Economic Transformation of Agriculture in Asia: Past Performance and Future Prospects

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ABSTRACT

As an economy develops, agriculture faces distinctly different problems: food insecurity, sectoral income inequality, and food trade deficits associated with declining comparative advantage. Fear of widespread famine was Asia's major agricultural problem in the 1960s, which was subsequently solved by the Green Revolution. As nonfarm sectors of the economy grew more rapidly than agriculture, an income gap appeared between farm and the nonfarm sectors; this gap has been reduced primarily by increasing nonfarm income of farm households and migration to urban areas. Advanced countries in Asia (i.e., Japan, Taiwan, and Korea) now face a third problem— trade deficits in agriculture, as reflected by the rapidly declining food self-sufficiency ratio. This foreshadows the problem facing other rapidly growing Asian countries in the future. Massive imports of food grains to Asia, if they occur, will aggravate the world food shortage and would have significant implications on climate change.

INTRODUCTION

Typically a subsistence farmer cultivates one to three hectares (ha) of farmland by using manual labor and applying simple technology as described by Schultz (1964). Thus, although the majority of the population is engaged in agriculture, the marketable surplus is a tiny fraction of the farm produce even in normal crop years, so that the food supply to urban areas is barely sufficient. Food shortage and widespread famine are real threats, as food production can easily fall short of demand in the event of droughts and floods. If the population continues to grow, the gloomy Malthusian prediction could materialize.

Agriculture in Asia had not been far from the simplified picture of traditional agriculture described above until the 1960s. (At present, agriculture in sub-Saharan Africa faces such a food problem.) The Green Revolution beginning in the late 1960s had solved the food problem in Asia (David and Otsuka 1994; Hazell 2010) through the development and diffusion of short-maturing, non-photoperiod sensitive, fertilizer-responsive rice varieties. Rice yields doubled, double cropping of rice expanded, and total rice production tripled, thereby eradicating the domestic food supply-demand imbalance in most countries in tropical Asia (Pingali et al. 1997). Partly because of the growth inducement effects of agriculture on nonfarm sectors (e.g.,

Christiaensen, Demery, and Kuhl 2011) and the successful transfer of nonfarm technology from advanced to less advanced economies (e.g., Sonobe and Otsuka 2006, 2011), however, nonfarm sectors have grown much more rapidly than agriculture, thereby creating an income gap between farm and nonfarm sectors. This income problem was originally pointed out by Schultz (1953) and elaborated in the context of Asian agriculture by Hayami (2005) in his presidential address at the fifth Conference of the Asian Society of Agricultural Economists.[1] To reduce the income gap, Japan, Taiwan, and Korea supported agricultural sectors through price supports and input subsidy programs (Anderson and Hayami 1986; Kruger, Schiff, and Valdes 1991; Anderson 2009). Recently, observing the ever-increasing income gap between farm and nonfarm sectors, the Chinese government has been tempted to support agriculture massively, even though the policy options are constrained by accession to the World Trade Organization (Rozelle, Huang, and Otsuka 2008; Christiaensen 2011). This paper argues that Asian farm household income has been increasing mainly through increased nonfarm income of farm households, as well as through rural-to-urban migration (Otsuka, Estudillo, and Sawada 2009). As a result, poverty, as well as the inter-sectoral income inequality between farm and nonfarm sectors in Asia, has been mitigated.

In the process of economic development, the comparative advantage of most Asian countries' economy has been shifting to nonfarm sectors partly because of the low income elasticity of the demand for foods and the more rapid technological progress in nonfarm sectors. Another, and probably more important, reason for the declining comparative advantage of agriculture in many Asian countries is the small farm size. When an economy grows, the wage rate increases, resulting in increased labor cost of farm production. To reduce the labor cost, farm size must expand and large mechanization must be introduced (Otsuka and Estudillo 2010). Farm size expansion, however, is difficult to realize due to imperfect land markets (Otsuka 2007). Moreover, as Johnson (1991) forcefully argues, agricultural support policies to reduce income inequality aggravate the problem by increasing the farm population, part of which would have outmigrated in the absence of such policies. As such, it is likely that the comparative advantage of Asian agriculture will continue to be lost. Thus, most high-performing Asian countries may become major importers of food grains in the future, which would have significant consequences on world food prices, the persistence of food insecurity and poverty outside Asia, and, possibly, climate change.

The purposes of this paper are to review the performance of Asian agriculture, and to identify the major issues in the future. After briefly reviewing how the food problem was solved in Asia and how increasing nonfarm income contributed to increases in farm household income, the paper examines the seriousness of the issue of declining comparative advantage. Policy implications are discussed in the final section.

The Food Problem and the Green Revolution

In the 1950s and early 1960s, tropical Asia's population grew rapidly, grain yield was low and remained unchanged, and the land frontier was gradually closed. If such a trend had continued, widespread famine and starvation would have occurred (Hayami and

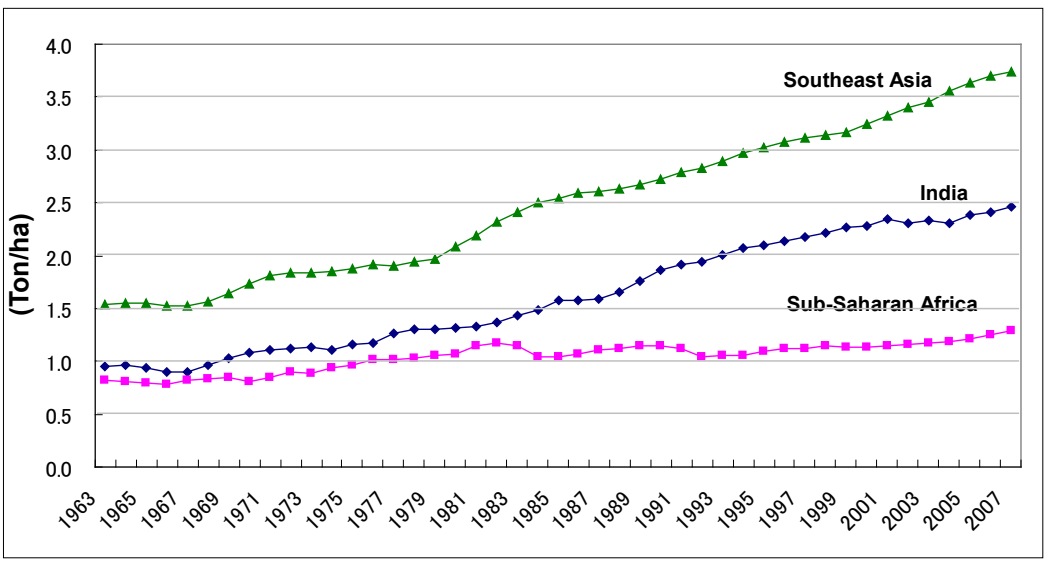
1 This paper is included in a new book in honor of Professors Vernon Ruttan and Yujiro Hayami edited by Otsuka and Runge (2011). Also see Timmer (2010).

Ruttan 1985). In fact, drought in India in and around 1966 sharply reduced cereal yields, resulting in a serious famine (Figure 1). As a result of the Green Revolution, yields of cereals, particularly rice and wheat, began increasing in the late 1960s. The Green Revolution involves the development and diffusion of a series of short-statured, early-maturing, and fertilizer responsive, high-yielding modern varieties (MVs), together with the dissemination of improved production practices (David and Otsuka 1994; Hazell 2010). This intervention has not been a one-shot change; it is a long-term process involving the interactive development of technology, markets, infrastructure (particularly irrigation), and research and extension programs. Asia's experience sharply contrasts with that of sub-Saharan Africa, where cereal yields only increased marginally and the rapidly growing population continues to press hard on limited land, resulting in increased food insecurity (Yamano, Otsuka, and Place 2011; Otsuka and Larson 2011).

