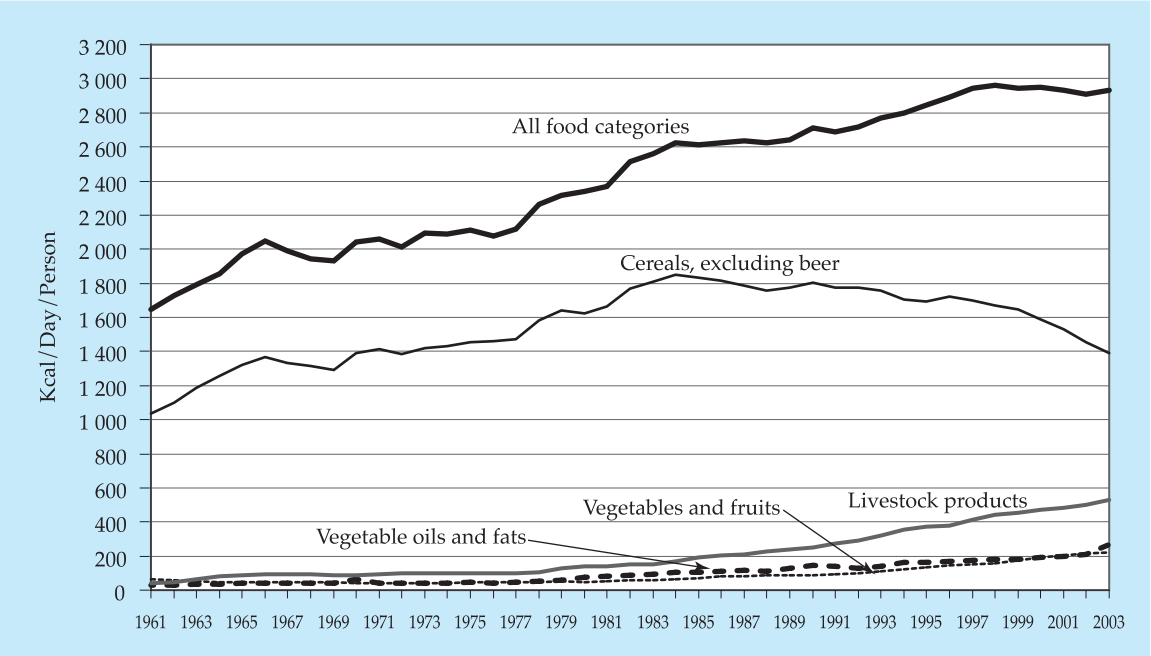
Figure 12: East Asian calorie consumption 1961–2003



Source: FAOSTAT

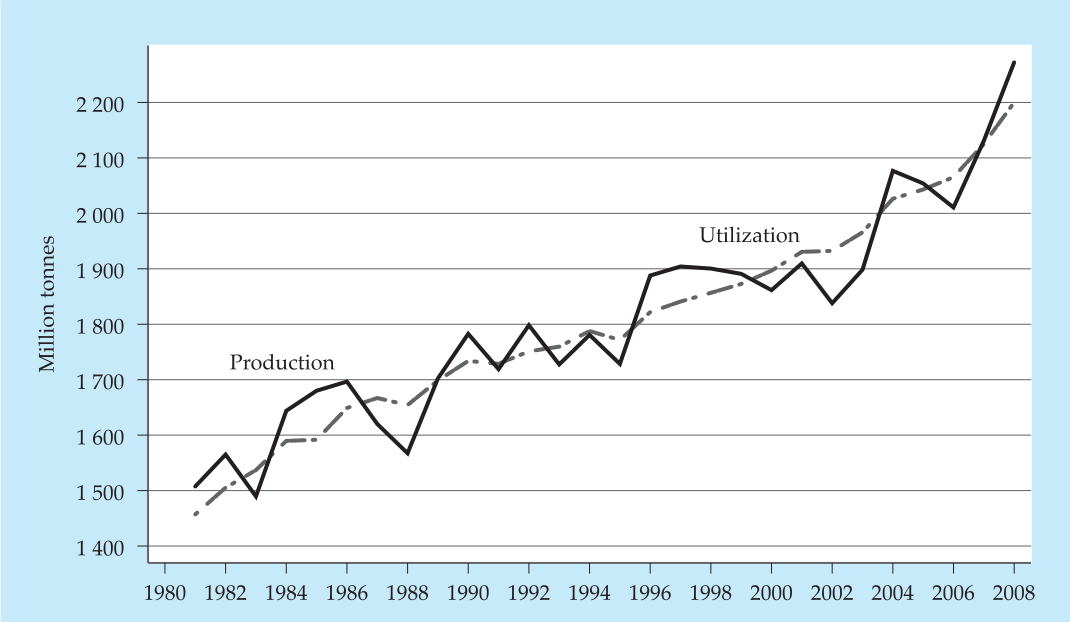
There are three principal conclusions from this data. First, all three subregions recorded increases in the consumption of dietary energy. East Asia recorded the largest increase (80 percent), followed by Southeast Asia (50 percent) and South Asia (33 percent). Second, as a result of this growth, diets now appear to be adequate in both quantity and quality in East Asia and are close to adequate in Southeast Asia. In South Asia, however, they are inadequate both in terms of quantity (2 400 kcal of dietary energy per person per day) and quality (cereals account for 63 percent of total dietary intake).Third, cereal consumption per head has increased very slowly in South Asia, but has been stagnant in Southeast Asia and falling in East Asia since the mid-1980s. Until that time, increases in cereal consumption were the main drivers of dietary energy consumption growth in all three subregions. After the mid-1980s, increases in dietary energy consumption were driven by a sharp increase in the consumption of livestock products in East Asia and by vegetable oils and fats and livestock products in the other two subregions.

