rate of area, yield, and production in developing countries for wheat and all cereals, 1948-86.

[1] See Annex 1, p. 54, for a list of countries in each region.

Cone of South America, as elsewhere, the source of production increases has switched from expanding area to raising yields as semidwarf wheat varieties and associated improvements in production technology have spread.

Changes in wheat yields in selected developing countries are shown in Figure 2. Zimbabwe has the highest wheat yield in the developing world and also one of the highest rates of growth in yields. Other, smaller wheat producers, including Saudi Arabia, North Korea, and Bangladesh, have also increased their wheat yields quickly and now surpass the developing world average. Among large wheat producers, China has made the most dramatic gains (see p. 17). Meanwhile, Algeria, Nepal, and Iran are examples of countries where yields are low and little progress has been made in raising them.

Major Factors Influencing Wheat Yields

Much of the progress in raising wheat yields over the past four decades can be attributed to three major factors: 1) the expansion of irrigation in developing countries, where nearly half of all wheat area is now irrigated; 2) the spread of high-yielding semidwarf wheat varieties; and 3) rapid increases in the use of chemical fertilizers on all crops, especially high-yielding wheats. This section focuses on the role, importance, and potential of each of these factors in increasing wheat production.

The Role of Moisture Regime in Wheat Production

Moisture availability, especially irrigation, is a major factor explaining wheat production trends in developing countries. By the mid-1980s, approximately 42% of total developing country wheat area was irrigated, producing 49% of the output. A further 28% of the area was characterized by well-watered rainfed conditions (> 500 mm) and contributed 28% of the Third World wheat crop. Thirty-one percent was found in dryland areas with less than 500 mm annual rainfall and produced 23% of the output (Table 1).

In developed countries, less than 5% of wheat is grown under irrigation. Excluding the USSR, for which data were not available, about two-thirds of all developed-country wheat is grown in areas receiving over 500 mm yearly rainfall (Table 1). Hence the proportion of wheat grown in well-watered areas is similar in developed countries (excluding the USSR) and in developing ones. But in developed countries, excluding the USSR, wheat yields average 2.8 t/ha, compared to 2 t/ha in the developing world.

Variation in moisture availability is strongly linked to differences in yield levels among developing countries. Averaged over all countries for each

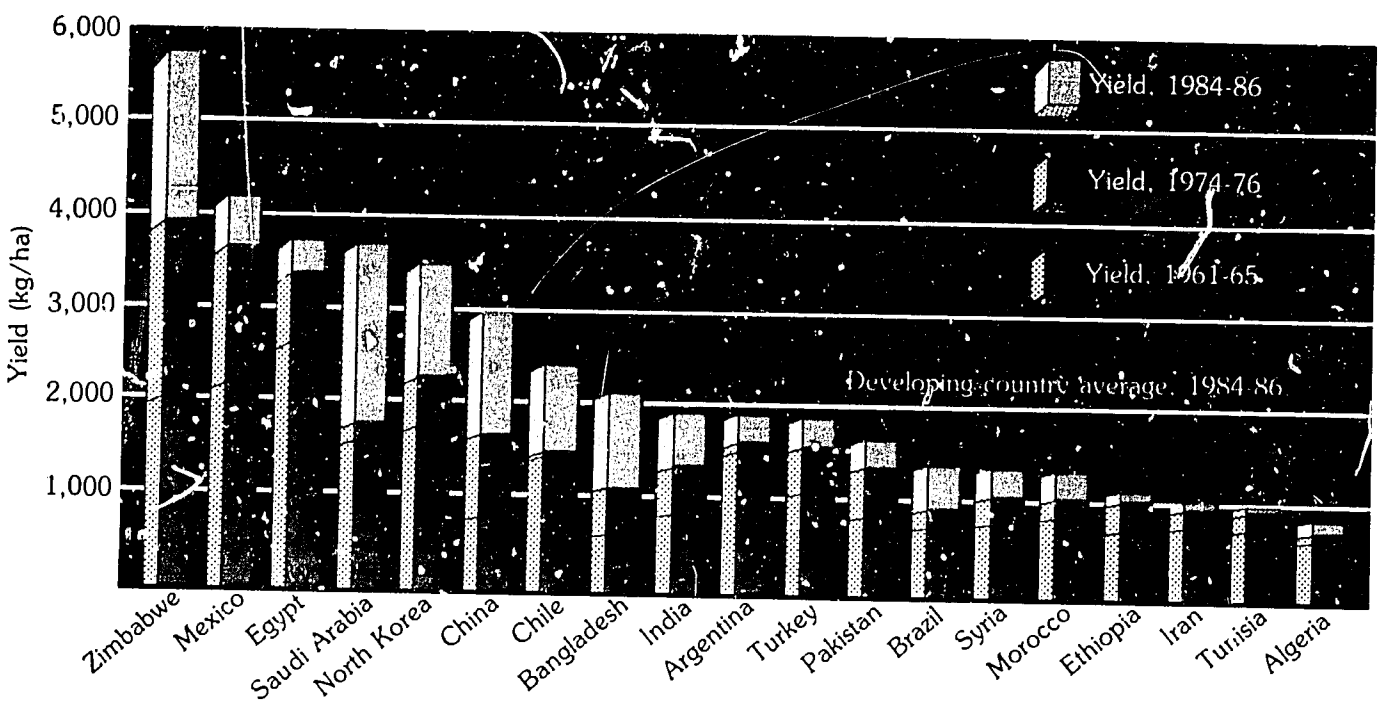
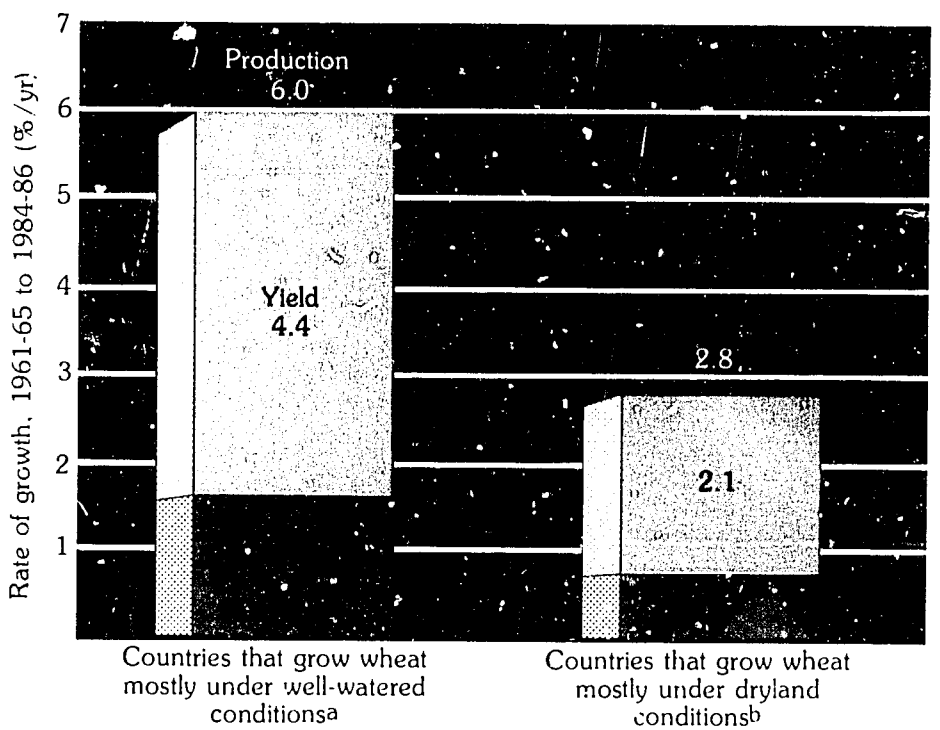


Figure 2. Wheat yields in selected developing countries in 1961-65, and increments over the next two decades.

Table 1. Percentage of wheat area by annual rainfall in major production regions, mid-1980s

Region	Irrigated	Rainfed			All areas
		[illegible]	[illegible]	[illegible]	
Sub-Saharan Africa	54	46	0	0	100
West Asia and North Africa	19	16	50	15	100
Other Asia[a]	53	21	25	1	100
Latin America	11	88	1	0	100
Developing countries	41	28	27	4	100
Developed countries[b]	3	65	32	0	100
World	27	42	29	2	100

[a] Excludes West Asian countries.
[b] Excludes USRR.



[a] Countries where wheat is mostly irrigated or rainfed with more than 500 mm of annual rainfall: Argentina, Bangladesh, Brazil, Chile, China, Egypt, Ethiopia, India, Kenya, Nepal, Mexico, Pakistan, Paraguay, Saudi Arabia, Sudan, Uruguay.

[b] Countries where wheat is mostly rainfed with less than 500 mm of annual rainfall: Afghanistan, Algeria, Iran, Iraq, Libya, Mongolia, Morocco, Syria, Tunisia, Turkey.

Figure 3. Rate of growth of wheat area and yields in two groups of developing countries by moisture regime, 1961-65 to 1984-86.

moisture regime, developing country wheat yields vary from 2.6 t/ha in irrigated areas to 0.6 t/ha in very dry areas receiving less than 300 mm of rainfall. Average wheat yields have risen rapidly in environments where moisture is plentiful, but in dryland areas (that is, rainfed areas with less than 500 mm rainfall) yield increases have been more modest. Countries where most wheat is grown under well-watered conditions (irrigation and/or moderate to high rainfall, over 500 mm) experienced sustained growth rates in yield of 4.4% yearly from 1961-65 to 1984-86, more than double the rate of increase (2.1% yearly) in countries where significant areas of wheat are grown under drought stress (Figure 3). This variation reflects both the limiting effects of drought on yields as well as the lower rate of adoption of improved technology in these risky environments.

As one might expect, the Third World wheat region where drought stress is most frequent is West Asia and North Africa, where nearly two-thirds of the wheat area receives less than 500 mm annual rainfall.

Quite different incidences of drought stress are associated with different wheat types (see "The Types of Wheat Grown in Developing Countries," p. 4). Only 27% of the spring bread wheat area in developing countries comprises dryland locations where drought stress is frequent, compared to 64% of the winter wheat area and 78% of the durum area. Nonetheless, because bread wheat dominates total wheat area, the absolute area of bread wheat—including facultative bread wheats[2]—in dryland locations

[2] Facultative bread wheats have some attributes of both spring and winter wheat types and have evolved to fit fairly specific enviornmental niches; their growth habit is intermediate between that of spring and winter wheats.

The Types of Wheat Grown in Developing Countries

Wheat is classified by growth habit into three basic types: spring, winter, and facultative. Spring wheats have a continuous four- to five-month growth cycle and generally cannot survive an extended period of freezing temperatures. Winter wheats, however, planted in autumn and harvested 8-10 months later, cannot develop properly without a continuous period of cold temperatures (although in areas with mild winters, spring wheats are sometimes planted in autumn and harvested in the spring). Facultative wheats have attributes of both spring and winter wheats and have evolved to fit fairly specific environmental niches.

Two-thirds of the 100 million hectares planted to wheat in developing countries in 1986 was sown to spring bread wheats (see table). The next most important category was winter bread wheat, produced on 14% of the area, almost exclusively in West Asia and China. Facultative wheats, which are intermediate between spring-habit and winter-habit wheats, were found on 7.7 million hectares, largely in China.† The remainder of the world wheat area is sown to spring and some winter durums, which together occupy 11 million hectares (see table).

Developing countries that plant mainly spring bread wheats include Argentina, Bangladesh, Brazil, Egypt, India, Iraq, Kenya, Mexico, Nepal, Pakistan, Peru, Sudan, and Uruguay. Those that produce primarily winter bread wheat include Iran, South Korea, and Turkey. In Algeria, Ethiopia, Jordan, Morocco, Tunisia, and Syria, at least half of the wheat area is sown to durums.

† Approximately 95% of facultative wheat area is planted to bread wheats (in China, Chile, Turkey, and Iran); the remaining facultative wheat area is planted to durums, mostly in Turkey.

Importance of different wheat types by geographic region, mid-1980s

	Percent of total in region					
	Spring bread wheat	Winter bread wheat	Facultative wheat[a]	Spring durum wheat	Winter durum wheat	All types
Region						
Sub-Saharan Africa	61	0	0	39	0	100
North Africa	38	0	0	62	0	100
West Asia	35	35	6	11	13	100
South Asia	90	0	0	10	0	100
East Asia	57	21	22	0	0	100
Mexico and Central America	90	0	0	10	0	100
Andean Region	70	0	0	30	0	100
Southern Cone, South America	96	1	2	1	0	100
All developing countries (%)	66.3	13.6	7.9	9.3	2.8	100

[a] Mostly bread wheat (about 95%).

(28.2 million hectares) is almost three times the total area of durums sown in dryland conditions (9.8 million hectares) (see "Trends in Durum Wheat Production," p. 8).

The Importance of Irrigation

Irrigation has been particularly important in Third World wheat production, although there are indications that its contribution to raising wheat production may be diminishing. Asia now produces over 90% of all irrigated wheat in the Third World. From 1965 to 1975, total irrigated area in Asia increased at an annual rate of over 2%, but in the 1980s the rate of increase slowed to just 0.7% (Table 2). The expansion of surface irrigation systems was significant until 1975 in some areas, especially in China. In South Asia supplies of irrigation water were increased chiefly by installing tubewells, which made groundwater available to crops. Over the past 20 years, the percentage of wheat area under irrigation rose from 50% to 72% in India and from 66% to 83% in Pakistan. Conversion of rainfed land to irrigated land in South Asia, along with the use of seed of improved varieties and fertilizer, increased wheat yields on that land by about 1 t/ha.

In all regions in recent years, expansion in irrigated area has slowed drastically (Table 2). China and the West Asia/North Africa region have registered zero and negative growth rates. The slackening rate of expansion reflects the cost of developing new irrigation schemes once the easier and cheaper sites have been exploited. Nonetheless, in the past few years some countries have invested heavily in irrigation in the hope of boosting wheat production. Often, as in Nigeria and Saudi Arabia, irrigation schemes have proven costly; in Nigeria they have yet to make a significant contribution to raising wheat production.

Aside from cost, irrigation schemes display other problems. In newer as well as older schemes, maintaining irrigated area is often difficult because of soil salinity or waterlogging, or simply because underground water supplies become exhausted. Expansion in irrigated area is therefore unlikely to make a major contribution to future increases in wheat production unless this trend is reversed and investment rises sharply (see "Third World Wheat Supply and Demand to the Year 2000," p. 22).

The Contribution of Wheat Breeding and the Spread of Semidwarf Wheats

The introgression of genes for reduced height (Rht genes) into the taller wheat varieties that dominated wheat production before the Green Revolution undoubtedly constitutes one of the most significant accomplishments in the history of plant breeding. Four Rht genes are the source of virtually all semidwarf varieties grown commercially in the world: Rht1, Rht2, Rht8, and Rht9.

Table 2. Rate of growth of total irrigated area in Asia and North Africa, 1965-84

Period	South Asia	China	W. Asia and N. Africa[a]	All Asia[b] and N. Africa
1965-69	2.7	2.9	1.7	2.5
1970-74	1.9	2.9	0.4	2.1
1975-79	2.2	0.0	0.7	1.9
1980-84	1.0	0.0	-0.8	0.7
1965-84	2.1	1.2	-0.3	1.6

Source: Levine et al. (1988).

[a] Includes Egypt.
[b] Includes Southeast Asia.

Table 3. Adoption of semidwarf wheat varieties by geographic region, mid-1980s

Region	Area sown to semidwarf varieties (million ha)	Percent of wheat area in region sown to semidwarfs
Sub-Saharan Africa	0.4	39
West Asia and North Africa	10.7	41
South, East, and Southeast Asia	45.1	72
Latin America	7.8	76
Developing countries	63.9	65
Developed countries[a]	37.2	58
World[a]	101.1	62

[a] Excluding USSR.

Genes Rht1 and Rht2 are found in nearly all semidwarfs grown in developing countries, except for China, and in many developed countries, including the USA. In developing countries--China is again the exception--the source of Rht1 and Rht2 has been germplasm provided by CIMMYT. Genes Rht8 and Rht9 are the sources of semidwarf stature in numerous varieties grown in southern and eastern Europe and China (Gale and Youssefian 1985; Dalrymple 1986).

It is now well known that introducing semidwarf wheat varieties into irrigated areas of Mexico, Pakistan, and India in the late 1960s made a spectacular contribution to wheat production and self-sufficiency (see, for example, Hanson et al., 1982). Less well known is the fact that in the 1970s and 1980s semidwarf wheats have steadily spread to other countries and environments (data on the use of semidwarf varieties for all developing countries can be found in Dalrymple, 1986). By the mid-1980s, the area planted to semidwarf varieties in the Third World was estimated at 62 million hectares or 62% of developing world wheat area.

Well over half of that area lies outside the original Green Revolution countries. South Asia and Mexico account for 26 million hectares sown to semidwarf varieties and China for 17 million. The remaining 19 million hectares is scattered widely across all major wheat-producing regions (Table 3). Semidwarf varieties now make up 70% or more of the wheat planted in Asia and Latin America. In North Africa, West Asia, and sub-Saharan Africa, semidwarf wheats are grown on 30-40% of the wheat area.

In developed countries also, semidwarf wheat varieties may now cover nearly half the wheat area. They are especially important in Australia, the USA, the UK, and several European countries, which now sow the greater proportion of their wheat area to semidwarfs. Worldwide (excluding the USSR, where semidwarf wheats are also reported to be widely grown), an estimated 102 million hectares are now sown to semidwarf wheat varieties.

Patterns of adoption of semidwarf wheats vary, depending on each country's particular climatic, technological, and socioeconomic circumstances (Figures 4a, b, c, d). Irrigated areas producing spring bread wheat, especially India, Pakistan, and Mexico, saw early, fast adoption of semidwarf wheats based on one or two major varieties originating in Mexico. But other irrigated areas required the new semidwarf materials to be further adapted to fit special requirements.

For example, adoption of semidwarf varieties in Bangladesh did not take off until the mid-1970s, when the early maturing variety, Sonalika, became widely available. Sonalika was particularly suited to the warmer environment and intensive cropping systems there. In China, where much of the irrigated wheat area is sown to winter-habit and facultative wheats, an extensive breeding program was needed to incorporate semidwarfing genes into local wheats. Hence although much of the Chinese wheat area had been sown to improved varieties with reduced height, semidwarf wheats did not diffuse widely until the 1980s (see p. 18).

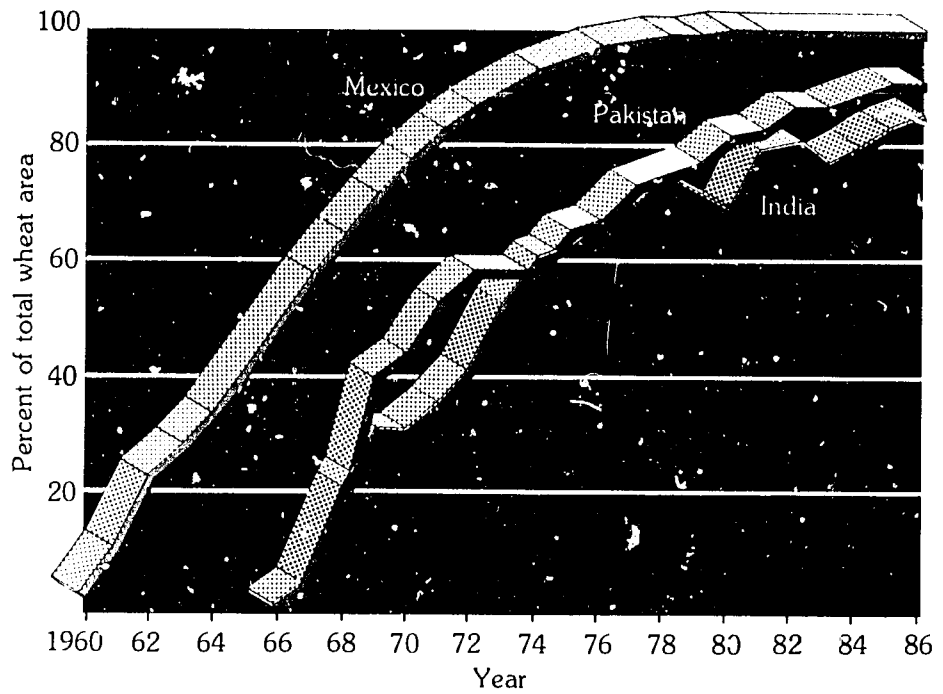


Figure 4a. Adoption of semidwarfs in developing countries that grow mostly irrigated wheat.

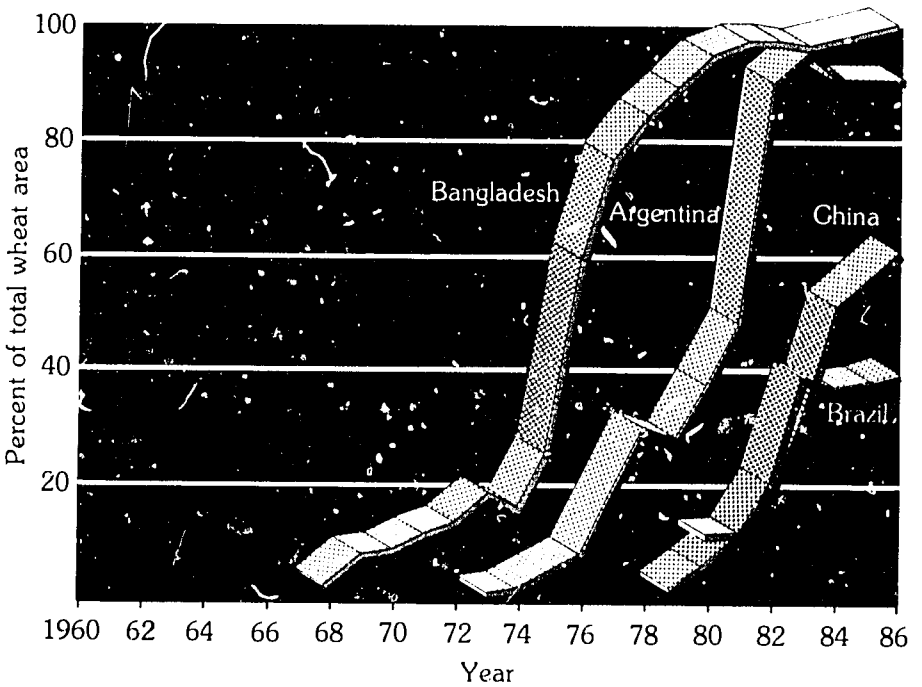


Figure 4b. Adoption of semidwarfs in developing countries that grow mostly rainfed well-watered wheat.

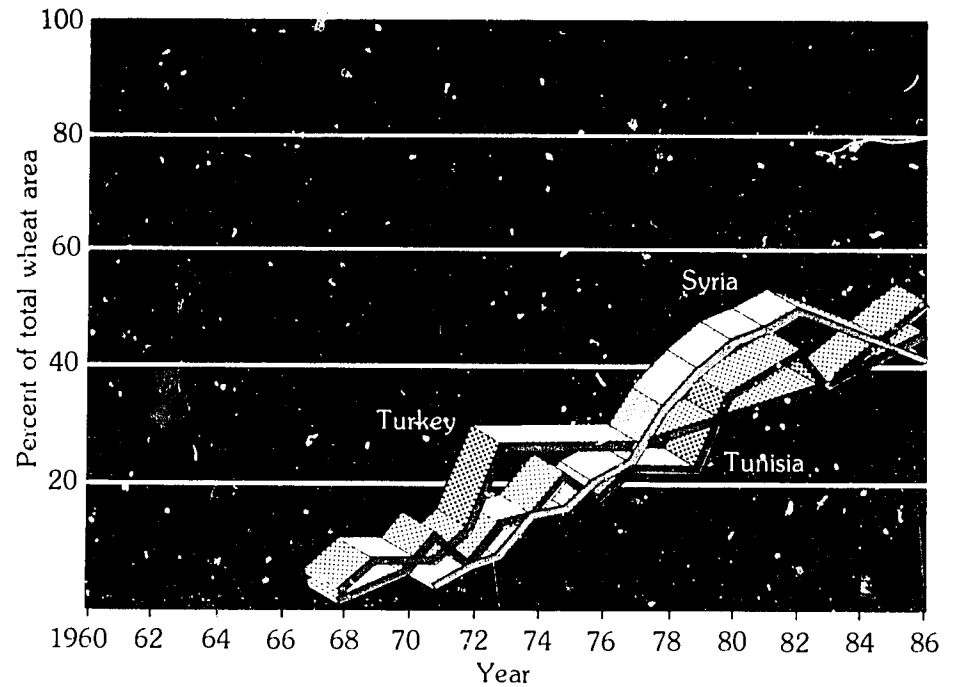


Figure 4c. Adoption of semidwarfs in developing countries that grow mostly dryland wheat.