A major effect of the Green Revolution on food security can be most clearly seen in declining rice prices. As Figure 2 shows, aside from the unusual "food crisis" period of 1973–1974, rice production had continued to increase until the late 1990s, accompanying a continued decrease in real rice price. As a result, the real rice price in 2000 was roughly just one-third of the level around 1970. The momentum of the Green Revolution faded away around the turn of this century, resulting in a turnaround of the price trend which culminated in a new "food crisis" in 2008. This food crisis was most serious in the Philippines and a few West African countries, which have become major importers of rice.

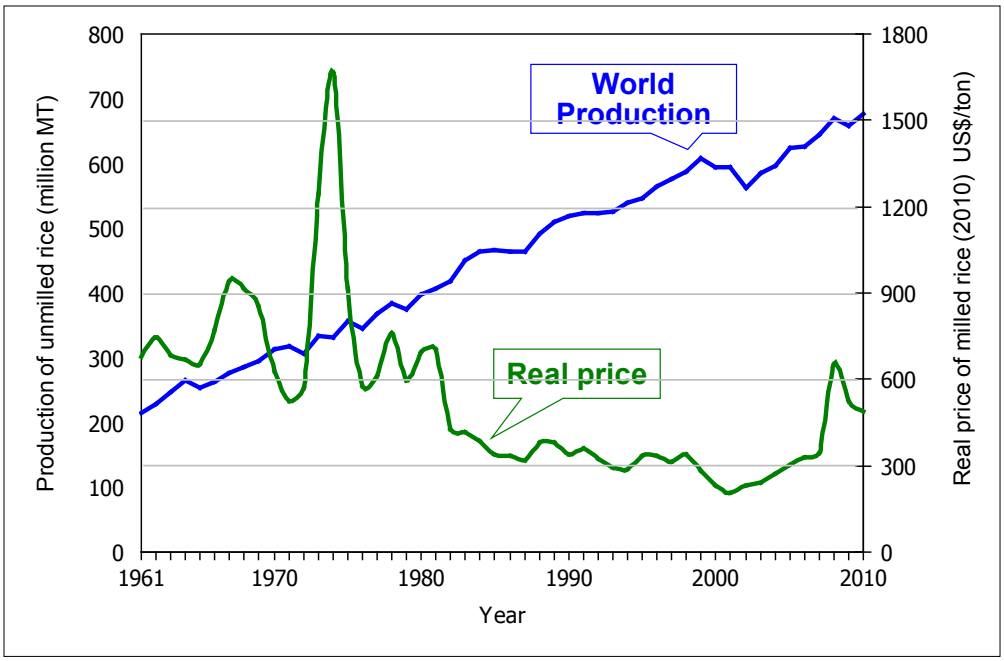
Roughly speaking, most developing countries in tropical Asia have maintained cereal self-sufficiency, which is measured by the total quantity of domestic production of rice, wheat, maize, and soybean divided by the total quantity of domestic consumption (Figure 3). Due to the continued rapid

Figure 1. Average cereal yields in Southeast Asia, India, and Sub-Saharan Africa (three-year moving averages)



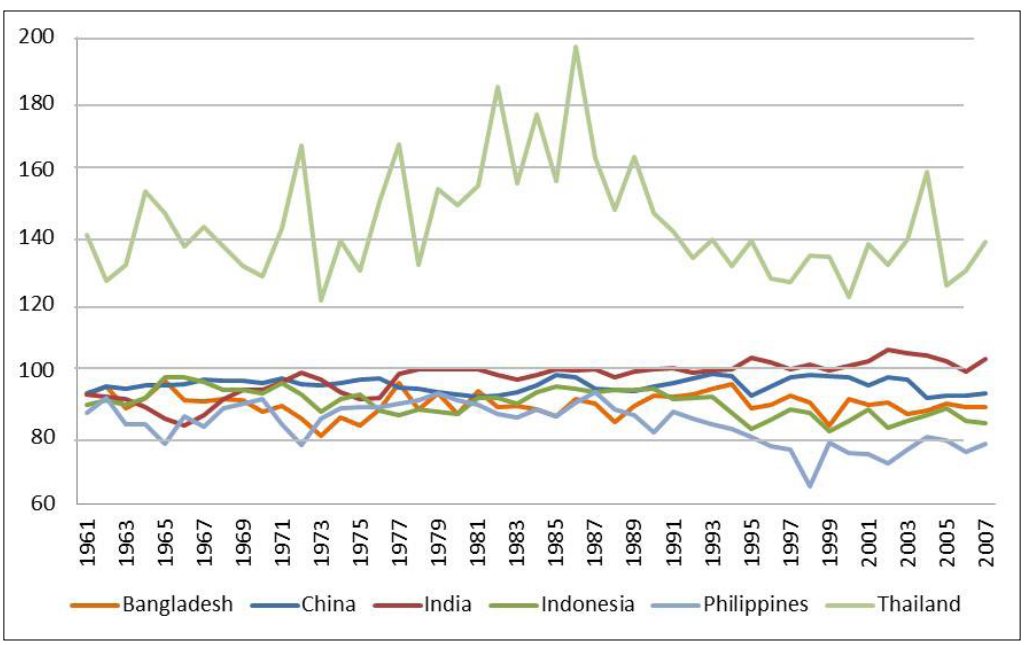
Source: Author's calculation with FAOSTAT data

Figure 2. Trends in world production and real price of rice, 1961-2010



Source: Production: USDA, 16 August 2011; www.worldbank.org
Note: Relate rice price to Thai rice 5%-broken deflated by -5 MUV Index deflator adjusted based on May 2011 data update)

Figure 3. Changes in grain self-sufficiency ratio in selected countries of Southeast and South Asia



Note: Grain here refers to rice, wheat, maize, and soybean

population growth and the early exhaustion of the Green Revolution technology potential in the Philippines, the self-sufficiency ratio in this country has been decreasing since the end of the 1980s (Dawe, Moya, and Casiwan 2006). The ratio significantly exceeded 100 percent in Thailand, due to its rich land endowment relative to the population. Without the Green Revolution, the cereal self-sufficiency ratio would have been much lower than it actually has been, and food security could have been a major issue in tropical Asia.

Nonfarm Jobs and Farm Household Income

Almost simultaneously with the evolution of the Green Revolution, the nonfarm sectors of the economy have been growing much faster than the farm sector in most Southeast and South Asian countries, thereby increasing the income of the working-age population in urban and industrialized areas. With the real rice price decline, farm income did not increase or even decrease despite improvements in the productivity of rice farming. Thus, a substantial income gap has emerged between farm and nonfarm households (Hayami 1988). In short, Asian agriculture faces an income problem.

A major way by which farm household income rose has been through increased nonfarm income. As clearly demonstrated in Table 1, which shows the income of rice-growing households in high-potential agricultural areas (basically irrigated areas) and marginal areas (mostly rainfed areas) in selected areas of Southeast and South Asia, the share of agricultural wage income in the total household income has generally declined from the mid- or late 1980s to the mid-2000s.[2] Likewise, the rice income share declined sharply because of falling rice prices coupled with only a modest increase in rice yield since the mid-1980s.