Despite all the changes that have taken place over the past five decades, cereals continue to be overwhelmingly the most important source of dietary energy for the people of this region. To understand the factors underlying price trends for cereals, it is necessary to examine world totals for cereal utilization and production since 1980, because international prices are determined by the balance between production and utilization worldwide.

Figure 13 presents a graph of cereal utilization and production in the world from 1980 to the present. Utilization includes all uses of cereals, such as food, animal feed, seed and industrial use. The graph shows that utilization grew at a relatively steady pace while production fluctuated. This is not surprising since agricultural production is subject to the vagaries of weather, pests and other factors beyond the control of farmers. This would not matter so much if a production shortfall in one year was equally likely to be followed by a production upturn the following year. Instead, what is observed is a pattern where production shortfalls persist, as do periods of above average production.

Figure 13 also shows that production exceeded utilization during the second half of the 1990s and that this was followed by a long period, 1999–2003, during which production did not keep up with utilization. A very brief recovery in 2004 was followed by another three years of production shortfalls. As a result, stock to utilization ratios for cereals declined to their lowest levels since the early 1980s,

Figure 13: World cereal utilization and production 1980 to 2008



Utilization is the sum of food, animal feed and other uses.

Source: FAOSTAT

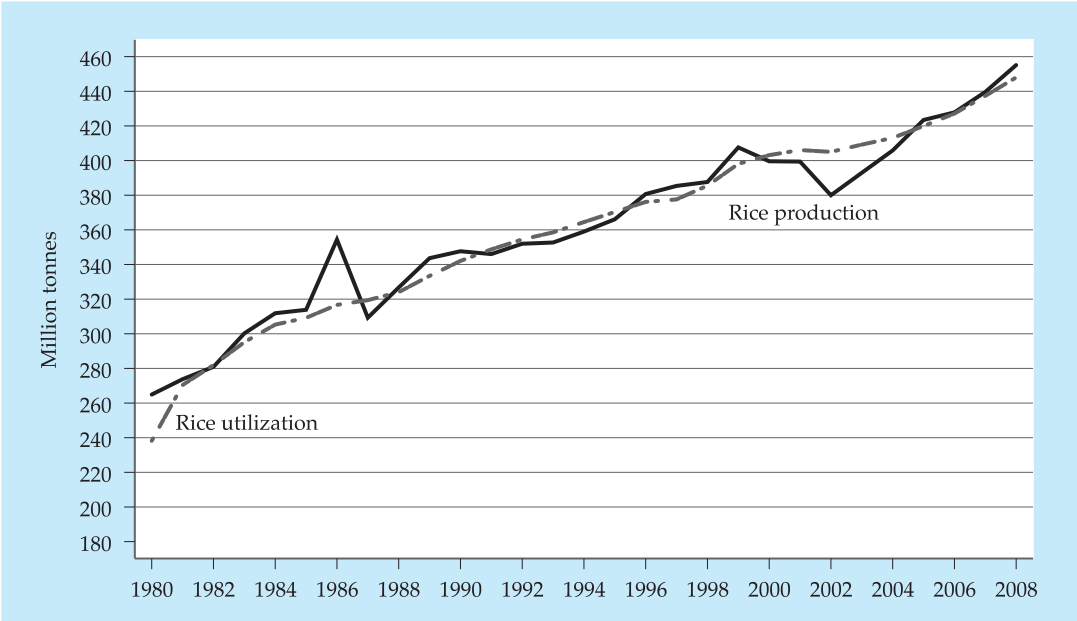
making the markets jittery and creating the potential for price spikes following bad news, such as the simultaneous restrictions on rice exports announced by India, China and Viet Nam in March–April 2008.

The Asia-Pacific region utterly dominates the economy for rice, accounting for over 80 percent of the production of rice, almost 90 percent of its use and much of its trade; indeed, when speaking about the market for rice, the terms "Asia-Pacific" and "the world" can be used interchangeably.

As seen in Figure 14, rice production remained below utilization from 1999 to 2005. As a result, the stock to utilization ratio for rice dropped sharply from 1999 onwards, as shown in Figure 15 below. The international market for rice is "thin" as is well known, with the ratio of rice trade to rice production at barely 7 percent compared with almost 20 percent for wheat. Hence the very sharp decline in the stock to utilization ratio for rice made the markets jittery, leading to some sharp reactions in response to the news that three major exporters were restricting exports in March–April 2008.

The price reaction can be seen below in Figure 16, which shows monthly nominal prices of 5 percent broken milled white rice in Thailand from 1980 to the present. It is clear from a comparison of Figure 14 with Figure 16 that the long slow decline in the nominal price of rice from 1996 to 2001 resulted, to a large extent, from the fact that world rice production comfortably exceeded rice utilization during this period. It is also clear that a fundamental cause of the unprecedented increase in food prices in 2007–2008 (though not the sharp spike from April to May 2008) is that world rice and cereal production failed to keep up with utilization in every year from 1999 to 2007 (except 2004).

