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"Food Insecurity, Income Inequality, and the Changing Comparative Advantage in World Agriculture"*

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I. Introduction

When I was an 18-year old high-school student in 1966, Asian Green Revolution (GR) began. In this year I had to decide what to study at the university. I chose agricultural sciences, because I learned that food insecurity in low-income countries in Asia was becoming a major concern of the world. It was then widely believed that Asia would starve because of population explosion coupled with stagnant crop yield and the exhaustion of uncultivated land. Thirteen years later, in 1979, when I finished Ph.D. in economics, however, the food insecurity issue in Asia was over, thanks to the GR. Instead what attracted my attention was the exorbitant price support policy for rice and the huge accumulation of rice surplus in my home country, Japan. So instead of studying the food insecurity, I studied the issue of the food surplus (Otsuka and Hayami 1985).

In recent years, the food insecurity has become a serious issue in Sub-Saharan Africa (SSA), which is reminiscent of the same issue in Asia four decades earlier. Thus, I have decided to contribute to the improvement of food security in SSA by conducting a large number of case studies and assisting the Coalition for African Rice Development organized by the Japan International Cooperation Agency and the Alliance for Green Revolution in Africa, which aims at doubling rice production in 10 years (Yamano,

Otsuka, and Place 2011; Otsuka and Larson 2012). Meanwhile, the food crisis occurred in 2008, which was followed by land grab in poor countries by richer countries. Also conspicuous was the sharply increasing food imports by Japan, Taiwan, and Korea, as well as by China.

The food insecurity in Asia in the 1960 and SSA in recent years, the rice price support and rice surplus in Japan in the 1970s, and the declining food self-sufficiency with massive imports of grains by East Asian countries may seem unrelated. The main thrust of this article is to argue that these phenomena reflect “common” evolutionary processes of agricultural development, particularly in land-poor countries in Asia and SSA. The story of land-rich countries is likely to different, however, as shortage of food production, excessive government support for domestic agriculture, and increasing food imports are not relevant issues in these countries.

More specifically, I would like to argue that in the process of economic development, agriculture in land-poor countries in Asia faces three distinctly different problems: food insecurity, sectoral income inequality, and declining food self-sufficiency associated with declining comparative advantage in agriculture at the high-income stage. The first and second problems are called “food problem” and

"income problem", respectively, terms first used by Schultz (1953).[1] The food problem, or the problem of food insecurity, tends to arise in the transition process from the extensive farming system relying on area expansion to intensive farming system dependent on intensive use of labor and other non-land inputs. In this process food supply fails to catch up with the increasing demand, because the uncultivated land is exhausted, but yield-enhancing technologies and production methods are yet to be developed and disseminated.[2] Income problem, or the income inequality between farm and nonfarm sectors, arises at the higher income stage because nonfarm sector usually grows much faster than farm sectors. Finally, grain imports increase as the wage rate increases further, because the comparative advantage in food production tends to decrease in land poor-countries where farm size is small and, hence, labor-intensive production methods are used even when labor cost is high. The problem of small farm size tends to be exacerbated by the government policy to protect and support agriculture, as it reduces the exodus of farm workers to nonfarm sectors, thereby preventing farm size expansion. Massive imports of food grains to Asia, if they occur, will aggravate the world food shortage, which will have significant implications for the poverty incidence

[1] Later the income problem was further elaborated in the context of Asian agriculture by Hayami (2005) in his presidential address at the fifth Conference of Asian Society of Agricultural Economists. His paper is included in a new book in honor of Professors Ruttan and Hayami edited by Otsuka and Runge (2011). Also see Timmer (2010).

[2] Such agriculture is described as "traditional agriculture" by Schultz (1964).

in the world. Climate change will be also affected adversely, because high food prices will reduce the use of agricultural products for biofuels. According to a recent study of the International Food Policy Research Institute (Nelson et al. 2010), food prices are projected to rise even without the "Asian Problem" to be discussed in this paper.

In order to avoid such a tragic scenario, I would like to argue, firstly, that we should strengthen our efforts to increase food production in SSA; secondly that farm size expansion must be promoted in East Asia to prevent the socially and "globally" excessive reliance on food imports; and finally, that international efforts to increase food production in land-rich regions, such as Latin America, must be accelerated to ensure food security in the world as a whole.

The organization of this paper is as follows. After briefly reviewing how the food problem was solved in Asia, with a view to solving the current food problem in SSA in Section II, I examine in Section III how the increasing nonfarm income contributed to increases in farm household income in Asia. I discuss how serious could be the issue of the declining comparative advantage in agriculture in East Asia in Section IV. Finally the policy implications of this study are discussed in Section V.