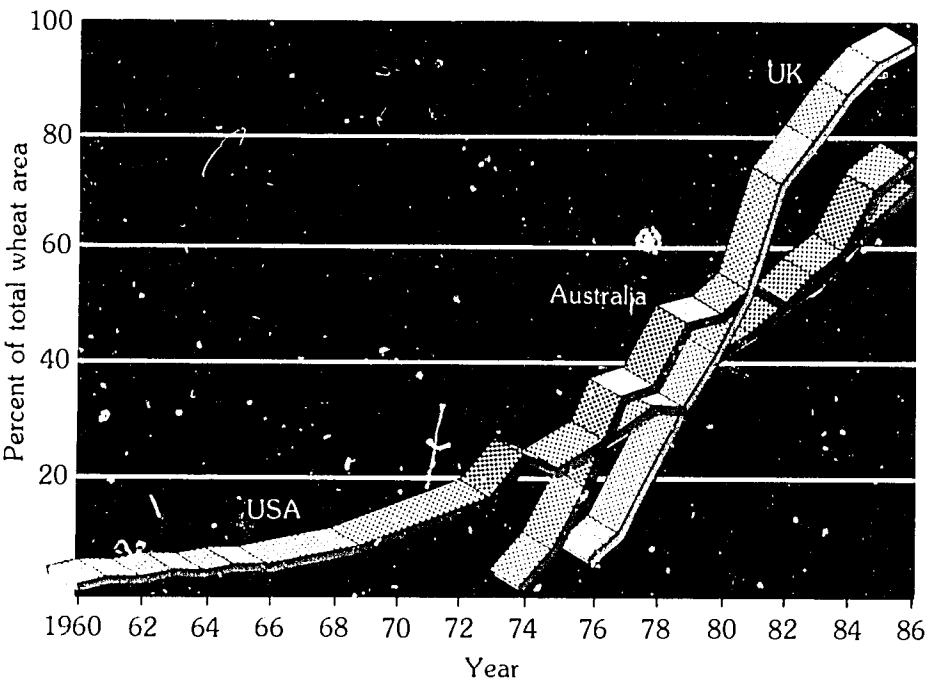


Figure 4d. Adoption of semidwarfs in selected developed countries.

Today virtually all irrigated wheat area is sown to semidwarf varieties. In rainfed areas, the spread of semidwarf varieties has lagged behind diffusion in irrigated areas and is generally positively correlated with moisture regime. Wide adoption of the first semidwarf varieties in rainfed areas was impeded by their lack of resistance to *Septoria* spp., disease pathogens that are especially prevalent in areas where rains continue through much of the growing season. Septoria resistance was incorporated into semidwarf materials in the 1970s, and now 60% of the developing world's wheat area in well-watered, rainfed locations (> 500 mm) is sown to semidwarf varieties. However, in very dry locations receiving less than 300 mm annual rainfall, only 21% of the wheat area is presently sown to semidwarfs. (As noted later in this report, yield gains from plant breeding are generally lower in dry areas.)

Once it began, adoption in rainfed areas was as rapid as in irrigated ones. For example, semidwarf varieties for rainfed conditions were quickly taken up in Argentina and Brazil during the late 1970s and 1980s (Figure 4b). *By the mid-1980s, about half of the 62 million hectares planted to semidwarf wheat varieties in developing countries was located in rainfed areas.*

Trends in Durum Wheat Production

Durum wheats are sown today on almost 22 million hectares (10%) of the total world wheat area, and on 11 million hectares (11%) of the wheat area in the developing world. Six developing countries alone—Turkey, Syria, India, Morocco, Tunisia, and Algeria—account for 83% of the durum area in the developing world.

Durum wheat is traditionally grown as a rainfed crop, often in places where rainfall is limited. It is the staple food for very poor people living in marginal environments of the Andean zone, North Africa and West Asia, and Ethiopia. An estimated 78% of the durum wheat area is located in environments subject to frequent moisture stress, whereas only 27% of the bread wheat area in developing countries is located in such environments.

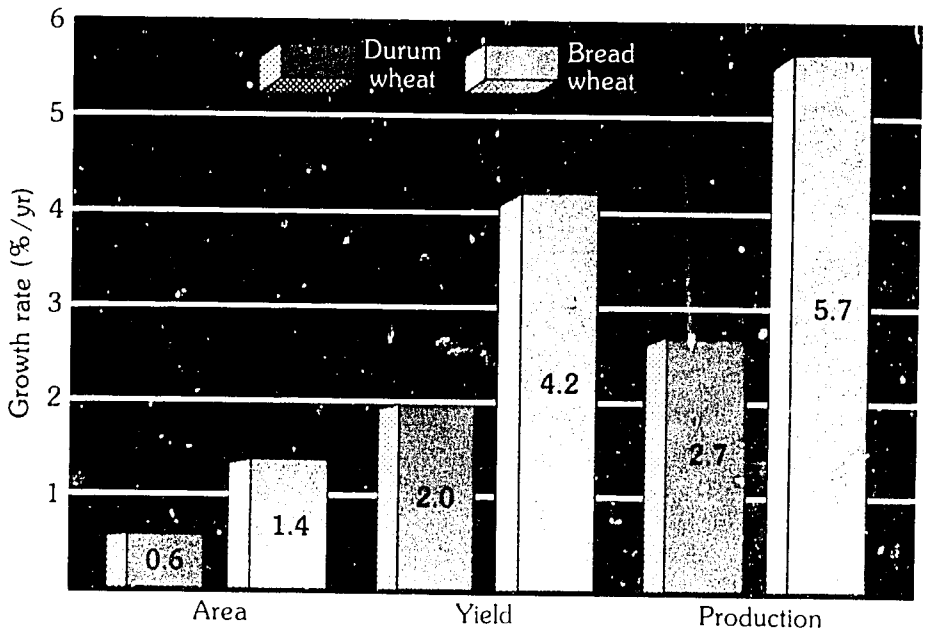
Not surprisingly, durum wheat yields in the developing world average only 1.2 t/ha, compared to 2.1 t/ha for bread wheats. A similar yield gap exists in developed countries, where durum yields average 1.4 t/ha, compared to 2.4 t/ha for bread wheats (see figure). Within the six major durum-producing countries in the developing world, the average yield is 1.9 t/ha for bread wheat and 1 t/ha for durum wheat. This discrepancy reflects the fact that bread wheat is grown mostly in areas that receive better rainfall and under better management practices.

† No information was available on the evolution of durum area or production in Iran or Ethiopia.

Before high-yielding durum varieties were introduced into developing countries in the 1970s, the release of semidwarf bread wheats in traditional durum-growing areas had encouraged some substitution of bread wheats for durum wheats, especially where no price advantage for durums made up for the traditional varieties' lower yields. The situation improved slightly when high-yielding durum varieties became available. Yet over the past decade, with the exception of Turkey and Tunisia, durum wheat production (and area) have declined relative to bread wheat in the major developing-country durum producers and in the Third World as a whole (see figure).

In spite of the decreasing importance of durum wheat relative to bread wheat in the Third World, all of the growth in world durum production in the past 15 years has occurred in developing countries. While durum production in developed countries from 1967-69 to 1983-85 remained virtually static, production in developing countries increased by 2.7% annually, about half the rate for bread wheat.

Among major developing-country durum producers, production declined in Syria, Morocco, and Algeria. The decrease occurred mainly because area was reduced, since yields actually rose by relatively small increments. By contrast, production increased sharply in Turkey, India, and Tunisia† (see figure). Durum area was significantly reduced in Argentina when semidwarf bread wheat varieties were adopted quickly in the 1970s. In Mexico durum wheat area has expanded rapidly with the release of very high-yielding durum varieties suitable for irrigated areas. These materials possess the additional advantages of excellent resistance to leaf rust and to Karnal bunt.



Changes in area, yield, and production of durum wheat and bread wheat in developing countries, 1967-69 to 1983-85.

A similar adoption pattern is apparent in developed countries (Figure 4d). The USA was the first country to release semidwarf varieties (Gaines and Nu-Gaines in Washington State in the early 1960s), but the rate of adoption has been slower than in other countries, partly because semidwarfing genes had to be incorporated into germplasm adapted to widely varying environments and market requirements. For example, the semidwarfing character had to be incorporated into red and white winter wheats and high-protein spring wheats.

In the UK, where only winter bread wheat is grown, adoption of semidwarf varieties was almost complete 10 years after the first semidwarf materials were released in the mid-1970s. During that period, which coincided with Great Britain's entry into the European Community and hence with the introduction of more favorable price incentives, average wheat yields in the UK rose from 4.3 t/ha in 1974-76 to 7 t/ha in 1984-86. As for Australia, where most wheat is grown under dryland conditions, stringent quality requirements delayed the widespread release of semidwarf varieties until after 1973, although Mexican semidwarf varieties available since the 1960s were adapted to much of the wheat-growing area. Since then adoption has not faltered, spreading gradually from wetter to drier areas.

Yield gains obtained from semidwarf varieties—One common way of measuring the contribution of wheat breeding to higher yields is to express yield gains attributed to the release of new varieties in terms of the rate of increase in yields per year. In well-watered environments such as the UK or irrigated areas of Mexico and Pakistan, yield gains from the release of new wheat varieties have averaged more than 1% per year over the past 30 years (Table 4). The rate of yield gain has been far more modest in drier environments, ranging from 0.3% per year in the driest areas such as South Australia (less than 350 mm annual rainfall) to 0.6% per year in the wetter, rainfed areas of New South Wales, Australia (about 500 mm annual rainfall) (Table 4). Translated into absolute gains in kilograms per hectare per year, the difference between irrigated and dry environments is even more marked, ranging from 2.4 kg/ha/yr in South Australia to over 50 kg/ha/yr in irrigated and/or well-watered rainfed areas of Mexico and the UK.

In irrigated areas, the first semidwarf wheat varieties, grown with moderate doses of fertilizer, were estimated to have increased yields by 40% (Waddington et al., 1986; Nagy 1984). Even without fertilizer, those varieties provided a significant yield increase of about 10-20% (see "New Wheat Varieties and Farmers in Marginal Areas," p. 14). The impact of semidwarfs on yields has been less in rainfed areas, with estimates ranging from 18% in low rainfall areas to 24% in high rainfall areas of Argentina; 16% in rainfed areas of Pakistan; about 10% in New South Wales, Australia; and only 5.5% in the dry wheat-growing areas of Western Australia where yearly rainfall is less than 350 mm. These increases have nonetheless been attractive enough to prompt significant, although somewhat slower, adoption of semidwarf varieties in recent years.

Table 4. Rates of gain in wheat yields from wheat breeding

	Period	Yield gain due to breeding (%/yr)	Source
Irrigated/well watered			
UK	1908-78	0.5	Austin et al. (1980)
UK	1953-78	0.9	Austin et al. (1980)
UK	1962-82	0.9	Godden (1988)
Mexico	1950-70	2.0	Fischer and Wall (1976)
Mexico	1950-82	1.1	Waddington, et al. (1986)
Mexico	1968-82	1.0	Waddington, et al. (1986)
Pakistan	1957-82	2.0	Byerlee and Heisey (1989)
Pakistan	1965-82	0.8-1.0	Byerlee and Heisey (1989)
Dryland			
Victoria, Australia	1898-1977	0.5	O'Brien (1982)
NSW, Australia	1947-80	0.6	Brennan (1984)
Western Australia			
< 325 mm rainfall	1960-86	0.3	Whan (1986)
325-450 mm rainfall	1960-86	0.5	Whan (1986)
South Australia	1917-67	0.3	Russell (1973)
Great Plains, USA	1943-77	0.6	Greb et al.(1979)
Kansas, USA	1969-78	0.6	Orazem and Jameson (1981)

Even though the rate of genetic gain in yields in irrigated/well-watered areas has averaged 0.8-1% per year since the release of the first semidwarf varieties, it is important to realize that most of this growth was contained in two or three discrete yield increases. Following the yield advantage conferred by the first widely successful varieties of the Green Revolution (largely the sister lines Mexipak, Siete Cerros, and Kalyansona), more modest—although significant—jumps in yield have occurred. For example, double dwarf varieties such as Yecora, released in the early 1970s, were widely grown in Mexico in the 1970s and in Pakistan from 1977 to 1984. They are estimated to have added 5-10% more to wheat yield potential over the Green Revolution varieties of the 1960s. In the early 1980s, wheat yield potential jumped another 10-15% over Yecora with the release of Veery wheats. The progeny of crosses between spring- and winter-habit wheats, Veery wheats possess the 1B/1R translocation, a change in genetic composition that enhances their performance. These varieties are dominant in Mexico and continue to spread rapidly in Pakistan and other countries; they now cover about 3.8 million hectares in developing countries.

Fertilizer Use in Wheat Production

Over the past two decades, fertilizer use in the developing world has grown continuously and explains much of the increase in wheat yields up to the 1980s. The use of fertilizer took off in the 1960s and early 1970s, rising from a very low base of 5 kg nutrient/ha for all crops in 1961-65 to reach 23 kg nutrient/ha in 1971-75. During the past decade fertilizer use per hectare on all crops rose by 8% annually to reach 53 kg nutrient/ha in 1981-85.

The release of semidwarf wheat varieties stimulated rapid increases in the use of fertilizer in Third World wheat-growing areas. Based on Martinez and Diamond (1982) and CIMMYT's own sources, we have assembled approximate statistics on fertilizer use on wheat in 41 countries. For all developing countries in our sample, excluding China, fertilizer use

Table 5. Average fertilizer use for all crops and for wheat, by region

Region	Fertilizer use on all arable crop land, 1981-85 (kg nut./ha)	Estimated fertilizer use on wheat, 1985 (kg nut./ha)	Growth rate, fertilizer use/ha, all arable crop land	
			1961-65 to 1971-75 (%/yr)	1971-75 to 1981-85 (%/yr)
Sub-Saharan Africa	8	31	16.7	5.9
West Asia/Nortn Africa	48	75	12.3	8.7
South and East Asia	78	83[a]	14.0	10.0
Latin America	36	73	9.6	2.9
All developing countries	53 (36)[a]	78[a]	12.8	8.5
All developed countries	111	106	6.9	1.5
World	81	96[a]	8.8	3.6

[a] Excludes China

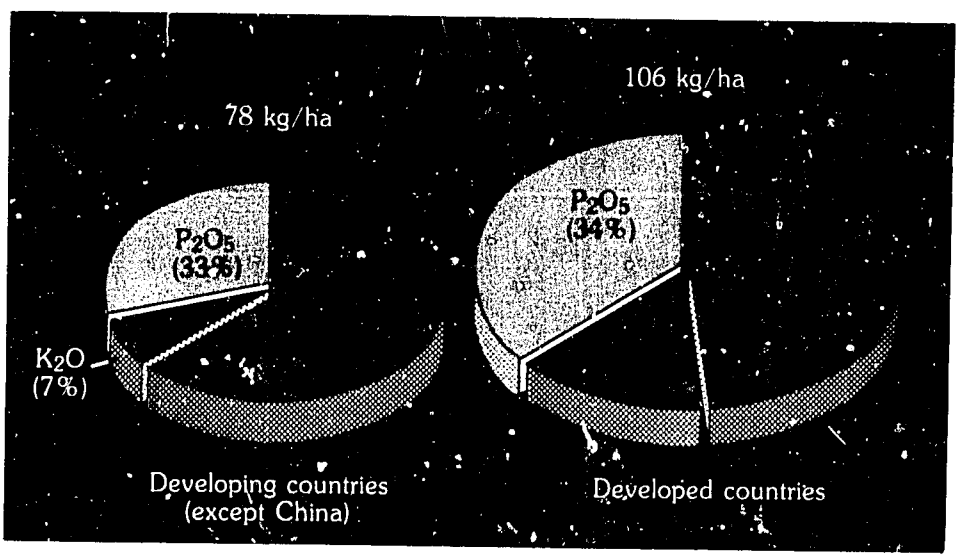


Figure 5. Approximate average total fertilizer dose applied to wheat, and share to N, P_2O_5 and K_2O, developing and developed countries, 1985.

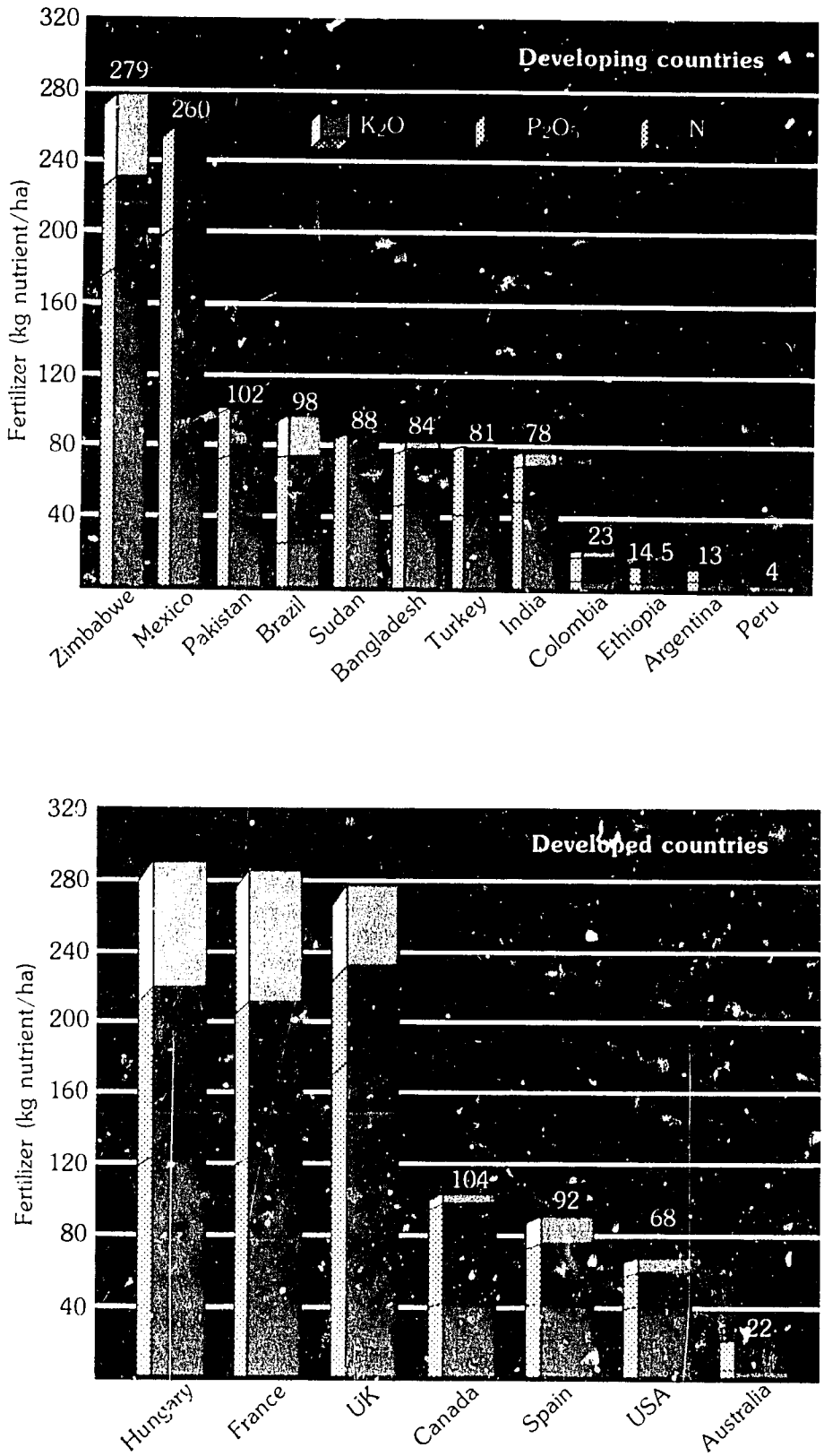


Figure 6. Average fertilizer doses on wheat in selected countries, about 1985.

on wheat averages 78 kg nutrient/ha, compared to 106 kg nutrient/ha in developed countries (Table 5). (Although reliable data for China are not available, fertilizer use on wheat in that country certainly averages over 100 kg/ha, assuming that farmers in China fertiize their wheat at the same rate as they fertilize all other crops.) Hence, if China is included, the average amount of fertilizer used on wheat in developing countries now appears to approach that in developed ones. The amount of fertilizer applied to wheat is also considerably higher than the average for all crops, which is 36 kg nutrient/ha excluding China and 53 nutrient/ha including China.

In developing countries, nitrogen accounts for about two-thirds of the fertilizer nutrients applied to wheat and most of the remainder is phosphate. In developed countries the proportion of nitrogen is lower and potassium is much more widely applied (Figure 5).

Fertilizer use on wheat varies considerably from region to region in the developing world and, as with adoption of semidwarf wheats, the use of fertilizer is positively related to moisture regime. The lowest fertilizer dose per hectare is applied in sub-Saharan Africa and the highest in Asia (Table 5). At the country level, the quantity of fertilizer applied to wheat (in nutrients) ranges from around 10 kg/ha in Peru and Ethiopia to over 200 kg/ha in Zimbabwe and Mexico (Figure 6). Variation can also be extensive within countries; for example, in the Indian Punjab farmers now apply over 170 kg/ha of fertilizer nutrients to wheat, whereas those in Bihar use an estimated 30-40 kg/ha.

In developed countries, fertilizer use on wheat averages about 106 kg nutrient/ha, surpassing 200 kg nutrient/ha in many European countries where wheat is usually grown under well-watered, rainfed conditions. In contrast, major wheat exporters such as the USA and Australia, who produce much of their wheat crop under dryland conditions, apply relatively low doses of fertilizer to wheat. Very few Australian farmers apply nitrogen to wheat, and the average dose for all nutrients (mostly phosphorus) is only about 20 kg/ha.

Growth in fertilizer consumption occurs through three sources: 1) an increase in the proportion of farmers who use fertilizer; 2) an increase in the dosage of a given nutrient; and 3) the adoption of nutrients that farmers have not used previously. All three sources of growth are evident in the developing world. In many major wheat producers such as India, Pakistan, Turkey, and China, almost all farmers now use chemical fertilizer on wheat, a remarkable change from two decades ago. However, the proportion of farmers applying fertilizer remains quite low in some countries, usually those in which wheat is grown under marginal conditions (for example, Colombia, Ethiopia, and Paraguay).

Fertilizer use also depends on price policies for wheat and fertilizer. The cost of 1 kg of nitrogen expressed in terms of kilograms of wheat varies quite substantially from one nation to another. In most large wheat-producing countries where nitrogen is not significantly subsidized, including India, Pakistan, and China, the price of 1 kg of nitrogen is equal to the value of 2-4 kg of wheat.

Countries such as Mexico, Egypt, Saudi Arabia, and Algeria maintain sizeable subsidies on fertilizers, or overvalued exchange rates, or high wheat prices that reduce the wheat:nitrogen price ratio to less than 1:2. In some cases, policies that increase the price of nitrogen above world price levels and/or maintain low producer prices for wheat result in a high ratio (more than 4:1) of nitrogen to wheat prices. Argentina is one country where policy distortions led to high nitrogen prices and seriously curbed the use of fertilizer on wheat. Recent policy changes have somewhat reduced these distortions, and fertilizer use on wheat has increased sharply.

The real price of nitrogen has changed little over the long term in most major wheat-producing countries, although fertilizer prices jumped dramatically in the mid-1970s. Mexico is a notable exception to this trend, as the real price of 1 kg of nitrogen has fallen from 4.3 kg of wheat in 1970 to 1.6 kg in the mid-1980s.