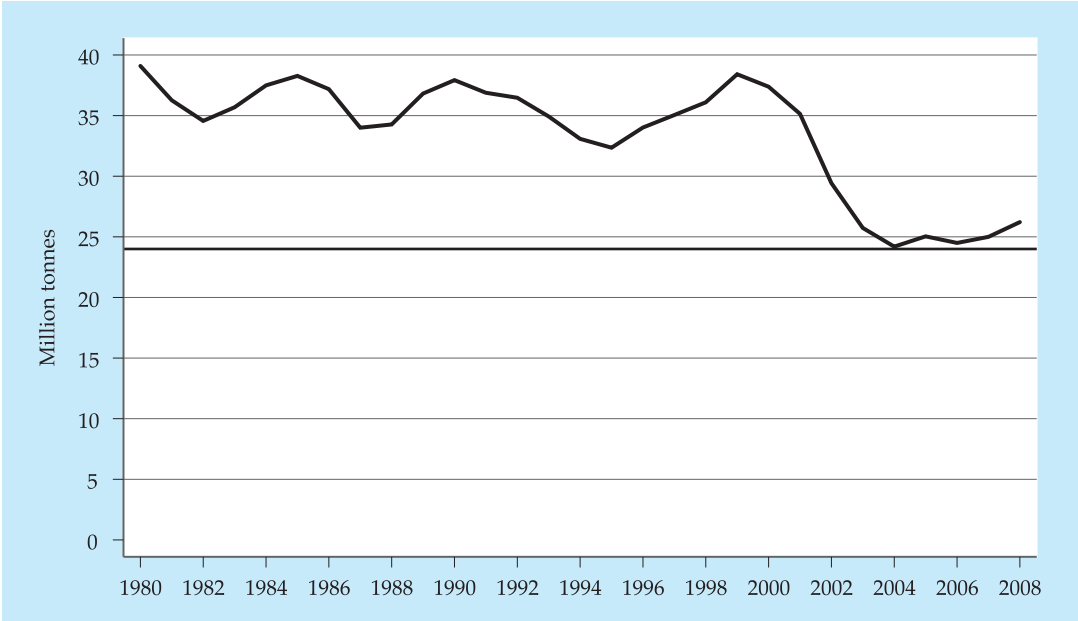
Figure 14: World: rice production and utilization 1980 to 2008



Utilization is the sum of food, animal feed and other uses.

Source: FAOSTAT

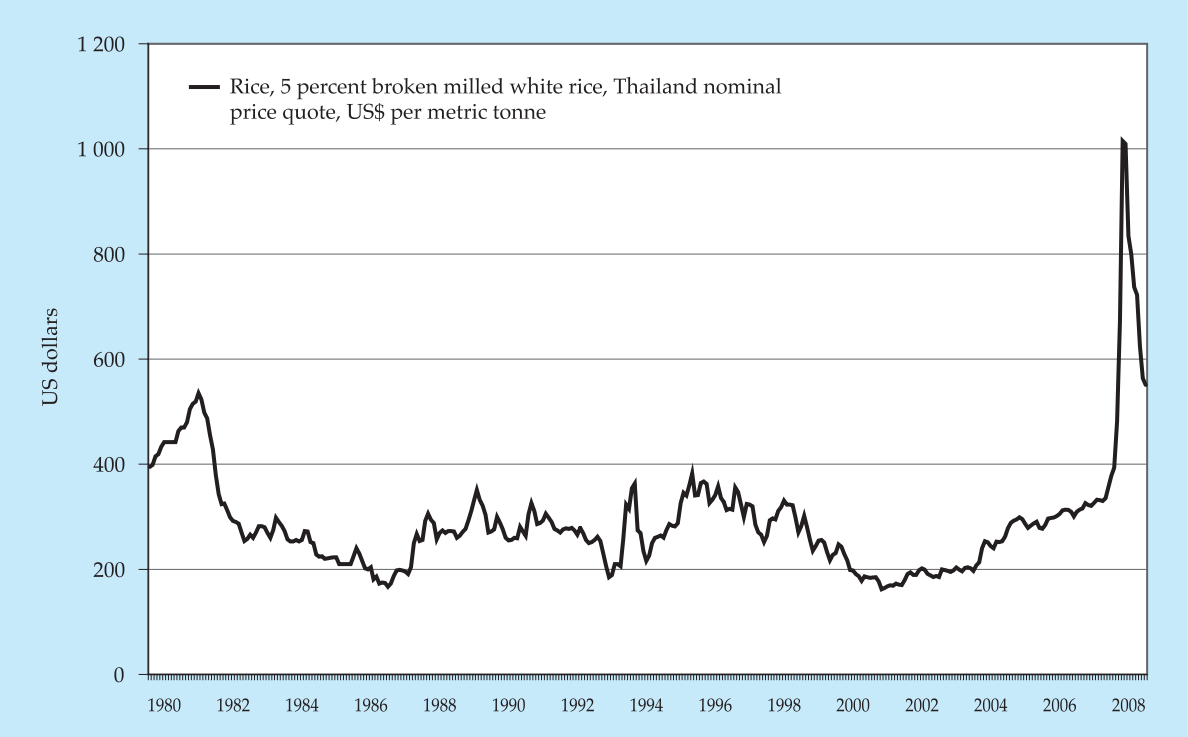
Figure 15: World stock–to–utilization ratio for rice 1980 to 2008



Utilization is the sum of food, animal feed and other uses.