In contrast, the nonfarm income share in the Philippines and Thailand has increased dramatically, as per capita incomes have risen significantly. In the high-potential areas in the Philippines, per capita income more than doubled and the nonfarm income share increased from 45 to 70 percent. Thus, undoubtedly nonfarm income has contributed to increased overall income. Similar or even more rapid changes are found in the marginal areas of the Philippines. Because agricultural production in such areas is not as promising as in high-potential areas, households in marginal areas have expanded nonfarm activities more actively to increase their income. As a result, the regional income gap has significantly declined. It must be pointed out that, as is shown in Table 1, remittances, which are primarily sent by overseas migrants, account for nearly one-third of the nonfarm income in the Philippines, attesting to the utmost importance of overseas migration in supporting the income of rural households in this country.

A more dramatic example of structural changes in the composition of rural household income can be found in the marginal areas of Thailand, which are located in the northeastern region, an area that used to experience extreme hunger (Cherdchuchai, Otsuka, and Estudillo 2009). Nonfarm income share increased significantly from 21 to 74 percent in 1987–2004. Since the areas are unfavorable to agricultural production, households raised their income through nonfarm activities. Such a change was made possible by the increased availability of nonfarm jobs in the local cities of Khon Kaen and Bangkok. Farmers in this region used to migrate to the western regions

2 For further details see Otsuka, Estudillo, and Yamano (2010), which extends the keynote speech delivered by Otsuka at the 6th Conference of Asian Society of Agricultural Economists held in Manila in 2008.

Table 1. Changes and differences in real rural household income per capita (PPP USD) and its compositions (%) in selected areas of Asia

	High-potential Agricultural Areas		Marginal Agricultural Areas	
	1980s	**2000s**	**1980s**	**2000s**
Philippines				
Per capita income (PPP USD)	1,065	2,364	386	1,119
Agricultural wage (%)	13	11	30	7
Rice (%)	37	12	20	9
Non-rice farm income (%)	5	7	13	24
Nonfarm (%)	45	70	36	60
Remittances (%)	(15)	(22)	(13)	(20)
Thailand				
Per capita income (PPP USD)	2,014	4,617	959	2,543
Agricultural wage (%)	4	6	12	5
Rice (%)	66	26	54	7
Non-rice farm income (%)	21	22	13	14
Nonfarm (%)	10	47	21	74
Bangladesh				
Per capita income (PPP USD)	634	1,001	841	1,094
Agricultural wage (%)	14	8	11	4
Rice (%)	35	20	24	13
Non-rice farm income (%)	18	21	20	26
Nonfarm (%)	33	51	55	57
Tamil Nadu (India)				
Per capita income (PPP USD)	520	697	228	623
Agricultural wage (%)	11	28	17	3
Rice (%)	62	50	39	22
Non-rice farm income (%)	19	18	40	49
Nonfarm (%)	9	4	7	27

Source: Authors' compilation
Note: Philippines: High potential agricultural areas are irrigated villages and marginal areas are drought-prone rainfed villages in Iloilo Province in 1985. *Thailand:* High potential agricultural areas are irrigated villages in Central Plain and marginal areas are drought-prone rainfed villages in the Northeast in 1987. *Bangladesh:* High potential agricultural areas are irrigated villages and marginal areas are drought-prone rainfed villages in 1988. *Tamil Nadu (India):* High potential agricultural areas are canal or well-irrigated districts and marginal areas are rainfed/tank irrigated districts in 1986–1987.

to work as sugarcane cutters, getting paid low wages. The high-wage nonfarm jobs in Khon Kaen and Bangkok have substituted the low-wage farm jobs in unfavorable areas. Similar to the case of the Philippines, the nonfarm income share in the high-potential areas increased but on a lower scale, from 10 to 47 percent, in the same period.

In Bangladesh, somewhat unexpectedly, per capita income in high potential areas is lower in the marginal areas, particularly in 1988, even though rice income is higher in the former (where irrigation is available) than in the latter areas. It is important to note that nonfarm income accounts for a much larger share of the total income in marginal areas in 1988, suggesting the decisive importance of access to nonfarm labor markets in determining the total income of rural households. Another important observation is the rapidly declining share of rice income, particularly in marginal areas over time. By increasing the nonfarm income share, the total income in high-potential areas has caught up with that in marginal areas. As in Southeast Asia, the share of agricultural wage income in Bangladesh has been very low and declining.

In India, represented by the southern state of Tamil Nadu, per capita income in marginal areas was less than half of that in high-potential areas in the mid-1980s. Similar to the experience in marginal areas of the Philippines and Thailand, households in India's marginal areas have increased their nonfarm income share from 7 to 27 percent. In addition, the share of non-rice farm income, consisting of income from the production of high-value crops (i.e., sugarcane and milk), has increased. As a result, per capita income has increased from USD 228 to USD 623, reducing the income gap with the high-potential areas. Therefore, as far as Asian countries are concerned, the development of nonfarm labor markets appears to have significantly increased the income of rural households, particularly in areas less favorable to agricultural production.

The extent that the farm and nonfarm household income gap has been reduced by the increasing nonfarm income of farm households remains to be analyzed.[3] Yet, no doubt the increased nonfarm income of rural households has played an important role in distributing the benefits of overall economic growth among the population at large.

Declining Comparative Advantage of Agriculture

Changing Optimum Farm Size

When labor is abundant relative to land, labor intensive methods of cultivation are socially efficient. In such cultivation systems, no major indivisible inputs are used and, hence, there is no major source of scale economies. Roughly speaking, a farm of 1–2 ha can be managed efficiently by family labor consisting of a few workers, even if no machinery is used. Beyond that scale, hired labor must be employed, but then, monitoring costs arise, increasing more than proportionally with the cultivation size (Otsuka, Chuma, and Hayami 1992; Hayami and Otsuka 1993). This explains why family farms dominate agriculture throughout the world (Berry and Cline 1979). The point is that the optimum farm size in low-wage economies would be small because of the intensive use of family labor. The substitution of capital for labor is costly because labor is cheap relative to capital.

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3 In the case of Sri Lanka, increasing nonfarm income in rural areas helped reduce the income gap between the urban and rural areas (Kumanayake, Estudillo, and Otsuka 2011).

As real wage rate rises, labor cost also increases, particularly if labor intensive production methods are employed. To reduce production costs, labor must be substituted by machinery. To operate machinery efficiently, particularly large machinery, farm size must expand.[4] Since large machinery is indivisible, scale advantages arise.[5] Thus, larger farms are more efficient than smaller farms, so that the land must be transferred from the latter to the former. Renting is a practical way to transfer land to the hands of a smaller number of large farms. In fact, landlords are usually small farmers and tenants are large farmers in high-income economies such as the USA and European countries.

When farm size is adjusted optimally by land renting as well as by land sales over time, scale economies will not be observed since all the existing farms are more or less equally large and efficient. Scale economies tend to be observed clearly when small inefficient farms and large efficient farms coexist (Hayami and Kawagoe 1989).[6] This is seen in the dynamic process of farm size adjustment and also when institutional constraints prevent farm size adjustment. Scale economies are expected to be observed in a high-wage economy, such as Japan, where the government intervenes in land rental transactions and the acreage control program of farm lands discourages the expansion of rice cultivation areas, so that small farms dominate despite the comparatively high-wage rates (Hayami 2005).[7]

If a high-wage economy fails to achieve farm size expansion, its comparative advantage in agriculture will be lost and this country will become a major importer of food grains. If many of the high-performing Asian countries become importers, world grain prices will shoot up and poverty would worsen, thereby creating a scenario that is unfavorable to the attainment of the first Millenium Development Goal, which is to eradicate extreme poverty and hunger

An Overview of Changing Farm Sizes in Asia

This section provides an overview of the agrarian structure in terms of average farm size and the inequality of operational landholdings in selected developing countries in Asia (i.e., Bangladesh, India, Indonesia, the Philippines, and Thailand), using agricultural census data in the 1970s, 1990s, and 2000s.[8] Specifically, it examines how the average farm size has been changing and whether the dominance of small farms has been strengthened or weakened over time in tropical Asia.