Estimates from several countries, as well as analyses of changes in world cereal production (Weber and Gebauer 1986), suggest that the average grain:nutrient ratio (that is, the gain in yield for every additional kilogram of fertilizer applied to the crop) for cereals in developing countries in the past two decades is about 8:1. If we assume that the use of fertilizer on wheat has increased at the same rate as for all crops, then the average fertilizer dose applied to wheat in developing countries, excluding China, has gone from about 7 kg nutrient/ha in 1961-65 to 78 kg nutrient/ha in 1981-85. In other words, fertilizer use has contributed approximately 560 kg, or about 75%, of the 720 kg/ha increase in wheat yields over this period—a finding consistent with other estimates (e.g., Scandizzo 1984).[3]

In some major wheat-producing regions, the marginal gains from using fertilizer actually may have been lower than suggested in the previous paragraph. Figure 7 shows wheat yields in the Indian and Pakistani Punjabs plotted against fertilizer nutrients applied. From 1966 to 1973, when fertilizer use rose rapidly, the gross grain:nutrient ratio (uncorrected for other factors) was about 10:1. From 1973 to 1986, the gross grain:nutrient ratio fell to 5:1 in the Pakistani Punjab and 7.5:1 in the Indian Punjab. Data suggest that recently the ratio has fallen even more, especially in Pakistan. A fall in the grain:nutrient ratio is expected given diminishing returns to fertilizer application. Nonetheless, these relatively low ratios at fertilizer levels around 100-150 kg/ha suggest that fertilizer *efficiency* is often quite low. This problem, although not well understood, may be related to the balance of nitrogen, phosphorus, and potassium nutrients applied or to general cultural practices, such as weed control, stand establishment, and planting date. If this problem is to be overcome, future production strategies should emphasize increasing the efficiency of fertilizer use (pushing the response curve upward) rather than the amount of nutrients applied (moving along the response curve).

Contribution of genetic and nongenetic factors to raising yields—A number of studies, largely from the USA, Australia, and the UK, have attempted to estimate how much

[3] Part of that yield gain must also be attributed to the use of semidwarf wheat varieties, which interact closely with fertilizer (see "Components of Wheat Yield Increases in the Pakistani Punjab," p. 16).

various technological components have contributed to improving wheat yields. The studies indicate that there has been wide variation in the relative contributions made by genetic factors (the effect of variety) and crop management factors (such as fertilizer, weed control, and crop rotation).

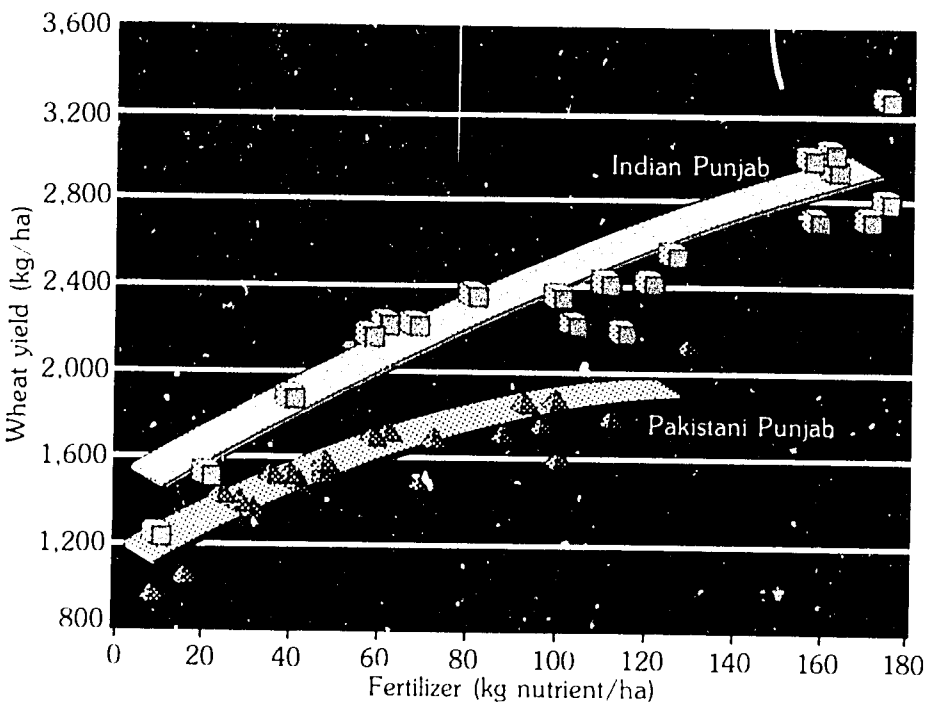
In well-watered rainfed areas and in irrigated areas, genetic contributions account for half or more of the yield gains. In dry areas such as the Great Plains of the USA or South Australia, the contribution of genetic gains to total yield gains has been relatively low--on the order of 20-35%. In those areas, crop management techniques that help conserve moisture and use it more efficiently have made important contributions to raising yields. They include summer fallowing, wheat-legume rotations, timely planting, and weed control.

Overall there is convincing evidence that, in drier environments, crop management will be more important than genetic gains in increasing wheat yields. In the Anatolian Plateau of Turkey, the successful introduction of improved tillage and weed control techniques for the widely grown tall varieties is perhaps the best example from the developing world of the role that improved crop management can play in increasing yields in drier areas. However, crop management research in developing countries is often weak relative to wheat breeding research. Also, compared with promoting new varieties, transferring results of research on crop management to farmers' fields generally requires more complementary support from extension services, price policies, and input suppliers. Given the difficulties in improving crop management and the relatively slow progress achieved by plant breeders in raising yields of wheats for dry environments, it is not surprising that yield gains have been modest over the past two decades in countries where dryland wheat predominates.

Recent Trends in Wheat Production: Pakistan and China

The preceding section of this report discussed the widespread transformation in wheat production over the past two decades. This section will focus in detail on recent changes in wheat production in two parts of the Third World: the Pakistani Punjab and China. For each area we discuss the components of increased wheat yields and productivity and their relative importance, as well as patterns of adoption of the new technology.

The case of the Pakistani Punjab is instructive because Pakistan was in the vanguard of the wheat revolution; recent trends in Pakistan therefore may provide an indication of future challenges in wheat production in the Third World. The case of China is remarkable because that country, a relative latecomer to the group of countries where the effects of the new wheat technologies were especially pronounced, has achieved the highest growth rate of all major wheat producers. How that achievement came about is discussed in detail.



Note: Each point represents one year from 1960 to 1985. No correction is made for changes in other factors.

Figure 7. Gross relationship between fertilizer use and wheat yield, Indian and Pakistani Punjabs.

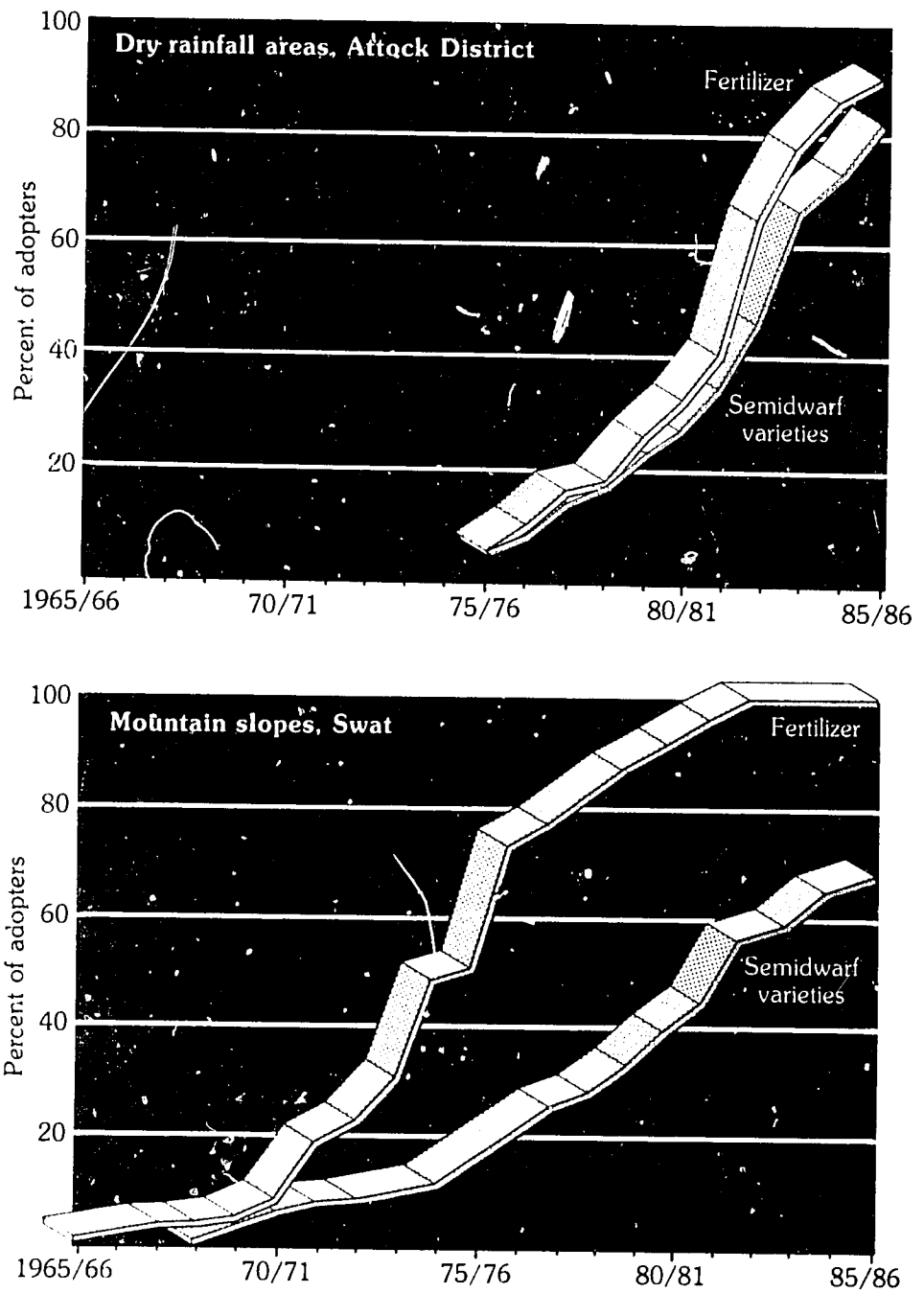
New Wheat Varieties and Farmers in Marginal Areas

Considerable controversy arose in the 1970s concerning the distribution of benefits from the new wheat and rice varieties. Critics of the Green Revolution asserted that the new varieties benefited mostly larger and wealthier farmers who could afford the inputs needed to exploit the new varieties' yield potential. The critics' claims were not supported by studies in the late 1970s and 1980s showing that small farmers had widely taken up the new technology, although in some cases adoption lagged behind that of large farmers (for an excellent summary of the evidence, see Lipton and Longhurst, 1985).

The controversy arose in part because of the mistaken belief that the new varieties would not provide any benefits without high levels of purchased inputs such as fertilizer, irrigation water, and pesticides. In fact, even without fertilizer, semidwarf wheat varieties yield better than the old, taller varieties (Wall et al. 1984). Most new varieties also have improved disease resistance, an advantage for small farmers who cannot always afford chemicals to control diseases. Furthermore, in the main wheat-growing areas where semidwarfs have been widely adopted, better input marketing and irrigation have enabled most smaller farmers to use levels of inputs similar to those used by larger farmers.

Today, millions of small farmers, including almost all of those in the irrigated wheat-growing areas of South Asia, grow semidwarf wheats with moderate doses of fertilizer and increasing use of other inputs. Perhaps the most dramatic example is Bangladesh, where new wheat varieties were rapidly adopted during the 1970s by farmers whose average farm size was less than 2 ha and whose land was generally not irrigated in the wheat growing season. By the mid-1970s, semidwarf wheats were used by over three-fourths of the farmers in irrigated areas of South Asia; in many districts the adoption rate was even higher.

But what about the marginal areas of South Asia and elsewhere, where many of the poorest farmers live? In the mid-1970s, a decade after the Green Revolution began, farmers in the less-favored dryland and mountainous areas of northern India



Diffusion curves for fertilizer and semidwarf varieties in marginal environments in Pakistan.

and Pakistan still planted the old, tall wheat varieties. Only in the past 10 years has that situation started to change, as farmers in some marginal wheat areas have quickly adopted semidwarf varieties.

The diffusion of semidwarf wheat varieties in three difficult environments of Pakistan is shown in the figures. The first area is Attock District in northern Punjab, where rainfall in the wheat growing season averages under 200 mm with high year-to-year variability. The second area, in the Swat mountains, receives relatively high rainfall; farmers grow wheat on very small holdings on steep slopes above 1,500 m elevation. The third area, Gilgit, lies in the remote, high mountain valleys near the Chinese border, where water from glacial melt irrigates the wheat crop.

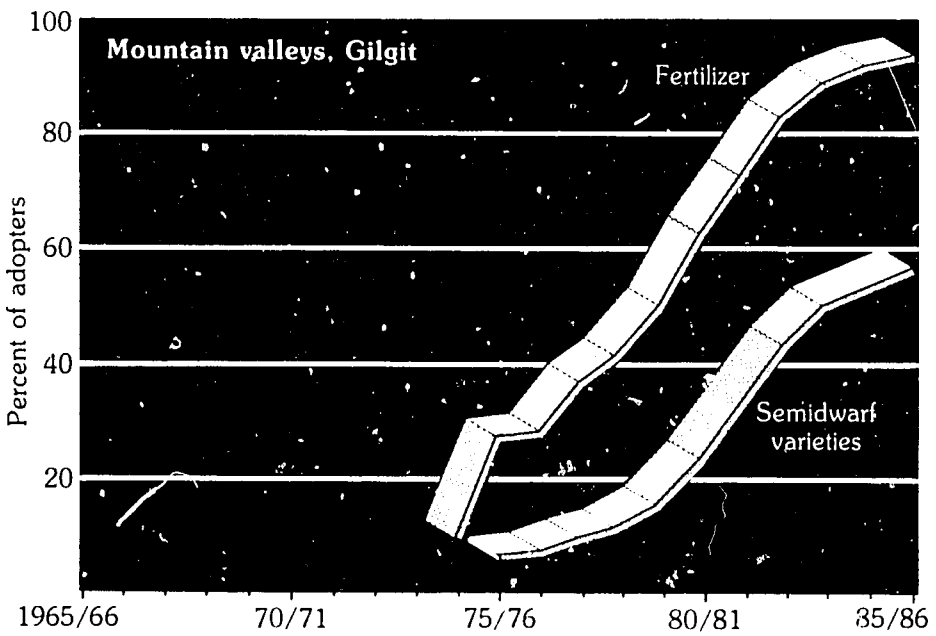
In recent years, all three places have seen rapid adoption of semidwarfs, rising from low rates in 1975 to over 50% adoption in each area by the mid-1980s. Several factors probably contributed to the initial delay in adoption, including the fact that not all semidwarf wheats were immediately suited to such difficult environments (for example, the first semidwarf wheat variety with good adaptation to dryland conditions in Pakistan was not released until 1973).

Another factor that may have held back adoption in these areas is that they have all been neglected by research and extension. Even when the technology was available, poor infrastructure prevented its transfer to remote areas.

Finally, in all three areas wheat straw is highly valued as livestock fodder because the dry season and/or winter is long and it is expensive to transport fodder from other areas. In the irrigated plains, the grain:straw price ratio is around 10:1, compared to a ratio of 2:1 and sometimes less in the marginal rainfall and mountainous environments. These high straw values, together with somewhat higher straw yields provided by tall varieties *when no fertilizer is used*, may negate the value of the extra grain obtained from new varieties.

In the past five years or so, some impediments to adoption have been overcome. Access to many areas has improved, sometimes dramatically, as with the completion of the Karakorum Highway to Pakistan's northern areas. Improved access, in some cases combined with great efforts by development agencies, has led to the widespread adoption of fertilizer by farmers. The use of fertilizer together with the release of more appropriate varieties has made it profitable for farmers to switch to semidwarf varieties. In particular, the increase in straw yields of semidwarf varieties when fertilizer is applied appears to compensate for their disadvantage in straw yields when no fertilizer is applied. More recent semidwarfs have higher biomass production, which increases straw yields even with little or no fertilizer.

The adoption of semidwarf wheats in Pakistan's less favorable environments over the past decade still leaves an estimated 9% of the country's wheat area planted to old varieties. Farmers who continue to plant old varieties generally live in exceptionally difficult locations with special varietal needs, such as the uplands of Baluchistan that require winter-hardy wheats, or the very dry areas needing varieties with extreme drought tolerance and/or a long, vigorous coleoptile to enable the seed to be sown deeply into residual moisture.† Research is now giving more attention to these difficult environments, although progress will be slow.



† Similarly, 2.5 million hectares of wheat area in the very dry warmer areas of Madhya Pradesh and Rajasthan in India are not yet planted to semidwarf varieties.

Components of Wheat Yield Increases in the Pakistani Punjab

In the following discussion we distinguish two periods of growth in wheat production in the Punjab of Pakistan: 1964-66 to 1971-73, and 1971-73 to 1984-86 (Table 6). In the first period, 1964-66 to 1971-73, the annual growth rate in wheat yields averaged 4.9% per year. Semidwarf varieties, which occupied less than 1% of the irrigated wheat area in 1964-66, had spread to just under 60% of the irrigated wheat area by 1971-73 (Table 6). In the second period, 1971-73 to 1984-86, total wheat production in the Punjab was still growing rapidly at 4.2% per year. Adoption of semidwarf wheat varieties was almost complete in the irrigated wheat areas, which had expanded at 2.2% annually. Wheat yields in those areas rose at the relatively modest rate of 2% per year.

The yield increases in irrigated wheat from 1964-66 to 1971-73 resulted almost entirely from farmers planting semidwarf varieties and applying modest doses of nitrogenous fertilizer (assuming that adoption of semidwarf varieties, together with 40 kg/ha fertilizer, increases yields by about 40%). Adoption of semidwarf wheats and fertilizer in irrigated areas is estimated to have raised yields by an average of 415 kg/ha, which is slightly lower than the total increase in yields of irrigated wheat in this period. The remaining yield increment can probably be explained by improved availability of irrigation water. The overall gross grain:nutrient ratio for fertilizer use during this period was about 10:1 (in other words, farmers harvested an additional 10 kg of grain for every 1 kg of nutrient applied).

The estimated components of increased yields in the second period, 1971-73 to 1984-86, appear in Table 7. The largest component is increased use of fertilizer; a conservative grain:nutrient response of 8:1 has been assumed. Gains achieved through plant breeding were divided between switching from tall varieties to semidwarf varieties on the remaining irrigated land, and the release and adoption of newer semidwarf varieties.

Together, these three effects—a switch from tall to semidwarf varieties on one-third of the area; higher yields of newer semidwarf varieties on 60% of the area; and increased doses of fertilizer of 73 kg nutrient/ha—should have raised yields by 730 kg/ha between 1971-73 and 1984-86. But the actual increase in yields of irrigated wheat was just 375 kg/ha, considerably less. The difference probably arises from the following negative influences on yields:

Increased cropping intensity. This factor has been particularly important in delaying the planting of wheat. The average date of planting in the Punjab is conservatively estimated to be at least seven days later in 1985 than it was in 1970. Given that the decline in yields under farmers' conditions is approximately 30 kg/ha for every day that planting is delayed (Byerlee, Akhter, and Hobbs 1987), an average delay of seven days would have lowered wheat yields by about 200 kg/ha between 1975 and 1980.[4]

Increase in weed losses. The weed *Phalaris minor* has spread throughout the rice-wheat area and central area of the Punjab, reducing yields by an average of 150 kg/ha. For the Punjab as a whole, this loss is roughly equivalent to 50 kg/ha.

Other factors. Several additional factors may explain the remaining yield gap of about 100 kg/ha. They include: increased soil salinity and waterlogging in some areas; reduced use of organic manure—Lowdermilk (1972) reported that, in 1970, 70% of farmers in one area of Pakistan applied farm yard manure; 15 years later, the number had dropped to 34%—disease losses from sowing rust-susceptible varieties; soil compaction caused by continuous use of tractors and tined cultivators; soil diseases and other problems that arise when crops are not rotated; and imbalanced application of fertilizer nutrients. No attempt was made to quantify these factors directly.

The overall yield increase in terms of fertilizer applied to wheat implies a very low grain:nutrient ratio during the second period of about 5:1,

[4] Although its effect on wheat yields is negative, increased cropping intensity may actually raise the overall productivity of the land.

Table 6. Cropping intensity, wheat yields, and inputs applied in irrigated wheat in three periods in the Punjab, Pakistan

	1964-66	1971-73	1984-86
Average wheat yield (kg/ha)	1,050	1,450	1,825
Area under semidwarf varieties (%)	10	56	93
Fertilizer applied to wheat (kg nut./ha)	10	40	114
Irrigation water supply (cm/ha)	49	72	60
Cropping intensity (all Punjab)	100	102	118

sharply below the ratio during the first period, and only marginally beneficial in economic terms.[5]

This analysis suggests that the sources of growth in wheat yields in the Pakistani Punjab for the past two decades—switching from tall to semidwarf varieties and applying greater doses of fertilizer—have been almost completely exploited. Pakistan will need different strategies to increase wheat yields in the future, such as developing varieties to fit double cropping systems and devising improved weed control and tillage methods.

Chinese Wheat Production and Technological Change[6]

During the past 25 years, the growth rate of wheat production in China has been among the most impressive in the world. Although wheat production increased little between the early 1950s and the mid-1960s, it doubled between 1964 and 1974 and doubled again from 1974 to 1983, when China became the world's largest producer (see "Distribution of Wheat Production in China," p. 19). Most of the 5% annual growth in output from 1952 to 1987 resulted from a 4.5% annual increase in average yields, which rose from about 0.7 t/ha to 3 t/ha over that period.

The explosive growth in Chinese wheat yields is the product of the same elements of agricultural change adopted elsewhere: improved water control facilities in wheat-growing regions; the selection, adaptation, and dissemination of fertilizer-responsive wheat varieties; and the provision of increasing quantities of chemical fertilizers to farmers in those regions. The Chinese case is distinguished from others by the extreme rapidity and scope of the progress in the wheat sector in the past decade.

Irrigation and water control—In 1949 China's irrigated area totalled 16 million hectares, having declined from a peak of at least 26.5 million hectares in the early 1930s. After 1949, irrigated area was rapidly recovered and expanded through surface water schemes. Almost 70% of the recovery and expansion in the 1950s took place in 11 major wheat-producing provinces, with more than 50% in such highly productive provinces as Shandong, Henan, Hebei, Jiangsu, and Sichuan.

From the late 1960s to the mid-1970s, the development of water resources focused on installing tubewells in North China. The wells, along with considerable work on drainage and some development of surface water resources—especially the construction of reservoirs—allowed North China's meager precipitation to be used more efficiently. By 1977,

Table 7. Components of yield changes in irrigated wheat, Punjab, Pakistan, 1972-86

Components	Yield change (kg/ha)
Positive components	
Switch from tall varieties to semidwarf varieties on 32% of area together with adoption of 40 kg/ha fertilizer[a]	140
Adoption of newer semi-dwarf varieties on 67% of area	100
Increased fertilizer use on 67% of area[b]	480
Total	720
Negative components	
Increased cropping intensity and delayed planting	-200
Increased weed losses	-50
Other factors[c]	-95
Total	-345
Actual yield change	375

[a] Assumes only 20% yield increase due to spread of semidwarf wheats to more marginal irrigated areas having problems with water, salinity, etc.

[b] Area where semidwarf wheats adopted in the earlier period, 1966-73. Assumes grain: nutrient ratio of 8:1.

[c] Calculated as residual.

[5] Another implication of the analysis is that at the farm level the average yield of semidwarf varieties over the Punjab has remained static for 15 years at about 1.8 t/ha. The negative influences of semidwarf varieties spreading to more marginal irrigated areas, increased cropping intensity, and a host of other factors have largely cancelled out gains from the release of newer varieties and rapid increases in fertilizer use.

[6] Bruce Stone of the International Food Policy Research Institute contributed this section of *Facts and Trends* and "Distribution of Wheat Production in China," p. 19. He would like to thank Dr. Zhuang Qiaosheng of the Institute of Crop Breeding and Cultivation of the Chinese Academy of Agricultural Sciences in Beijing and CIMMYT reviewers for detailed comments on earlier drafts.