Source: FAOSTAT

Figure 16: Nominal rice prices, 1980–2008



3.3 Sources of agricultural growth

The failure of cereal production to keep pace with cereal utilization came after nearly four decades of solid growth in agricultural production. This growth was particularly strong in developing countries and especially for cereals such as rice in Asia, wheat in irrigated and favourable production environments worldwide and maize in selected parts of Asia and Africa (Pingali and Heisey, 2001).

To understand the reasons that cereal production failed to keep pace with cereal utilization from 1999 to 2005, it is necessary to review the sources of growth in crop production. Direct inputs into crop production growth (e.g. land, labour, water and fertilizer) depend crucially on the presence of publicly provided irrigation, marketing and transport infrastructure. Vital public goods, such as basic agricultural research and agricultural extension services, are also important. From the mid-1990s, growth rates of private inputs slowed down in the Asia-Pacific region and public expenditure on agriculture also declined. This is an important reason for the decline in crop production growth rates in the 1990s.

Agricultural growth occurs if:

- the amount of arable land increases;
- cropping intensity increases;
- output per unit of input (i.e. workers, land or water) increases;
- the composition of output changes towards higher-valued products with a constant value of inputs.

The relative importance of these factors depends on the situation faced by a particular country. A country like the United States, which has 0.7 hectares of arable land per head, can continue to rely on land as a source of agricultural growth in a manner that is not open to a country like India, which has only 0.2 hectares of arable land per head. For India, growth has to come primarily from

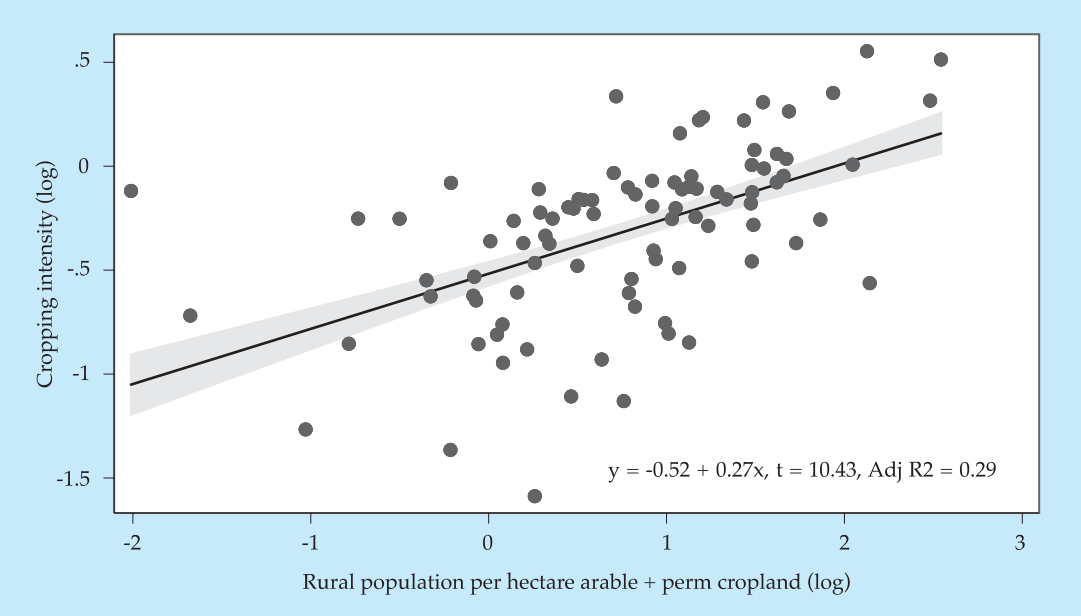
sources that economize on land and water, which are the two main constraints. This implies that cropping intensity must increase or yields have to grow, i.e. there has to be an increase in productivity.

Output growth is the result of growth in area harvested and yield growth. Yield in turn is a function of measurable inputs (e.g. soil quality, weather conditions, labour use per hectare, type of seed, fertilizer use per hectare, availability of irrigation and availability of tractors) and inputs that are difficult to measure, such as a farmer's ability and capacity for work. Agricultural production has increased in most areas of the world, but to what degree did this growth arise out of area expansion or yield growth?

Expansion of harvested area can occur either because more land is cleared for cultivation or because land is used more intensively. Cropping intensity increases when farmers get two instead of one harvest from the same plot of land each year, or when farmers transfer from shifting cultivation to permanent agriculture. Two or more harvests per year are only possible if the growing periods are relatively short and if there is an assured supply of water. As population density begins to increase from low levels, the first response is likely to be to clear more land for agriculture; the arable land area should increase first, without much impact on yield. As density continues to increase, this option becomes increasingly unrealistic and there is a tendency for cropping intensity to increase and for yields to rise. Figure 17 shows cross-section evidence on this point from 2000–2002 from a sample of developing countries throughout the world.[16] It is evident that higher rural population densities are associated with higher cropping intensities.

