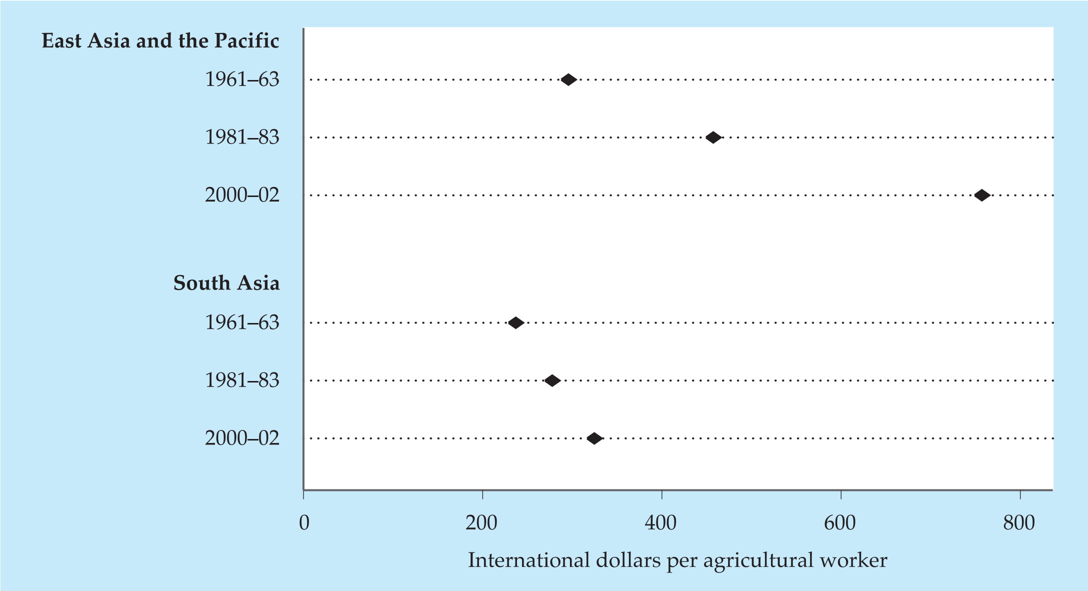
Figure 24: Output per worker



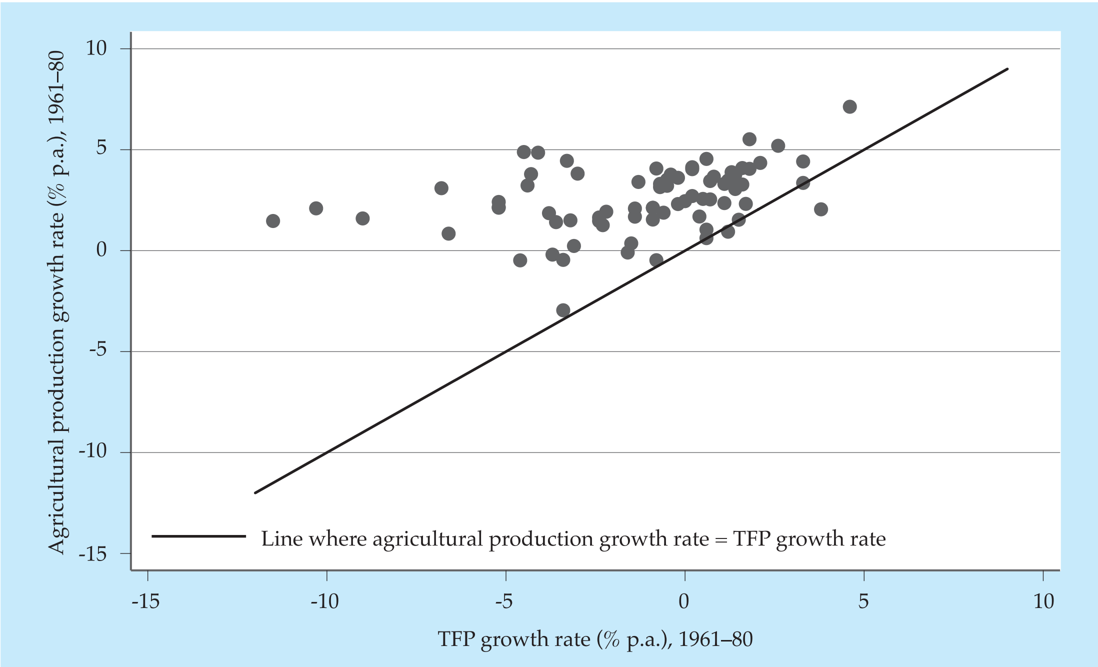
Source: FAOSTAT

3.5 Total factor productivity growth and agricultural production growth

If land and labour productivity growth occurred in both subregions (particularly in the East Asia and Pacific subregion), it follows that TFP must also have grown.

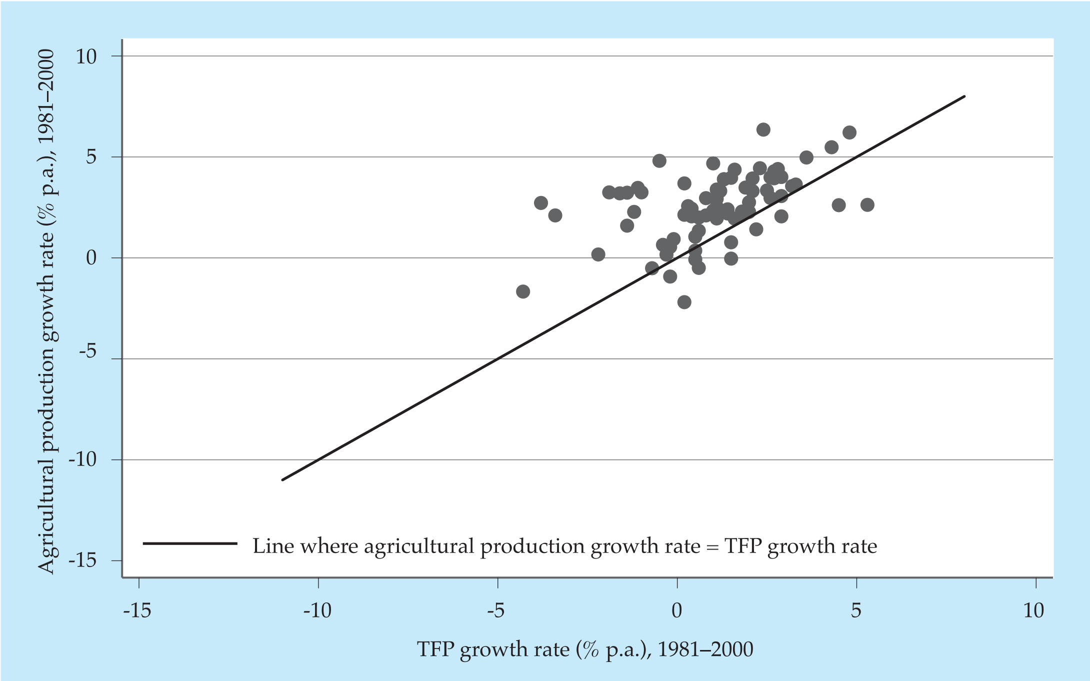
Figures 25 and 26 plot agricultural production growth against agricultural TFP growth in two time periods – 1961–1980 and 1981–2000. These figures include data from many developing countries from all regions to ensure that a sufficient number of data points would be available to draw sound conclusions. Agricultural production growth is positively related to growth in agricultural TFP, as shown by the red regression line.