45-50% of the wheat area was irrigated in Shandong and Henan and 60% in Hebei (Table 8). Wheat yields in Henan rose from an average of 849 kg/ha in 1954-57 to 1,072 kg/ha in 1965 69 and 2,249 kg/ha in 1975-78. However, the recent rapid growth in wheat yields in these three provinces (yields averaged 3.4 t/ha in 1984-86) has had less to do with growth in irrigated area than with other factors, as the three provinces actually experienced a decline of 0.5 million hectares of irrigated area between 1978 and 1985.

As of the 1980s, Chinese wheat area that is either irrigated or receives adequate rainfall probably totals more than 60%, about twice that during the 1950s. Although total irrigated area in China has contracted by about 1.7% since 1977 because of the costs of building and maintaining irrigation facilities, the net decline in irrigated area has not prevented rapid growth in average wheat yields during the last decade.

Varietal change--Scientific selection and dissemination of superior domestic and imported wheats commenced well before the People's Republic was established in 1949. The breeding and extension system originated as an informal, fragmented activity in universities and mission stations as early as the 1920s and progressed rapidly in the 1950s under official coordination. By 1957, nearly 70% of China's wheat area had been planted with improved materials, and the breeding of semidwarf wheats had been initiated.

Most of those improved materials were chosen from among popular Chinese varieties or germplasm imported from Europe (primarily Italy), the USSR, or the USA. The Italian varieties Abbondanza, Funo, Sukesi, and Mentana, as well as Orofen, a Chilean variety descended from Mentana, were particularly important in Chinese wheat breeding in the 1950s and 1960s. These materials appear in the pedigrees of numerous varieties popular throughout China (Orofen and Abbondanza were once widely cultivated in China's wheat regions and are still grown in parts of the northwest and southwest). In the early 1970s, the introduction of some fertilizer-responsive semidwarf wheats from Mexico attracted considerable attention from Chinese breeders as sources of leaf and stem rust resistance, semidwarfism, and spike productivity.

It must be emphasized that primary credit for the success of Chinese wheat breeding should not be awarded to the various imports but to the development of a strong, broadly based system of agricultural research and extension that exploited germplasm collected in China and imported from abroad. Among the 14 most influential parent varieties used to generate 864 improved varieties, 10 were either bred in China or selected or improved from Chinese

Table 8. Wheat production, irrigated area, fertilizer use, adoption of semidwarf varieties, and wheat yields in major provinces of China, 1956-87

Province	Percent of 1986 wheat production	Percent of cultivated area irrigated		Percent of 1983-85 wheat area under short varieties[a]		Average use of manufactured fertilizers[a] (kg nut./ha)		Average wheat yields (t/ha) in national peak years		
		1957	1985	< 100 cm	< 105 cm	1981	1987	1956	1979	1987
Henan	17.4	-	47	70	80-90	75	113	0.88	2.49	3.47
Shandong	17.3	-	62	70	70-80	141	180	0.92	2.57	3.68
Jiangsu	10.4	50	77	70	80-90	148	209	0.75	3.57	4.06
Hebei	9.1	23	54	30-70	60-80	83	134	0.91	2.23	3.08
Anhui	7.3	-	47	70	80-90	92	144	0.75[b]	2.00	3.61
Sichuan	7.2	-	41	70	80-90	98	123	1.22	2.26	3.27
Shaanxi	4.9	5	31	30-70	60-70	53	91	1.48	2.25	2.46
Hubei	4.2	48	61	70	90	79	162	0.99	2.26	3.12
Heilongjiang	4.0	4	7	30	60	41	61	0.86[b]	1.79	1.89
Xinjiang	3.8	93	82	30	60	41	81	1.45	1.57	2.96
Gansu	3.7	1	23	≥ 30	60-70	38	65	1.29	1.66	2.11
Shanxi	3.4	14	26	30-70	60-80	66	102	1.00	1.87	2.32
Subtotal	92.7	-	-							
Total China	100.0	24	45			92	138	0.91	2.14	2.05

[a] Average use of manufactured fertilizers and percent of wheat area under short varieties were both very low in the 1950s.

[b] 1957.

Distribution of Wheat Production in China

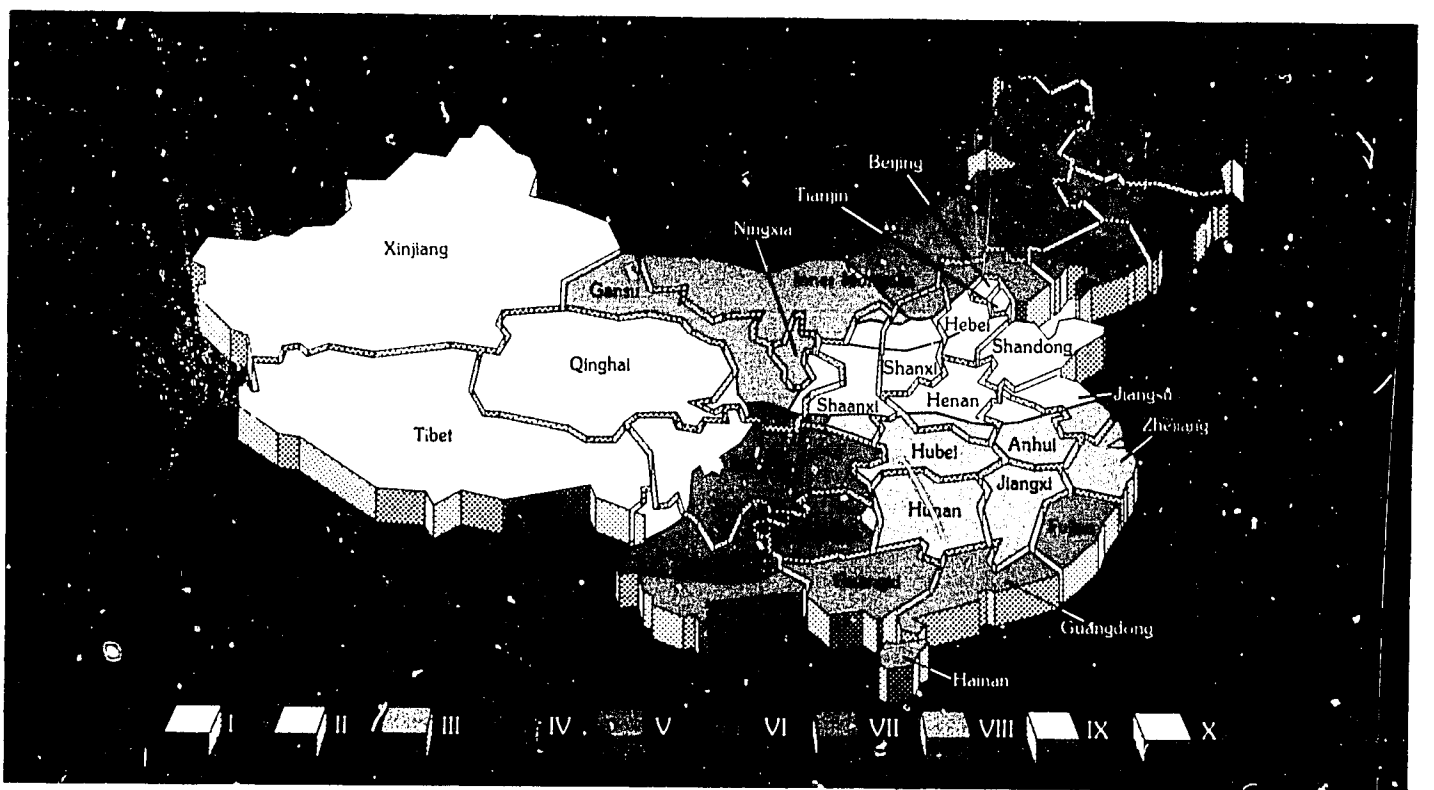
Understanding the diversity of wheat cultivation in China is critical for comprehending the scope of recent changes in Chinese wheat production. Wheat is grown in each of China's 26 provinces and three major municipal areas, but three-fourths of the 1987 wheat crop came from eight provinces lying along or to the north of the Yangtze River in East and Central China: Henan (19%), Shandong (17%), Jiangsu (10%), Hebei (8%), Anhui (8%), Shaanxi (5%), Hubei (5%), and Shanxi (3%).

The Chinese Academy of Agricultural Sciences (CAAS) divides the country into 10 major agroecological wheat production zones with 26 subzones (see map). The largest share (45%) of China's wheat area lies within Zone II, encompassing the basins and surrounding plains of the Yangtze and Huai Rivers. Just to the south, Zone III (the lower and middle Yangtze Valley) contains 16% of the wheat area. To the north, Zone I (the smaller North China Plain) contributes 10% of the area, as does Zone IV in the southwest, which includes the Sichuan Basin and the Yunnan-Guizhou Plateau. Zones I to IV together comprise more than 80% of China's wheat area.

Spring-habit wheats are the most common wheat type grown in China; planted mostly in autumn but also in spring, they cover 51% of the country's total wheat area. Facultative varieties cover 30% of the area and the remaining 19% is planted to winter-habit wheats.†

Chinese statistical publications divide production data between spring and "winter" (that is, autumn-sown) wheat, although not all wheats sown in autumn are true winter-habit types. Autumn-sown wheat actually includes spring, winter, and facultative types and covers over 84% of China's wheat area, mostly in the four major production zones and also in Zone V (in the far south) and Zone X (Xinjiang). The remaining 16% of China's wheat area consists exclusively of spring-habit wheats sown in spring.

† For a definition of spring, winter, and facultative wheats, see "The Types of Wheat Grown in Developing Countries," p. 4.



China's wheat production zones.

farmers' varieties. By 1980, no more than 2-3% of Chinese wheat area was sown with varieties bred outside China, while contributions from the Chinese breeding system covered over 95% of the area.

The public system has proved an extremely rapid mechanism for adapting improved cultivars to local conditions and distributing them in critical areas of China's major wheat-growing regions. A new generation of wheat varieties dominates farmers' plantings in only five years in Zones I, II, and III (see map, p. 19), and in as little as three to four years in the most important wheat areas. By the end of 1984, the share of China's total area planted to semidwarf wheats of potential height less than 100 cm had reached 50-60%. If slightly taller varieties under 105 cm are included, the area exceeds 70% (Table 8).

Fertilizer use—The use of manufactured fertilizer in China started to grow rapidly in the 1950s, rising from a small base. The famine of 1959-61 shifted national priorities in favor of using fertilizer on food crops, wheat included, and in the mid-1960s, small, county-based plants began to produce either synthetic ammonia, calcium single superphosphate (SSP), or calcium magnesium phosphate (CMP). The ammonia was sold as aqueous ammonia or converted to ammonium bicarbonate (ABC).

Both ABC production and imports of nitrogenous fertilizers rose rapidly in the late 1960s. After 1970 the quantity of ABC produced in China was significant enough to tempt the government to reduce fertilizer imports. Since ABC was more volatile than the imported fertilizers it replaced, the amount of nitrogen *absorbed* by the wheat crop was not growing nearly as fast as the amount of fertilizer *applied*. Some progress was seen in food production, but yield gains in major staple crops were insufficient to generate rapid increases in marketable surplus.

To meet the demand for nitrogen, the Chinese government decided in the early 1970s to import 13 large synthetic ammonia/urea manufacturing complexes. The plants came on line between 1976 and 1980 and in four years, together with continued rapid growth in the small manufacturing sector, were responsible for a 162% increase in nitrogenous fertilizer production.

Rising fertilizer production and imports enabled the application of nitrogenous fertilizer on all crops to rise from an annual average of around 3.3 million metric tons (MT) in 1972-75 to almost 10 MT in 1979-82, surpassing 100 kg of nutrient per sown hectare in the 1980s (Table 8). At the same time, the type of fertilizer changed from the more volatile products such as aqueous ammonia to other, more stable fertilizers. Thus the growth in *absorbed* nitrogen considerably exceeded the apparent increase in *application* of nitrogenous fertilizers during this period.

The trend toward increased fertilizer use continues in the 1980s, and other nutrients, especially phosphates, have become more important as the nitrogen problem is being resolved. The use of nitrogenous fertilizer on all crops averaged 28% higher in 1936/87 than in 1980/81. Application of manufactured phosphate was 68% higher on average, the application of potash and compound fertilizer rose 350%, and the campaign to improve micronutrient-deficient soils in major growing areas gained impetus.

Thus, the doubling of average wheat yields between 1964-69 and 1978-81 may be attributed to three factors: to an expansion in irrigation by an area equal to 11-12% of cultivated area, mostly in China's principal wheat-growing regions; a steady stream of locally adapted improved varieties—especially shorter varieties—provided by China's increasingly sophisticated breeding and extension systems; and the tremendous growth in availability of fertilizer nutrients.

Policy initiatives and organizational reform—Clearly, government policy related to such inputs as seed, water, and fertilizer has been important for promoting progress in wheat production. But wheat production has also been influenced by rural reforms and other public policies. Throughout the last 35 years, the single most supportive public initiative for wheat not directly related to inputs has been the government grain purchase system. In the absence of a well-integrated national private market, government institutions communicated throughout the country the pressure of unsatisfied demand for wheat in urban areas and much of the north and northeast. The state price structure favored wheat over other staple crops, even rice, and farmers selling wheat were given preferential access to inputs and credit. Because of this historic policy preference for wheat, the government's drive for local self-sufficiency in the 1960s and 1970s, disastrous for many marketed crops because of trade restrictions between localities and provinces, was less damaging for wheat.

Policies related to rural organizational change have also affected wheat production. The commune system aided technological change in the 1960s and 1970s by greatly simplifying the extension of improved cultural practices and seed and by giving laborers the obligation and incentive to work on irrigation projects (thus holding down costs to the government). The year-to-year growth of fertilizer purchases was less inhibited by concerns over risk and the ability to mobilize family savings to purchase inputs. In the northeast,

where labor is relatively scarce, the commune system facilitated the purchase or rental of farm machinery.

Communization generally increased control over rural economic activity but was not the only control mechanism. State monopolization or restriction of input supplies and control of higher financial institutions, grain markets, and urban housing also made it possible to partially restrict migration, labor markets, capital movements, and land transactions. Thus farmers, land, and, to some extent, capital remained in the service of farming, despite the fact that the state set prices at levels that would otherwise have driven many more persons into occupations outside farming.

The well-publicized liberal reform package instituted in 1980-81 actually involved fewer changes for wheat production in many major wheat-producing regions than in other locations and for other agricultural activities. In many localities the government continued to plan how much area would be sown to wheat, a process that differed little from the earlier practice of assigning quotas. Despite the appearance of wheat in some free markets, wheat marketing was still dominated by the state. The reforms allowed reductions in wheat area in locations less suited to wheat cultivation and freed large numbers of rural laborers from farming responsibilities. However, concern over this situation and the large amount of foreign exchange needed to import wheat led state organizations to strengthen support for wheat production in prime areas by pushing for increases in wheat area and improving supplies of inputs and financial incentives for growing and selling wheat.

These activities in support of wheat production are all features of the system initiated in the 1950s rather than components of the policy reform of the 1980s. Their effectiveness rests not on the liberalization of product and labor markets but on the continued restriction and state control of markets for fertilizers, credit, and other material inputs, and on the large imperfections that remain in labor markets. It is difficult to conclude that incentives stimulated by the policy reforms were the principal source of wheat yield gains in the past decade, given that the pre-reform incentive structure favored wheat relatively heavily and kept considerable excess farm labor in rural areas.

Wheat in the 1990s Government policy and technological change combined created an environment in which wheat yields rose rapidly in China between 1978 and 1984. However, those increases were followed in 1984-87 (and probably 1988) by a plateau in which average yields remained at 2.9-3.1 t/ha. Adoption of fertilizer-responsive varieties has been almost complete for several years. Has wheat in China reached a yield ceiling that will be difficult to raise? Not necessarily.

Some 85% of the wheat varieties grown in China have a yield potential of at least 5-6 t/ha. Although the gap between yields on experiment stations and in farmers' fields is not easy to close, China is in a strong position to make further progress. In 1987/88 the government resolved to intensify public sector support for food grain production, a decision brought about by the lack of growth in aggregate grain production since 1984.

The strongest expression of this recommitment to grain production is investment in new domestic fertilizer production capacity. Annual additions to fertilizer production facilities are likely to be greater in the first half of the 1990s than in any year of the 1980s. Aside from facilities for producing nitrogen, potash, and compounds, there is a heavy concentration on new phosphatic fertilizer plants. Phosphate deficiency is widespread and often acute within China's most important wheat zones; eliminating this deficiency should have a significant impact on wheat yields.

Concern over the grain production plateau has also helped reverse a long decline in agriculture's share of the national capital construction budget. In many districts increased financing for irrigation has helped reverse the decline in irrigated area. Investment from the national government and international organizations in Chinese agriculture will rise again in 1989, with emphasis on constructing and renovating water control facilities. The situation for other inputs, including credit and labor, also looks positive. The Agricultural Bank of China pledged to expand credit to localities by 22% to support agricultural (especially grain) production. Curbs on credit for enterprises are expected to reduce the construction boom and reduce the net flow of labor from farming.

What do these developments mean for wheat? Progress in wheat production should continue in the 1990s, if scrupulous attention is given to further developing the broad and sophisticated network for providing locally adapted, high-yielding varieties; continuing a rapid long-term rate of growth in supplies of manufactured fertilizers; and improving water control in the most important wheat-producing regions. In the past, government purchasing organizations have been instrumental in substantially reducing market risk for wheat farmers and providing incentives to facilitate the almost uninterrupted and rapid rate of adoption of improved varieties and higher doses of fertilizer. The challenge for the next decade will be to reconcile this strong public sector approach with the liberal reforms that generated unprecedented growth in China's non-grain rural economy.

Third World Wheat Supply and Demand to the Year 2000

Extraordinary changes in the world wheat economy have been the rule rather than the exception during the past 20 years. Both production and consumption of wheat increased at an annual rate of 3.1% worldwide and 5% in developing countries. But if China and India are excluded, wheat consumption increased by 4.1% annually in the developing world against a growth rate in production of 3.3%, indicating a sharp drop in self-sufficiency in wheat in the Third World.

In this section we examine likely changes in demand for and supply of wheat by drawing on recent projections to the year 2000 by the Food and Agricultural Organization of the United Nations (FAO) (1987), the International Wheat Council (IWC) (1987), and the World Bank (1986), as well as CIMMYT's own model for projecting wheat consumption. Our conclusions are less than optimistic: it seems improbable that the recent growth of wheat production and consumption in the developing world can be maintained over the next decade or more.

Wheat Demand

Four main factors define the demand for wheat: population growth, urbanization, income growth, and consumer prices.

The population in developing countries will grow at an average of 1.9% per year to reach nearly 5 billion by the year 2000. This rate is slightly less than the one that prevailed from 1970 to 1985. However, population growth in different parts of the world will vary substantially, ranging from just 1.4% in China to over 3% per year in sub-Saharan Africa.

Urbanization also determines levels of wheat consumption. By the year 2000, 40% of the developing world's population will live in urban areas, compared to 31% in 1985. Urbanization stimulates demand for convenience foods such as bread. Also, since many large cities are located on coasts, governments frequently look to imports, especially of wheat, as a way of supplying food to urban consumers.

Income growth in developing countries is much more difficult to project than the other factors given the present uncertainty in the world economy. In light of the continuing economic difficulties and debt-servicing problems experienced by many developing countries, we have reduced the FAO projection of a 3% annual increase in per capita GNP to the year 2000 to an average of 2.6%, representing a range from 0.2% in sub-Saharan Africa to 3.4% in Asia.

The changes in wheat consumption that occur as incomes rise vary considerably by region and also depend on whether wheat is used as food or feed. For wheat used as food, the percentage change in per capita wheat consumption for a 1% change in income (that is, the income elasticity of demand) averages 0.38, varying from about 1.0 in sub-Saharan Africa to 0.2 in North Africa, West Asia, and Latin America. (Note that in developed market economies the income elasticity for wheat products for human consumption is generally negative.) As incomes rise, demand for grain used as animal feed accelerates much more rapidly than demand for food grain. However, only 5% of wheat in developing countries is currently used for feed, so the overall effect on wheat consumption is small.

We did not attempt to project changes in consumer prices, the fourth influence on demand. Declining real prices for wheat products caused by such factors as consumer subsidies and overvalued exchange rates were a major source of growth in wheat consumption from 1970 to 1985 (CIMMYT 1983). During the 1980s, many countries have realigned

Table 9. Projections of wheat consumption by region to the year 2000

	Growth rate 1985-2000 (%/yr)		Total consumption 2000 (million t)	Per capita consumption 2000 (kg/yr)	Percent used for feed, 2000
Region	Food wheat	Feed wheat			
Sub-Saharan Africa	5.2	3.1	14	21	1
West Asia/North Africa	2.8	4.2	95	219	7
Asia	2.8	5.2	249	73	5
Latin America	2.7	4.1	42	68	10
Developing countries	2.9	4.7	401	78	6
Developed countries	0.6	2.2	293	129	42
World	2.1	2.6	693	89	21

[a] Excludes West Asian countries.

exchange rates and reduced food subsidies; consequently, real prices of wheat products have probably risen. If this trend continues and consumer prices for wheat products continue to rise in real terms, the growth in wheat demand in developing countries may be slower than we have projected.

The demand projections in Table 9 indicate that wheat consumption will grow at 3% annually in developing countries to the year 2000, and at 2.2% annually on a global level. These growth rates are much slower than in the recent past, partly because incomes will rise less rapidly and partly because wheat consumption will probably not be stimulated further by decreasing consumer prices of wheat relative to other staples. The fastest growth in demand is projected for sub-Saharan Africa, where per capita demand could increase at 5% annually from 16 kg/year to 21.5 kg/year. The high growth rate in sub-Saharan Africa reflects the changing food preferences of growing urban populations and the inability of domestic food production to supply urban consumers.

Wheat Production

CIMMYT believes that developing countries are unlikely to maintain historical production growth rates. We have already analyzed the components of recent production increases—area expansion, irrigation, variety and fertilizer use. Here we will briefly discuss two projections of the potential of expanding area, irrigation, variety, and fertilizer use to be future sources of growth (Table 10). We begin with the more optimistic projection, turn to the more realistic one, and conclude by discussing the potential for improved crop management practices to raise wheat yields and productivity.

Wheat area—The rate of increase in wheat area slowed from 1.7% in the 1950s to 1.1% from 1971 to 1986. For the coming decade, the maximum likely rate of expansion is 0.8%, reflecting the greater scarcity of land that can be brought under cultivation. In parts of Asia there is considerable potential to increase cropping intensity, but any growth in production from this source may be negated as greater urbanization leads to a decline in cultivated area and as crops of higher value compete with wheat for land, especially in China.

Irrigation—Although irrigated area in Asia expanded by only 0.7% annually from 1975 to 1985, the FAO projects a rate of increase of 2.4% per year from 1984 to 2000 (excluding China), mostly because irrigated area in India is expected to expand. The FAO also projects an increase in the proportion of irrigated wheat area from 54% to 64% by the year 2000. Assuming that conversion of rainfed land to irrigated land raises yields about 1 t/ha (the average for South Asia), increased irrigation will help wheat yields in all developing countries combined to grow at 0.3% per year. But in view of recent difficulties with irrigation projects in many countries, including India, these projections seem optimistic.

Variety—Much of the high growth rate in wheat production in the past two decades can be attributed to the interaction of the adoption of semidwarf varieties with increased fertilizer use and expanded irrigation. By now this source of growth has largely been exploited in some major wheat-producing regions, including northwestern India, Pakistan, North China, and Mexico, where over 90% of irrigated wheat area is now sown to semidwarf varieties and moderate to high doses of fertilizer are applied.

Since the first semidwarf wheat varieties were released in the 1960s, plant breeders have maintained a long-term average yield gain of new varietal releases of about 1% per year in irrigated areas of Mexico and Pakistan. These yield gains were measured on the experiment station where varieties were grown under high levels of management; if we consider the effect of farmers' management and the much slower gains in dry areas, the yield gains from breeding for all wheat-growing areas of developing countries have probably averaged about 0.7% per year. Wheat breeders may be able to continue to achieve steady gains of similar magnitude, but before the year 2000 it is unlikely that a higher rate of genetic gain will be attained, at least at the farm level.