To analyse productivity growth, an index of crop production[17] will be used. Table 1 below shows growth rates by world region for crop production, total crop land (i.e. area under arable and permanent crops), cropping intensities and yields. It should be noted that "historical data for arable land for many countries are particularly unreliable" (Bruinsma 2003, Chapter 4, p. 125).

Figure 17: Cropping intensity and rural population density average 2000–2002



Source: FAOSTAT

[16] Please note that these countries are from all parts of the world, not only the Asia-Pacific region.

[17] This measure is different from the indices of agricultural production and food production used in the previous subsections because those include livestock products, whereas the index of crop production used here covers the output of 34 crops.

Table 1: Growth rates, percent increase per year

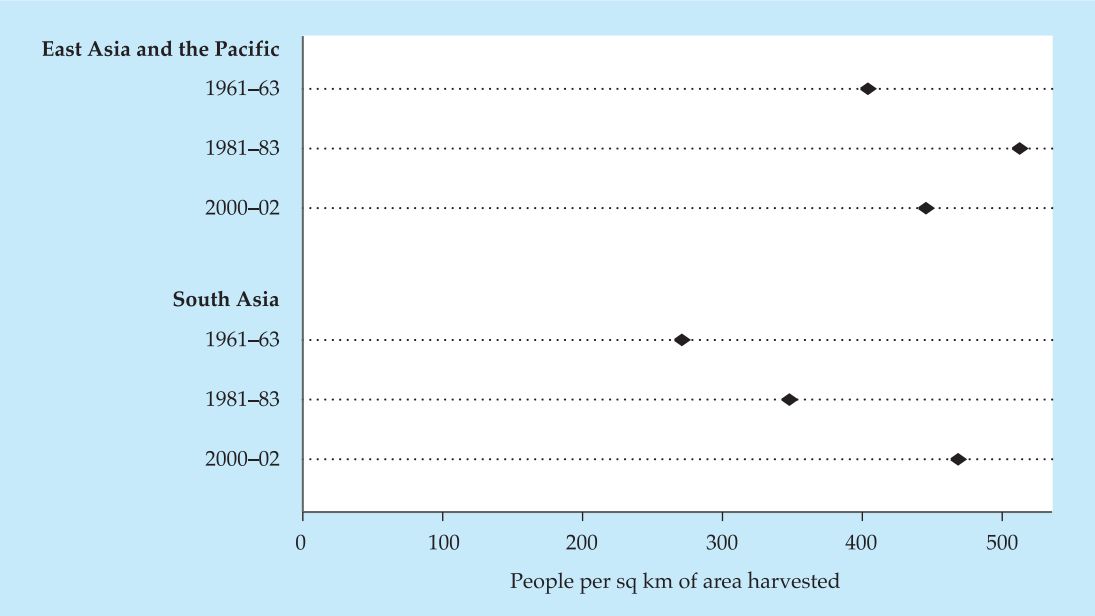
	1961–75	1976–90	1991–05
East Asia and the Pacific			
Production	3.2	3.8	3.8
Total crop land	0.1	2.0	1.2
Cropping intensity	0.4	-1.3	-0.3
Yield	2.7	3.1	2.9
South Asia			
Production	2.3	3.0	1.8
Total crop land	0.4	0.1	0.0
Cropping intensity	0.2	0.3	0.0
Yield	1.7	2.6	1.8

Source: FAOSTAT

To a surprising extent, land was still being cleared for cultivation in the 1990s in the East Asia and Pacific subregions; the increase in total crop land in East Asia and the Pacific is surprising. It is possible that this effect is an artifact of the data, particularly in such densely populated areas of the world as East Asia. It is difficult to understand how China's arable area could have increased at 2.5 percent per year from 1976 to 1990, or how Cambodia's arable area increased at 5.1 percent per year over the same time period. It is interesting that South Asia, a densely populated subregion that has good land records, shows little or no tendency for an increase in arable area.

Rural population densities were close to 500 per sq km of harvested area by the end of the twentieth century in East Asia and the Pacific and South Asia (see Figure 18 below). Area expansion had ceased to be a feasible source of crop production growth by the end of the twentieth century. If the land frontier is now closed in the Asia-Pacific region, the obvious sources of further growth in crop production are land productivity (i.e. yield growth), labour productivity and/or total factor productivity.