Figure 25: Agricultural production growth and TFP growth, 1961–1980



Source: FAOSTAT and SOFA 2003, Table A8.

Figure 26: Agricultural production growth and TFP growth, 1981–2000



Source: FAOSTAT and SOFA 2003, Table A8.

In the earlier period, almost all countries experienced an agricultural production growth rate higher than the TFP growth rate. This implies that production inputs were also growing at positive rates. However, in the later period, there were ten countries for which the TFP growth rate was greater than the agricultural production growth rate. This implies that in these countries, productive inputs were growing at negative rates, i.e. they were producing more with less.

While a large number of countries had either negative or negligible TFP growth in the period from 1961–1980, the vast majority of countries had positive agricultural TFP growth and positive agricultural production growth rates from 1981–2000. By 1981–2000, growth in agricultural production and agricultural TFP was fairly strong, with rates of agricultural TFP growth ranging from 0 to 5 percent per year.

While the increase in output per worker helped raise wages, the increase in total factor productivity meant that the resulting increase in demand for food and other agricultural commodities could be met without an increase in food prices. This is an important part of the explanation for the success of East Asia and the Pacific in reducing hunger and poverty.

3.6 Impact and implications for future growth

While crop production growth was generally positive from 1961 to 2000, growth in crop production per head was close to zero in South Asia until about 1980; it became positive in East Asia and the Pacific by the early 1970s.

Agricultural growth was faster in East Asia and the Pacific than in South Asia from 1960–2006. A major reason was that East Asia and the Pacific experienced strong yield growth combined with area expansion. However, it is unclear why yield growth was stronger in that subregion, since it appears that fertilizer was the only input which grew faster in East Asia and the Pacific than in South Asia.

This growth appears to have been reasonably pro-poor, in that it led to declines in poverty and hunger, with larger declines where agricultural growth was stronger. Further evidence of the pro-poor nature of growth comes from the fact that growth in output per worker did result in an increase in agricultural wages and incomes. Where the increase in output per worker was larger, there was a bigger increase in agricultural wages, e.g. in China.

TFP growth was positive in the majority of countries in the Asia-Pacific region from 1981–2000. While area expansion has been an important source of crop production growth until quite recently, further opportunities for area expansion appear to be exhausted. Increases in cropping intensity may offer a solution to the problem of how to expand area despite high rural population densities. This will require an expansion of irrigation, which is still possible because less than 40 percent of the land in both regions is irrigated.

Yield growth is another way of economizing on land. The data show that countries with high population densities tend to be the ones with high land productivity. However, there is a large group of densely populated countries (e.g. China and Indonesia) that have achieved high land productivity and moderate to high labour productivity.

The other determinants of yield growth are fertilizer, tractors and irrigation. Data indicate that there is some tendency for these variables to level off in East Asia and the Pacific, with no such tendency in South Asia. Nevertheless, it is clear that current rates of growth cannot be maintained indefinitely. Growth in TFP offers the only feasible solution to the problem of ensuring continued crop growth.

3.7 Declining government expenditures

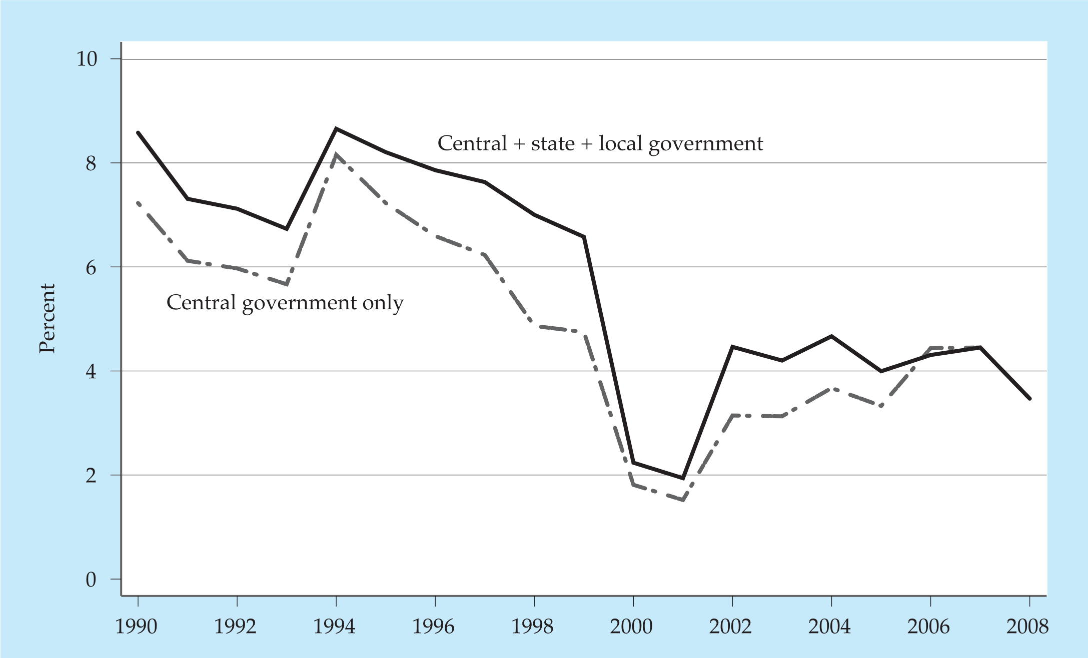
One of the most important determinants of agricultural TFP growth is government expenditure on road and marketing infrastructure, basic research and a host of other essential items. This is required for raising the productivity of private inputs in production.