Table 10. Projected growth rate in production due to various factors to 2000[a]

	Rate of gain to the year 2000 (%/yr)	
	Optimistic projection	Realistic projection
Area	0.8	0.5
Yield		
Irrigation effect	0.3	0.1
Variety effect	0.7	0.4
Fertilizer effect	1.3	1.0
Total	3.1	2.0

[a] Excludes the effects of crop management factors other than fertilizer.

Fertilizer—Average fertilizer use on wheat in developing countries is now about 75 kg nutrient/ha (excluding China). The FAO *Agriculture Toward 2000* study (1987) projects that fertilizer use per hectare for all crops will grow at a rate of 4.7% per year to the end of the century. At that rate, fertilizer use on wheat would reach reach 150 kg nutrient/ha (excluding China) by the year 2000, which seems unlikely. Since fertilizer use on wheat is already higher than on other crops, we have assumed a more modest growth rate of 3.7%, leading by 2000 to an average of 130 kg nutrient/ha of fertilizer applied to wheat. Under the conservative assumption of an average marginal grain:nutrient conversion ratio of 8:1, this level of fertilizer use would increase yields by 440 kg/ha or 1.3% per year. This grain:nutrient ratio is probably high, given that fertilizer use on wheat is likely to rise fastest in rainfed areas and given the low productivity of additional fertilizer use in some irrigated areas.

Implications for the future—If the four factors discussed above (area, irrigation, variety, and fertilizer) contribute to increases that are sufficient to maintain a wheat production growth rate of 3.1% (Table 10), which is similar to the growth in wheat demand projected for developing countries, then self-sufficiency in wheat in developing countries should remain at about 80%. This scenario still implies that wheat imports by developing countries will increase by 50% from 1985 to reach about 90 million tons by 2000. At the regional level, imports will grow most rapidly in sub-Saharan Africa, to reach perhaps 12-13 million tons of wheat per year if current trends persist.

A more realistic projection—We believe it is unlikely that the projected growth rates in area and projected yield increases from variety, irrigation, and fertilizer will be achieved. Some countries, especially China, have already seen a reduction in area devoted to cereal crops. In addition gains from plant breeding research are slow to reach farmers' fields in some important wheat-producing countries because the diffusion of new varieties is slow (Heisey 1989). To increase irrigated area, substantial new investments must be made in irrigation facilities. Finally, information from some parts of the world—Mexico, the Indian Punjab, and Pakistan—indicates that the marginal returns to additional fertilizer use are now quite low.

A more realistic projection of growth is 0.5% for area, and for yields 0.1% due to irrigation, 0.4% due to variety, and 1% due to fertilizer. These factors contribute to an overall growth rate of 2% (Table 10), which does not take into account other potential sources of yield increases, especially improved crop management.

Potential gains from improved crop management—In irrigated areas considerable opportunities remain to increase yields and productivity through reduced and zero tillage, better stand establishment, more efficient fertilizer use, identification of soil micronutrient deficiencies, control of weeds and pests, crop rotation to manage soils and soil diseases and reduce conflicts with timely wheat planting, and more efficient management of irrigation water. In dryland areas, too, improvements in productivity usually rest on such practices as better tillage to conserve moisture, weed control, and efficient use of fertilizers.

Hence, although a wheat production growth rate of 3% per year (or more) is certainly feasible, a greater proportion of the gains will have to come from improved crop management than in the past, both in irrigated and in rainfed areas. Improved management practices are required not only to exploit the yield potential of available technology, but also to increase the efficiency of input use and sustain the resource base.

Greater attention to crop management will require a different strategy than in the past, when primary emphasis was given to breeding improved wheats, investing in irrigation, and promoting fertilizer use (often through subsidies). Research systems will need to develop well-focused, problem-solving crop management research programs that integrate strategic and applied research on major management problems with adaptive research for specific locations.

Because improved crop management practices are generally complex, farmers need more assistance from extension to adopt them profitably. The emphasis must be shifted from prescriptive information or "recipes" for crop production to providing farmers with a better understanding of new technology and improving their technical and managerial skills. There is a need to move away from the "package approach" to more specific recommendations combined with technical information to help farmers adapt the recommendations to their own needs (Byerlee 1987). This shift requires a well-developed public sector extension system, complemented by greater private sector involvement in distributing inputs and supplying information on how to use them efficiently.

Finally, the evidence is increasing that in a science-based agriculture farmers' productivity is limited by low levels of education. For example, in much of South Asia, a high proportion of wheat farmers has no formal schooling. This deficiency may be a formidable constraint to increasing the payoffs to the investment in research and extension that will be necessary if rapid gains in productivity are to be sustained.

Conclusion

Third World wheat yields and production have risen almost as rapidly in the past decade as during the first years of the Green Revolution. Over 80% of the gains in wheat production realized over the past 10 years can be attributed to yield increases. The expansion of wheat area, like that of other cereal crops, has slowed considerably since the years before the Green Revolution, when expanding area was the major source of growth.

Semidwarf wheat varieties are now grown on most of the spring bread wheat area of the developing world and to an increasing extent on the area sown to winter and facultative bread wheats and to durum wheats. Most of the increase in area sown to semidwarf varieties over the past decade has occurred in rainfed areas. Although semidwarf varieties have expanded into some more marginal areas, their adoption is lowest in the driest ones. In addition, as the new varieties have spread to rainfed areas, the impact on wheat yields has been less than in irrigated areas.

The adoption of semidwarf wheats has been complemented by rapid growth in the use of fertilizer in both irrigated and high to medium rainfall areas. Fertilizer use on wheat in developing countries (China excluded) now averages about 80 kg/ha, high relative to the average for all crops. In irrigated wheat, which makes up about half of the wheat area in the Third World, an average of over 100 kg/ha of fertilizer is now applied.

The evidence suggests that the easy gains from these sources of growth in wheat production over the past two decades have now been largely exploited. Wheat breeders continue to make steady yield gains of 0.5-1% per year, but no new breakthroughs on the order of the first semidwarf varieties have been made. The marginal returns to fertilizer use in many areas have fallen; in some cases, such as in the Punjab of Pakistan, the productivity of additional fertilizer use is very low under current management. Finally, investment in new irrigation schemes has become quite costly; with the possible exception of India and new schemes in Turkey, the main challenge in most of the world will be to maintain the productivity of existing irrigation facilities.

This information suggests that to the year 2000 the rate of increase in wheat production will be considerably slower than in the past two decades. Although wheat consumption will also increase more slowly, there is some uncertainty whether current levels of self-sufficiency can be maintained, especially in the main wheat-producing countries of Asia.

Ample scope for increasing wheat productivity still appears to exist, but new gains will have to be obtained by adopting a strategy somewhat different than the one followed in the past. In irrigated and well-watered rainfed areas, further gains can be made by speeding up the diffusion of new wheat varieties and, in some cases, by increasing fertilizer use and irrigated area. However, emphasis should be placed on increasing the efficiency with which these inputs are used. Increasing the efficiency of input use may involve a range of other factors, such as improved tillage methods, better stand establishment, weed control, precision land levelling, correction of micronutrient deficiencies, reduction in harvest losses, and more appropriate crop rotations. This strategy suggests that in the future improved crop management will play a greater role relative to improved varieties in raising productivity. Unfortunately, many major wheat-producing countries still lack the effective crop management research systems, strong extension systems, and well-developed input support systems needed to effect this new strategy.

Even though this report has emphasized changes in wheat production in irrigated and well-watered environments, a continuing challenge in wheat production is to exploit the potential of drier environments where the pace of change has been slowest. Some evidence has been presented that gains from wheat breeding in drier environments may be only half or less in relative terms (percent per year), and even smaller in absolute terms (kilograms per year), than in areas with adequate moisture availability. Thus, in dry areas particularly the key to increasing productivity is improved crop management, as well as conservation and more efficient utilization of moisture. The next *World Wheat Facts and Trends* will give special attention to these issues.

Part 2: The Current World Wheat Situation

World wheat production in 1988 is estimated at 502 million metric tons (MT), a 2% decrease from the previous year's level of 512 MT.[7,8] This drop was largely the result of the worst drought to hit the North American grain belt in over 50 years. The decline in global production would have been far more severe except that decreases in North American production were partially offset by improvements in the Western European, Eastern European, and Soviet crops.

Production in Developing Countries

Wheat production in developing countries continues to rise slowly as technological advances raise yields. The 1988 wheat crop was helped by generally favorable weather in Asia and Africa, but dryness during the planting season depressed production throughout much of Latin America. The strong showing of the Asian and North African crops helped total production in developing countries to reach an estimated 216 MT in 1988, a slight increase from the previous year's level of 215 MT.

7 This information is current as of November 1988.

8 The 1988 wheat crop comprises all wheat whose vegetative growth stage occurred primarily in 1988. This includes the Northern Hemisphere crop planted in late 1987 (winter wheat) or early 1988 (spring wheat) and harvested in 1988, as well as the Southern Hemisphere crop planted in mid- or late 1988 and harvested in late 1988 or early 1989.

Asian wheat production in 1988 totalled 187 MT, surpassing the previous year's harvest by nearly 3 MT but failing to match the record level of over 190 MT achieved two years earlier. In China, poor weather affected the spring wheat crop, slightly lowering production to 87 MT. Wheat production in China was also affected adversely by recent agricultural policy reforms, which decreased the profitability of grain production relative to other high-value crops such as fruits and vegetables. Larger than expected wheat crops were harvested in India and Pakistan, reversing the 1987 production declines caused by bad weather during harvesting.

In West Asia and North Africa, total wheat production rose slightly in 1988. However, the aggregate regional figure masks considerable variability between individual countries. Turkey produced a record crop in 1988 because good weather encouraged extensive wheat plantings; favorable weather also helped increase Iranian and Egyptian production. Production rose dramatically in Morocco but fell in Algeria and Tunisia because seasonal rains arrived late, delaying planting. The Tunisian crop was devastated by bad weather throughout the growing season and fell from 1.4 MT in 1987 to 0.2 MT in 1988.

In Eastern and Southern Africa, good weather produced generally encouraging results. The rainfed crops of Kenya and Tanzania were average or above average. A good harvest was expected for the second consecutive year in Zimbabwe, where supplies of irrigation water were once again adequate following several years of drought in the major wheat-producing areas. In Sudan and Ethiopia, where civil strife disrupted farming, production fell despite satisfactory growing conditions.

The Latin American wheat sector showed signs of recovering in 1987 after a series of bad years in the mid-1980s, when plantings declined in the face of depressed world wheat prices. Unfavorable weather reversed this recovery in 1988, however, and it remains to be seen whether the long-term rising trend will resume.

Perhaps the most impressive performance in Latin America was registered by Brazil's wheat industry, which has been completely transformed in recent years. Brazilian wheat production has increased dramatically, rising from 2.4 MT in 1984, to 4.3 MT in 1985, 5.8 MT in 1986, and 6.1 MT in 1987, before falling slightly to 5.8 MT in 1988 because of dry weather at planting. These gains were achieved largely by opening up new land to wheat production, distributing improved germplasm, and developing improved management practices (e.g., tillage methods and crop rotations). Production gains in other countries in the region have been more modest. Argentinian wheat production rose from 9.7 MT in 1986 to 10 MT in 1987 before falling sharply to 8.5 MT in 1988 as the result of serious planting delays. These delays also affected the 1988 Chilean and Uruguayan crops, reversing slight gains recorded in previous years.

Production in Developed Countries

Developed countries are expected to account for 287 MT of the wheat produced in 1988, compared to 300 MT produced the previous year. Although a considerable part of the decline in developed country production must be attributed to the North American drought, production very likely would have decreased in developed countries regardless of the

unfavorable weather that affected the USA and Canada. Had this happened, it would have signalled that policies enacted by many leading producers to reduce wheat production were beginning to have their intended effect on the world wheat supply. Area planted to wheat in most developed countries has remained stable or declined during recent years, although average yields continue to improve.

A closer look at North American wheat production shows the extreme effects of the drought. Total 1988 wheat production in the USA is estimated at just under 50 MT, a 13% decline from the 1987 harvest of 57 MT. Production in Canada suffered proportionally greater losses, falling 40% to 15 MT. Spring-sown wheats (including durums) were particularly severely affected in the USA and Canada, where average yields dropped by over 50% in many areas.

Over the long term, patterns of North American wheat production appear to be changing. In the USA, efforts to reduce wheat surpluses by inducing farmers to take land out of production (primarily through the Acreage Reduction Program) have had a noticeable impact on wheat plantings. Following a series of record harvests in the early 1980s, production in the USA declined from 66 MT in 1985 to 57 MT in 1986, a level that was exceeded slightly in 1987 because of good weather. Although wheat plantings in the USA and in Canada are expected to increase in 1989 as farmers react to higher prices, North American production should eventually stabilize once depleted stocks have been restored.

In the three years before 1988, Western European wheat production remained stable at around 81 MT, but in 1988 it rose 6% to 86 MT because weather was favorable throughout much of the growing season. This slight increase reveals that the European Community (EC), which accounts for nearly 90% of the wheat produced in the region, has not yet managed to reduce costly surpluses.

Eastern European wheat production also benefited from favorable weather in 1988, rising about 6% to 36 MT. Since 1980, wheat production in Eastern Europe has increased by 2.6% per year. Although area planted to wheat has changed little during this period, yields have increased as a result of government programs to introduce more intensive production technologies.

In the USSR, estimated 1988 production of 85 MT was slightly higher than the previous year's level of 83 MT. What is particularly noteworthy about the Soviet wheat sector is that production levels have been maintained while the area planted to wheat has steadily decreased. Rising wheat yields have compensated for diminishing area, largely because of a policy initiated in 1985 to introduce intensive production technology, restructure economic incentives for farmers, and decentralize crop management decision making.

Australian wheat production rebounded in 1988 from its exceptionally low level in 1987, when farmers reacted to unattractive world prices by taking a significant amount of land out of production. The 1988 production increase is additional evidence of the extreme sensitivity of Australian production to global wheat prices.

Wheat Utilization

The underlying factors determining wheat consumption (for example, population growth, rising incomes, retail price policies, and food aid) continue to provide a strong impetus to demand, particularly in developing countries. Consequently, global utilization of wheat has continued to expand in line with past trends of over 3% per year despite the recent instability in supply.

Except in the very short term, population growth outweighs all other factors in determining the rate of increase in wheat utilization worldwide. Approximately two-thirds of the long-term historical growth in demand for wheat and wheat products can be attributed to population growth. Global population is increasing at about 1.7% per year, a figure that belies considerable variation between countries. Even though population growth rates have slowed considerably in many industrialized countries, they continue to rise in many developing countries where wheat consumption is growing most rapidly.

Given the great variability in the growth of world income in recent years, the future effect of income growth on wheat consumption is difficult to predict with precision. If real incomes in the developing world on aggregate continue to grow at their average rate of the past two decades (3-4%), per capita demand for wheat should grow by 1.5-2% per year in developing countries. This rising demand translates into the need to produce an additional 3-4 MT of wheat each year, without taking into account additional growth in population.

Retail price policies in many developing countries favor wheat consumption by lowering the price of bread and other wheat-based products relative to the prices of coarse grains. Despite their obvious short-term political and economic benefits, such subsidies can have deleterious long-term consequences. They can discourage local cereal production, strain limited budgetary resources, and increase the dependence on sometimes unreliable world grain markets.

A growing awareness of these long-term effects has led governments in many developing countries, both wheat producers and importers, to take steps to adjust retail price policies by reducing subsidies on bread and other wheat-based products (e.g., Brazil and Mexico). A few governments (e.g., Nigeria and Zimbabwe) have additionally imposed trade restrictions on wheat to further discourage imports and consumption. Such policy adjustments may slow future growth in wheat utilization worldwide. However, the reluctance of most governments to implement drastic price changes for politically sensitive staple foods such as bread suggests that retail price policy adjustments will be phased in gradually, thus dampening the effect on demand.

In interpreting figures on global wheat utilization, the influence of food aid should be noted. Shipments of wheat intended as food aid amounted to 8.2 MT in 1985/86, of which the USA provided over 60%, with the balance coming primarily from Canada, the EC, and Australia. Approximately 50% of all wheat donated in 1985/86 was destined for Africa (including Egypt), 35% for Asia, and 15% for Latin America. Even though wheat food aid is only a small percentage of wheat utilization worldwide, it is important in selected regions. For example, a considerable portion of the wheat imported into sub-Saharan Africa comes in as food aid. Also, since consumers in countries receiving substantial amounts of donated wheat are likely to develop a taste for it, current wheat food aid, while relatively modest, has the potential to significantly affect future levels of consumption.

Wheat Trade and Stocks

World trade in wheat changed markedly in 1988/89 as the effects of the North American drought rippled through global markets. The volume of wheat traded internationally in 1988/89 is estimated at 97 MT, down nearly 8% from the previous year's level of 105 MT. The declining volume of trade reflected the tighter supplies and soaring export prices of wheat brought on by the drought. Two other factors contributed to the decline in the volume of world trade in wheat: a sharp reduction in Soviet purchases because the quantity and quality of the Soviet wheat crop increased, as well as reduced wheat imports by some developing countries, including Brazil, China, Iran, Algeria, and Morocco.

The sharp downturn in world wheat trade during 1988/89 reveals the volatility of global trading patterns. World wheat trade in 1987/88 totalled 105 MT, up 15% over 1986/87 and only fractionally below the record 1984/85 level of 107 MT. Thus, prior to the drought, heightened competition among the major exporters had provoked increasingly aggressive trading (often based on awarding credit to importers at concessionary terms) that created a buyer's market for wheat and flour in 1987/88. These developments occurred at an opportune time for many Asian and African countries, where a run of poor cereal harvests

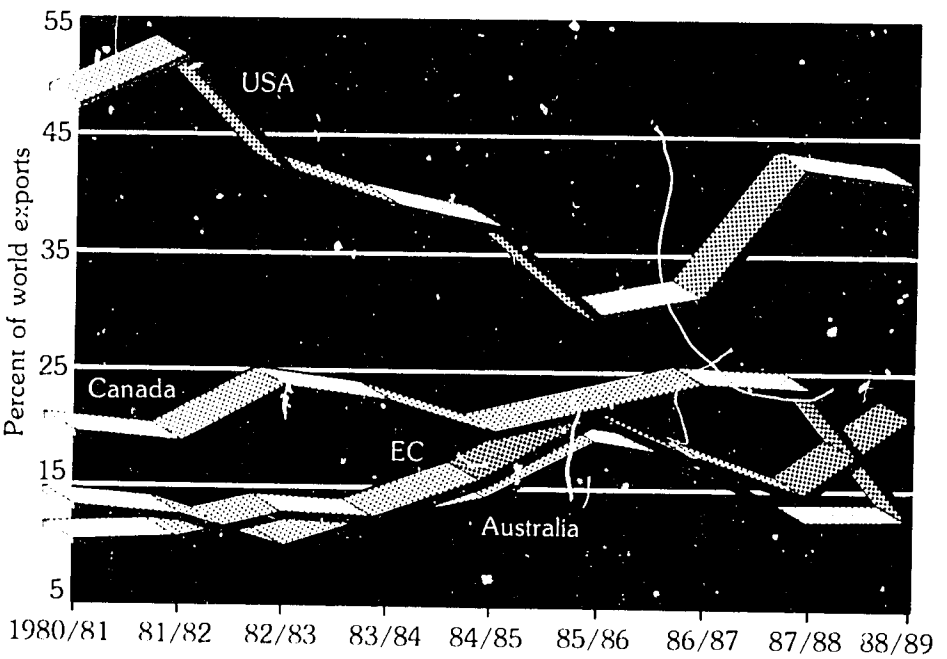


Figure 8. Changes in country shares of world wheat exports, 1980/81 to 1988/89.

was caused by inclement weather. The strong rise in global trading that resulted was abruptly reversed after the drought reduced world wheat supplies and prices rose.

Principal Importers

The principal importers of wheat continue to be developing countries and the centrally planned economies of Eastern Europe and the USSR. Although wheat imports on aggregate declined for these two groups in 1988/89 because domestic cereal harvests were generally favorable, the longer term trend is upward. Additional demand for imports continues to come from Asia, where claims that the traditional large cereal importers have significantly raised levels of food self-sufficiency will have to be regarded with caution in view of recent variability in production. For example, as a consequence of the poor monsoon in 1987 that greatly reduced rice production, India will import 3 MT of wheat in 1988/89, the highest level in seven years.

Wheat imports are also up in Pakistan, which is expected to import nearly 2 MT in 1988/89.

Following the pattern of recent years, the USSR in 1988/89 was again the world's largest wheat importer despite its good wheat crop. Soviet imports of wheat and flour (including durum) are estimated at 15 MT in 1988/89, considerably less than the 22 MT imported the preceding year but nevertheless more than the amount imported by any other single country. China was the next biggest individual importer in 1988/89, accounting for over 13 MT of wheat. After these two dominant importers came Egypt (7.1 MT), Japan (5.6 MT), South Korea (4.0 MT), and Iran (3.5 MT). Utilization of wheat varies somewhat among these countries. Because of its high quality, imported wheat is almost always used for human consumption, but in a few countries, notably the USSR and Japan, imported wheat allows low-quality local wheat to be used as animal feed.

A final noteworthy change in global import patterns during the 1980s has been the decline in wheat imports by a number of countries in South America. They include Brazil, Chile, and Paraguay, all of which have made significant progress in raising their wheat self-sufficiency.

Principal Exporters

Even before the North American drought of 1988 disrupted global trading patterns, drastic changes were underway in country shares of the world export market for wheat (Figure 8). Policy adjustments implemented in the USA (including lowered domestic support prices and export subsidies extended through the Export Enhancement Program) had helped to increase American exports in recent years. At the same time, wheat supplies in many traditional exporting countries such as Australia and Argentina were limited by reduced plantings and poor weather. The result of these two influences was that by 1987/88 the USA had recaptured much of the world market share it had lost because of its competitors' aggressive trading policies and the strong value of the US dollar relative to the currencies of competing exporters. However, the effects of the drought are expected to considerably erode North America's share of the market in 1988/89. United States exports are projected to fall by 9% and Canadian exports by 50%. The EC will be the main beneficiary of declining North American exports, as EC-12 wheat exports are projected to rise 38% to 20 MT in 1988/89.

Wheat Stocks

Two consecutive years of declining global wheat production have greatly depleted world wheat stocks (Figure 9). Total closing stocks of wheat for

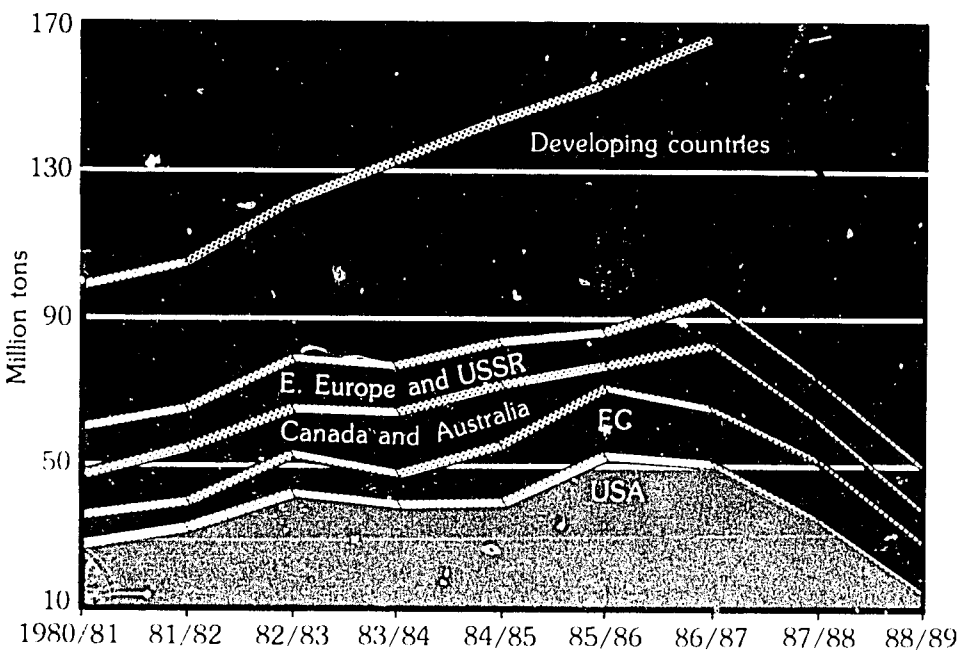


Figure 9. World closing wheat stocks, 1980/81 to 1988/89.

the 1988/89 season are projected at 102 MT, down 36% over two years. The ratio of closing stocks to world wheat utilization is expected to reach levels not seen since 1972/73, the first years of the so-called "world food crisis." Although some importers are concerned about the future availability of wheat on world markets, it seems unlikely that global food security will be threatened, barring the unlikely recurrence of a severe drought.

