The Asian Maize Economy in 2025

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Introduction

The seven country chapters of this volume provide systematic summaries of maize policy for much of Asia at the turn of the 21st Century. These essays also provide helpful comments about likely near-term trends for their respective countries. By design, however, they offer neither descriptions of how the maize sectors will look in the future nor a sense of the variables and parameters that might shape country-specific outcomes in unpredictable ways.

This chapter, by contrast, looks more qualitatively at Asia as a single region and focuses more speculatively on the longer run. It is also more personal, since views of the year 2025, like beauty, depend inevitably on the eyes of the beholder.[1] The chapter begins by running history backwards via a thought experiment. Suppose in 1975 that one had been predicting the contours of the Asian maize economy in 2000. What variables and parameters would forecasters have missed in significant ways? This procedure turns out to be a very sobering exercise for anyone now predicting events in 2025.

Despite the warnings provided by this past-as-prologue approach, the third section summarises the leading quantitative projections for maize that have been made for the year 2025. These projections, by

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1. Although written in 2004, this chapter generally uses 2000 as its base year and 2025 as its forecast year. The historical portions of this essay depend considerably on personal experiences while on the CIMMYT Board of Trustees (1980-1987 and 1994-2001) and on notes from a course on "The World Food Economy," taught or co-taught at Stanford University each year since 1973. It also draws heavily from Falcon and Naylor (1998).

their very nature, tend to produce smooth and well-behaved outcomes through time. They are the best estimates currently available, but as the 1975-2000 period showed, there are also likely to be some surprises. The fourth portion of the chapter thus offers commentary on several additional variables and parameters that may shape the Asian maize economy of 2025.

Much of this essay is in keeping with the recent evolution of the Asian maize economy. It focuses primarily on livestock issues and on the increasing percentage of maize being used for feed purposes. There are, however, still likely to be many resource-poor farmers in 2025 growing maize for subsistence consumption. The final section of the chapter speculates on the extent to which maize is likely to play a direct role in the reduction of Asian rural poverty during the first quarter of this century.

Twenty-Five Years of Progress and Surprises

Analysts who wrote in 1975 about the Asian maize economy of 2000 are surely now surprised, if not embarrassed. In 1975, China, India, and Indonesia, the first, second, and fourth most populous countries in the world, had total fertility rates of 3.4, 5.4, and 5.0, respectively.[2] Chinese agriculture was mired in collectivism, and the country had not yet adopted the household responsibility system in agriculture. India was progressing very slowly at what the late Raj Krishna referred to as the "Hindu rate of growth" (Krishna and Krishna, 1995). Indonesia was just emerging from the chaos of a regime change between Presidents Sukarno and Soharto; Timmer (1987) gives an excellent assessment of the country's maize economy, as the sector evolved from 1965-1985. Much of Southeast Asia was still war-torn and pursuing well-intended but misguided socialist policies within the agricultural sector. The spread of improved maize germplasm for much of tropical Asia was seriously curtailed by pest problems, by anti-private sector attitudes toward the seed sector, and an inability of most public sector seed systems to deal adequately with hybrid varieties (Morris, 1998). Concerns over the long drought in

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2. Unless otherwise noted, economic and population data used in this report come from The World Bank (2004). Food and agriculture statistics come from FAO (2004).

South Asia of the mid-1960s were reinforced by the severe agricultural (and macroeconomic) impacts of the 1972-73 El Niño. Supply failures of the early 1970s, changed patterns of grain trading by the Soviet Bloc, and US monetary problems arising from the Vietnam War caused real maize prices to reach modern-day highs in 1974 (Hathaway, 1974). Hathaway and his two discussants, Hendrick Houthakker and John Schnittker, all agreed that the US had run out of excess agricultural capacity by the early 1970s (Figure 10.1). The supply and demand circumstances in 1975 had almost everyone forecasting that trends in the real prices of grains would henceforth rise rather than fall.[3] This view was further amplified by energy disruptions, and by the hype in the US about synthetic fuels that were projected to consume upwards of 50 million tonnes of maize by 1990 for making ethanol (Congressional Quarterly, 1979). Overall, most dimensions of the projected 2000 Asian maize economy looked exceedingly grim in 1975, particularly for consumers but also for poorer producers.