Peasants or small family farms make up a major part of the production organization in Asian agriculture. In the 1970s, the average operational farm size was small, ranging from about 1 ha in Indonesia to 3–4 ha in the Philippines and Thailand (Table 2). In high-performing Southeast Asian countries, such as Indonesia and Thailand, the reduction in farm size has been relatively modest over time partly due to rapid labor absorption in nonfarm sectors

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4 To the author's personal knowledge, farm size expansion has begun taking place in Punjab in India, Central Thailand, and the Mekong Delta region of Vietnam.

5 The development of machinery rental markets will lessen the scale disadvantages, but the use of large machinery in a number of small farms will be more costly than in a small number of large farms.

6 The discussion of scale economies follows the conventional use of "farm size" instead of "field size" (Eastwood, Lipton, and Newell 2009; Otsuka 2007), while recognizing that fields located closer to one another could potentially realize a greater degree of economies of scale.

7 According to the recent study of Foster and Rozensweig (2010), large farms have become more productive than small farms in India due to rising wage rate.

8 Census data in the 2000s for Bangladesh, India, and Indonesia are not yet available online.

Table 2. Distribution of operational farm sizes in selected countries in Asia

Country	Year of Survey	Average Operational Farm Size (ha)	Percentage of Farms and Farmlands			
			Below 1 ha		Above 10 ha	
			Farms	Area	Farms	Area
Bangladesh	1976/77	1.4	49.7	28.8	n.a.* (9.4)**	n.a.* (1.6)**
	1996	0.6	80.8	41.1	0.1 (32.4)**	1.4 (16.5)**
India	1970/71	2.3	50.6	9.0	3.9	30.9
	1990/91	1.6	59.4	15.0	1.7	17.3
	1995/96	1.4	71.1	33.1	1.4	24.1
Indonesia	1973	1.0	70.4	30.0	5.9	10.3
	1993	0.9	70.8	29.8	0.2	3.4
Philippines	1971	3.6	13.6	1.9	4.9	33.9
	1991	2.1	36.6	7.3	2.4	23.3
	2002	2.0	40.1	8.3	2.0	20.5
Thailand	1978	3.7	16.4	2.5	6.0	23.6
	1993	3.4	21.5	3.6	4.5	23.2
	2003	3.1	13.1	n.a.	2.1	n.a.

Sources: Bangladesh: Report on the Agricultural Census of Bangladesh, 1977; 1978 Land Occupancy Survey of Bangladesh; Census of Agriculture 1996
India: National Sample Survey, No. 215, 26th Round, 1971–72; All India Report on Agricultural Census 1980/71; Agricultural Census 1990–91
Indonesia, 1973 Agricultural Census; 1993 Agricultural Census
Philippines, 1971 Census of Agriculture; 1991 Census of Agriculture
Thailand, 1978 Agricultural Census Report; 1993 Agricultural Census

Notes: Since farm size classes differ from country to country, interpolations were made.
* "n.a." means not available.
** Farm size above 3 ha

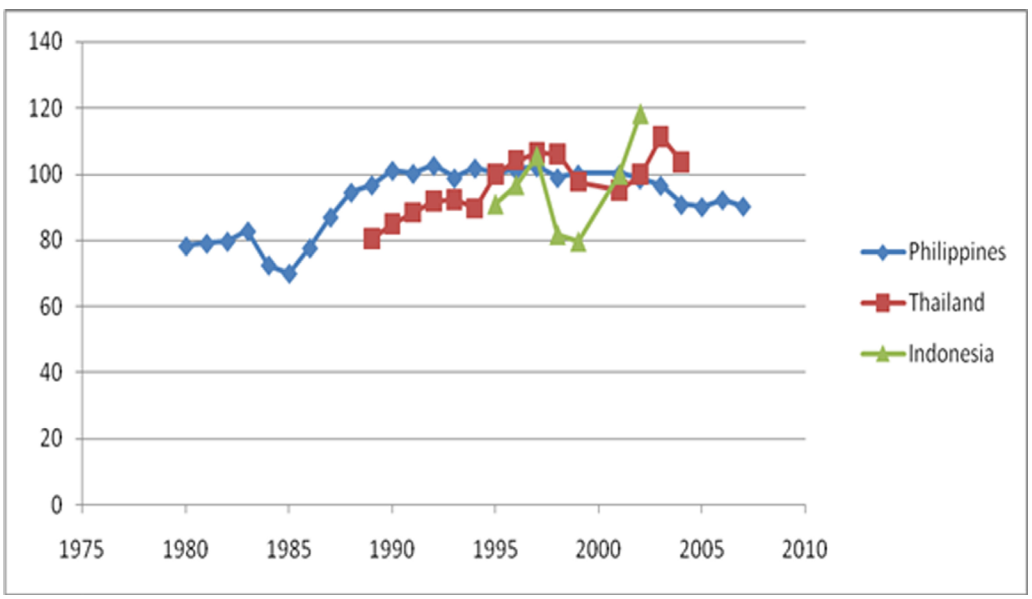
and to area expansion. Figure 4 shows that nonfarm wages (represented by the real wage index in manufacturing) has been increasing in these two countries—modestly in Indonesia from 1995–2001 and more rapidly in Thailand from 1989–2003. The impact of population pressure on farm size dynamism has been mitigated by the rise in nonfarm wages, which has driven the rural labor force away from the farm to the nonfarm sector.

In contrast, average farm size significantly declined in other economies due partly to rapid population growth in rural areas and to the stagnant growth of nonfarm sectors. Particularly conspicuous is Bangladesh, where the average farm size had declined from 1.4 ha in 1976/77 to 0.6 ha in 1996.[9] In this country, about 50 percent of the farms were smaller than 1.0 ha in 1976/77, increasing to more than 80 percent in 1996. Large farms (above 10 ha) are rare in Bangladesh, suggesting the absence of scale economies in low-income agriculture.

Inefficiency of Small Farms in Japan

In industrial economies where the wage rate is high relative to the prices of other factor inputs, extensive mechanization becomes profitable, creating scale advantages and hence enlarging the optimum size of farm operation. Yet in Japan, the average farm size had remained at around 1 ha or slightly above until the mid-1990s (less than one-tenth of the level in European countries and nearly two-hundredths of that in the USA), despite the country's remarkable growth in real wages. The dominance of small farms in Japan is likely due to the regulation of tenancy transactions by land

Figure 4. Real manufacturing wage indexes in the Philippines, Thailand, and Indonesia



Source: Key Indicators of the Labor Market online
Note: Deflator is the consumer price index in each country.

9 Landless agricultural households are excluded from the estimation of average farm size except in India. In Bangladesh, the average size declined to 0.46 ha in 1996, if landless households are considered.

reform laws, even though it has been relaxed over time.

Land reform in Japan has not changed the identity of the cultivators of land and, consequently, the distribution of operational landholdings (Ogura 1963). As Table 3 shows, the average operational farm size and distribution were largely the same in l940 and l960, partly because the land reform did not directly affect the farm size structure, and the land reform regulations restricted its changes (Hayami l988). Moreover, the average farm size did not change appreciably even from 1960 to l980; it increased from 1.0 to 1.2 ha only, despite continuous and rapid increases in wages and substantial progress in mechanization. There is, however, some indication that the shares of both very small farms (less than 0.5 ha) and relatively large farms (more than 3 ha) have increased, particularly by 2005. Such a tendency seems to reflect what Hayami and Kawagoe (1989) call the 'polarization' of the farm structure in Japan, in which large farmers accumulate land through renting and purchasing land from small and medium-sized famers.