II. Food Insecurity and the Green Revolution

In the 1950s and early 1960s in tropical Asia, population grew rapidly, grain yield was low and stagnant, and land frontier was gradually closed. If such a trend had continued, there is no question that widespread famine and starvation could not have been avoided (Hayami and Ruttan 1985). In fact, successive droughts in India in the mid-1960s resulted in serious famines in this country. Similarly in contemporary SSA, widespread famines are real threats, as food production can easily fall short of demand in the event of droughts and floods. If population continues to grow, the gloomy Malthusian prediction could become a reality.

However, cereal yields, particularly rice and wheat yields, began increasing in the late 1960s in Asia due to the GR (Figure 1), i.e., the development and diffusion of a series of short-statured, early-maturing, and fertilizer-responsive, high-yielding modern varieties (MVs) of rice together with the dissemination of improved production practices (David and Otsuka 1994; Pingali, Hossain, and Gerpacio 1997; Hazell 2010). GR was induced by the increasing scarcity of land relative to labor and was realized by the transfer of relevant scientific knowledge from the temperate to the tropical zone (Hayami and Ruttan 1985; Otsuka and Runge 2011). The GR is not a one-shot phenomenon; it is a long-term evolutionary process involving the interactive development of technology, markets, infrastructure (particularly irrigation), and research

and extension programs. The focus of the Asian GR is irrigated rice. This is in sharp contrast with SSA, which is characterized by highly heterogeneous production environments and highly diversified food crops. In SSA, cereal yields increased only marginally and the rapidly growing population continues to press hard on limited land, resulting in the increased food insecurity.

A significant effect of the Asian GR on food security can be most clearly seen in declining rice price. As is shown in Figure 2, rice production continued to increase until the late 1990s, which accompanied a continued decrease in the real rice price, aside from the unusual “food crisis” period of 1973-74. As a result, the real rice price in 2000 was roughly one-third of its level around 1970. The momentum of the Asian GR, however, faded away around the turn of the 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 West African countries, which were major importers of rice.

Roughly speaking, most developing countries in South and Southeast 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 (Table 1). Due to the continued and rapid growth of population and the

early exhaustion of the GR technology potential, the self-sufficiency ratio in the Philippines has been decreasing since then end of the 1980s (Dawe et al. 2006). The self-sufficiency ratio significantly exceeded 100% in Thailand due to the rich endowment of land relative to the population in this country. Without the GR, the cereal self-sufficiency ratio could have been much lower than it actually has been, and food security could have been a major issue in many countries in tropical Asia.

It is an opportune time for SSA to realize a GR, where room for land expansion has been increasingly limited. In fact, the average farm size is only 1.8 hectares in SSA, if South Africa is excluded, which is not so different from the average farm size of 1.2 hectares in tropical Asia. If the induced innovation theory works, it should work now. While some researchers (e.g., Collier and Dercon 2009) argue that smallholder agriculture does not have a potential to increase food production dramatically, many others (e.g., World Bank 2008; Diao, Hazell, and Thurlow 2010; Hazell et al. 2010; Yamano, Otsuka, and Place 2011; Otsuka and Larson 2012) assert that smallholder agriculture in SSA has potential to realize a GR as in the case of Asia.[3] Moreover, there is a sign that the inverse relationship between farm size and grain yield, which has been observed in South Asia, has emerged in SSA (Holden, Otsuka, and Place 2009; Larson

[3] It is worth emphasizing that the development of smallholder agriculture is equitable (Hazell et al. 2010). Furthermore, to the extent that land ownership distribution is egalitarian, the economic growth tends to be pro-poor (Deininger and Squire 1998; Ravallion and Dutt 2002).

et al. 2012). This is most likely because it is difficult to supervise hired workers in spatially dispersed agricultural environments, so that small family farms, which depend primarily on family labor, have an efficiency advantage over large farms which employ hired workers (Feder 1985; Hayami and Otsuka 1993; Binswanger and Deininger 1997; Otsuka 2007; Eastwood, Lipton, and Newell 2009).[4] Considering that the inverse relationship was rarely reported before in SSA, its emergence is likely to reflect the intensification of farming systems in this region in recent years.

Otsuka and Larson (2012) argue that lowland rice is the most promising crop for a GR in SSA partly because high yields have been actually achieved in a large number of areas, such as Senegal River Basin and Mwea irrigation scheme in Kenya, and partly because many of the Asian technologies (e.g., modern varieties of rice and production practices such as bunding and leveling) are easily transferable from Asia to SSA (e.g., Nakano and Otsuka 2011; Kijima, Ito, and Otsuka 2012). What is needed is the effective extension system to disseminate the potentially productive rice technology. In contrast, yield potential of available maize technology does not seem high, which indicates that the development of appropriate technology is the prerequisite for a successful maize

[4] Advantage of small family farms is likely to be greater in labor-intensive and spatially dispersed agriculture (Rozelle and Swinnen 2004; Gorton and Davidova 2004; Swinnen 2009) or more generally in arable farming as compared with livestock farming (Allen and Lueck 1998).