Figure 10.1

Real Prices Received by Farmers, US Corn 1960-2003 $/metric tonne, 1996 Dollars
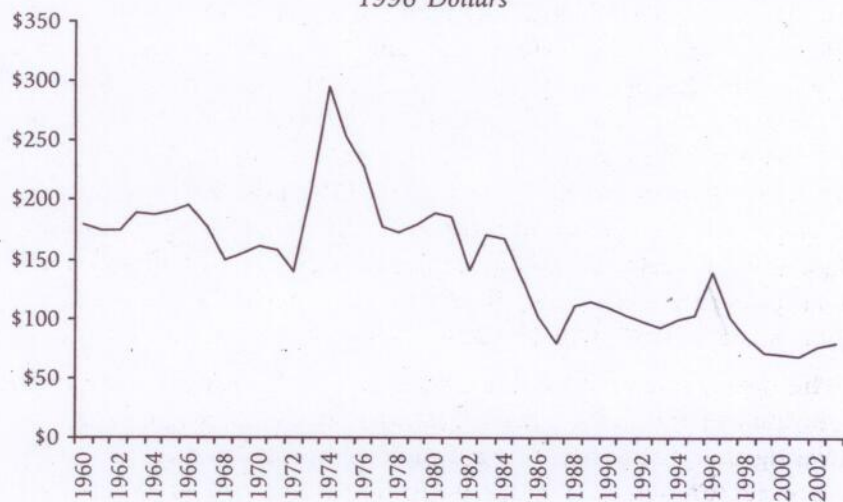
Source: USDA (2004a).

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3. A consistent exception to this point of view was the late D.G. Johnson. A later summary of his longer-run views on this topic can be found in Johnson (1997).

Surprisingly, few of the 1975 headline topics remained central issues for the first part of this century. These unexpected outcomes contain several lessons, including the warning that both forecasters and readers of forecasts need to be wary of projections.[4]

Each agricultural historian has a preferred listing of unanticipated events and outcomes for the 1975-2000 period. With respect to the Asian maize economy, however, several conclusions appear to stand out. First and foremost, economic policies of Asian nations really mattered—whether the issue was economic growth, property rights, trade policy, technology investments, or population programs. Asia did much better during the last quarter of the 20th century because policies were bolder and more generally oriented toward incentives, personal freedom, and institutional flexibility—that is, towards the basic fundamentals of long-run economic growth—than *pundits* in 1975 would have thought possible.

A second conclusion is that population growth turned out to be far less important as a negative factor for Asian food security, and income growth to be far more important as a positive factor, than was predicted. In 1975, Asia's population growth was 2.4 per cent annually, but by 2000 it had fallen to 1.3 per cent per year. In China alone, the total fertility rate went from 3.4 to 1.9, a rate less than replacement, during the 25 years. The income data are even more revealing. In different ways and from very different policy bases, Asia's three largest developing countries—China, India and Indonesia—liberalised their economies. Between 1975 and 2000, these three countries averaged growth in GDP of 9.1 per cent, 5.1 per cent, and 5.8 per cent annually, with large consequent effects on both grain and animal-product consumption. By 2000, these countries had (PPP) per capita incomes of $3,870, $2,420, and $3,060, respectively.

The development of new technology, especially germplasm, and alterations in the public and private institutional mechanisms for delivering this technology changed radically for maize after 1975. The private sector played a more dominant role, hybrid maize area

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4. See McCalla and Revorado (2001) for a formal assessment of projection models for population and food. Besides the actual review of models, these authors also make very useful distinctions among quantitative forecasts or projections, qualitative predictions, and scenario analyses.

expanded rapidly, and some of the most severe tropical constraints on maize production, e.g. downy mildew, were substantially overcome (Pingali, 2001). Maize did not undergo an early green revolution in Asia comparable to rice and wheat. However, the gains in maize yields were nonetheless impressive over large parts of the continent, going from an average yield of about 1.9 t/ha in 1975 to 3.6 t/ha in 2000. Few experts in Asia, North America, or Europe thought in 1975 that such widespread gains would be feasible.

Although circumstances and the geo-politics surrounding petroleum-based energy were frequently tense, the price of petroleum (Saudi light) averaged about $18 per barrel between 1975 and 2000. (Figure 10.2). Petroleum prices varied considerably, but they did not rise systematically, even in nominal terms. Thus the price of oil did not fundamentally drive changes in end uses for maize in the US, and the 50 million t of maize thought destined for ethanol plants did not materialise. As a consequence, ethanol demand did not put strong upward pressure on world maize prices, and the US continued as the dominant supplier to the global market for maize.[5]