As already noted, the success of the Green Revolution created a sense of complacency among policy-makers and this eventually led to a failure to increase public investment in agriculture sufficiently to meet growing demand. In fact, government expenditures on agriculture as a proportion of total expenditures in Asian countries showed a noticeable decline beginning in 1990, reached a low in 2001 and recovered somewhat in subsequent years. The proportion of agriculture expenditures to total expenditures (i.e. central government plus state and local) declined from about 8.5 percent in 1990 to less than 2 percent in 2001, before recovering to about 4.5 percent in 2004 (see Figure 27 below).[19]

This declining trend in the share of government expenditures on agriculture in Asia is symptomatic of the neglect of the sector. These numbers confirm the need to refocus policy attention and government resources on the agriculture sector to ensure food security and poverty reduction and to avoid a repetition of the food price spike of 2008.

[19] The data presented in Figure 27 are taken from the IMF data base on government expenditures and pertain to 19 Asian countries.

Figure 27: Government expenditure on agriculture as percentage of total select Asian countries



Source: IMF

IV. Projections to 2030–2050

4.1 Process and method

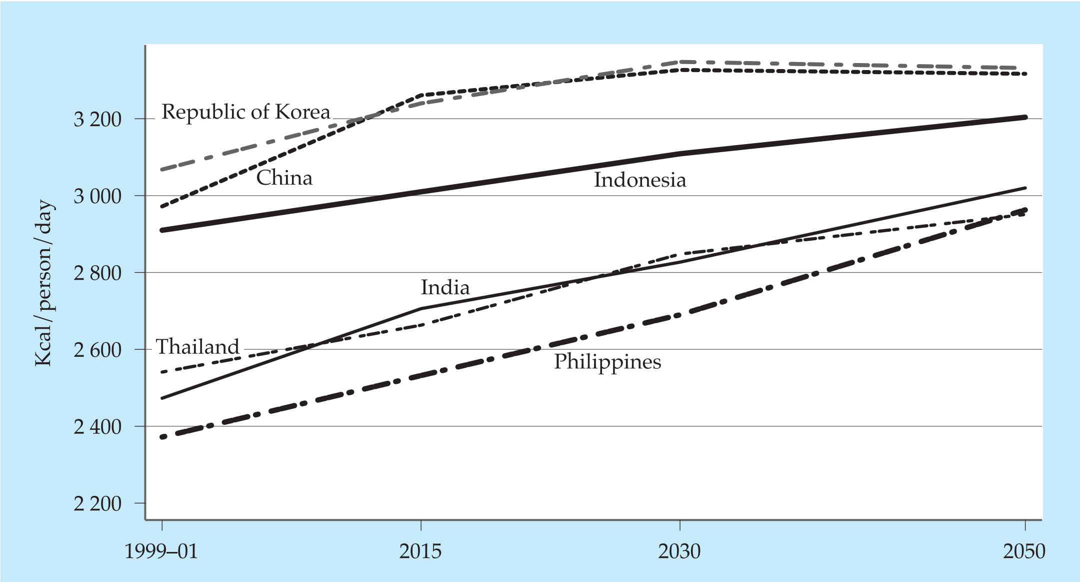
FAO is currently preparing a prospective assessment of world agriculture from 2030–2050. Preliminary results of that work, along with the results of earlier assessments, provide additional insights on the challenges and opportunities that face Asian agriculture.

Projections of demand, production and net trade start with projections of per capita GDP to 2015, 2030 and 2050 based on figures provided by the World Bank and the United Nations Population Division. A world food model provides initial projections of per capita consumption for each of 32 agricultural crop and livestock commodities by combining the per capita GDP projections with income elasticities of demand estimated from base period data. The production and trade projections start with provisional production estimates for each commodity and country based on past trends and simple assumptions about future self-sufficiency rates, taking into account a country's land and water resources. Net trade is derived as the residual between total demand and production. Final estimates for demand, supply and trade are developed through an iterative process that involves vetting by experts at each stage, ensuring that accounting identities are obeyed and making full use of the wealth of expert judgment available in FAO.

4.2 Projections of food consumption

Figure 28 illustrates projections of dietary energy consumption for a number of large Asian countries. Consumption of dietary energy can be expected to level off in some of the largest countries, such as China, beginning in 2015 even if income growth continues because there are physical limits to increased food consumption. By contrast, calorie consumption in countries with currently low levels of calorie consumption – below 2 500 calories per person per day – is projected to continue to increase with income growth up to 2050. In India, for example, calorie consumption is projected to increase from almost 2 500 to about 3 000 calories per person per day by 2050.

Figure 28: Total dietary energy consumption per person projections for selected Asian countries 1999–2001 to 2050