The driving force behind this structural change has been the emergence of scale advantages associated with large-scale mechanization. In 1960, there was no appreciable difference in revenues and costs among farms of different sizes categorized into several groups: less than 0.5 ha, 0.5–1 ha, 1–3 ha, larger than 3 ha (1960) or 3–5 ha (1975, 1990, and 2007), and larger than 5 ha. Mechanization then was characterized by the widespread adoption of threshers and introduction of small power-tillers. In 1970, however, a significant gap in production costs emerged with the introduction of large machinery; the total cost of rice production per ha became substantially higher on small farms (< 0.5 ha) than on larger ones (> 5 ha), primarily because the former had much higher labor and machinery costs. This tendency was further strengthened in 1990: the total cost as well as labor and machinery costs on farms of less than 0.5 ha was double that of farms larger than 5 ha, even though the revenue per ha remained largely the same across farm sizes. Thus, the increased share of large farms in recent years is consistent with the emergence of the scale advantage associated with large-scale mechanization.

As was pointed out before, no significant economies of farm size will be observed if the operational sizes of farms are all adjusted to the optimum in order to reap all the potential scale advantages. This implies that farm size adjustment in Japan has been too slow to wipe out the disequilibrium manifested in the observed scale advantages. It takes time to adjust farm sizes to the optimum levels, so the scale advantages continue to exist in a dynamic

Table 3. Percentage distribution of farms by size of cultivated area (ha) in Japan: 1940, 1960, 1980, and 2005

	< 0.5	0.5–1.0	1.0–3.0	3.0–5.0	> 5.0	Average (ha)
1940	33.3	32.8	30.2	2.2	1.4	1.3
1960	38.5	31.7	27.4	1.5	1.0	1.0
1980	41.3	28.1	26.6	2.2	1.5	1.2
2005	22.3	34.4	33.8	5.0	4.5	1.8

Source: Ministry of Agriculture, Forestry and Fisheries (Japan), Census of Agriculture and Fisheries, various issues

setting. Further, the memory of land reform, coupled with the imperfect protection of lessors' rights in tenancy transactions, would appear to make farmers cautious with respect to renting out land. This is reflected in the fact that small part-time farmers rent out their lands only to a small circle of relatives and close friends. Such renting arrangements make the restoration of equilibrium in land rental markets impossible. Herein lies the durable impact of land reform, which is inconsistent with the expansion of farm size to efficient levels in contemporary Japan.

The grain self-sufficiency ratio in Japan has declined rapidly since 1961, clearly attesting to the sharply declining comparative advantage of agriculture in this country (Figure 5). Although the definitions of grain self-sufficiency ratio in Taiwan and Korea are somewhat different from Japan's,[10] the self-sufficiency ratios have also declined in both these countries almost in parallel with that of Japan. In these countries, farm size is as small (around 1 ha) as in Japan and wage rates have been likewise rising. The fundamental cause of the loss of comparative advantage of agriculture in these three Northeast Asian countries is most likely in the labor-intensive small-scale agriculture in the midst of high and rising wages.

Implications for China and Other Asian Countries

The most important lesson that can be drawn from the experiences of Japan, Taiwan, and Korea is that significant inefficiency in agricultural production arises if farm size remains small in a high-wage economy. If the option of land tenancy is unrestricted, however, tenancy transactions will play an important role in transferring land from inefficient to efficient farm households, thereby contributing to the achievement of higher production efficiency. This view stands in sharp contrast to the conventional view that tenancy is inefficient (Otsuka 1992).

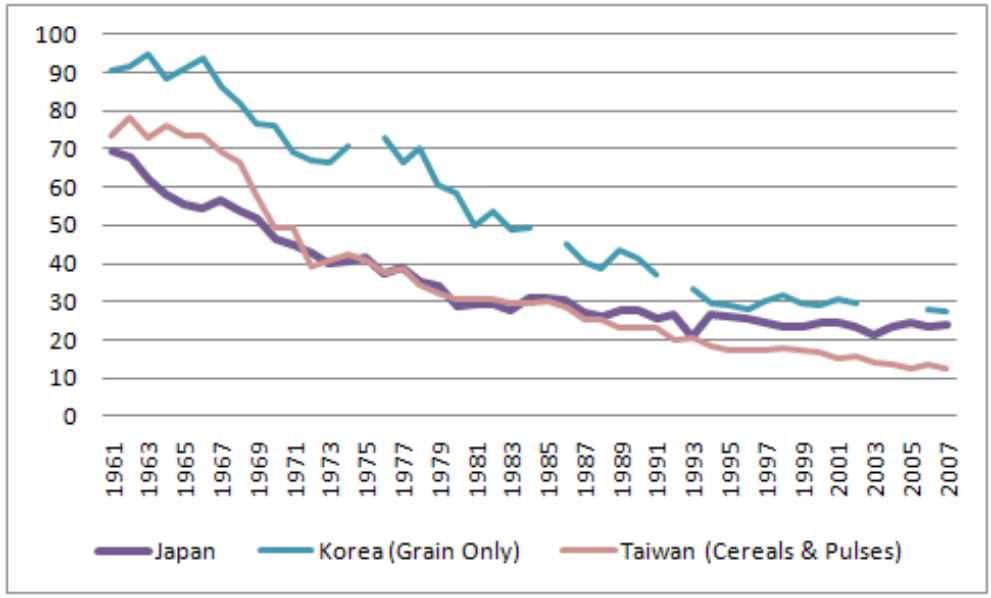
Following the introduction of the household responsibility system since 1978, household farming now prevails in China (Lin 1988; McMillan, Whalley, and Li 1989), which is similar to owner farming in other Asian countries. However, since land is collectively owned in China, the land market does not operate freely and, in view of the increasing number of migrants from rural to urban areas, differences in factor endowments among farm households are bound to arise. Thus, tenancy transactions must play a role in transferring land from land-abundant to labor-abundant households. Although the Chinese government has strengthened individual land rights (Kung 1995; Yao 2000), the provision of land rights appears to be insufficient to achieve efficient resource allocation (Kimura et al. 2011).

China has been rapidly growing over the past three decades, with the wage rate rising sharply, particularly since the late 1990s. Although its real GDP per capita based on purchasing power parity is still just one-fifth of the Japanese level as of 2005, it is comparable to the Japanese level in the 1960s. Given the existing income gap with Japan and other developed countries, the Chinese economy will likely continue to grow rapidly for many years to come based on technology transfer from abroad.

The real wage rate in China's manufacturing sector has been increasingly rapidly since 1997 (Figure 6), suggesting the exhaustion of "surplus" labor in rural sectors. Thus, the agricultural wage rate or opportunity cost of family labor in farming must have been

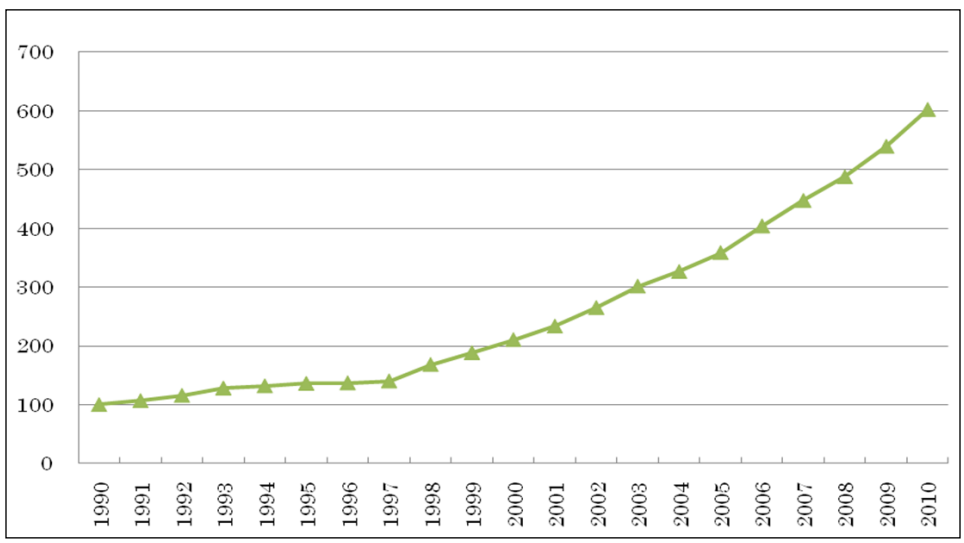
10 Pulses are included in the Taiwan data, whereas coarse grains are included in the Korean data.