Figure 10.2

Nominal Price of Saudi Light Crude Oil, 1970-2003 ($/barrel)
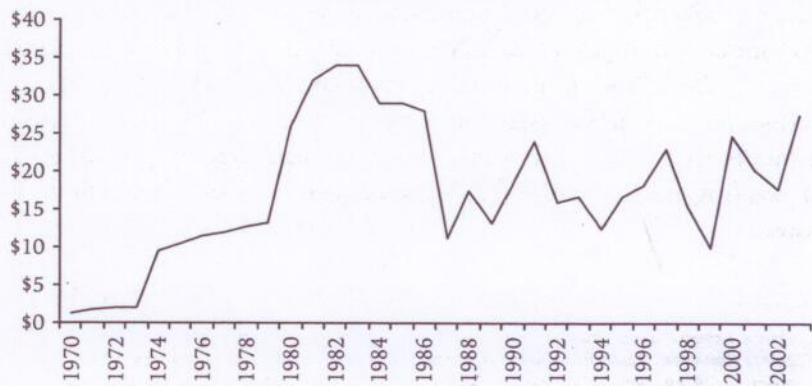
Source: DoE (2004).

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5. The ethanol situation in the US changed between 2000 and 2004. A combination of low maize prices and subsidies, coupled with the 9/11 attack, rekindled US efforts to achieve greater energy independence *via* ethanol. About 10 per cent of US maize production was used for ethanol in 2003, and an additional 4 per cent went to the production of high-fructose corn syrup and the proportion for ethanol has continued to expand during 2004-2007.

Of all the global and regional maize surprises, none exceeded the multifaceted story in China. China's GDP per capita grew at 7.6 per cent annually, pork consumption grew from 8.5 kg per capita in 1975 to 32.5 kg in 2000,[6] and China became the world's third largest maize exporter in 2000. One could have received astronomical odds in 1975 for betting these events would evolve. Yet they happened.[7]

Estimates of the Asian Maize Economy for 2025

Forecasting what will happen to the Asian maize economy is fraught with uncertainty. But it is both possible and desirable to obtain consistent 2025 estimates that make reasonable assumptions about population growth, economic growth, supply and demand elasticities, etc. The devil is largely in the parameter details of such models, and the devil also lurks outside these models in the form of various kinds of discontinuities—abrupt policy changes, wars, climate change, and unexpected technological breakthroughs.

A number of groups, such as the modelers at Iowa State University (FAPRI, 2004), produce systematic and thoughtful forecasts and comments about commodity markets. For example, the annual Iowa State projections look ahead for 10 years. FAO (2003b) also presents a series of commodity forecasts for the year 2030. For longer-run forecasts, however, the gold standard in models has become IFPRI's 2020 Model (Rosegrant *et al.*, 2001), which has recently been extended to 2025.[8] The IFPRI models have evolved over a decade, and their conclusions are widely used for both analytical and policy purposes. The model uses 1997 as its base, which is close enough to 2000 to use as a starting point for the 2025 projections and the discussion that follows:

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6. China experts agree that pork production/consumption grew rapidly between 1975 and 2000. However, Ma *et al.* (2004) argue that pork consumption in 2000 was probably on the order of 24 kg. per capita, rather than the higher estimate reported by the FAO.

7. The expansion of maize production in China came at considerable cost to the environment, with maize being planted on hillsides and other marginal areas where soil and nutrient runoffs have been substantial. See Li *et al.* (1997).

8. The author is grateful to Rosegrant (2004) and his colleagues for their willingness to share unpublished 2025 results.

Table 10.1 shows projections of maize production and trade in 2025 for the countries where the IMPACT model provides individual data. Using 1997 as a base year, Rosegrant and his colleagues predict that maize production will nearly double in most Asian countries by 2025, with China remaining by far the most important producer.[9] On the trade side, the model predicts that almost all the East and Southeast Asian countries will be net importers of maize by 2025, with China easily surpassing Japan as the largest importer. The model also anticipates that most of the South Asian countries will remain very modest exporters.

Table 10.1

Projected Maize Production and Trade, 2025

	Production			Net Trade		(mmt)
	1997	2025	Annual Growth, 1997-2025 (Per cent)	1997	2025	
Bangladesh	0.00	0.00	0.0	0.0	0.0	
China	121.90	230.56	2.3	-1.9	-39.8	
India	10.33	14.38	1.2	0.0	0.5	
Indonesia	9.40	14.10	1.5	-0.5	-0.2	
Japan	0.00	0.00	0.0	-16.3	-15.6	
Korea, S.	0.08	0.14	2.0	-8.1	-12.7	
Malaysia	0.05	0.07	1.3	-2.3	-3.9	
Myanmar	0.30	0.54	2.1	0.1	0.2	
Pakistan	1.27	2.39	2.3	0.0	0.1	
Philippines	4.17	8.46	2.6	-0.4	-1.9	
Thailand	4.45	8.05	2.1	-0.2	-1.3	
Vietnam	1.60	2.78	2.0	0.1	-0.7	

Source: Rosegrant (2004).