Production in the USA and Canada is expected to rise sharply in 1989, which would restore global wheat stocks to a more acceptable level. The recent reduction in closing stocks may actually be welcomed by many of the major exporting countries, who have borne much of the cost of storing the world's excess wheat supply.

Wheat Prices

World Price Movements

The drought of 1988 dramatically affected world wheat prices. Between May and July 1988, US export prices for all grades of wheat surged in the expectation of shortages. Export quotations rose 25% or more to surpass US$ 160/t for most bread wheats and US$ 190/t for durums. Upward pressure on prices eased somewhat during August and September when the Export Enhancement Program was scaled back, but the market remained nervous in the face of the uncertain outlook for exports. By the fourth quarter of 1988, the price of US Hard Red Winter (HRW No. 2, FOB Gulf Ports) was around US$ 158/t, while the price of US Hard Amber Durum (HAD No. 3, FOB Lakehead) stood at US$ 176/t.

Rather than reversing a decline in world wheat prices, the rising prices caused by the North American drought merely accelerated a trend that began several years earlier. Long before the full extent of the 1988 drought became apparent, world wheat prices had started climbing as supply tightened. Following six years of decline, wheat prices actually bottomed out in July-August 1986 before beginning to move up again in late 1986.

Leaving aside the short-term effects of the 1988 drought, the gradual strengthening of world wheat prices that began in mid-1986 can be attributed to a number of factors. Many traditional wheat-exporting countries registered production declines in 1986 and 1987 that led to a generally tighter global wheat supply. These production declines were partly the result of programs to reduce supply, as in the USA, and partly caused by reduced plantings that reflected lower prices in previous years, as in Argentina and Australia.

Meanwhile, poor weather in a number of wheat-producing countries, such as the USSR, and population growth in many countries that do not produce wheat, including some in Africa and West Asia, created a continuing strong demand for wheat imports. Poor weather during 1986 and 1987 also caused rice production to decline precipitously in many Asian countries, temporarily increasing the demand for wheat imports to make up for rice shortages. The fact that many leading wheat exporters were pursuing aggressive export subsidy programs to reduce excess stocks encouraged these food-deficit nations to turn to imported wheat to make up shortfalls in domestic grain production.

Many analysts view the longer term strengthening of global wheat prices as the inevitable result of policy adjustments made in a number of developed countries in response to chronic overproduction. Although real global prices of wheat (adjusted for inflation) have declined since the beginning of the century, in recent

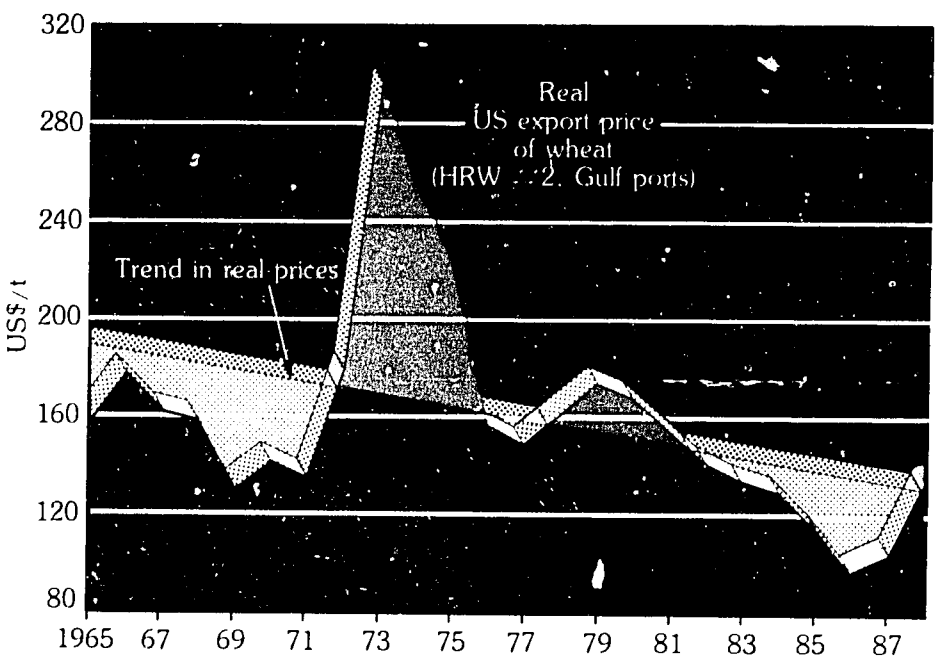


Figure 10. Movements in real export prices of wheat, 1965/88.

years real wheat prices had fallen considerably below the long-term trend (Figure 10). While there is still no reason to believe that the long-term decline in real wheat prices will reverse, in the eyes of many analysts short-run policy adjustments were needed to curb overproduction and reduce spiralling costs of farm support programs. One consequence of such policy adjustments would be to drive up real wheat prices from their abnormally low level of 1986, which may have been happening before the drought intervened to send prices sharply higher.

Exchange Rate Effects

Since most wheat price quotations are denominated in US dollars, fluctuations in the value of the US dollar relative to the value of other leading currencies influence prices received by competing wheat exporters and prices paid by wheat importers. This currency effect would be expected to influence world prices and patterns of trade.

Following unprecedented strengthening in the early 1980s, the US dollar has declined sharply in value since the beginning of 1985, losing fully 25% of its value in terms of Standard Drawing Rights (SDR) as defined by the International Monetary Fund. Assuming no change in the values of other currencies, this decline in the value of the US dollar would be expected to reduce the cost of imports for importing countries and to reduce the earnings of competing exporters. But the effects of the dollar's fall are frequently mitigated or exacerbated by various factors. For example, after adjusting for inflation, the currencies of many important wheat importers such as Algeria, China, Brazil, Egypt, and Saudi Arabia, and of some exporters such as Argentina, have actually depreciated against the US dollar since early 1985. Because of these factors, the fall in the US dollar probably has contributed little to the increase in global wheat trade that has occurred during the past two years (IWC 1987).

Freight Rates

Ocean freight rates for grains have recently rebounded from a prolonged slump, particularly rates for short hauls (Figure 11). As of September 1988, rates from US Gulf ports to Rotterdam, the reference price for short-haul ocean freight rates, stood at US$ 11.25/t, a level last seen in February 1981. Rates for long hauls have strengthened as well, although not nearly so much. As of September 1988, rates from US Gulf ports to Bangladesh, the reference price for long-haul ocean freight rates, stood at US$ 28/t, a 12% increase over mid-1987 rates but still far below the all-time highs achieved in 1980.

Two sets of factors related to supply and demand explain the recent rise in ocean freight rates. On the supply side, shipping firms reacted to generally unremunerative prices by reducing surplus tonnage during the early and mid-1980s. The world fleet of dry cargo vessels was reduced by 20 million deadweight tons from 1982 to 1987 as orders for new ship construction stagnated and record tonnage was delivered to shipbreakers. On the demand side, the modest global economic recovery of the past few years has expanded trade in minerals and primary commodities, swelling demand for shipping even as the supply was decreasing. Transatlantic trade in particular grew sharply, encouraged partly by Soviet grain purchases from the USA and Canada, which explain the relatively greater rise in short-haul ocean freight rates compared to long-haul rates.

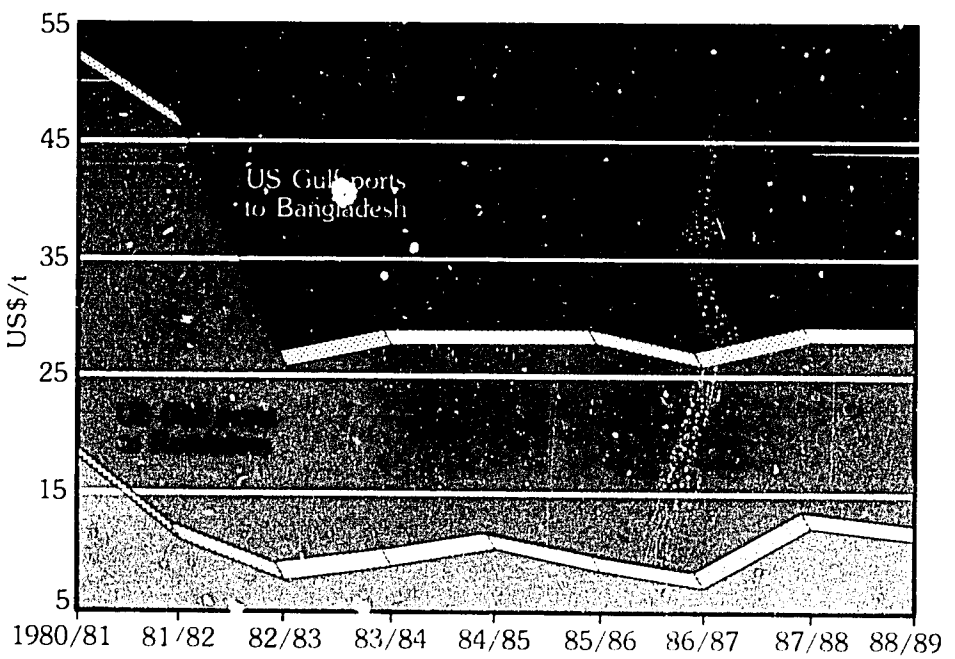


Figure 11. Representative ocean freight rates, 1980/81 to 1988/89.

Fertilizer Prices

Export prices for fertilizers fell to historical lows in 1986 before recovering slightly in 1987. During early 1988, fertilizer prices became stronger in the face of greater demand and rising petroleum prices. Later in the year, fertilizer prices drifted down again as overproduction of petroleum lowered petroleum prices. Despite the modest strengthening in prices early in 1988, prices of most fertilizers remain far below the high levels reached during the early 1980s.

One factor depressing the price of many fertilizers is continuing excess capacity in the manufacturing industry, made worse in recent years by the increased manufacturing capacity of Mexico, India, and a number of other developing countries. At the same time, the sharp decrease in cereal area in many important wheat-producing countries has reduced demand for fertilizer.

Outlook for Wheat

For the first time in years, in 1987 wheat utilization worldwide exceeded production as a result, global wheat stocks were depleted and world prices strengthened. The drought of 1988 greatly heightened those effects by reducing production in the USA and Canada and sending global wheat prices soaring. Although much of the recent tightening of wheat supplies resulted from losses associated with the drought, it is important to recognize that the drought merely accelerated a longer-term trend. Even before the drought, policies designed to reduce chronic overproduction had succeeded in diminishing plantings in many wheat-exporting countries.

Although global wheat production is expected to increase sharply in the short run as the USA and Canada boost production to reconstitute their depleted stocks, eventually the longer term problem of overproduction in developed countries will have to be addressed. To the extent that policies for controlling wheat supply are reintroduced in coming years by the leading producers, and to the extent that these policies actually reduce surpluses, global wheat supplies may cease expanding at historical rates.

Despite prospects that supply may level off in the long term, global demand for wheat and wheat-based products is expected to remain strong. Population growth in Africa, Asia, and Latin America and increasing urbanization worldwide are spurring the increase in demand for wheat at approximately 3% per year, a rate which is likely to accelerate if and when former levels of real income growth can be resumed in these regions. On the other hand, the inability on the part of many developing countries to purchase wheat will likely restrict demand. Demand for wheat is also likely to be depressed in some countries by policies introduced to limit consumption of costly imported cereals.

Future world price levels for wheat depend largely on the domestic price policies pursued by the leading producers, especially the USA and the EC. These two well-financed superexporters tend to subsidize producers heavily, whereas other exporters, such as Argentina, Australia, and Canada, tend to adopt more balanced pricing policies. During most of the 1980s, the USA and the EC could not achieve significant progress in reducing price supports to farmers, resulting in chronic overproduction and steadily accumulating wheat stocks. Both the USA and the EC chose to dispose of these stocks by implementing aggressive trading practices that facilitated disposal of surpluses (e.g., subsidized credit, price discounts). However, the excessive cost of this strategy has led to increased calls for policy reforms to reduce the surpluses. The 1985 Food Security Act (Farm Bill) introduced a number of measures designed to lower producer prices and reduce area. Although the preliminary evidence suggests that the policy adjustments are succeeding in reducing the area planted to wheat, additional measures will probably be necessary on both sides of the Atlantic to bring production fully under control.

Future availability and prices of wheat also depend on production levels in a number of key Eastern bloc and developing countries. The USSR has recently embarked upon an ambitious program to introduce improved wheat production technologies. Future Soviet purchases on the world market will depend heavily on whether these improved technologies can increase yields as anticipated. China has made remarkable progress in increasing production of wheat and other cereals, but more recent developments suggest that Chinese policymakers are shifting to a strategy of concentrating on high-value export crops at the cost of reduced levels of domestic food grain production. This strategy, if pursued to an extreme, could result in large future increases in wheat imports into China. And India, a relatively unimportant actor in global wheat markets, could once again become a major importer if demand for wheat outstrips the huge production increases achieved as a result of the Green Revolution.

Part 3: Selected Wheat Statistics

The tables that follow present 41 statistics related to wheat production, trade, utilization, and prices, as well as some basic economic indicators. The statistics were selected to provide the latest available information; most of the production statistics include 1987 data. (Note however that data up to 1986 are the basis of the analysis presented in Part 1 of this report.) Some of the statistics were assembled especially for Part 1, including the percentage of wheat area by type, moisture regime, adoption of semidwarf varieties, fertilizer applied, and irrigated crop area.

Countries listed in the tables are classified either as wheat producers or consumers. Wheat consumers include developing countries consuming over 100,000 tons of wheat per year and developed countries consuming more than 1 million tons of wheat per year from 1984 to 1986. Wheat producers include developing countries in which wheat production exceeded 100,000 t/yr from 1985 to 1987 or accounted for 50% of total wheat consumption from 1984 to 1986, and developed countries in which wheat production exceeded 1 million tons per year from 1985 to 1987 or accounted for 50% of total wheat consumption from 1984 to 1986. Unless otherwise indicated, the regional aggregates given in the last table include all of the countries of a particular region (see Annex 1, p. 54), regardless of whether they are included in the preceding tables.

Notes on the Variables

Variable 1: The source of this information was the FAO tapes of population statistics (1987).

Variable 2: The source of this variable was the World Bank *World Development Report* (1988).

Variable 3: The source of this variable was the World Bank's *World Development Report* (1988).

Variables 4-20 and 38: The sources of these variables were the FAO tapes of population statistics (1988). Growth rates were calculated using the standard formula for annual percentage compound growth:

$$X_t = X_0 [1 + (g/100)]^t$$

where:

- X_t = average of data for ending period
- X_0 = average of data for base period
- t = number of years from the midpoint of one period to that of the other
- g = average annual percent growth rate

Variables 21-23: The sources of these data were the FAO tapes of trade statistics (1987 and 1988); the FAO Commodities and Trade Division 1987 computer printout; and the USDA supply and utilization tables (1987). Net imports are imports minus exports. Negative numbers indicate that the country is a net exporter. Utilization was calculated as production plus net imports minus stock changes. Data on opening and closing stocks are from USDA and the FAO Commodities and Trade Division. Growth rates were calculated using the standard formula given above.

Variables 24-34: These data (which are for 1984-86) were collected through a general country survey of knowledgeable wheat scientists. The survey was conducted to obtain background information for Part 1 of this report. Some data were estimated by CIMMYT staff. Regional totals and regional averages in some instances are based on data from a subset of countries in the region.

Variable 35: The source for this variable was the FAO *Production Yearbook* (various years).

Variable 36: Data for this variable were based on Martinez and Diamond (1982); International Fertilizer Development Center *Fertilizer Use Statistics in Crop Production;* the FAO *Fertilizer Use by Major Crops* (1984); the FAO *Fertilizer Yearbook* (1986); and CIMMYT estimates. These data were updated to 1985 assuming that fertilizer use on wheat changed at the same rate as for all crops.

Variable 37: The source for this variable was the FAO *Fertilizer Yearbook* (various years). Data reported are total fertilizer applied per hectare of arable land and permanent crops.

Variables 39-41: These data were collected through a general country survey of wheat scientists and economists. Data for the majority of the countries refer to the wheat crop harvested in 1986/87, although in some cases 1985/86 is the reference year. The wheat price is the postharvest price received by farmers. The nitrogen price is usually the price paid by farmers for the most common nitrogen fertilizer. In some countries, the price of compound fertilizer only was available, and variable 40 refers to the price of nutrient only, whether it is N, P_2O_5, and/or K_2O.

Eastern and Southern Africa

		Producers				
		Ethiopia	Kenya	Sudan	Tanzania	Zimbabwe
General indicators	1. Estimated population, 1987 (million)	45.8	22.3	22.7	24.2	9.4
	2. Estimated growth rate of population 1986-2000 (%/yr)	2.9	3.9	2.9	3.4	3.0
	3. Per capita income, 1986 (US$)	120	300	320	250	620
	4. Per capita cereal production, 1985-87 (kg/yr)	122	145	142	157	282
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	-1.2	-1.6	0.2	1.8	0.1
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	600	132	106	44	39
	7. Wheat yield, 1985-87 (t/ha)	1.3	2.0	1.4	1.6	5.7
	8. Wheat production, 1985-87 (000 t)	800	261	145	72	223
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	-0.9	1.3	6.3	..	..
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	-1.0	0.7	2.7	..	12.4
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	1.3	1.4	-9.1	..	0.9
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	2.4	1.7	0.6	..	..
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	2.6	1.9	1.2	..	4.5
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	3.0	2.4	3.4	..	3.7
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	1.5	3.0	7.0	..	..
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	1.5	2.7	3.9	..	17.5
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	4.4	3.9	-6.0	..	4.6
	18. Wheat area as percent of total cereal area, 1985-87 (%)	13	6	2	..	2
	19. Average yield of all cereals, 1985-87 (t/ha)	1.2	1.5	0.5	1.1	1.5
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	1.6	0.5	-0.5	1.2	3.0
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	699	171	783	67	80
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	30	19	40	6	29
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	1.2	4.8	4.6	0.1	2.1
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	43	100	100	..	100
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	0	0	0	..	0
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	0	0	0	..	0
	27. Percent of total wheat area sown to durum wheat, mid-1980s	57	0	0	..	0
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	10	83	100	100	100
	29. Percent of total wheat area irrigated, mid-1980s	..	0	100	..	100
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	100	..	100
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	..	100	0	..	0
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	10	83	..	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	..	0	0	..	0
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	2.5	6.2	2.9	6.1	8.4
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	11	..	88	..	279
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	4	38	6	5	60
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	19.7	7.0	2.3	15.6	..
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	..	194	3,080	144	176
	40. Ratio of farm level nitrogen price to wheat price, 1986/87	..	2.3	0.3	..	4.6
	41. Farm wage in kg of wheat per day, 1986/87	..	6	1	..	11

Eastern and Southern Africa, continued

		Consumers		
		Mozambique	Somalia	Regional total or average
General indicators	1. Estimated population, 1987 (million)	14.7	4.9	202.8
	2. Estimated growth rate of population, 1986-2000 (%/yr)	3.0	3.1	3.2
	3. Per capita income, 1986 (US$)	210	280	255
	4. Per capita cereal production, 1985-87 (kg/yr)	39	123	133
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	-3.8	1.2	-0.7
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	4	4	992
	7. Wheat yield, 1985-87 (t/ha)	1.1	0.4	1.6
	8. Wheat production, 1985-87 (000 t)	4	1	1,582
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	..	..	0.1
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	..	..	-0.3
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	..	..	-0.8
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	..	..	2.6
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	..	..	3.0
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	..	..	3.1
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	..	..	2.5
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	..	..	2.7
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	..	..	2.3
	18. Wheat area as percent of total cereal area, 1985-87 (%)	..	..	4
	19. Average yield of all cereals, 1985-87 (t/ha)	0.6	0.7	1.1
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	-0.5	0.9	0.9
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	106	161	2,450
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	9	32	20
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	0.9	7.8	2.0
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	..	..	61
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	..	..	0
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	..	..	0
	27. Percent of total wheat area sown to durum wheat, mid-1980s	..	..	39
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	..	..	39
	29. Percent of total wheat area irrigated, mid-1980s	..	..	..
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	..
	31. Percent of total wheat area in high rainfall regions (≥ 500 mm), mid-1980s	..	..	..
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	..	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	..	..	..
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	2.3	-0.3	3.4
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	..	..	31
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	8	2	10
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	7.5	5.0	8.8
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	..	..	..
	40. Ratio of farm level nitrogen price to wheat price, 1986/87	..	..	..
	41. Farm wage in kg of wheat per day, 1986/87	..	..	..

West Africa

		Consumers						
		Angola	Côte D'Ivoire	Mauritania	Nigeria	Senegal	Zaire	Regional total or average
General indicators	1. Estimated population, 1987 (million)	9.2	10.5	2.0	101.3	6.8	31.8	244.4
	2. Estimated growth rate of population, 1986-2000 (%/yr)	2.8	3.6	2.8	3.3	3.0	3.0	3.1
	3. Per capita income, 1986 (US$)	..	730	420	640	420	160	538
	4. Per capita cereal production, 1985-87 (kg/yr)	39	106	48	116	161	37	107
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	-4.3	0.1	-2.8	-1.8	-0.7	1.4	-1.1
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	4	0	1	25	0	26	71
	7. Wheat yield, 1985-87 (t/ha)	0.6	..	1.0	2.5	..	0.8	1.4
	8. Wheat production, 1985-87 (000 t)	3	0	1	63	0	20	103
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	..	..	..	..	..	5.2	3.1
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	..	..	..	4.3	..	10.7	3.0
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	..	..	..	8.9	..	19.1	7.1
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	..	..	..	..	..	0.1	1.4
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	..	..	..	1.5	..	-1.2	0.1
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	..	..	..	3.3	..	3.5	1.6
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	..	..	..	..	..	5.3	4.5
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	..	..	..	5.8	..	9.3	3.1
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	..	..	..	12.4	..	23.3	8.8
	18. Wheat area as percent of total cereal area, 1985-87 (%)	..	..	..	0.3	..	2	0.2
	19. Average yield of all cereals, 1985-87 (t/ha)	0.5	0.9	0.6	1.2	0.8	0.9	0.9
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	-1.0	1.9	1.3	1.6	1.6	-0.3	0
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	108	230	126	886	113	248	2,491
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	21	22	81	14	20	7	13
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	2.6	0.7	10.2	9.9	2.7	2.7	5.2
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	..	..	..	..	..	..	..
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	..	..	..	..	..	..	..
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	..	..	..	..	..	..	..
	27. Percent of total wheat area sown to durum wheat, mid-1980s	..	..	..	..	..	..	..
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	..	..	..	..	..	..	..
	29. Percent of total wheat area irrigated, mid-1980s	..	..	..	..	..	..	..
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	..	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	..	..	..	..	..	..	..
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	..	..	..	..	..	..	..
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	..	12.0	..	23.2	4.2	..	10.6
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	..	..	..	..	..	..	..
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	4	11	6	8	5	1	6
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	4.4	12.9	..	24.8	0.7	13.4	13.5
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	..	..	..	..	..	..	..
	40. Ratio of farm level nitrogen price to wheat price, 1986/87	..	..	..	..	..	..	..
	41. Farm wage in kg of wheat per day, 1986/87	..	..	..	..	..	..	..