Figure 18: Rural population density



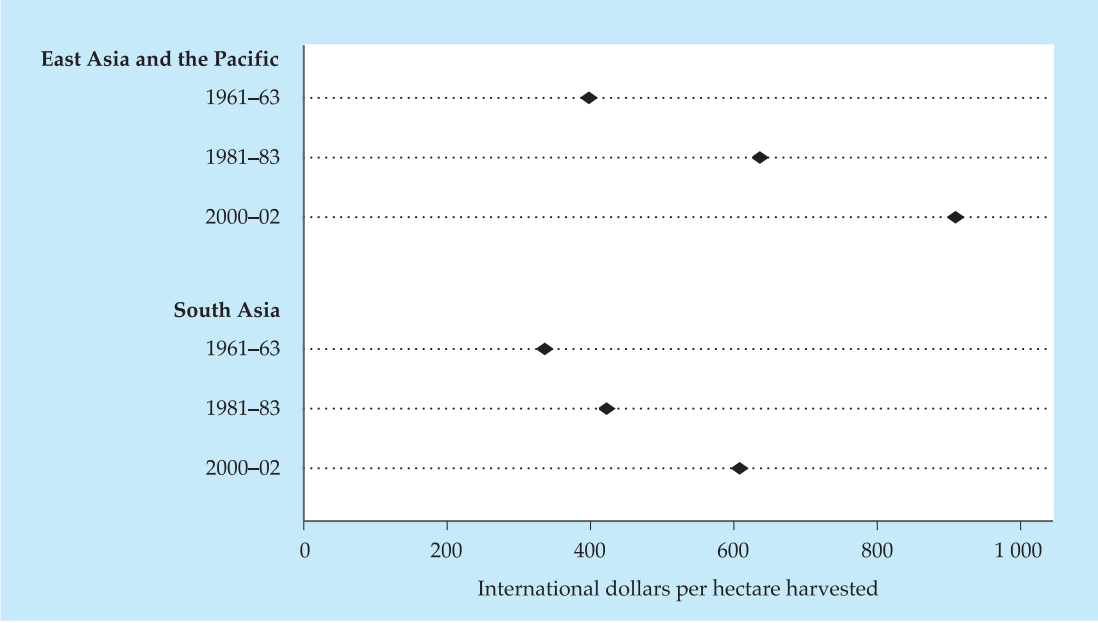
Source: FAOSTAT

Is there a tendency for yield growth to increase over time with the closing of the land frontier? This certainly seems to be the case in East Asia and the Pacific and in South Asia (see Figure 19). Yield increases have been particularly impressive in East Asia and the Pacific.

The issue is not which of the two sources of agricultural growth has a stronger impact, but which one is still a potential source of growth. It is hard to see how there could be continued opportunity for area expansion in most regions of the developing world. Further increases in crop production will have to come from yield growth and/or increases in cropping intensity.

Table 2 sheds some light on the relative contributions of each of three factors on crop production growth. When Table 2 is read with Figure 19, it can be seen that arable area expansion has been an important contributor to crop production growth in East Asia and the Pacific, while its contribution is now negligible in South Asia. Because of this expansion of arable area, crop production growth would have been stronger in East Asia and the Pacific even if yield growth had been the same in both subregions. However, from Figure 19, it is apparent that crop yields grew more strongly in East Asia and the Pacific than in South Asia, starting from roughly similar levels in 1961–1963. A major reason for the large differences observed between the two subregions in crop production growth

Figure 19: Crop yield



Source: FAOSTAT

Table 2: Sources of growth in crop production (percentage)

	1961–75	1976–90	1991–05
East Asia and the Pacific			
Arable area expansion	3	46	30
Increased cropping intensity	11	-24	-9
Yield growth	86	78	79
South Asia			
Arable area expansion	13	3	0
Increased cropping intensity	13	9	0
Yield growth	75	88	100

Source: FAOSTAT

rates is that the East Asia and Pacific subregion benefited from higher growth rates in crop yields and area expansion. Changes in cropping intensity had, by contrast, a negative impact on crop production growth in the East Asia and Pacific subregion after 1975.

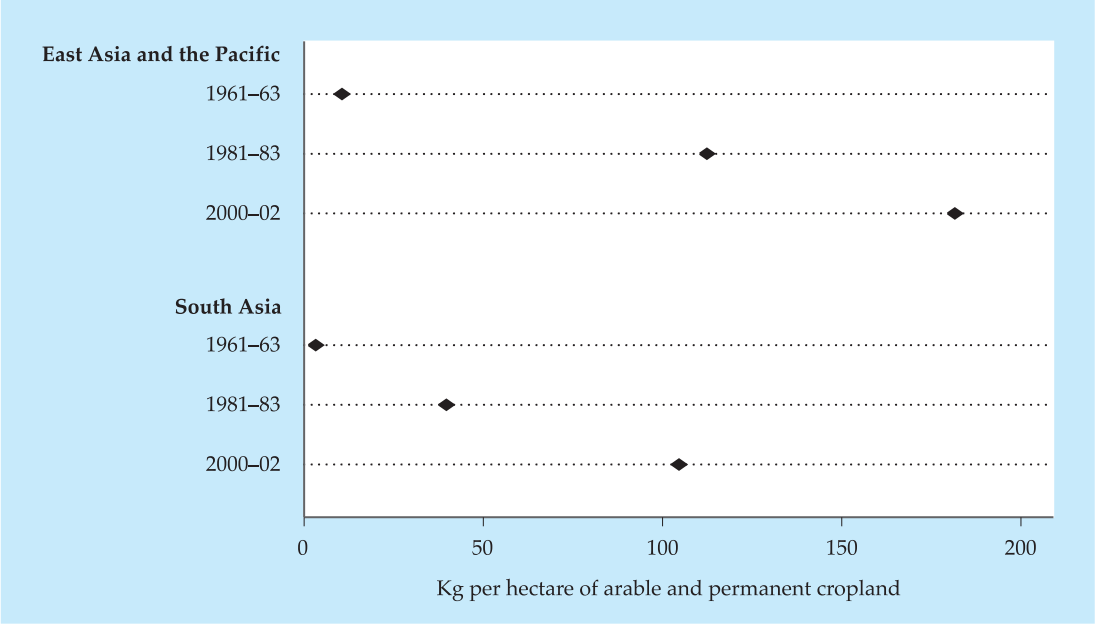
3.4 Determinants of crop yield growth

As discussed above, yield is a function of factors including fertilizer application per hectare, farm machinery per hectare, availability of irrigation, type of seeds used and agricultural labour per hectare. In the following subsections, changes in these variables are examined and their impact on crop yield growth is discussed.