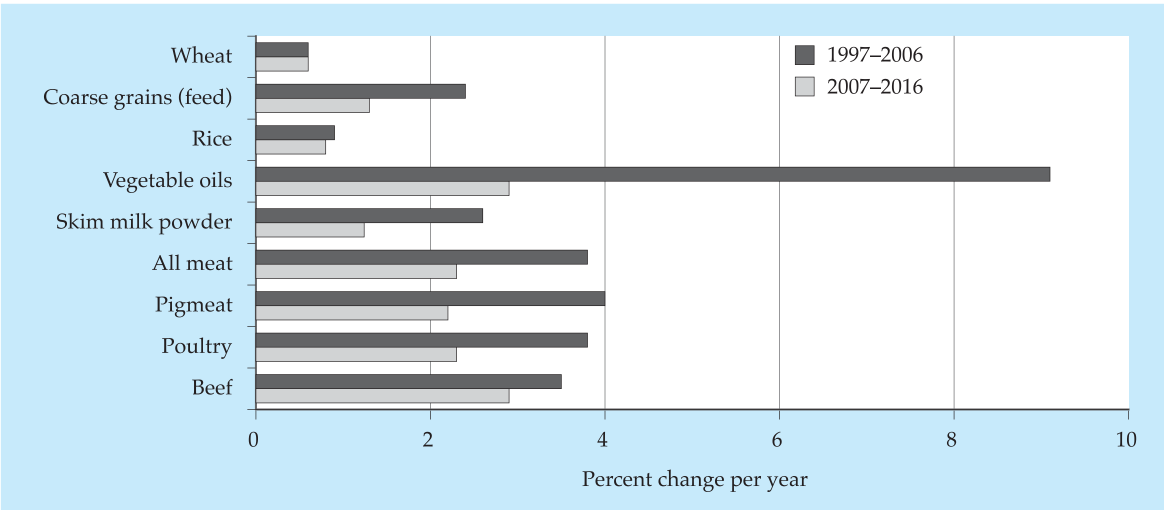


China refers to Mainland China.

Source: FAO Global Perspective Studies Unit

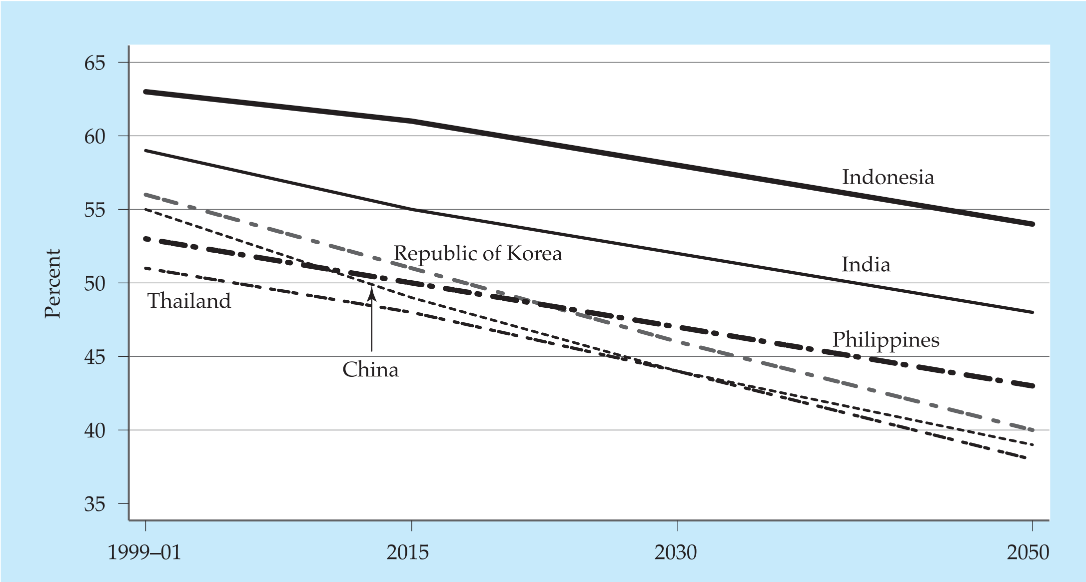
Even though consumption levels in Asia continue to grow, the composition of diets is changing as incomes rise and preferences change in response to urbanization and globalization.[20] As is typical of countries with rising incomes, the share of calories derived from cereals is declining in Asia (see Figures 10 to 12) and is projected to fall even further by 2050 (see Figure 30 below). Conversely, the share of calories derived from higher-value foods like fruits and vegetables, vegetable oils and livestock products is projected to increase, with the most rapid growth projected for chicken. Figure 29 below presents projections for the near future for the Asian region as a whole. The most striking feature is the marked slowdown in demand growth that is projected for the region. Longer-term projections, covering the period up to 2050, are presented in Figures 30, 31 and 32 below.

Figure 29: Asian food consumption projections



[20] Pingali, Prabhu. 2006. "Westernization of Asian diets and the transformation of food systems: Implications for research and policy. " *Food Policy* 12: 281–298.

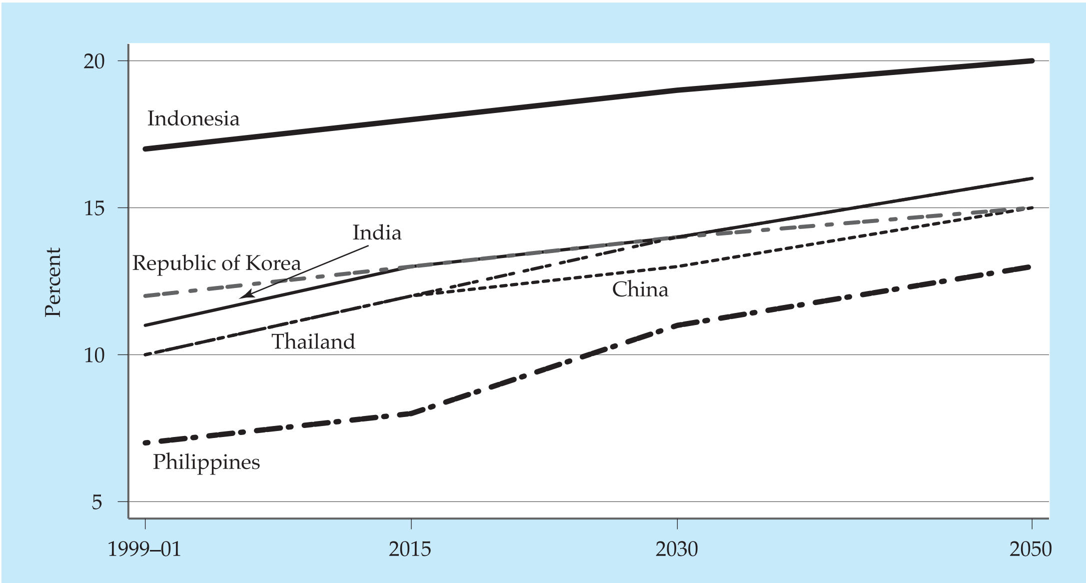
Figure 30: Share of calories from cereals projections for selected Asian countries 1999–2001 to 2050



China refers to Mainland China.