Table 10.2 shows IFPRI's projections of key maize and livestock series for 2025. This table is broken down between South Asia (SA),

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9. Which base year one chooses when looking at trends in Chinese maize production and trade turns out to be very important. Between the years 1995 and 2002, China's maize production vacillated between a low of 104 mmt and a high of 133 mmt, according to FAO data. Over the same period, China was in one year a 6 mmt net exporter of maize, and in another an 11 mmt net importer.

and East and Southeast Asia (ESEA). It includes all countries of each region, making it broader in scope than the individual country studies of this volume. In addition to those seven countries, Pakistan and Bangladesh are also in the South Asia totals, and Korea, Japan, Laos, Malaysia, Myanmar, and Cambodia are in the East and Southeast Asia category.[10]

Table 10.2

Maize Livestock Economy, South Asia and East/Southeast Asia, 1997-2025

(mmt)

	S Asia		SE and E Asia	
	1997	*2025*	*1997*	*2025*
Maize production	13.2	20.1	143.3	266.7
Beef production	4.1	9.0	6.5	16.6
Pork production	0.52	1.1	42.8	75.8
Sheep production	1.8	3.8	2.4	3.9
Poultry production	1.1	3.7	15.4	43.3
Milk production	96.4	221.4	23.2	43.6
Maize trade	-0.1	0.61	-30.1	-76.5
Beef trade	0.16	-0.22	-1.3	-3.5
Pork trade	0.0	-0.07	-0.8	-3.0
Sheep trade	0.01	-0.05	-0.1	-0.3
Poultry trade	0.0	-0.19	-0.8	-4.6
Milk trade	-0.71	-5.1	-8.4	-15.9

Source: Rosegrant (2004).

Rosegrant and his colleagues forecast that maize production in SA will be about 1.5 times greater in 2025 than in 1997, and about 1.85 times greater in ESEA. (The implied annual growth rates for maize production are 1.5 per cent and 2.2 per cent, respectively). Maize trade for Asia as a single region increases by a factor of 2.5, with Asian imports totaling about 75 million metric tons (mmt) in 2025, over 60 per cent of projected world maize trade. Imports of meat into Asia also

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10. The IFPRI model customarily treats Japan as its own region, but for the purposes of this paper it has been included in the 'SE and E Asia region' and in the totals for Asia.

accelerate, going from an aggregate import of 2.9 mmt in 1997 to 11.9 mmt in 2025. With all of these changes, it is interesting that the IFPRI base solution shows real maize prices remaining virtually constant—slightly more than $100/t—for both 1997 and 2020.

The IFPRI authors subject the model to several sensitivity and scenario analyses, including varying assumptions about feed conversion ratios, economic growth in key countries, and yield increases. They highlight the fact that under different, but plausible assumptions, maize prices could either go up by 36 per cent or down by 22 per cent by 2020. The implicit error bars around the model's estimates are therefore sizeable.

An example helps to make this point even more explicit (Falcon and Naylor, 1998). It is instructive to consider alternative scenarios in which various combinations of three Asian parameters are analysed simultaneously: per capita income growth (3 per cent or 5 per cent), income elasticities of demand for meat (0.4 or 0.6), and feed conversion ratios (2:1 or 3:1). Different combinations of these six parameters, under the assumption of equal probabilities for each of the pairs, lead to a demand growth for maize that varies from about 2 per cent annually to about 5 per cent annually. (see Table 10.3.) It might be possible to provide more precise probability distributions, but it would be difficult to narrow the range of potential outcomes by very much. The difference in utilisation between 2 and 5 per cent, compounded over 25 years, is impressively large, and the consequent effect on world prices would also be significant.

Table 10.3
Annual Growth in Asian Maize Demand, 2000-2025*

| | Annual Per Capita Income Growth | | | |
	3 Per cent		5 Per cent	
Income elasticity, meat	0.4	0.6	0.4	0.6
Two to one, marginal conversion ratio	2.3	2.8	3.3	3.9
Three to one, marginal conversion ratio	2.8	3.1	3.9	4.8

Note: * Adapted from Falcon and Naylor (1998).

Uncertainties on the supply side are equally difficult for projection purposes. About two-thirds of Asian maize is now hybrid. Can Asia, as it did from 1975-2000, continue to increase maize yields by 2.4 per cent annually, as compared to the world average during that period of only 1.7 per cent? The IFPRI model assumes annual production increases of 1.5 and 2.2 per cent for South Asia and East and Southeast Asia, respectively, but whether the figures are twice or half that high would clearly have a significant impact not only on Asian supplies and prices, but also on the entire world maize economy.