3.4.1 Use of fertilizer

Figure 20 below depicts growth in fertilizer use in kg per hectare of arable and permanent land from 1961–2002. Fertilizer consumption grew at very high rates in East Asia and the Pacific in the 1960s and 1970s, but at a markedly lower rate in the 1980s and 1990s. In South Asia, by contrast, fertilizer use grew more rapidly in the 1980s and 1990s than in the earlier period. Currently, fertilizer use per hectare of arable land in East Asia and the Pacific is almost double the level in South Asia, which surely explains some of the differences in crop productivity between the two subregions.

Figure 20: Fertilizer consumption

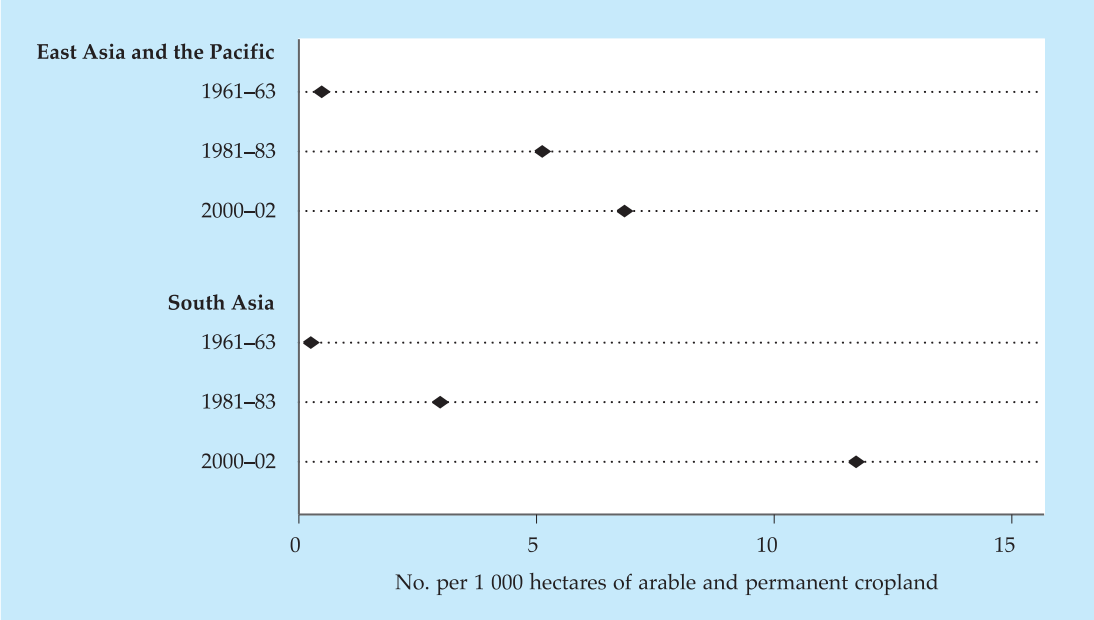


Source: FAOSTAT

3.4.2 Use of tractors

Figure 21 presents evidence about tractor use, which is another important input. There was a marked increase in the number of tractors per acre of arable and permanent cropland in South Asia in the 1980s and 1990s. South Asia now has a higher number of tractors per hectare than the East Asia and Pacific subregion. Rice farmers in East and Southeast Asia appear to have switched from using animal drawn ploughs to power tillers, while South Asia has relied more on four-wheel tractors.

Figure 21: Tractors in use



Source: FAOSTAT

3.4.3 Use of irrigation

Irrigation is an important factor in enhancing crop productivity. More than 60 percent of the value of Asian food crops comes from irrigated land and irrigation was the source of more than 50 percent of the increase in global food production from 1965–1985. Figure 22 shows evidence on changes in the percentage of irrigated arable and permanent cropland. The percentage of irrigated land has steadily expanded in South Asia and has relatively stagnated in East Asia and the Pacific, where about one-third of the arable and permanent cropland has access to irrigation facilities.

3.4.4 Use of modern varieties of seeds

The use of modern seed varieties (MVs) spread around the world beginning in the 1960s and the combination of MVs, irrigation and fertilizer was a crucial factor in their success. Some preliminary research, e.g. by Evenson and Gollin (2003) (*op cit.),* indicates that the gains from MVs were larger in the 1980s and 1990s than in the prior two decades when the Green Revolution began. Their research is consistent with the data shown in Figures 8 and 9 – agricultural output per capita began to show a consistent positive growth trend several years before agricultural value added per capita – indicating that use of MVs had a lagging impact on productivity.

3.4.5 Labour productivity

Though there is no logical reason for land productivity to be positively correlated with labour productivity, in actual fact it does seem to be. Figure 23 shows data from 90 developing countries from all regions and shows a clear positive correlation between these factors.