Source: FAO Global Perspective Studies Unit.

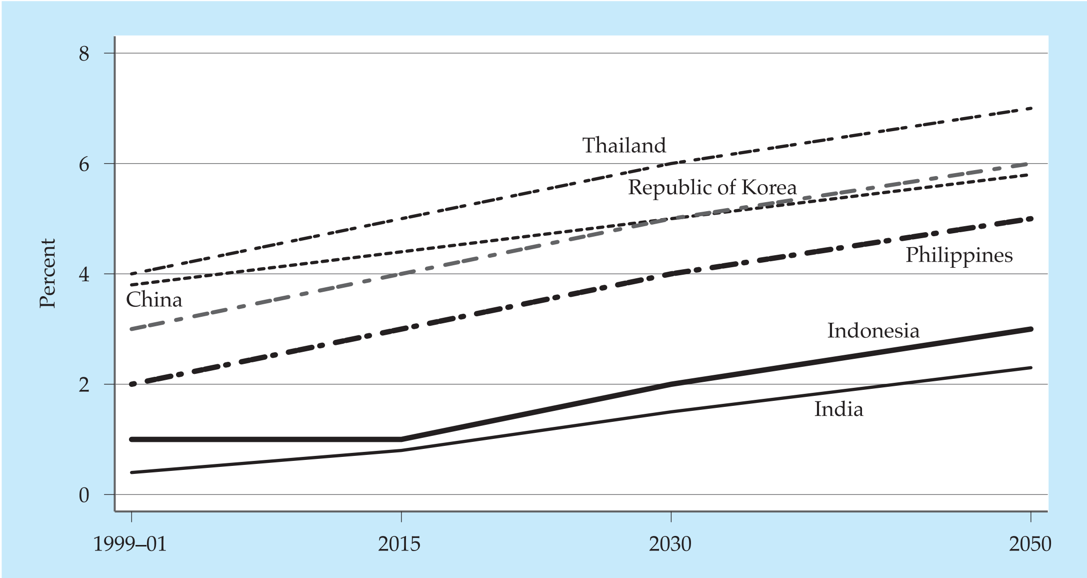
Figure 31: Share of calories from vegetable oils projections for selected Asian countries 1999–2001 to 2050



China refers to Mainland China.

Source: FAO Global Perspective Studies Unit

Figure 32: Share of calories from chicken and eggs projections for selected Asian countries 1999–2001 to 2050



China refers to Mainland China.

Source: FAO Global Perspective Studies Unit.

Projected growth in demand for cereals is driven primarily by an increase in population. By contrast, demand for potatoes, fruits and vegetables, sugar and meat (excluding chicken) is driven by rising incomes and changing preferences (along with population growth) and is projected to double. Demand for vegetable oil and milk is expected to triple and demand for eggs and chicken is projected to increase even more rapidly.

4.3 Projections for agricultural inputs

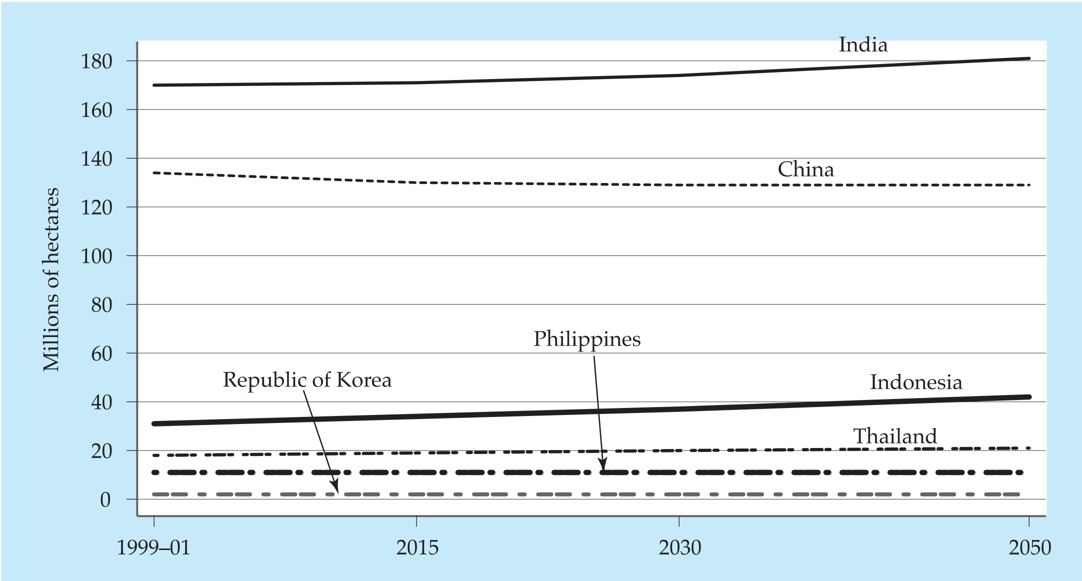
How will these levels of increased demand be met? Increases in crop production derive primarily from increases in yield, expansion of arable land and increases in the frequency with which crops are harvested from a given area (i.e. cropping intensity). As seen in Table 2, yield growth accounted for 100 percent of crop production growth in South Asia from 1991 to 2005. However, in East Asia and the Pacific, area expansion also played an important role. The contribution of cropping intensity to crop production growth had become negligible by the 1990s and was actually negative in the East Asia and Pacific subregion.

What can be expected over the next 40 years? Figures 33–36 provide projections for selected Asian countries. In India for example, arable and permanent cropland area is projected to grow only slightly, from 170 million (58 million irrigated) hectares in 1999–2001 to 181 million (78 million irrigated) hectares in 2050 (see Figure 33). Area is projected to decline in China.

Over the same period, cropping intensity in India is also projected to increase only slightly: from 101 to 104 percent in rainfed areas, from 127 to 129 percent in irrigated areas and from 110 to 115 percent overall (see Figure 34 below). Cropping intensity is projected to increase more rapidly in the Philippines, reflecting the fact that most land with agricultural potential is already cultivated in that country, and to level off in China after 2030.