Even without sharp discontinuities in key variables, there is room for honourable disagreement among experts about the future contours of maize supply, demand, prices, and trade in Asia. The IFPRI models and projections are well vetted and complete, yet the projected baseline results should not be regarded as being inevitable.

Unresolved Issues and Potential Surprises for the 2000-2025 Period[11]

The longer-run welfare of both maize producers and consumers in Asia will depend fundamentally on Asian countries adopting and maintaining growth-oriented macro policies that are also pro poor (Timmer, 2004). Twenty-five years of future Asian per capita GDP growth rates in the 5 per cent range would have pervasive effects on job and income creation in both urban and rural areas. Such a growth effect would dominate any agricultural policy that could be devised and is thus of overwhelming importance. Some analysts might despair that staple food policies are no longer the dominant element in the Asian policy set. Looked at differently, this lack of dominance is a good measure of how far most of Asia has moved along the development scale.

Serious macro questions remain, however, whose answers through time could generate surprises in either direction. Can China continue to grow and find accommodation within the World Trade Organization (WTO)? Can India's liberalisation efforts reach the countryside? Can Indonesia make the transition to democracy in such a way that

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11. Avoidance of large-scale wars between 2004 and 2025 is an underlying assumption for the comments in this section.

populist pressures do not seriously retard efficient growth? For each country in Asia, there are similar issues, although only rarely do these questions involve maize policy *per se* as a first-order policy determinant. Were it possible, however, to forecast accurately whether Asia's GDP would grow at 2, 4, or 6 per cent per capita over the next 25 years, descriptions of the Asian maize economy of 2025 would be much clearer and easier to make.

Within the maize sector itself, many of the most important unresolved issues will have to do with trade policy. Of central importance is whether trade negotiations succeed, and whether the next 25 years will see a decline in agricultural tariffs comparable in scope to the reduction in industrial tariffs of the past 25 years. With the exceptions of Japan, North Korea, and to some extent the Philippines, most Asian nations have chosen past trade policies that have kept domestic maize prices mostly within the c.i.f.-f.o.b. (import-export) price band. As more Asian countries move into the 'developed' designation, will they support the (inevitable) lag in relative agricultural incomes via various protective devices? If so, what forms of protection will they choose? The answers will loom important in shaping domestic maize prices, incentives, and trade flows in 2025.

China will undoubtedly play a dominant role in determining Asia's aggregate maize numbers in the future. Two aspects of China's development will be critical. First, will China find substantial ways to subsidise the maize sector? Rozelle argues that China was import- (c.i.f.) competitive in 2003 for maize, but not export- (f.o.b.) competitive, i.e., China's exports have been subsidised since 1997 (Rozelle, 2003). The magnitude of agricultural subsidies, and whether (or how) China's subsidy program will be resolved within WTO rules, is important, but as yet unclear.

Second, the structure of China's future animal production, especially pork, will greatly influence global feed conversion ratios. The decentralised (household) pattern of pig production was a key reason why pork expanded in the 1975-2000 era without putting undue strain on the maize market. The quarter century from 2000 will surely see an 'industrialisation' of pork production in China, more use of commercial feeds, and an increased concern with the environmental

problems associated with large confined livestock production systems. Will the probable increase in maize requirements from this change in production methods be met from domestic sources or from trade? If land and other environmental problems become even more severe, will there be a greater tendency to import animal products directly rather than the feed grains needed to produce the animals within China? How this dilemma is resolved is another potential surprise in the making.

Two other countries will also play important roles in determining the tenor of the Asian maize economy until 2025. The first is India. Will India's largely vegetarian culture, for example, prove to be more important than its rapid income growth and what has such growth historically implied in other countries for the consumption of meat (USDA, 2004b)? Or will milk continue to dominate the Indian consumption of animal products, which would be much less maize-intensive than if the diet is more meat-based? This issue is particularly relevant given the boom in India's poultry consumption, which has grown by a factor of 5 between 1980 and 2000.

Although not part of Asia, what happens to maize utilisation in the US will also be an important piece of the puzzle. In 2000, for example, the US supplied 61 per cent of global maize exports, more than four times the amount of the second-largest exporter (Argentina). Whether US export dominance continues, and what it will mean for Asia if it does not, raises the potential linkage between maize and energy.