Figure 5. Changes in grain self-sufficiency ratio in Japan, Korea, and Taiwan



Note: The Japanese case refers to self-sufficiency of rice, wheat, maize, and soybean, the Korean case includes coarse grains, and the Taiwan case includes cereals and pulses.

Figure 6. Changes in the real wage index in the manufacturing sector in China (1990=100)



Source: CEIC China Premium Database

rising and will continue to rise, inducing large mechanization and thereby creating scale advantages. Indeed, the use of riding tractors and combine harvesters is becoming common in high-wage areas such as Jiangsu and Zhejiang provinces. In these circumstances, the production inefficiency of small farms will increase, making it necessary to adjust farm size appropriately through tenancy transactions. Yet the average farm size remains at 0.6 ha and no appreciable expansion of farm size has been observed (Christiaensen 2011).

Table 5 shows that the import ratio of soybeans (i.e., import divided by the sum of domestic production and import) has been increasing in China, particularly since the late 1990s. The high ratio of soybean imports is explained mainly by the increasing demand for livestock feeds, associated with the population's shift of diet from grains to livestock products. However, potentially important is also the preservation of small farm size, which is becoming less efficient. Such small farms will certainly have increased production costs for all major grains, including rice and wheat. This will lead to an increase in the imports of these grains in the future, which will highly likely result in sharp rises in world grain prices.

The extremely small farm size presents a major challenge for Chinese agriculture.[11] For example, in order to establish a 10-ha farm, a typical farmer must rent land from as many as 16 other farmers. Such tenancy transactions are likely to be very costly. Also, if rented fields are scattered, scale advantages potentially arising from large mechanization will not be fully enjoyed. Thus, renting is unlikely to be the major means of creating large farms in China. Since 2008, the Chinese government has allowed the consolidation of village farmlands, which is managed by a small number of selected full-time farmers. In this arrangement, ex-farmers who now work in nonfarm sectors own shares, from which they receive a certain amount of dividends from farming. Whether, and to what extent, such new arrangements work to create new efficient large farms remain to be seen.

What is clear is that unless such drastic measures succeed in enlarging the farm size in China, this large country is likely to become a major importer of grains in the world market. As argued by Otsuka and Estudillo (2010), other high-performing Asian countries, with the exception of Thailand, are likely to follow a similar path of agricultural development, unless serious efforts are made to achieve sizable farm size expansion.

Changes in food self-sufficiency ratio

Even if land markets work efficiently, and consequently, the optimum farm size is achieved, high food self-sufficiency will not be maintained because of the scarcity of farm land in Japan, Taiwan, and Korea. The problem is that farm sizes are far from the socially optimum due to the protection of domestic agriculture. According to Anderson (2009, 2011), agriculture in Japan, Taiwan, and Korea has been heavily protected and subsidized. Figure 7 shows the assistance to agriculture relative to non-agriculture in terms of subsidies

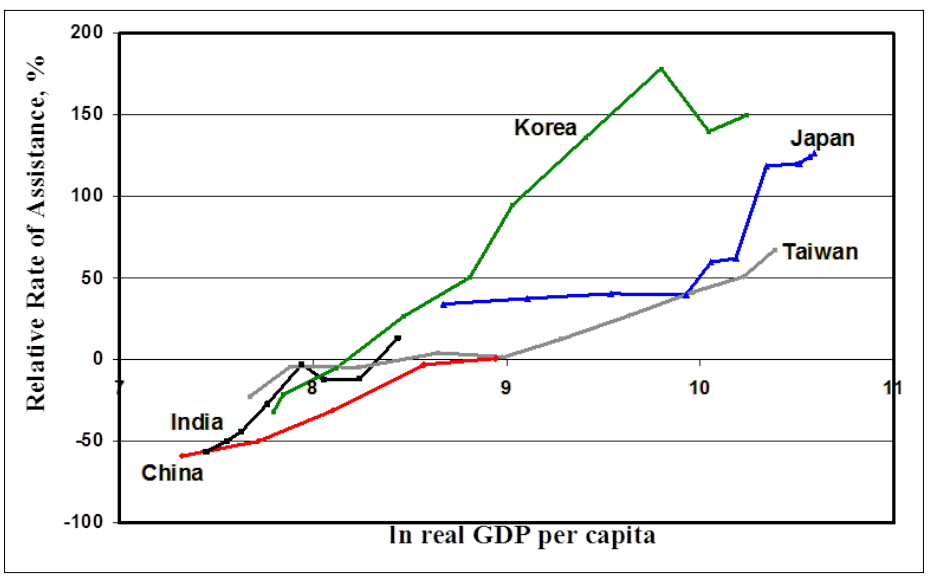
11 Recognizing that farm sizes in China are too small to reap the economies of scale necessary for domestic production to satisfy domestic demand, the Chinese have proposed construction of new dams and roads in Mozambique and elsewhere in exchange for favorable land leases to run mega-farms and cattle ranches primarily to boost food production to facilitate the rapid export of foodstuffs to China. The most important agenda of this project is to increase rice production destined for the Chinese market since rice accounts for only a small fraction of the Mozambican basic diet. The operation of such mega-farms resembles a plantation system, which is less efficient than family farms because of the high cost of labor supervision or excessive mechanization (Hayami 2009). Furthermore, mega-farms may create social conflict between the capitalist and native people.

Table 5. Percentage of imports to total domestic consumption in China, 1990–2006

Year	Rice	Maize	Wheat	Soybean
1990	0.05	5.30	12.07	15.32
1991	0.12	5.23	12.29	16.77
1992	0.09	5.30	10.27	18.59
1993	0.08	5.03	6.48	14.19
1994	0.43	5.32	7.73	13.24
1995	1.31	9.43	11.03	17.55
1996	0.55	4.79	7.74	22.30
1997	0.23	5.24	2.31	27.66
1998	0.18	3.64	2.32	25.53
1999	0.13	3.67	1.34	31.90
2000	0.20	4.45	2.08	45.22
2001	0.23	4.38	1.88	51.53
2002	0.23	4.00	1.97	45.62
2003	0.29	4.19	1.93	60.11
2004	0.67	3.59	8.36	56.12
2005	0.45	3.45	4.75	63.98
2006	0.58	3.28	1.49	66.42
2007	0.27	2.89	1.28	72.26
2008	0.17	2.48	0.89	71.78

Source: FAOStat online

Figure 7. Relative rate of assistance to agriculture and log of real per capita GDP in India, China, Japan, Korea, and Taiwan, 1995–2005



Source: Anderson (2011)

and trade protection. There is no question that the support policies have increased the farm population by making agriculture more attractive, thereby artificially conserving small-scale agriculture, which, in turn, has increased dependence on imports of food grains.