Cereal yields are projected to increase as shown in Figures 35 and 36 below. Growth in cereal production is likely to be driven by yield increases since there is little scope left for bringing more land under the plough or for increasing cropping intensity, except in a handful of countries.

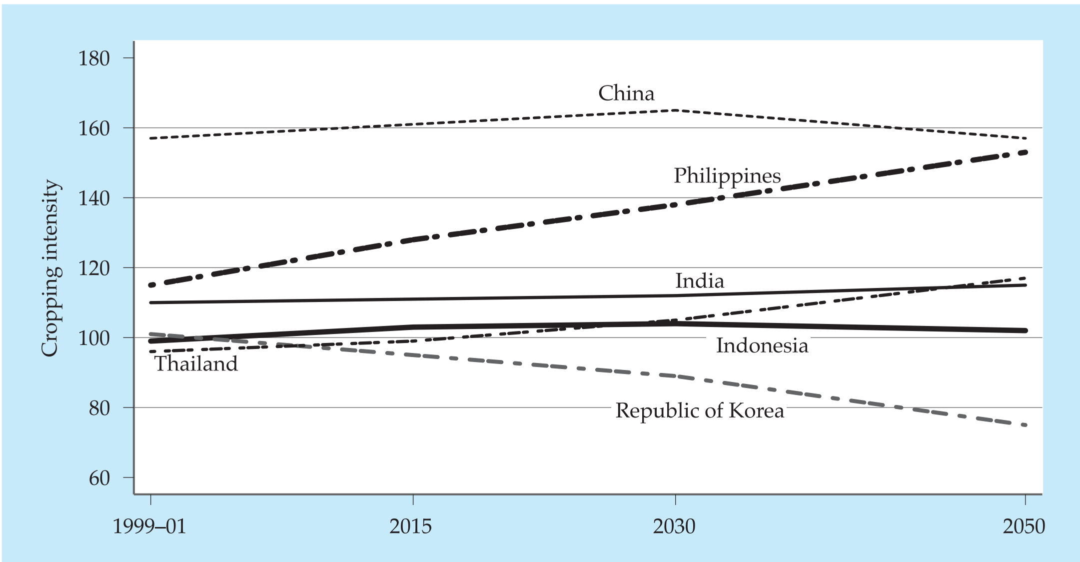
Figure 33: Arable and permanent crop area projections for selected Asian countries 1999–2001 to 2050



China refers to Mainland China.

Source: FAO Global Perspective Studies Unit

Figure 34: Cropping intensity projections for selected Asian countries 1999–2001 to 2050

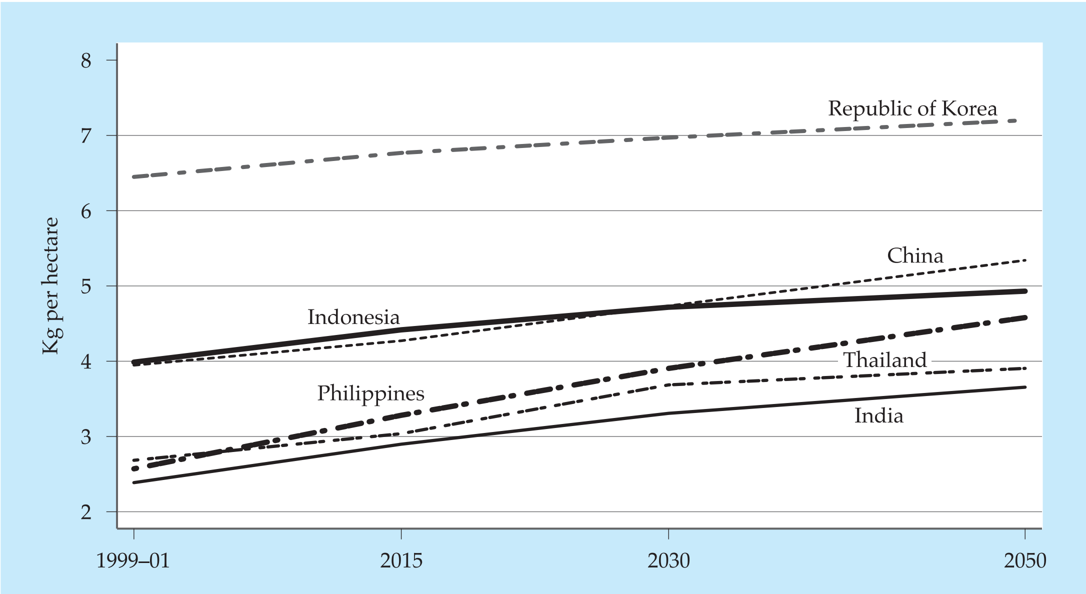


China refers to Mainland China.

Cropping intensity is the ratio of area harvested to arable area (multiplied by 100).

Source: FAO Global Perspective Studies Unit

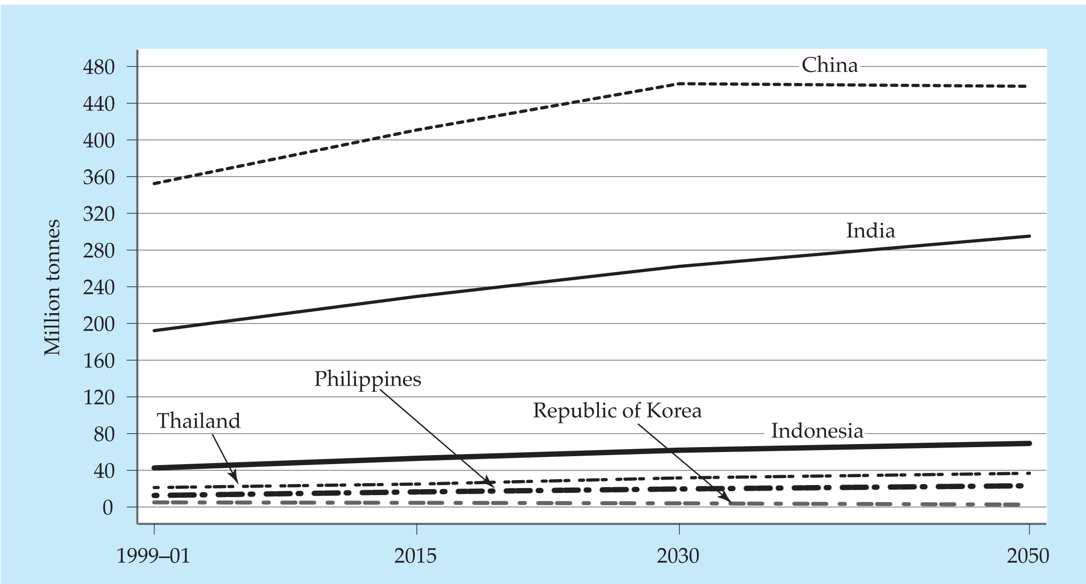
Figure 35: Cereal yield projections for selected Asian countries 1999–2001 to 2050



China refers to Mainland China.