That the maize-energy linkage did not materialise importantly in the 1980s does not guarantee that it will remain unimportant in the coming years. By 2003, 10 per cent of the US corn crop was devoted to ethanol production (Babcock, 2004). As energy prices have continued to rise well above US $40 per barrel 12 and US – Middle East tensions remained high, the political economy of ethanol has taken on renewed vigour in the US. The diversion of maize grown puts significant upward pressure on the world price of maize. It would also give substantial impetus to more wheat being utilised as feed

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12. Rapid economic growth in China, India, and other Asian countries obviously also puts strong upward pressure on the world petroleum market.

rather than food. How that new set of relative prices and feedstuffs might then play out in Asia is exceedingly important, even if unanswerable at this time.

A final conjecture has to do with variability in the global maize market. Two competing forces are at work. As countries liberalise and as trade deepens, markets and prices tend to become more stable. But if there is continuing climate change, if water for irrigation becomes increasingly scarce,[13] and if extreme weather events become more frequent and more severe in Asia and elsewhere, the forces of instability are heightened (Molyneux, 2003). Recent large El Niños have had serious impacts on Indonesia, the Philippines and Vietnam, with important implications for year-to-year stability in maize markets (Naylor *et al.*, 2002). Moreover, climate change over a twenty-five year period could alter the probability distributions of rainfall and temperature in ways that generate serious surprises, both positive and negative, in a significant number of Asian agro-ecosystems. A recent report on China, for instance, suggests that climate change will have a positive effect on rainfed maize yields but a negative effect on irrigated maize yields (CAAS 2004). None of the foregoing scenarios, however, seems as surprising as what actually happened in China between 1975 and 2000.

The Role of Maize in Asian Poverty Alleviation

The dynamism in Asia's maize system during the 1975-2000 period has been driven by a number of factors: improved germplasm, greater use of hybrids, more involvement by the private sector in seed development and distribution, and the accelerated derived-demand for maize that has arisen from rapid growth in animal-product consumption. A similar dynamism will no doubt continue in the future. Nevertheless, there are, and will continue to be, substantial numbers of poor maize producers and consumers who are not a central part of that dynamism. What does maize have to offer these disadvantaged groups?

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13. Given that much of Asian maize is rainfed, irrigation is less likely to be a constraining factor for maize than for other crops such as rice.

The data requirements for answering this question, even in a rudimentary way, are demanding. Statistics are needed on current and future projections of poverty. These data then need to be linked to regions and households where maize is a key staple, or in some instances, where maize fodder is a key input to the subsistence production of animal products.

Table 10.4 provides a partial basis for answering maize/hunger-alleviation relationships. In 2000, there were about 200 million people in poverty in East and Southeast Asia and about 300 million in South Asia. The IFPRI 2020 model projects a decline in child undernourishment of about 50 per cent in East and Southeast Asia, and of about 20 per cent in South Asia by 2020. Taken together, these estimates indicate that perhaps there will be a total of some 350 million people in poverty in the years ahead.

The error bars about people-in-poverty estimates are large, and as noted earlier, the estimates are related importantly to the rate of growth in GDP. Besley and Burgess (2003) have estimated poverty elasticities for the period 1980-2000. They relate percentage changes in real per capita GDP with percentage changes of those in poverty. Their elasticity estimate for East Asia and the Pacific is -1.0 and for South Asia is -0.59—the difference reflecting variations in regional development strategies. In other words, if real incomes rise by 10 per cent, the number of people in poverty would be reduced by about 10 per cent in East Asia and by about 6 per cent in South Asia. There are many caveats that should be added to these estimates, but the underlying analytics are helpful when thinking about the future.

A second empirical relationship is also useful. Most poor people are net purchasers of food (i.e., they consume more than they produce), irrespective of whether they live in urban or rural areas (Timmer, Falcon, and Pearson, 1983). In most cases, therefore, high prices for staple foods leave the poor worse off.[14] So for the poor who produce and/or eat maize, income growth and maize prices are key.

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14. It is possible, but not likely, that higher staple prices could create sufficient dynamism in the countryside to expand employment opportunities sufficiently to offset the higher cost of food. This is usually the case when staple foods have been significantly undervalued relative to international prices for a substantial period of time. Raising domestic food prices in such circumstances often unleashes a substantial boom in rural incomes that helps the poor as well as larger, surplus-producing farmers.