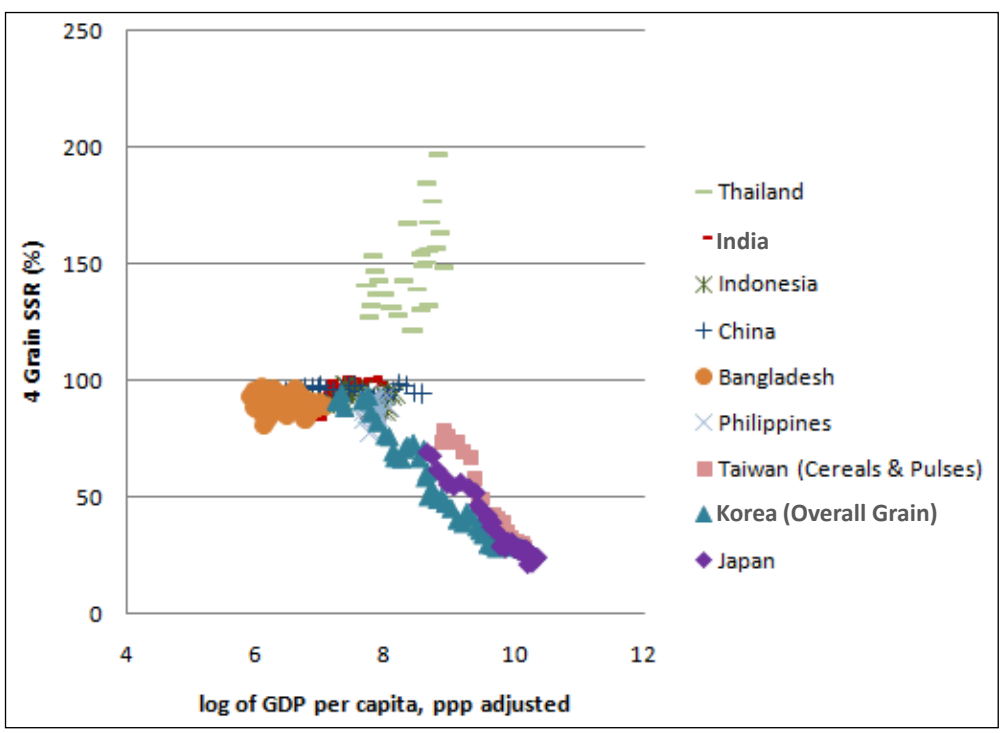
It may also be noted from Figure 7 that the current positions of China and India are not significantly different from those taken by Japan, Taiwan, and Korea, when their per capita incomes were comparable with those of China and India. The possibility that the latter two countries follow the paths of the three advanced Asian countries can hardly be denied.

Such conjecture is reinforced by Figure 8, which shows the grain self-sufficiency ratio given in Figures 3 and 5 against the PPP adjusted per capita income. Aside from Thailand, the grain self-sufficiency ratios of Japan, Korea, and Taiwan are not significantly lower than those of Southeast and South Asian countries, when their per capita incomes were comparable. As rapidly growing Asian countries catch up with the three leading Asian countries and become middle- to high-income countries, they are likely to become major importers of food grains, unless farm size expansion takes place.

CONCLUDING REMARKS

This paper argues that as an economy develops, agriculture faces distinctly different problems as regards to food, income, and trade. Asian agriculture has solved the food problem through the Green Revolution and has significantly reduced the income problem by increasing the nonfarm income of farm households. Richer Asian countries have been facing (and emerging Asian countries are about to face) the third problem: trade deficits in agriculture due to the loss of comparative

Figure 8. Changes in Self-Sufficiency of Grains and Real GDP per capita in Asian Countries



Source: Korea data - annual yearbook; Taiwan - annual yearbook, COA data

advantage. This problem is likely to be unique to Asia, which is characterized by meager endowments of land relative to population. This unfavorable endowment of land is aggravated by agricultural protection policies in rich Asian countries, which prevent farm size expansion from taking place to a significant extent.

Indeed, this study has demonstrated that the optimum farm size increases as the economy develops; hence, wage rates rise. In most developing countries in Asia where wage rates are relatively low, the optimum farm size is small. In all likelihood, however, the optimum farm size increases sharply as wage rates increase. The critical land tenure issue then is the transfer of land from small to large farmers to reap the potentially large benefits of scale economies. This structural transformation, however, may not take place because of land market distortions created by government policies.

Considering that high-wage advanced economies such as the USA and European countries are exporters of grains and low-wage economies such as African countries are net importers, it is clear that high wages do not imply the absence of a comparative advantage in agriculture. This is because labor can be substituted by capital as well as land, which is less expensive than labor. Such substitution is possible only when farm size becomes sufficiently large.

Asian countries are handicapped in farm size expansion because of the small endowment of land relative to labor. This implies that as the wage rate increases, these countries are likely to lose their comparative advantage in agriculture. The extent of loss of the comparative advantage, however, will depend on the pace of farm size expansion. If the farm size does not expand sufficiently fast, as in the case of Japan, the comparative advantage will be seriously lost, and such countries will become major importers of grains. If a large country like China fails to expand farm size rapidly, the world may experience food shortages as large food imports are likely to affect food prices at the world market. Consequently, the use of biofuels will become less economical, which would have serious implications on climate change.

According to a recent study by the International Food Policy Research Institute (IFPRI) (Nelson et al. 2010), food prices are projected to rise even without the "Asian problem" discussed above. To achieve food security and prevent excessive climate change on a global scale, Asian agriculture must pursue efficient development paths, however painful the adjustment of farm size expansion may be in the short- to medium-run.

REFERENCES

Anderson, Kym, ed. 2009. *Distortions to Agricultural Incentives: A Global Perspective, 1955–2007*. Washington, DC: World Bank.

Anderson, Kym. 2011. "Government Distortions of Agricultural Prices: Lessons from Rich and Emerging Economies." In *Community, Market, and State,* edited by K. Otsuka and K. Kalirajan. Hampshire, UK: Palgrave Macmillan.

Anderson, Kym, and Yujiro Hayami. 1986. *The Political Economy of Agricultural Protection*. Sydney: Allen & Unwin.

Berry, R.A., and W.R. Cline. 1979. *Agrarian Structure and Productivity in Developing Countries*. Baltimore: Johns Hopkins University Press.

Cherdchuchai, Supattra, Keijiro Otsuka, and Jonna P. Estudillo. 2009. "Income Dynamics, Schooling Investment, and Poverty Reduction in Thai Villages, 1987–2004." In Rural Poverty and Income Dynamics in Asia and Africa, edited by K. Otsuka, J.P. Estudillo, and Y. Sawada, 69-93. London: Routledge.

Christiaensen, Luc. 2011. "Agriculture for Development in China 2030: Challenges and Prospects." Washington, D.C.: World Bank, mimeo.

Christiaensen, Luc, Lionel Demery, and Jesper Kuhl. 2011. "The (Evolving) Role of Agriculture in Poverty Reduction: An Empirical Perspective." *Journal of Development Economics* 96 (2)*:* 239-254.

David, C.C., and Keijiro Otsuka. 1994. *Modern Rice Technology and Income Distribution in Asia.* Boulder, Colorado: Lynne Rienner.

Dawe, David C., Piedad F. Moya, and Cheryll B. Casiwan. 2006. *Why Does the Philippines Import Rice? Meeting the Challenge of Trade Liberalization.* Los Baños, Laguna: International Rice Research Institute.

Eastwood, Robert, Michael Lipton, and Andrew Newell. 2009. "Farm Size." In *Handbook of Agricultural Economics (Vol. 4)*, edited by P. Pingali, and R.E. Evenson, 3323-3397. Amsterdam: Elsevier.