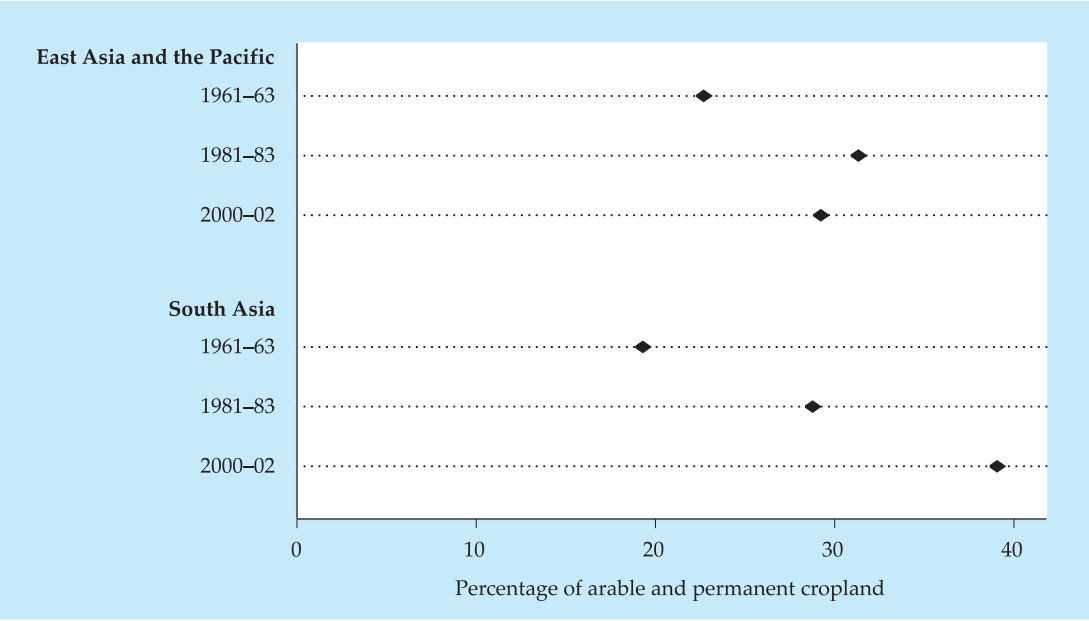
As can be seen in Figure 24 below, output per worker[18] increased with output per hectare in both subregions of the Asia-Pacific region from 1961–2002, but did so dramatically in East Asia and the Pacific. The marked rise in the productivity of labour coupled with the relative egalitarian social

[18] Note that this is labour productivity in crops alone and does not include other sectors, such as livestock or non-farm income.

structures of the subregion meant that workers could share in the gains. The seven-fold increase in real rural income that occurred in China is, at least in part, a consequence of the almost three-fold increase in output per worker in crop production that occurred in China over this period.

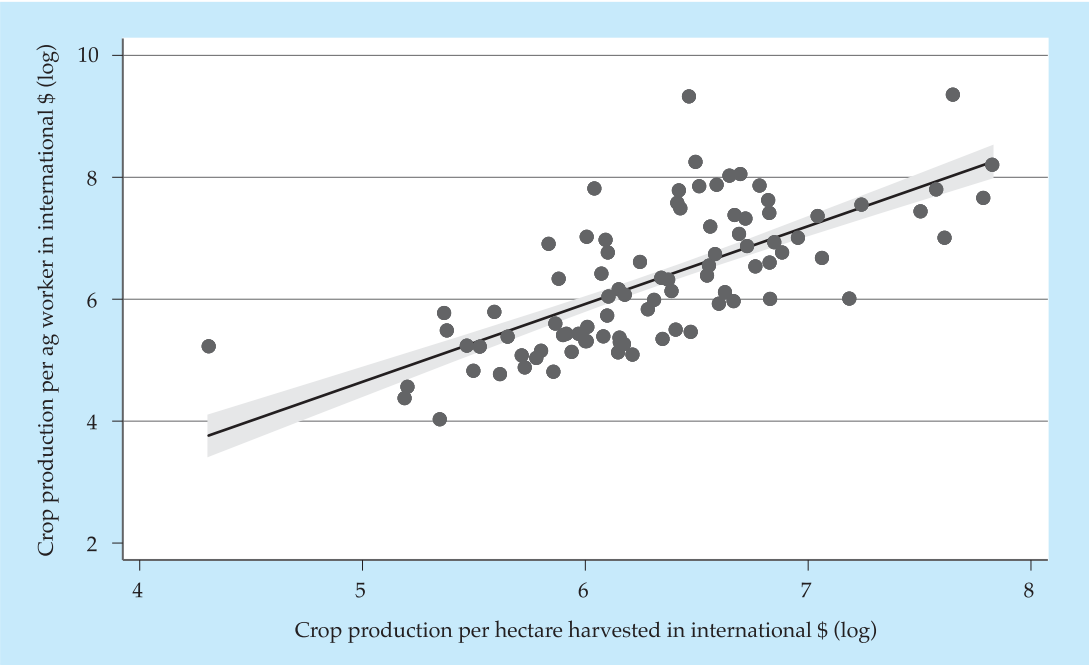
By contrast, it is apparent that labour productivity has grown very slowly in South Asia. Surely this explains some of the stubbornness with which poverty and malnutrition have persisted despite strong overall economic growth.

Figure 22: Percentage of land that is irrigated



Source: FAOSTAT

Figure 23: Output per worker and per hectare average 2000–2002



Source: FAOSTAT