Table 10.4

Maize Production, Utilisation, Undernourishment, and Poverty in Asia, 2000

	Domestic Production (Metric tonnes)	Maize Used as Feed (Per cent)	Maize Used as Food (Per cent)	Maize Consumption, cal/cap/day	Number of Undernourished in Population, 1999-2001 (Millions)	Proportion of Undernourished in Population 1999-2001 (Per cent)	Population Below $1/day (PPP), Most Recent (Per cent)
Bangladesh	10,000	4.7	84.5	18.0	44.1	32	29.1
Cambodia	156,972	5.0	94.3	101.1	5.0	38	n.a.
China	106,178,315	67.6	18.4	132.2	125.3	11	18.5
India	12,043,200	43.1	39.6	38.5	213.7	21	44.2
Indonesia	9,677,000	5.9	71.8	232.3	12.6	6	12.9
Japan	180	74.3	9.7	75.9	n.a.	<2.5	<2
Korea, N.	1,041,000	5.8	49.3	333.9	7.5	34	n.a.
Korea, S.	64,205	71.8	8.6	106.9	0.7	<2.5	<2
Laos	117,000	10.3	86.9	171.2	1.2	22	26.3
Malaysia	65,000	88.9	5.6	49.9	0.5	<2.5	n.a.
Myanmar	362,700	50.2	37.8	15.4	3.2	7	n.a.
Nepal	1,414,850	16.8	71.2	413	3.8	17	37.7
Pakistan	1,643,200	20.0	71.5	72.7	26.8	19	31.0
Philippines	4,511,104	77.1	9.8	35.6	16.8	22	n.a.
Sri Lanka	31,050	57.1	37.8	28.6	4.6	25	6.6
Thailand	4,462,000	88.3	8.5	63.9	11.9	19	<2
Vietnam	2,005,900	69.5	28.8	68.2	15.1	19	n.a.

Source: FAO (2004), FAO (2003a), World Bank (various years).

That is also why, in open economies, what happens in one country can affect the welfare of the poor in another country or continent.

Disaggregating overall poverty numbers into specific categories of poor maize consumers and producers could be done in principle. If there were expenditure estimates through time by item and by income class, it would be possible to talk more specifically about the role of maize in alleviating poverty. Without those surveys, however, more generalised statements must suffice.

Maize will likely have the greatest role in poverty alleviation in countries where there are significant numbers of hungry people and where maize is an important staple food. Table 10.4 suggests where those conditions are likely to prevail, but caution must be exercised in using these data.

The usual sources of information about average food consumption by commodity are the food balance sheets of the FAO. In the case of maize, however, where the feed use of maize has been growing very rapidly, the food-balance-sheet data for a few key Asian countries are seriously outdated. Figure 10.3, for example, compares USDA and FAO data on feed use in Indonesia. The USDA data suggest that maize's role as a feed is much more important and as a food is much less important than was previously suggested by FAO data.[15,16]

There are also surprising differences between the FAO's measure of undernourished people and the World Bank's estimates of people below the poverty line of $1 per day. A closer correspondence might have been expected, especially in countries like Nepal, China, India, Pakistan, and Sri Lanka. (See Table 10.4.) As a consequence, analysts using different data sources could reasonably come to quite different conclusions about the role of maize in alleviating hunger and poverty in Asia's poorer regions.

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15. The sharp drop in the USDA feed series in 1998 for Indonesia reflects a severe El Niño drought and the substitution of maize-for-feed into maize-for-food to offset severe shortfalls in rice production. This temporary shift toward the more 'inferior' food crop illustrates another shorter-run role for maize in poverty alleviation, and the advantage of a multi-staple food system.

16. Until very recently, FAO feed data for other important Asian countries—India in particular—demonstrated a similarly radical departure from figures published by other sources. Ironically, FAO's most recent maize-for-feed data for India were updated on August 27, 2004, and the last ten years of data now more plausibly attribute greater quantities of maize to feed use.

Figure 10.3

Maize Used as Feed in Indonesia, FAO versus USDA Data
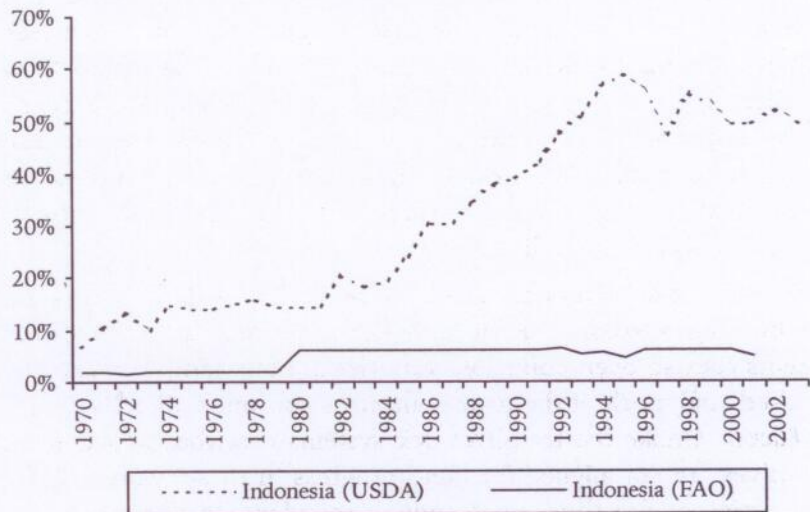
Sources: FAO (2004), USDA (2004c).