Source: FAO Global Perspective Studies Unit.

Figure 36: Cereal production per annum projections for selected Asian countries 1999–2001 to 2050



China refers to Mainland China.

Source: FAO Global Perspective Studies Unit.

V. Emerging Issues

5.1 Climate change

FAO's Interdepartmental Working Group on Climate Change has prepared a framework document on Climate Change and Food Security. This document explores the effects that global warming and climate change may have on food system performance and food security outcomes. It also presents strategies for mitigating and adapting to climate change for several key policy domains that are likely to shape future food system behaviour and food security outcomes.

FAO projections indicate that it will be possible to increase food production globally by an amount sufficient to feed a growing world population and meet increasing market demand, even in the face of climate change. However, to achieve food security food must be available in adequate quantities, must be physically and economically accessible to consumers and must be used in ways that satisfy tastes and nutritional needs. Climate change may affect all these dimensions of food security. Immediate impacts will be adverse effects from more frequent, more intense and more extreme weather events on food production, food distribution infrastructure, livelihood assets and opportunities in rural and urban areas. Less immediate, but possibly even more significant, impacts are anticipated because of changes in mean temperatures and rainfall and increasing weather variability. These will affect the suitability of land for different crops and pasture, the health and productivity of forests and the incidence and vectors of pests and diseases. Climate change is thus likely to have significant impact on a wide range of factors essential to human well-being, including employment, income, health and prices for water, energy and food.

Climate change will affect the extent and nature of agro-ecological zones in Asia and elsewhere, the estimates of areas with potential for crop production and the projections of maximum attainable yields. Some of these changes could be favourable (e.g. increasing the length of the growing period in higher latitudes or altitudes) and some of them could be unfavourable (e.g. reducing precipitation in dry areas or increasing salinization or flooding in coastal areas). Changes in potential cropland and maximum attainable yields would not necessarily mean changes in actual yields or production because these depend not only on biophysical properties but also on technology and market conditions.

5.2 Biofuels

High and volatile petroleum prices and mounting concerns over global climate change have stimulated interest in bioenergy as a strategy for climate change mitigation and energy security. Many governments have adopted mandates and incentives to encourage the development of liquid biofuels in particular. Biofuels offer a number of potential advantages over fossil fuels, but concerns have been raised regarding the potential for negative secondary effects on food security and the environment. The growing use of cereals, sugar, oilseed and vegetable oils to produce fossil fuel substitutes (e.g. ethanol and biodiesel) is one factor driving up crop prices and, indirectly through higher animal feed costs, the prices for livestock products. Higher commodity prices can worsen food insecurity for households that spend a significant portion of their income on food. At the national level, net food importers may see their food import bills rise. On the other hand, higher prices are beneficial for commodity producers, so biofuel demand could represent a significant new source of income for farmers who are able to take advantage of the opportunities, with related benefits for farm workers and other rural people. If biofuel development supports greater access to energy services in remote rural areas, it could stimulate economic growth more broadly. Carefully designed and implemented policies are required to achieve the advantages of biofuels while avoiding unintended negative consequences.

VI. Conclusions

The main conclusions from this survey are:

1. The Asia-Pacific region has benefited enormously from strong economic growth. However, serious problems remain particularly in South Asia. Poverty and malnutrition continue to give cause for alarm.
2. Asian households are consuming more calories. The main source of these extra calories appears to be vegetable oil and fats in Southeast and South Asia and livestock products in China. Cereal consumption per capita can be expected to increase only in South Asia, having levelled off elsewhere in the region.
3. Agricultural growth did not really become strong in this region until the early 1980s and it grew faster in the East Asia and Pacific subregion than in the South Asia subregion from 1960–2006. A major reason for this was that strong yield growth was combined with area expansion in the East Asia and Pacific region. However, it is unclear why yield growth was stronger in that subregion because fertilizer appears to have been the only input for which use grew faster in East Asia and the Pacific than in South Asia.
4. This growth appears to have been reasonably pro-poor in that it led to declines in poverty and hunger with larger declines where agricultural growth was stronger. Further evidence of the pro-poor nature of growth comes from the fact that growth in output per worker resulted in an increase in agricultural wages and incomes. Where the increase in output per worker was larger, there was a bigger increase in agricultural wages, e.g. in China.
5. The use of modern inputs, such as fertilizer, tractors and modern seed varieties, grew rapidly, as did irrigation. At least until the end of the last century, there was no clear evidence of stagnation in the growth of these inputs in South Asia, though there were signs in East Asia and the Pacific.
6. Projections indicate that demand for superior foods will continue to increase as incomes rise, but supply will be able to cope. However, these projections did not consider the impact of climate change.
7. Unfortunately, little can be said about the impact of climate change on agriculture that is both true and useful to policy-makers. The high levels of uncertainty that exist serve only to reinforce the policy advice that governments in this region must not neglect agriculture, as they seem to have done in the 1990s. Indeed, there are encouraging signs of a change in attitude on this point in recent years.

Appendix 1

A note on the Geary-Khamis procedure for estimating "international prices" for agricultural commodities

It may be helpful to clarify the method used for calculating the "international prices" used in the computation of the FAO production index numbers (PINs).

The basis for any production index number is the value of agricultural output (net or gross) in "international prices" (IPs), which is the same for every commodity regardless of where it is produced in the world. By using IPs we avoid a major problem in comparing the growth rates of different baskets of output produced in different countries where the weight of each commodity in the basket is given by the local price in that country. The problem arises because these prices could be very different, implying that even if each of those commodities were to grow at the same rate across countries over some time period, the calculated growth rate for each basket would differ from country to country. This makes international comparisons problematic.