		Producers					
		Algeria	Egypt	Libya	Morocco	Tunisia	Regional total or average
General indicators	1. Estimated population, 1987 (million)	23.1	49.2	3.9	23.0	7.2	106.5
	2. Estimated growth rate of population, 1986-2000 (%/yr)	2.9	2.2	3.6	2.2	2.2	2.4
	3. Per capita income, 1986 (US$)	2,590	760	..	590	1,140	1,159
	4. Per capita cereal production, 1985-87 (kg/yr)	110	190	70	255	216	185
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	-1.5	-0.6	-0.8	0.1	0.2	-0.5
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	1,589	527	280	2,135	848	5,390
	7. Wheat yield, 1985-87 (t/ha)	0.8	4.1	0.6	1.3	1.3	1.4
	8. Wheat production, 1985-87 (000 t)	1,242	2,174	166	2,762	1,071	7,417
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	0.1	-0.4	2.4	1.7	0.1	0.7
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	-0.9	0.3	1.7	0.7	0.0	0.1
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	-2.9	-0.6	1.8	1.3	-1.3	-0.7
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	0.5	2.3	5.4	1.9	2.4	1.6
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	1.6	2.2	3.6	2.7	2.4	2.4
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	1.6	2.0	5.0	3.8	4.7	3.1
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	0.7	1.9	7.9	3.6	2.6	2.3
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	0.7	2.4	5.3	3.4	2.4	2.5
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	-1.4	1.4	6.9	5.1	3.3	2.4
	18. Wheat area as percent of total cereal area, 1985-87 (%)	55	27	67	43	55	46
	19. Average yield of all cereals, 1985-87 (t/ha)	0.9	4.7	0.6	1.1	1.0	1.6
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	0.6	1.9	3.2	1.4	1.9	1.5
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	3,530	6,799	705	1,772	795	13,602
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	224	184	236	207	225	202
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	3.0	2.2	3.5	2.2	1.3	2.4
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	36	100	85	30	11	38
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	0	0	0	0	0	0
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	0	0	0	0	0	0
	27. Percent of total wheat area sown to durum wheat, mid-1980s	64	0	15	70	89	62
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	31	58	67	50	36	44
	29. Percent of total wheat area irrigated, mid-1980s	0	100	38	4	0	13
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	100	58	90	100	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	17	0	0	40	39	27
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	33	..	..	33	50	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	83	0	63	56	61	60
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	0	..	53	0	50	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	1.1	-0.1	3.2	4.9	4.9	0.8
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	..	276	..	34	..	..
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	25	329	38	29	17	56
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	6.3	5.6	17.1	8.4	7.0	6.2
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	467	118	481	240	81	..
	40. Ratio of farm level nitrogen price to wheat price, 1986/87	1.1	2.5	1.2	1.0	..	..
	41. Farm wage in kg of wheat per day, 1986/87	38	16	24	12	.	..

West Asia

		Producers					
		Afghanistan	Iran	Iraq	Saudi Arabia	Syria	Turkey
General indicators	1. Estimated population, 1987 (million)	17.8	47.4	17.0	12.4	11.3	51.4
	2. Estimated growth rate of population, 1986-2000 (%/yr)	.	3.0	3.6	3.8	3.3	1.9
	3. Per capita income, 1986 (US$)	..	..	..	6,950	1,570	1,110
	4. Per capita cereal production, 1985-87 (kg/yr)	255	256	139	189	245	564
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	-0.9	1.0	-2.5	3.5	-1.7	0.5
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	2,309	6,369	1,213	579	1,178	9,356
	7. Wheat yield, 1985-87 (t/ha)	1.2	1.2	0.9	3.7	1.5	2.0
	8. Wheat production, 1985-87 (000 t)	2,767	7,388	1,055	2,164	1,773	18,332
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	0.4	3.1	0.7	8.0	0.7	2.0
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	0.1	1.2	-0.5	10.4	0.4	0.7
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	-0.2	1.1	-0.3	23.7	-3.0	0.0
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	0.9	0.7	1.8	2.8	1.5	2.2
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	1.0	1.9	1.4	4.0	3.1	2.6
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	0.0	1.5	1.4	8.3	4.7	1.3
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	1.3	3.9	2.5	11.0	2.2	4.3
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	1.2	3.2	0.8	14.7	3.5	3.3
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	-0.2	2.6	1.1	33.9	1.6	1.3
	18. Wheat area as percent of total cereal area, 1985-87 (%)	69	70	48	90	43	68
	19. Average yield of all cereals, 1985-87 (t/ha)	1.3	1.3	0.9	3.5	1.0	2.1
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	1.0	0.7	0.8	2.9	0.3	2.2
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	74	2,608	2,706	-122	794	208
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	165	209	243	161	237	365
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	-0.6	1.3	3.4	4.6	1.5	1.0
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	91	24	89	100	50	19
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	9	25	0	0	0	48
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	0	50	0	0	0	5
	27. Percent of total wheat area sown to durum wheat, mid-1980s	0	1	11	0	50	28
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	38	29	50	100	41	45
	29. Percent of total wheat area irrigated, mid-1980s	43	35	..	100	13	1
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	73	56	..	100	90	100
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	9	8	..	0	10	25
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	..	80	..	..	85	81
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	48	58	..	0	77	74
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	0	6	..	..	27	33
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	0.9	0.3	1.5	2.1	0.0	2.3
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	22	61	..	293	..	81
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	7	61	19	156	30	53
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	23.4	19.9	19.9	13.2	12.7	13.9
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	..	588	..	554	662	132
	40. Ratio of farm-level nitrogen price to wheat price, 1986/87	..	0.4	..	0.6	0.8	3.6
	41. Farm wage in kg of wheat per day, 1986/87	..	44	..	18	10	23

West Asia, continued

		Consumers						
		Jordan	Kuwait	Lebanon	United Arab Emir.	Yemen Arab Rep.	Yemen Dem.	Regional total or average
General indicators	1. Estimated population, 1987 (million)	3.8	1.9	2.8	1.4	7.3	2.3	179.5
	2. Estimated growth rate of population, 1986-2000 (%/yr)	3.1	2.9	..	2.8	3.0	2.8	2.8
	3. Per capita income, 1986 (US$)	1,540	13,890	..	14,680	550	470	2,423
	4. Per capita cereal production, 1985-87 (kg/yr)	27	1	8	4	83	55	302
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	-6.9	..	-7.1	..	-4.0	0.1	-0.1
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	90	0	15	1	64	11	21,310
	7. Wheat yield, 1985-87 (t/ha)	0.8	..	1.2	1.3	1.3	1.5	1.6
	8. Wheat production, 1985-87 (000 t)	73	0	18	1	83	17	33,680
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	-1.1	..	-4.1	..	4.2	4.8	1.9
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	-5.2	..	-7.3	..	4.9	0.9	0.8
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	-3.5	..	-10.1	..	0.3	-1.3	0.3
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	-0.1	..	1.3	..	0.7	-0.1	1.8
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	-1.2	..	1.4	..	1.3	-1.9	2.4
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	5.7	..	0.3	..	2.4	-2.3	1.7
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	-1.2	..	-2.8	..	4.9	4.7	3.7
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	-6.3	..	-6.1	..	6.3	-1.1	3.2
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	2.0	..	-9.8	..	2.7	-3.6	2.1
	18. Wheat area as percent of total cereal area, 1985-87 (%)	68	..	80	..	8	16	64
	19. Average yield of all cereals, 1985-87 (t/ha)	0.8	4.6	1.2	..	0.7	1.7	1.6
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	-0.7	..	0.7	..	0.0	2.8	1.6
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	582	138	353	202	775	197	8,560
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	102	56	150	142	111	110	239
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	-3.6	-4.0	0.4	2.9	13.8	1.9	1.1
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	..	..	..	..	..	..	36
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	..	..	..	..	..	..	30
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	..	..	..	..	..	..	17
	27. Percent of total wheat area sown to durum wheat, mid-1980s	..	..	..	..	..	..	17
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	18	..	..	..	..	..	41
	29. Percent of total wheat area irrigated, mid-1980s	3	..	..	..	..	..	20
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	..	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	13	..	..	..	..	..	16
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	84	..	..	..	..	..	64
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	-1.9	..	2.9	2.6	1.7	5.1	1.0
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	..	..	..	..	..	..	74
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	30	315	119	276	9	11	45
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	13.1	..	3.3	..	..	..	14.8
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	351	..	172	..	..	..	..
	40. Ratio of farm level nitrogen price to wheat price, 1986/87	..	..	..	..	..	..	..
	41. Farm wage in kg of wheat per day, 1986/87	..	..	..	..	..	..	..

South Asia

		Producers					Consumer	Regional total or average
		Bangladesh	Burma	India	Nepal	Pakistan	Sri Lanka	
General indicators	1. Estimated population, 1987 (million)	106.6	38.7	788.3	17.3	105.6	16.7	1,074.9
	2. Estimated growth rate of population, 1986-2000 (%/yr)	2.5	2.3	1.8	2.5	3.0	1.5	2.0
	3. Per capita income, 1986 (US$)	160	200	290	150	350	400	279
	4. Per capita cereal production, 1985-87 (kg/yr)	229	390	205	245	184	152	211
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	-0.7	0.6	0.4	-1.2	1.4	2.1	0.4
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	600	113	23,124	490	7,456	0	31,828
	7. Wheat yield, 1985-87 (t/ha)	2.0	1.7	2.0	1.2	1.7		1.9
	8. Wheat production, 1985-87 (000 t)	1,179	196	45,566	611	12,547	0	60,115
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	7.8	6.0	2.6	3.7	1.6	..	2.4
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	12.3	-0.8	2.9	7.5	1.7	..	2.7
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	15.2	2.8	1.6	4.3	2.0	..	1.9
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	3.4	5.6	3.0	0.9	1.7	..	2.6
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	5.3	5.5	4.1	0.0	3.7	..	4.0
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	3.7	8.6	3.6	1.1	1.9	..	3.2
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	11.5	12.0	5.7	4.6	3.3	..	5.0
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	18.2	4.7	7.2	7.5	5.5	..	6.9
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	19.5	11.6	5.2	5.4	4.0	..	5.1
	18. Wheat area as percent of total cereal area, 1985-87 (%)	6	2	23	19	66	..	24
	19. Average yield of all cereals, 1985-87 (t/ha)	2.2	2.8	1.6	1.6	1.7	3.0	1.7
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	1.2	2.1	2.1	-0.4	1.8	2.4	1.9
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	1,525	0	-237	4	1,074	620	3,004
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	28	5	59	35	129	43	60
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	5.8	2.7	2.6	5.0	1.4	1.5	2.5
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	100	..	87	98	100	..	90
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	0	..	0	0	0	..	0
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	0	..	0	2	0	..	0
	27. Percent of total wheat area sown to durum wheat, mid-1980s	0	..	13	0	0	..	10
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	100	..	85	87	85	..	85
	29. Percent of total wheat area irrigated, mid-1980s	40	..	72	92	81	..	74
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	100	..	100	95	93	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	60	..	23	0	14	..	22
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	100	..	55	..	51	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	0	..	5	8	5	..	4
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	0	0	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	6.8	2.2	2.2	9.5	1.5	2.1	2.1
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	85	15	78	..	102	..	83
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	54	15	40	14	60	75	41
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	13.3	16.7	12.6	19.5	15.4	3.1	12.6
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	167	.	129	164	120	..	..
	40. Ratio of farm level nitrogen price to wheat price, 1986/87	2.0		3.0	2.8	3.0	..	..
	41. Farm wage in kg of wheat per day, 1986/87	4		12	34	14	..	..

Consumers

		Hong Kong	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam	Regional total or average
General indicators	1. Estimated population, 1987 (million)	5.7	172.9	16.3	57.3	2.6	53.3	62.5	389.8
	2. Estimated growth rate of population, 1986-2000 (%/yr)	1.0	1.8	1.9	2.3	0.8	1.6	2.4	2.0
	3. Per capita income, 1986 (US$)	6,910	490	1,830	560	7,410	810	..	808
	4. Per capita cereal production, 1985-87 (kg/yr)	0	263	121	233	..	444	269	269
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	..	2.5	-0.3	1.3	..	0.3	0.1	1.1
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	0	0	0	0	0	0	0	0
	7. Wheat yield, 1985-87 (t/ha)	0	0	0	0	0	0	0	0
	8. Wheat production, 1985-87 (000 t)	..	..	..	..	..	..	..	..
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	..	..	..	..	..	..	..	..
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	..	..	..	..	..	..	..	..
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	..	..	..	..	..	..	..	..
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	..	..	..	..	..	..	..	..
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	..	..	..	..	..	..	..	..
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	..	..	..	..	..	..	..	..
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	..	..	..	..	..	..	..	..
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	..	..	..	..	..	..	..	..
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	..	..	..	..	..	..	..	..
	18. Wheat area as percent of total cereal area, 1985-87 (%)	..	..	..	..	..	..	..	..
	19. Average yield of all cereals, 1985-87 (t/ha)	..	3.5	2.9	1.9	..	2.1	2.7	2.6
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	..	2.5	2.0	1.6	..	1.2	2.0	2.0
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	215	1,553	571	841	159	192	162	3,921
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	37	9	36	15	63	3	2	10
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	0.9	15.6	1.3	0.0	2.0	5.5	-3.5	2.9
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	..	..	..	..	..	..	..	..
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	..	..	..	..	..	..	..	..
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	..	..	..	..	..	..	..	..
	27. Percent of total wheat area sown to durum wheat, mid-1980s	..	..	..	..	..	..	..	..
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	..	..	..	..	..	..	..	..
	29. Percent of total wheat area irrigated, mid-1980s	..	..	..	..	..	..	..	..
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	..	..	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	..	..	..	..	..	..	..	..
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..	..	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	..	..	..	..	..	..	..	..
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	..	1.7	1.8	3.4	..	3.5	2.8	2.5
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	..	..	..	..	..	..	..	..
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	..	79	109	31	790	21	47	48
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	..	12.6	9.0	5.0	7.1	12.0	5.0	9.6
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	..	..	..	..	..	..	..	..
	40. Ratio of farm-level nitrogen price to wheat price, 1986/87	..	..	..	..	..	..	..	..
	41. Farm wage in kg of wheat per day, 1986/87	..	..	..	..	..	..	..	..

East Asia

		Producers			Consumer	Regional total or average
		China	North Korea	Mongolia	South Korea	
General indicators	1. Estimated population, 1987 (million)	1,086.0	21.4	2.0	42.5	1,151.9
	2. Estimated growth rate of population, 1986-2000 (%/yr)	1.4	2.1	2.4	1.2	1.4
	3. Per capita income, 1986 (US$)	300	..	..	2,370	379
	4. Per capita cereal production, 1985-87 (kg/yr)	328	534	452	201	327
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	2.2	1.8	1.9	-0.6	2.1
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	29,253	205	473	2	29,958
	7. Wheat yield, 1985-87 (t/ha)	3.0	3.8	1.4	3.4	3.0
	8. Wheat production, 1985-87 (000 t)	87,875	773	682	6	89,337
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	0.8	3.2	8.0	..	0.8
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	0.9	2.8	1.5	..	0.9
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	0.4	3.6	3.7	..	0.5
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	4.2	2.8	2.8	..	4.1
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	5.3	3.8	3.2	..	5.2
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	6.3	5.1	4.0	..	6.3
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	5.0	6.1	11.1	..	5.0
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	6.2	6.7	4.8	..	6.2
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	6.8	8.9	7.8	..	6.8
	18. Wheat area as percent of total cereal area, 1985-87 (%)	33	8	75	0	32
	19. Average yield of all cereals, 1985-87 (t/ha)	3.9	4.5	1.4	5.6	3.9
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	3.3	3.0	2.8	2.3	3.2
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	9,256	360	3	3,518	13,137
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	90	43	326	73	89
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	4.0	1.2	1.5	5.6	4.0
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	57	..	..	0	57
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	21	..	..	100	21
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	22	..	..	0	22
	27. Percent of total wheat area sown to durum wheat, mid-1980s	0	..	..	0	0
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	60	..	..	..	60
	29. Percent of total wheat area irrigated, mid-1980s	31	..	..	..	31
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	60	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	55	..	..	..	55
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	60	..	..	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	14	..	..	..	14
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	50	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	0.8	3.8	13.6	1.8	0.9
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)		..	..	..	..
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	166	349	12	352	172
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	13.8	7.8	..	4.1	12.6
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	156	..	..	476	..
	40. Ratio of farm-level nitrogen price to wheat price, 1986/87	2.7	..	..	1.3	..
	41. Farm wage in kg of wheat per day, 1986/87	10	..	..	19	

		Producer	Consumers				
		Mexico	Costa Rica	Cuba	Dominican Republic	El Salvador	Guatemala
General indicators	1. Estimated population, 1987 (million)	82.9	2.7	10.3	6.5	5.9	8.5
	2. Estimated growth rate of population, 1986-2000 (%/yr)	2.1	2.1	0.8	2.1	1.9	2.7
	3. Per capita income, 1986 (US$)	1,860	1,480	710	820	930	330
	4. Per capita cereal production, 1985-87 (kg/yr)	298	121	61	92	114	152
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	0.8	0.7	2.4	2.6	0.1	0.0
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	1,157	0	0	0	0	30
	7. Wheat yield, 1985-87 (t/ha)	4.1	..	..	..	..	1.5
	8. Wheat production, 1985-87 (000 t)	4,798	0	0	0	0	47
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	1.9	..	..	..	..	-0.1
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	1.9	..	..	..	..	-0.2
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	3.8	..	..	..	..	-2.7
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	4.2	..	..	..	..	2.8
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	2.6	..	..	..	..	2.5
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	1.4	..	..	..	..	2.2
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	6.2	..	..	..	..	2.6
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	4.5	..	..	..	..	2.3
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	5.3	..	..	..	..	-0.6
	18. Wheat area as percent of total cereal area, 1985-87 (%)	10	..	..	..	..	4
	19. Average yield of all cereals, 1985-87 (t/ha)	2.2	2.2	2.6	3.7	1.7	1.6
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	2.8	1.4	2.8	2.9	0.8	2.2
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	406	125	1,468	253	140	147
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	66	47	142	32	29	27
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	2.8	0.9	3.3	3.2	3.2	1.1
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	90	..	..	..	..	..
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	0	..	..	..	..	..
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	0	..	..	..	..	..
	27. Percent of total wheat area sown to durum wheat, mid-1980s	10	..	..	..	..	..
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	100	..	..	..	..	..
	29. Percent of total wheat area irrigated, mid-1980s	85	..	..	..	..	..
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	100	..	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	10	..	..	..	..	..
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	100	..	..	..	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	5	..	..	..	..	..
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	100	..	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	2.9	4.6	6.5	2.4	9.5	3.3
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	261	..	..	..	..	..
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	64	128	179	36	117	48
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	9.5	4.3	4.5	5.3	4.0	7.4
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	95	..	..	..	..	..
	40. Ratio of farm level nitrogen price to wheat price, 1986/87	1.6	..	..	..	..	..
	41. Farm wage in kg of wheat per day, 1986/87	23	..	..	..	..	..

Mexico, Central America, and the Caribbean, continued

		Consumers				
		Haiti	Honduras	Jamaica	Trinidad & Tobago	Regional total or average
General indicators	1. Estimated population, 1987 (million)	6.9	4.7	2.4	1.2	140.2
	2. Estimated growth rate of population, 1986-2000 (%/yr)	2.0	3.0	1.4	1.3	2.1
	3. Per capita income, 1986 (US$)	740	840	5,360	1,554	..
	4. Per capita cereal production, 1985-87 (kg/yr)	66	114	4	6	214
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	-2.6	-1.7	-0.8	-3.7	0.8
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	0	1	0	0	1,189
	7. Wheat yield, 1985-87 (t/ha)	..	0.7	..	..	4.1
	8. Wheat production, 1985-87 (000 t)	0	1	0	0	4,845
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	..	..	..	..	1.8
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	..	..	..	..	1.9
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	..	..	..	..	3.6
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	..	..	..	..	4.2
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	..	..	..	..	2.6
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	..	..	..	..	1.5
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	..	..	..	..	6.1
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	..	..	..	..	4.5
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	..	..	..	..	5.2
	18. Wheat area as percent of total cereal area, 1985-87 (%)	..	..	..	..	9
	19. Average yield of all cereals, 1985-87 (t/ha)	1.2	1.5	1.7	2.4	2.1
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	1.0	1.7	1.3	0.5	2.5
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	167	112	186	113	3,427
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	26	23	76	88	61
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	3.4	3.0	-0.3	-0.5	2.3
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	..	..	..	..	90
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	..	..	..	..	0
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	..	..	..	..	0
	27. Percent of total wheat area sown to durum wheat, mid-1980s	..	..	..	..	10
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	..	..	..	..	100
	29. Percent of total wheat area irrigated, mid-1980s	..	..	..	..	85
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	..	..	..	..	10
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	..	..	..	..	5
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	3.1	1.7	1.9	3.3	3.3
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	..	..	..	..	261
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	5	15	60	48	70
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	21.3	2.7	-0.6	0.3	7.1
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	..	..	..	..	..
	40. Ratio of farm-level nitrogen price to wheat price, 1986/87	..	..	..	..	..
	41. Farm wage in kg of wheat per day, 1986/87	..	..	..	..	..

Andean Region, South America

		Producer	Consumers				
		Peru	Bolivia	Colombia	Ecuador	Venezuela	Regional total or average
General indicators	1. Estimated population, 1987 (million)	20.7	6.7	29.9	9.9	18.3	87.0
	2. Estimated growth rate of population, 1986-2000 (%/yr)	2.1	2.6	1.8	2.4	2.2	2.1
	3. Per capita income, 1986 (US$)	1,090	600	1,230	1,160	2,920	1,498
	4. Per capita cereal production, 1985-87 (kg/yr)	99	145	114	92	121	117
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	-0.4	1.0	0.7	-0.9	2.2	0.5
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	93	105	43	17	1	260
	7. Wheat yield, 1985-87 (t/ha)	1.2	0.7	1.7	1.1	0.4	1.1
	8. Wheat production, 1985-87 (000 t)	115	79	75	18	0.4	287
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	-1.3	1.5	-3.6	-3.2	..	-1.5
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	-2.4	2.8	-4.0	-6.8	..	-1.9
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	-3.1	2.7	3.1	-12.1	..	-1.6
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	0.8	0.6	2.5	2.8	..	1.2
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	1.4	0.5	2.5	0.6	..	0.9
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	2.5	-0.4	4.0	1.7	..	1.8
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	-0.5	2.1	-1.2	-0.5	..	-0.3
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	-1.0	3.3	-1.6	-6.3	..	-1.1
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	-0.7	2.3	7.1	-10.6	..	0.2
	18. Wheat area as percent of total cereal area, 1985-87 (%)	11	15	3	3	..	6
	19. Average yield of all cereals, 1985-87 (t/ha)	2.4	1.4	2.6	1.8	2.0	2.2
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	1.6	0.7	2.6	1.9	2.3	1.9
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	989	305	661	243	1,063	3,329
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	54	68	25	27	59	42
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	0.2	1.2	1.6	0.9	-0.2	0.5
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	70	..	..	..	..	..
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	0	..	..	..	..	..
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	0	..	..	..	..	..
	27. Percent of total wheat area sown to durum wheat, mid-1980s	30	..	..	..	..	..
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	31	..	..	..	..	..
	29. Percent of total wheat area irrigated, mid-1980s	3	..	..	..	..	..
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	97	..	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	36	..	..	..	..	..
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	40	..	..	..	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	61	..	..	..	..	..
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	10	..	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	0.7	3.7	1.6	0.9	1.9	0.9
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	4	..	23	..	..	11
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	28	2	55	28	53	37
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	-1.9	4.7	4.2	8.7	12.5	4.4
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	289	88	257	276	..	..
	40. Ratio of farm level nitrogen price to wheat price, 1986/87	1.5	..	..	..	..	..
	41. Farm wage in kg of wheat per day, 1986/87	6.7	..	..	..	..	..