Despite data limitations, the following assumptions appear warranted about maize's role in poverty alleviation. Asians who consume significant amounts of maize directly as food also tend to grow the crop; most maize consumers are poor, i.e., the income elasticity of demand for maize as food is negative; and many of the 'maize poor' live in agro-ecosystems that have severe production constraints—drought, flooding, alkaline soils, etc. Portions of Nepal, Laos, North Korea, the Philippines, India, China, and Indonesia appear to fit the category of regions with significant poverty within corn-based cropping systems. One set of economists estimates the number of poor Asians who eat significant amounts of maize directly (> 300 kcalories daily) to be on the order of 75 million people, i.e., about one-sixth of the total number of Asians who are currently undernourished.[17]

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17. The origin of this number may be of interest. The 10 persons mentioned in the first note were polled independently as to their 'estimates' of the number of poor people in Asia who consume more than 300 kcalories of maize per day. The median estimate was 15 per cent.

From both a policy and an analytic perspective, it is useful to distinguish two broad types of maize production systems in Asia.[18] One system uses hybrids, is more commercial, and is linked to the expanding livestock sector. For this system, there is considerable market potential for private seed and chemical companies to service farmers. These regions are likely to have reasonable access to germplasm containing protected intellectual property, including transgenic materials. The growth potential for maize appears excellent for these areas, even if the provision of public goods and the role of the public sector are quite limited.

In fairly sharp contrast are the maize situations described as food-for-the-poor systems. In these regions, poverty and maize-based systems coexist; open pollinated varieties are the norm; few chemicals are used; and much of the maize output is consumed directly by small producers. Unlike the feed-livestock systems described above, private incentives are not aligned for rapid progress in these poorer systems. These regions are thus much more dependent on the provision of public goods, especially in the form of improved germplasm, if they are to make progress.

The need for public sector participation in Asian smallholder maize systems has not gone unrecognised. In a recent ranking by the International Maize and Wheat Improvement Center (CIMMYT) of areas where public sector attention to maize would be the most useful, Asian lowland maize systems topped the list (Pingali, 2001). Also worthy of note is the large potential role that biotechnology could play in addressing the most serious biophysical constraints for some of these systems (Naylor *et al.*, 2004). The use of molecular markers is already proving an important tool for reducing the time for breeding new cultivars using classical techniques. Better understanding of similarities among plants via genomics may also be critical in helping to cope with constraints like drought and pests. Similarly, intelligent use of transgenic technology could be of importance for maize systems in certain marginal areas—if relevant techniques can somehow be mobilised publicly for systems that have limited market potential for

18. A much fuller and more disaggregated description of Asian maize systems can be found in Gerpacio, this volume.

the private sector.[19] Although new forms of biotechnology can clearly be of assistance in and for the poverty areas, it is equally clear that biotechnology is not a panacea for them.

The real world does not break cleanly into the poverty and commercial maize systems outlined above. Yet the dichotomy is useful for thinking about longer-run strategies. Will national agricultural systems focus on 'commercial' farmers and pay little attention to the poverty sector?[20] Similarly, will international institutes such as CIMMYT focus on both poverty and commercial groups or only one, and if one, which one? In regions where the market potential is small for the private sector, and where the farming systems are tightly constrained, public sector choices with respect to the use of modern biotechnology, extension, seed production and distribution, and infrastructure investment will be critical. Decisions in these fields will determine whether maize has an important role in alleviating poverty directly, or whether some 75 million people now living in maize-dominated poverty areas will instead have to wait for trickle-down effects from other more prosperous regions and sectors.

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19. This same technology might also be brought to fruition differentially in other commodities, e.g., sorghum or other orphan crops, which might then substitute for maize in certain cropping systems.

20. Because of its sheer size, one of the most interesting Asian poverty-conservation initiatives is China's Conservation Program. It embraces some 15 million ha. and affects some 60 million households, a substantial number of whom are small-scale maize producers. See Uchida *et al.* (2004).

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