Foster, A.D., and M.R. Rosenzweig. 2010. "Barriers to Farm Profitability in India: Mechanization, Scale and Credit Markets." mimeo.

Hayami, Yujiro. 1988. *Japanese Agriculture under Siege: The Political Economy of Agricultural Policies*. New York, NY: St. Martins Press.

Hayami, Yujiro. 2005. "An Emerging Agricultural Problem in High-Performing Asian Economies." Presidential Address to the Fifth Conference of the Asian Society of Agricultural Economists, Zahedan, Iran, August 29-31. Reproduced in *Can Economic Growth Be Sustained? The Collected Papers of Vernon W. Ruttan and Yujiro Hayami*, edited by Keijiro Otsuka, and C. Ford Runges. Oxford, UK: Oxford University Press, 2011.

Hayami, Yujiro. 2009. "Plantations Agriculture." In *Handbook of Agricultural Economics, (Vol. 4)*, edited by P. Pingali, and R.E. Evenson, 3305-3321. Amsterdam: Elsevier.

Hayami, Yujiro, and Toshihiko Kawagoe. 1989. "Farm Mechanization, Scale Economies, and Polarization." Journal of Development Economics 31 (2): 221–39.

Hayami, Yujiro, and Keijiro Otsuka. 1993. *The Economics of Contract Choice: An Agrarian Perspective*. Oxford, UK: Clarendon Press.

Hayami, Yujiro, and Vernon W. Ruttan. 1985. *Agricultural Development: An International Perspective*. Baltimore, MD: Johns Hopkins University Press.

Hazell, P.B.R. 2010. "Asia's Green Revolution: Past Achievements and Future Challenges." In *Rice in the Global Economy: Strategic Research and Policy Issues for Food Security*, edited by S. Pandey, D. Byerlee, D. Dawe, A. Dobermann, S. Mohanty, S. Rozelle, and B. Hardy. Manila, Philippines: International Rice Research Institute.

Johnson, D. Gale. 1991. *World Agriculture in Disarray*, 2nd ed. Basingstoke, UK: Macmillan Press.

Kimura, Shingo, Keijiro Otsuka, Tetsushi Sonobe, and Scott Rozelle. 2011. "Efficiency of Land Allocation through Tenancy Markets: Evidence from China." *Economic Development and Cultural Change* 59 (3): 485–510.

Kruger, A.O., Morris Schiff, and Alberto Valdes. 1991. *Political Economy of Agricultural Pricing Policies*. Baltimore: Johns Hopkins University Press.

Kung, James K.S. 1995. "Equal Entitlement versus Tenure Security under a Regime of Collective Property Rights: Peasants' Preference for Institutions in Post-Reform Chinese Agriculture." *Journal of Comparative Economics* 21 (1): 82–111.

Kumanayake, N.S., J.P. Estudillo, and Keijiro Otsuka. 2011. "Changing Sources of Household Income, Poverty, and Inequality in Sri Lanka, 1990-2006." National Graduate Institute for Policy Studies, mimeo.

Lin, J. Y. 1988. "The Household Responsibility System in China's Agricultural Reform: A Theoretical and Empirical Study." *Economic Development and Cultural Change* 36 (2): 199–224.

McMillan, John, John Whalley, and J.Z. Li. 1989. "The Impact of China's Economic Reforms on Agricultural Productivity Growth." *Journal of Political Economy* 97 (4): 781–807.

Nelson, G.C., M.W. Rosegrant, Amanda Palazzo, Ian Gray, Christina Ingersoll, Richard Robertson, Simla Tokgoz, Tingju Zhu, T.B. Sulser, Claudia Ringer, Siwa Msangi, and Liangzhi You. 2010. *Food Security, Farming, and Climate Change to 2050: Scenarios, Results, Policy Options*. Washington, DC: International Food Policy Research Institute.

Ogura, Takekazu. 1963. *Agricultural Development of Modern Japan*. Tokyo: Fuji Publishing.

Otsuka, Keijiro. 1992. "Agricultural Reforms and Development in Asia: A Comparative Perspective." In *Economic Reform and Internationalisation: China and the Pacific Region*, edited by Ross Garnaut and Liu Guoguang. Sydney and London: Allen & Unwin.

Otsuka, Keijiro. 2007. "Efficiency and Equity Effects of Land Markets." In *Handbook of Agricultural Economics, Vol. 3*, edited by R.E. Evenson, and Prabhu Pingali. Amsterdam: Elsevier.

Otsuka, Keijiro. 2011. "The Contributions of Ruttan and Hayami." In *Can Economic Growth Be Sustained? The Collected Papers of Vernon W. Ruttan and Yujiro Hayami*, edited by Keijiro Otsuka and C. Ford Runge. Oxford, UK: Oxford University Press.

Otsuka, Keijiro, Hiroyuki Chuma, and Yujiro Hayami. 1992. "Land and Labor Contracts in Agrarian Economies: Theories and Facts." *Journal of Economic Literature* 30 (4): 1965–2018.

Otsuka, Keijiro, and J.P. Estudillo. 2010. "Economic Development, Land Tenure, and the Changing Optimum Farm Size." In *Rice in the Global Economy: Strategic Research and Policy Issues for Food Security*, edited by S. Pandey, D. Byerlee, D. Dawe, A. Dobermann, S. Mohanty, S. Rozelle, and B. Hardy. Manila, Philippines: International Rice Research Institute.

Otsuka, Keijiro, J.P. Estudillo, and Yasuyuki Sawada. 2009. *Rural Poverty and Income Dynamics in Asia and Africa*. London, UK: Routledge.

Otsuka, Keijiro, J.P. Estudillo, and Takashi Yamano. 2010. "The Role of Labor Markets and Human Capital in Poverty Reduction: Evidence from Asia and Africa." *Asian Journal of Agriculture and Development* 7 (1): 23–40.

Otsuka, Keijiro, and Donald Larson. 2013. *An African Green Revolution: Finding Ways to Boost Productivity on Small Farms*. London: Springer

Pingali, Prabhu L., Mahabub Hossain, and R.V. Gerpacio. 1997. *Asian Rice Bowls: The Returning Crisis?* Wallingford, UK: CAB International.

Rozelle, Scott, Jikun Huang, and Keijiro Otsuka. 2008. "Agriculture in China's Development: Past Disappointments, Recent Successes, and Future Challenges." In *China's Great Economic Transformation*, edited by Loren Brandt and Tomas Rawski. Cambridge: Cambridge University Press.

Schultz, T.W. 1953. *The Economic Organization of Agriculture*. New York, NY: McGraw-Hill.

Schultz, T.W. 1964. *Transforming Traditional Agriculture*. New Haven: Yale University Press.

Sonobe, Tetsushi, and Keijiro Otsuka. 2006. *Cluster-Based Industrial Development: An East Asian Model*. Hampshire, UK: Palgrave Macmillan.

Sonobe, Tetsushi, and Keijiro Otsuka 2011. *Cluster-Based Industrial Development: A Comparative Study of Asia and Africa*. Hampshire, UK: Palgrave Macmillan.

Timmer, C.P. 2010. "Rice and Structural Transformation." In *Rice in the Global Economy: Strategic Research and Policy Issues for Food Security*, edited by S. Pandey, D. Byerlee, D. Dawe, A. Dobermann, S. Mohanty, S. Rozelle, and B. Hardy. Manila, Philippines: International Rice Research Institute.

Yamano, Takashi, Keijiro Otsuka, and Frank Place. 2011. *Emerging Development of Agriculture in East Africa: Markets, Soil, and Innovations*. Amsterdam, Netherlands: Springer.

Yao, Yang. 2000. "The Development of Land Lease Market in Rural China." *Land Economics* 76 (2): 252–266.