Southern Cone, South America

		Producers					
		Argentina	Brazil	Chile	Paraguay	Uruguay	Regional total or average
General indicators	1. Estimated population, 1987 (million)	31.5	141.3	12.4	3.9	3.1	192.2
	2. Estimated growth rate of population, 1986-2000 (%/yr)	1.1	1.9	1.2	2.5	0.7	1.7
	3. Per capita income, 1986 (US$)	2,350	1,810	1,320	1,000	1,900	1,852
	4. Per capita cereal production, 1985-87 (kg/yr)	837	283	214	283	324	370
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	0.5	1.3	0.6	4.8	0.4	0.8
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	5,097	3,338	584	175	189	9,364
	7. Wheat yield, 1985-87 (t/ha)	1.8	1.6	2.7	1.5	1.4	1.8
	8. Wheat production, 1985-87 (000 t)	9,167	5,353	1,555	264	262	16,601
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	0.2	4.7	-0.8	12.8	-2.6	0.9
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	-0.1	7.6	-1.2	14.3	-3.5	1.4
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	-0.2	0.4	-1.4	21.0	-7.8	-0.2
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	1.2	2.1	2.2	3.0	1.1	1.3
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	1.8	3.6	2.4	1.4	1.9	1.8
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	1.2	8.1	5.7	4.6	4.6	3.4
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	1.5	6.9	1.3	16.3	-1.6	2.3
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	1.7	11.5	1.2	15.9	-1.6	3.2
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	1.0	8.5	4.2	26.5	-3.6	3.2
	18. Wheat area as percent of total cereal area, 1985-87 (%)	49	15	71	25	38	27
	19. Average yield of all cereals, 1985-87 (t/ha)	2.5	1.8	3.2	1.6	2.0	2.0
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	1.9	0.9	2.5	0.7	2.4	1.4
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	-6,008	3,019	220	38	60	-2,670
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	111	56	150	72	132	73
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	-1.5	2.5	-0.8	2.5	-1.6	0.2
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	99	100	48	100	100	96
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	0	0	25	0	0	1
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	0	0	27	0	0	2
	27. Percent of total wheat area sown to durum wheat, mid-1980s	1	0	0	0	0	1
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	90	37	83	91	75	73
	29. Percent of total wheat area irrigated, mid-1980s	0	1	24	0	0	1.7
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	60	100	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	100	99	76	100	100	98
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	90	28	78	91	75	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	0	0	0	0	0	0
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	2.3	7.0	0.7	3.7	5.3	3.2
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	13	98	149	68	..	48
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	3	36	26	5	36	25
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	6.8	8.2	0.7	7.2	3.7	7.6
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	48	240	166	101	126	..
	40. Ratio of farm-level nitrogen price to wheat price, 1986/87	8.1	1.9	..	6.6	7.3	..
	41. Farm wage in kg of wheat per day, 1986/87	..	12	..	36	33	..

Eastern Europe and USSR

		Producers			
		Bulgaria	Czechoslovakia	Germany, Dem. Rep.	Hungary
General indicators	1. Estimated population, 1987 (million)	9.0	15.6	16.7	10.6
	2. Estimated growth rate of population, 1986-2000 (%/yr)	0.2	0.3	0.0	-0.1
	3. Per capita income, 1986 (US$)	..	..	..	2,020
	4. Per capita cereal production, 1985-87 (kg/yr)	754	737	697	1,353
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	1.1	2.7	3.1	3.1
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	1,081	1,209	748	1,325
	7. Wheat yield, 1985-87 (t/ha)	3.4	4.8	5.5	4.5
	8. Wheat production, 1985-87 (000 t)	3,631	5,827	4,090	6,028
	9 Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	-0.7	1.1	1.2	-0.1
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	-0.2	1.6	2.0	0.8
	11 Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	1.7	-0.3	0.3	0.2
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	3.3	2.7	2.4	3.4
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	0.9	3.2	2.2	3.4
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	-0.7	2.4	3.6	2.0
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	2.5	3.8	3.6	3.3
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	0.8	4.9	4.3	4.3
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	1.0	2.1	3.9	2.3
	18. Wheat area as percent of total cereal area, 1985-87 (%)	55	48	30	46
	19. Average yield of all cereals, 1985-87 (t/ha)	3.4	4.6	4.6	5.0
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	3.4	2.7	2.5	3.4
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	-31	20	564	1,630
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	417	381	300	468
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	0.8	2.6	3.0	3.2
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	..	..	2	0
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	..	..	98	100
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	..	..	0	0
	27. Percent of total wheat area sown to durum wheat, mid-1980s	..	..	0	0
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	..	..	2	80
	29. Percent of total wheat area irrigated, mid-1980s	..	..	0	..
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	..	..	80	..
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	..	..	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	..	..	20	..
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	0	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	1.8	5.1	2.8	-0.5
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	296	320	..	270
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	240	338	320	282
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	8.3	4.8	1.9	8.7
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	..	..	312	..
	40 Ratio of farm-level nitrogen price to wheat price, 1986/87	..	..	4.1	2.6
	41 Farm wage in kg of wheat per day, 1986/87	..	..	43	67

Eastern Europe and USSR, continued

		Producers				
		Poland	Romania	USSR	Yugoslavia	Regional total or average
General indicators	1. Estimated population, 1987 (million)	37.8	23.0	282.7	23.4	421.9
	2. Estimated growth rate of population, 1986-2000 (%/yr)	0.6	0.5	0.7	0.5	0.6
	3. Per capita income, 1986 (US$)	2,070	..	..	2,300	..
	4. Per capita cereal production, 1985-87 (kg/yr)	666	1,230	697	706	741
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	1.3	3.3	1.1	1.1	1.5
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	2,014	2,375	48,559	1,380	58,884
	7. Wheat yield, 1985-87 (t/ha)	3.6	2.7	1.7	3.6	2.1
	8. Wheat production, 1985-87 (000 t)	7,301	6,495	84,565	4,969	123,448
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	0.9	-0.2	0.7	-0.8	0.6
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	1.0	-1.1	-1.7	-1.3	-1.5
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	0.9	0.2	-2.3	-1.8	-1.9
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	3.0	3.5	2.4	2.9	2.6
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	2.6	1.9	2.1	2.1	2.4
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	2.1	0.6	2.3	1.1	2.4
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	3.9	3.3	3.2	2.1	3.2
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	3.6	0.7	0.3	0.7	0.9
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	3.0	0.8	-0.1	-0.7	0.5
	18. Wheat area as percent of total cereal area, 1985-87 (%)	24	38	44	33	42
	19. Average yield of all cereals, 1985-87 (t/ha)	3.0	4.5	1.8	3.9	2.2
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	2.4	5.2	2.5	3.1	2.6
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	1,935	-112	16,691	362	17,789
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	225	300	345	223	328
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	1.7	1.0	-0.2	-0.7	0.3
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	19	..	..	2	..
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	81	..	..	98	..
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	0	.	..	0	..
	27. Percent of total wheat area sown to durum wheat, mid-1980s	0	..	..	0	..
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	80	..	..	82	..
	29. Percent of total wheat area irrigated, mid-1980s	0	..	..	0	..
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	100	..	..	100	..
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	..	..	..	99	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	0	..	..	0	..
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	-5.1	13.4	3.5	1.1	3.7
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	307	..	90	..	111
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	229	154	94	124	118
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	6.5	12.0	9.2	5.0	7.9
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	171	.	..	175	. ..
	40. Ratio of farm-level nitrogen price to wheat price, 1986/87	1.0	..	..	1.3	..
	41. Farm wage in kg of wheat per day, 1986/87	33	.	..	59	..

		Producers				
		Austria	Belgium-Luxembourg	Denmark	France	Germany, Fed. Rep.
General indicators	1. Estimated population, 1987 (million)	7.6	10.2	5.1	55.6	60.8
	2. Estimated growth rate of population, 1986-2000 (%/yr)	-0.1	-0.1	-0.1	0.4	-0.3
	3. Per capita income, 1986 (US$)	9,990	9,230	12,600	10,720	12,080
	4. Per capita cereal production, 1985-87 (kg/yr)	682	214	1,520	959	411
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	3.5	0.2	0.9	2.6	2.1
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	322	196	365	4,868	1,648
	7. Wheat yield, 1985-87 (t/ha)	4.6	6.1	5.9	5.7	6.1
	8. Wheat production, 1985-87 (000 t)	1,476	1,206	2,153	27,631	10,068
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	1.2	0.3	4.2	0.4	1.5
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	0.3	-0.7	6.5	0.8	0.8
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	1.3	-0.1	12.2	1.8	0.3
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	2.9	1.9	1.4	3.1	2.5
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	2.4	2.7	1.4	2.8	2.8
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	1.8	4.1	1.7	3.7	3.4
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	4.1	2.2	5.6	3.5	4.0
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	2.7	2.0	8.0	3.7	3.7
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	3.1	3.9	14.2	5.5	3.7
	18. Wheat area as percent of total cereal area, 1985-87 (%)	31	51	23	51	34
	19. Average yield of all cereals, 1985-87 (t/ha)	5.0	5.7	5.0	5.6	5.2
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	3.4	2.0	1.4	3.4	2.4
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	-556	482	-327	-16,629	166
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	117	175	353	234	161
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	0.1	2.2	6.2	1.0	2.5
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	..	4	..	1	6
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	..	96	..	94	94
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	..	0	..	0	0
	27. Percent of total wheat area sown to durum wheat, mid-1980s	..	0	..	5	0
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	80	95	95	14	0
	29. Percent of total wheat area irrigated, mid-1980s	..	0	..	0	0
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	..	100	..	100	100
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	..	95	..	14	0
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	..	0	..	0	0
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	0.0	0.0	10.8	2.6	1.0
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	283	..	256	286	298
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	248	521	248	304	421
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	1.7	0.7	2.1	4.2	1.5
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	..	198	..	131	196
	40. Ratio of farm-level nitrogen price to wheat price, 1986/87	..	3.0	..	4.6	..
	41. Farm wage in kg of wheat per day, 1986/87	..	183	..	238	216

Western Europe and Other Developed Countries

		Producers				
		Greece	Italy	Netherlands	South Africa	Spain
General indicators	1. Estimated population, 1987 (million)	10.0	57.2	14.6	34.0	38.8
	2. Estimated growth rate of population, 1986-2000 (%/yr)	0.3	0.1	0.3	2.3	0.4
	3. Per capita income, 1986 (US$)	3,680	8,550	10,020	1,850	4,860
	4. Per capita cereal production, 1985-87 (kg/yr)	505	319	80	327	499
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	2.3	0.7	-3.1	-0.1	2.6
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	884	3,086	119	1,934	2,127
	7. Wheat yield, 1985-87 (t/ha)	2.4	2.9	7.2	1.2	2.4
	8. Wheat production, 1985-87 (000 t)	2,109	8,975	853	2,367	5,163
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	0.2	-1.1	0.6	2.1	-1.8
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	-1.3	-1.5	-1.3	2.5	-3.4
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	-0.5	-0.7	-0.2	0.8	-2.4
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	2.4	1.8	1.9	1.9	3.1
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	1.6	1.2	2.4	3.2	3.6
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	0.6	1.5	3.2	1.1	4.4
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	2.6	0.7	2.5	4.0	1.3
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	0.2	-0.3	1.1	5.8	0.1
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	0.1	0.8	3.0	1.9	1.9
	18. Wheat area as percent of total cereal area, 1985-87 (%)	60	65	67	28	28
	19. Average yield of all cereals, 1985-87 (t/ha)	3.4	3.8	6.6	1.6	2.5
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	3.5	2.5	2.3	2.0	2.8
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	-241	3122	956	53	237
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	135	209	127	72	143
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	-2.4	0.6	1.6	1.8	0.3
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	50	30	..	100	..
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	0	20	..	0	..
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	0	0	..	0	..
	27. Percent of total wheat area sown to durum wheat, mid-1980s	50	50	..	0	..
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	100	93	100	42	55
	29. Percent of total wheat area irrigated, mid-1980s	0	0	0	7	1
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	..	100	100
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	86	69	..	19	84
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	100	95	..	..	56
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	14	31	..	74	15
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	100	89	..	45	48
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	3.3	1.0	6.7	1.4	2.1
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	..	..	212	90	92
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	158	168	781	75	72
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	5.3	5.3	1.9	6.0	3.4
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	210	276	..	164	138
	40. Ratio of farm-level nitrogen price to wheat price, 1986/87	1.2	2.0	..	3.0	..
	41. Farm wage in kg of wheat per day, 1986/87	..	154	.	28	..

Western Europe and Other Developed Countries, continued

		Producers		Consumers		
		Sweden	United Kingdom	Japan	Portugal	Regional total or average
General indicators	1. Estimated population, 1987 (million)	8.4	56.9	122.1	10.3	519.4
	2. Estimated growth rate of population, 1986-2000 (%/yr)	0.0	0.1	0.5	0.3	0.4
	3. Per capita income, 1986 (US$)	13,160	8,870	12,840	2,250	9,803
	4. Per capita cereal production, 1985-87 (kg/yr)	671	401	127	154	390
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	1.1	2.6	-2.0	-0.6	1.4
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	299	1,962	250	311	18,898
	7. Wheat yield, 1985-87 (t/ha)	5.2	6.4	3.5	1.5	4.2
	8. Wheat production, 1985-87 (000 t)	1,544	12,586	871	479	79,547
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	-0.2	2.1	-3.0	-2.2	-0.1
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	1.1	3.7	-2.6	-2.9	-0.2
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	-1.7	5.8	11.0	-3.0	0.7
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	2.3	2.4	2.0	2.3	2.8
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	1.5	2.4	1.4	2.4	3.0
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	1.5	4.0	2.8	2.5	3.7
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	2.1	4.5	-1.0	0.1	2.7
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	2.6	6.1	-1.2	-0.5	2.7
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	-0.2	10.0	14.1	-0.6	4.4
	18. Wheat area as percent of total cereal area, 1985-87 (%)	21	49	9	31	38
	19. Average yield of all cereals, 1985-87 (t/ha)	3.9	5.7	5.8	1.6	4.1
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	1.9	2.3	1.6	2.2	2.4
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	-600	-1,741	5,181	589	-7,692
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	117	188	53	110	139
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	1.0	1.1	0.5	1.3	0.8
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	30	..	61	0	28
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	70	..	39	90	56
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	0	..	0	0	0
	27. Percent of total wheat area sown to durum wheat, mid-1980s	0	..	0	10	17
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	95	100	95	79	55
	29. Percent of total wheat area irrigated, mid-1980s	0	0	0	0	1.1
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	100	100	100	0	82
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	95	100	95	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	0	0	0	100	17
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	..	79	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	4.8	1.7	-0.3	0.1	1.5
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	160	278	364	125	225
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	157	352	416	74	149
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	2.3	2.9	1.6	3.6	0.9
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	151	163	780	294	..
	40. Ratio of farm-level nitrogen price to wheat price, 1986/87	5.6	3.3	..	2.2	..
	41. Farm wage in kg of wheat per day, 1986/87	242	253	24	31	..

USA, Canada, and Australia

		Producers			
		Australia	Canada	USA	Regional total or average
General indicators	1. Estimated population, 1987 (million)	16.0	25.8	242.6	284.4
	2. Estimated growth rate of population, 1986-2000 (%/yr)	1.0	0.7	0.6	0.6
	3. Per capita income, 1985 (US$)	11,920	14,120	17,480	16,862
	4. Per capita cereal production, 1985-87 (kg/yr)	1,445	2,051	1,304	1,380
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	1.6	1.4	1.7	1.6
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	10,645	13,825	24,468	48,939
	7. Wheat yield, 1985-87 (t/ha)	1.4	2.0	2.5	2.1
	8. Wheat production, 1985-87 (000 t)	14,909	27,324	60,073	102,306
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	2.1	0.7	-0.4	0.3
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	1.3	0.8	0.7	0.8
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	1.5	3.0	-1.3	0.3
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	0.7	1.7	2.2	1.8
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	1.2	1.1	1.7	1.4
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	1.5	0.1	1.8	1.1
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	2.8	2.5	1.8	2.1
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	2.5	1.9	2.4	2.3
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	3.0	3.1	0.5	1.5
	18. Wheat area as percent of total cereal area, 1985-87 (%)	68	63	37	47
	19. Average yield of all cereals, 1985-87 (t/ha)	1.5	2.4	4.7	3.7
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	0.9	2.0	2.9	2.4
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	-15,608	-18,804	-28,080	-62,492
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	216	189	117	136
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	-0.5	0.5	1.4	1.2
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	100	..	21	45
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	0	..	75	52
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	0	..	0	0
	27. Percent of total wheat area sown to durum wheat, mid-1980s	0	..	4	3
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	75	..	58	63
	29. Percent of total wheat area irrigated, mid-1980s	1	..	6	4
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	100	..	100	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	17	..	80	55
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	85	..	56	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	82	..	14	41
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	54	..	56	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	2.0	2.7	1.5	1.5
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	22	104	68	67
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	25	46	101	80
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	0.2	6.8	3.4	3.3
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	64	82	79	..
	40. Ratio of farm level nitrogen price to wheat price, 1986/87	7.0	4.4	2.7	..
	41. Farm wage in kg of wheat per day, 1986/87	590	..	470	..

Regional Aggregates

		Developing countries	Developed market economies	Eastern Europe and USSR	World
General indicators	1. Estimated population, 1987 (million)	3,769.2	803.8	421.9	4,995.0
	2. Estimated growth rate of population, 1986-2000 (%/yr)	2.0	0.5	0.6	1.7
	3. Per capita income, 1986 (US$)	616	12,296	..	2,769
	4. Per capita cereal production, 1985-87 (kg/yr)	252	740	741	373
	5. Growth rate of per capita cereal production, 1961-65 to 1985-87 (%/yr)	0.9	1.7	1.5	0.9
Wheat production	6. Wheat area harvested, 1985-87 (000 ha)	100,363	67,837	58,884	227,084
	7. Wheat yield, 1985-87 (t/ha)	2.1	2.7	2.1	2.3
	8. Wheat production, 1985-87 (000 t)	213,968	181,853	123,448	519,269
	9. Growth rate of wheat area, 1948-50 to 1985-87 (%/yr)	1.4	0.2	0.6	0.8
	10. Growth rate of wheat area, 1965-67 to 1985-87 (%/yr)	1.4	0.5	-1.5	0.2
	11. Growth rate of wheat area, 1975-77 to 1985-87 (%/yr)	0.7	0.4	-1.9	-0.1
	12. Growth rate of wheat yield, 1948-50 to 1985-87 (%/yr)	2.8	2.2	2.6	2.4
	13. Growth rate of wheat yield, 1965-67 to 1985-87 (%/yr)	3.8	1.9	2.4	2.7
	14. Growth rate of wheat yield, 1975-77 to 1985-87 (%/yr)	4.1	2.2	2.4	3.0
	15. Growth rate of wheat production, 1948-50 to 1985-87 (%/yr)	4.3	2.4	3.2	3.2
	16. Growth rate of wheat production, 1965-67 to 1985-87 (%/yr)	5.2	2.5	0.9	2.9
	17. Growth rate of wheat production, 1975-77 to 1985-87 (%/yr)	4.9	2.6	0.5	2.9
	18. Wheat area as percent of total cereal area, 1985-87 (%)	24	44	42	32
	19. Average yield of all cereals, 1985-87 (t/ha)	2.2	3.8	2.2	2.6
	20. Growth rate of yield of all cereals, 1948-50 to 1985-87 (%/yr)	2.2	2.4	2.6	2.3
Trade and utilization	21. Net imports of wheat, 1985-87 (000 t)	51,250	-70,184	17,789	..
	22. Per capita total wheat utilization, 1984-86 (kg/yr)	72	138	328	104
	23. Growth rate of per capita wheat utilization, 1964-66 to 1984-86 (%/yr)	2.6	0.9	0.3	1.0
Wheat types and productivity factors	24. Percent of total wheat area sown to spring-habit bread wheat, mid-1980s	67	41	7	56
	25. Percent of total wheat area sown to winter-habit bread wheat, mid-1980s	13	53	93	29
	26. Percent of total wheat area sown to facultative bread wheat, mid-1980s	10	0	0	7
	27. Percent of total wheat area sown to durum wheat, mid-1980s	10	6	0	9
	28. Percent of total wheat area under semidwarf varieties, mid-1980s	65	60	..	64
	29. Percent of total wheat area irrigated, mid-1980s	40	3	0	25
	30. Percent of irrigated wheat area under semidwarf varieties, mid-1980s	..	..	..	..
	31. Percent of total wheat area in high rainfall regions (> 500 mm), mid-1980s	39	64	78	49
	32. Percent of high rainfall area under semidwarf varieties, mid-1980s	..	..	..	..
	33. Percent of total wheat area in low rainfall regions (< 500 mm), mid-1980s	22	33	22	26
	34. Percent of low rainfall area under semidwarf varieties, mid-1980s	..	..	..	..
	35. Growth rate of irrigated crop area, 1961-65 to 1981-85 (%/yr)	1.7	1.5	3.7	1.9
	36. Fertilizer applied to wheat, 1985 (kg nutrients/ha)	78	101	111	96
	37. Fertilizer applied to all crops, 1981-85 (kg nutrients/ha)	53	109	118	82
	38. Growth rate of fertilizer applied to all crops, 1961-65 to 1981-85 (%/yr)	10.6	2.4	7.9	6.2
Wheat prices	39. Farm price of wheat, 1986/87 (US$/t)	..	..	..	..
	40. Ratio of farm level nitrogen price to wheat price, 1986/87	..	..	..	..
	41. Farm wage in kg of wheat per day, 1986/87	..	..	..	..

Annex 1: Regions delineated for this study

Developing Countries:

Eastern and Southern Africa:
Botswana
Burundi
Comoros
Djibouti
Ethiopia
Kenya
Lesotho
Madagascar
Malawi
Mauritius
Mozambique
Rwanda
Seychelles
Somalia
Sudan
Swaziland
Tanzania
Uganda
Zambia
Zimbabwe

Western and Central Africa:
Angola
Benin
Burkina Faso
Cameroon
Cape Verde
Central African Republic
Chad
Congo
Côte d'Ivoire
Equatorial Guinea
Gabon
Gambia
Ghana
Guinea
Guinea-Bissau
Liberia
Mali
Mauritania
Namibia
Niger
Nigeria
Reunion
Sâo Tome
Senegal
Sierra Leone
St. Helena
Togo
Zaire

North Africa:
Algeria
Egypt
Libya
Morocco
Tunisia

West Asia:
Afghanistan
Bahrain
Cyprus
Iran
Iraq
Jordan
Kuwait
Lebanon
Oman
Qatar
Saudi Arabia
Syria
Turkey
United Arab Emirates
Yemen Arab Republic
Yemen Democratic Republic

South Asia:
Bangladesh
Bhutan
Burma
India
Maldives
Nepal
Pakistan
Sri Lanka

Southeast Asia and Pacific:
American Samoa
Brunei
Cook Islands
East Timor
Fiji
French Poleynesia
Guam
Hong Kong
Indonesia
Kampuchea Democratic
Kiribati
Laos
Macao
Malaysia
Nauru
New Caledonia
Niue
Norfolk Island
Pacific Islands
Papua New Guinea
Philippines
Samoa
Singapore
Solomon Islands
Thailand
Tokelau
Tonga
Tuvalu
Vanuatu
Vietnam
Wallis and Futana Island

East Asia:
China
North Korea
South Korea
Mongolia
Taiwan

Mexico, Central America, and Caribbean:
Antigua
Bahamas
Barbados
Belize
Bermuda
Cayman Islands
Costa Rica
Cuba
Dominica
Dominican Republic
El Salvador
Grenada
Guadeloupe
Guatemala
Haiti
Honduras
Jamaica
Martinique
Mexico
Montserrat
Netherlands Antilles
Nicaragua
Panama
St. Christopher and Nevis
St. Lucia
St. Pierre and Miquelon
St. Vincent Granadines
Trinidad and Tobago
U.K. Virgin Islands
U.S. Virgin Islands

Andean Region, South America:
Bolivia
Colombia
Ecuador
French Guiana
Guyana
Peru
Surinam
Venezuela

Southern Cone, South America:
Argentina
Brazil
Chile
Paraguay
Uruguay
Falkland Islands

Developed Countries:

Eastern Europe and USSR:
Albania
Bulgaria
Czechoslovakia
German Democratic Republic
Hungary
Poland
Romania
USSR
Yugoslavia

Western Europe and other developed countries
Austria
Belgium-Luxumbourg
Denmark
Faeroe Island
Federal Republic of Germany
Finland
France
Greece
Greenland
Iceland
Ireland
Israel
Italy
Japan
Malta
Netherlands
New Zealand
Norway
Portugal
South Africa
Spain
Sweden
Switzerland
United Kingdom

USA, Canada, and Australia:
Australia
Canada
United States of America

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