To avoid this problem, IPs are calculated as follows. We begin with the simplest case of two commodities and two countries. Suppose these commodities are wheat and rice and the countries are China and India. The international price of wheat is defined as the weighted average of the price of wheat in India and the price in China; the weights being given by the proportion of wheat produced in each country. However, these two prices need to be converted into a common measure, i.e. they have to be multiplied by an "agricultural exchange rate" that converts rupees and yuan into "international dollars".

$$\frac{X_{wheat}^{China}}{X_{wheat}^{China} + X_{wheat}^{India}} \cdot p_{wheat}^{China} \cdot E_{\pi}^{Yuan} + \frac{X_{wheat}^{India}}{X_{wheat}^{China} + X_{wheat}^{India}} \cdot p_{wheat}^{India} \cdot E_{\pi}^{Rupee} = \pi_{wheat} \qquad (1A)$$

$$\frac{X_{rice}^{China}}{X_{rice}^{China} + X_{rice}^{India}} \cdot p_{rice}^{China} \cdot E_{\pi}^{Yuan} + \frac{X_{rice}^{India}}{X_{rice}^{China} + X_{rice}^{India}} \cdot p_{rice}^{India} \cdot E_{\pi}^{Rupee} = \pi_{rice} \qquad (1B)$$

The symbols should be self-explanatory: X stands for production, p for prices in local currency units, π for prices in "international dollars" and E for agricultural exchange rates from local currencies into "international dollars". For example, E_{π}^{Yuan} gives the number of "international dollars" that can be bought with one yuan.

The problem is that we have a system of two equations and four unknowns: E_{π}^{Yuan} , E_{π}^{Rupee} , π_{wheat} and π_{rice}. However, two more equations can be defined for determining the two exchange rates, one for each country:

$$\frac{\pi_{wheat} \cdot X_{wheat}^{China} + \pi_{rice} \cdot X_{rice}^{China}}{p_{wheat}^{China} \cdot X_{wheat}^{China} + p_{rice}^{China} \cdot X_{rice}^{China}} = E_{\pi}^{Yuan} \qquad (2A)$$

The numerator is simply the value of China's agricultural output at international prices while the denominator is the value of China's agricultural output at domestic prices. The ratio of the two is the agricultural exchange rate. A similar equation can be defined for India:

$$\frac{\pi_{wheat} \cdot X_{wheat}^{India} + \pi_{rice} \cdot X_{rice}^{India}}{p_{wheat}^{India} \cdot X_{wheat}^{India} + p_{rice}^{India} \cdot X_{rice}^{India}} = E_{\pi}^{Rupee} \qquad (2B)$$

We get a system of four linear equations and four unknowns, which can be solved for the unknowns.

What happens if we add a commodity? Then a third equation has to be added to the first pair of equations; we would now have equations 1A, 1B and 1C, in addition to 2A and 2B, making a total of five equations and five unknowns. Similarly, adding a country implies that a new exchange rate equation 2C would need to be added to the second pair, resulting once again in five equations and five unknowns. In general, with N commodities and M countries the equation system would consist of N + M equations and N + M unknowns.

To summarize, the PINs are defined as:

$$PIN = \frac{\pi^0 \bullet X^1 - \pi^0 \bullet X^0}{\pi^0 \bullet X^0}$$

where:

- X^1 and X^0 are vectors of final agricultural output (minus all agricultural intermediates such as bran, oilcakes, etc.) as well as seed and animal feed at times one and zero respectively;
- π^0 is a vector of "international prices" as defined above.

By contrast, growth in agricultural value added is calculated as follows:

$$\Delta AgVA = \frac{[p^1 \bullet X^1 - w^1 \bullet f^1] - [p^0 \bullet X^0 - w^0 \bullet f^0]}{p^0 \bullet X^0 - w^0 \bullet f^0}$$

where:

- ΔAgVA is growth in agricultural value added in some country or region;
- X^1 and X^0 are defined as above;
- f^1 and f^0 are vectors of input quantities in period one and period zero respectively, such as labour services, land services or capital services;
- p^1 and p^0 are vectors of prices expressed in local currency units.

Remark 1: It should be noted that as with any price system, this price system is homogeneous of degree zero, which implies that only relative prices can be defined. Hence one international price (it doesn't matter which) has to be chosen as the numéraire.

Remark 2: If each country produces a set of commodities that is totally distinct from the sets produced by the others, then international prices do not make any sense because they can be any multiple of domestic prices, including one times the domestic price.

Remark 3: The calculation of GDP at Purchasing Power Parity follows exactly the same procedure, except that it is done for all final commodities rather than agricultural commodities as in this case.

Remark 4: There is no reason why these two measures should be expected to give the same or even similar results. For example, even in the special case where f^1 and f^0 are the same – e.g. if input use has not grown – and even if it is assumed that w^1 and w^0 are roughly the same, the equation still reduces to:

$$\Delta AgVA = \frac{p^1 \bullet X^1 - p^0 \bullet X^0}{p^0 \bullet X^0 - w^0 \bullet f^0}$$

Even this will not be close to the agricultural PIN because international prices could be quite different from local currency prices. For example, the price of beef is likely to be low relative to other prices in India, whereas the international price ratios will reflect the importance of beef internationally.

The conclusion is that there is no "correct" way to measure agricultural growth. FAO uses "international dollar" prices for exactly the same reason that the ICP does: to avoid using exchange rates for computing world and regional aggregates and to facilitate international comparisons of productivity at the national level.

The really interesting question is to pinpoint the sources of the divergence. That may tell us something interesting, just like the finding that value-added growth had been negative at world prices in some Soviet bloc countries in the 1980s, despite output growth being positive.

Remark 5: "The basic ideas underlying the Geary-Khamis system were formulated in the early 1950s when Geary worked as a consultant to FAO. A formal description of the method appeared in a brief paper (Geary, 1958). The method gained prominence through work by Khamis (1970, 1972, 1984), where the method was given a systematic exposition and therefore the method has come to be known as the Geary-Khamis method." (http://www.fao.org/es/ess/yearbook/gearyKhamis.pdf)