GR.[5] Considering declining soil fertility in upland fields in SSA (Yamano, Otsuka, and Place 2011), Otsuka and Larson argue that the "optimum" farming system consisting of livestock raising, the application of manure, compost, and chemical fertilizer, rotational cultivation of feed and food crops, the use of agroforestry, and the adoption of high yielding maize and other crop varieties must be established. In short, the vision of the appropriate technologies and their dissemination strategies is still missing or at best weak in SSA. As Ruttan (2011) forcefully argues, social scientists must contribute to the design of effective development strategy for African agriculture.

Food insecurity is not much of a problem in land-rich countries, such as Latin America, Eastern Europe, and Central Asia, because of the favorable land endowment. Moreover, large-scale corporate farms have emerged in such countries and scale economies arising from large mechanization are already taking place (Key and Runsten 1999; Rozelle and Swinnen 2004; Gordon and Davidova 2004; Helfand and Levine 2004; Eastwood, Lipton, and Newell 2009; Deininger and Byerlee 2012). Such scale economies will explain the increasing yield trends of cereal crops in South America shown in Figure 1.

[5] Yields of sorghum and millet are no different between Asia and SSA and, hence, the transferability of Asian technology is limited.

III. Nonfarm Jobs and Farm Household Income

Because of the growth linkage effects of agricultural development on the development of nonfarm sectors (e.g., Christiaensen et al. 2011), income elastic demand for industrial products and services, and active technology transfers from advanced to less advanced economies in nonfarm sectors (Sonobe and Otsuka 2006 2011), nonfarm sectors tend to grow more rapidly than farms sectors, thereby creating an income gap between the two sectors. In order to reduce the income gap, the governments of Japan, Taiwan, and Korea supported agricultural sectors by means of price supports and input subsidy programs (Anderson and Hayami 1986; Kruger et al. 1991; Anderson 2009). Recently, upon 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 its accession to the World Trade Organization (Rozelle, Huang, and Otsuka 2008; Christiaensen 2011).

A major way through which farm household income has been increasing in Asia has been through the increased nonfarm income of farm households, as well as through rural-to-urban migration (Otsuka, Estudillo, and Sawada 2009; World Bank 2012). As a result, rural poverty as well as the inter-sectoral income inequality between farm and nonfarm sectors has been mitigated in high-income countries in Asia. Japan is

a good example, where despite the small farm size, the average income of farm households has been higher than that of urban households over the last several decades due importantly to the increased nonfarm income (Kada 1980). Similarly in China, increased nonfarm income is a major factor that explains a significant reduction in rural poverty (Rozell and Huang 2012).

Almost simultaneously with the evolution of the GR in Southeast and South Asia, the nonfarm sectors of the economy have been growing much faster than the farm sector in most countries, thereby increasing the income earning opportunities in nonfarm sectors for the working-age population. Since the real rice price declined sharply, income from rice farming did not increase as much or even declined in some countries despite the improvement in the productivity of rice farming. Thus, a substantial income gap has emerged between farm and nonfarm households (Hayami 1988). In other words, agriculture in tropical regions of Asia has started to face an income problem.

As is clearly demonstrated in Table 2, which shows the income of rice growing households in high-potential agricultural areas (largely irrigated areas) and marginal areas (largely 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 (Otsuka et al. 2010). Also declining sharply is the rice income share because of the declining rice prices coupled with only a modest increase in the rice yield since the mid-1980s.

In contrast, the non-farm income share in the Philippines and Thailand has increased dramatically, as their per capita incomes have risen significantly. In the high-potential areas in the Philippines, the per capita income more than doubled, while the non-farm income share increased from 45 to 70 percent in roughly 20 years. Thus, there is no doubt that the increasing non-farm income has contributed to the increasing overall income for farm households. Similar or even more rapid increases in income are found in the marginal areas of the Philippines. Because agricultural production in such areas is not as promising as in the high-potential areas, households in the marginal areas have expanded their non-farm activities more rapidly. As a result, the regional income gap has significantly declined.[6]

A more dramatic example of the structural change in the composition of rural household income can be found in the marginal area of Thailand, located in the northeastern region, formerly known as an area of extreme hunger (Cherdchuchai,

[6] It must be pointed out that, as is shown in the parentheses, remittances, which are primarily sent by overseas migrants, account for nearly one-third of the non-farm income in the Philippines, attesting to the utmost importance of overseas migration in supporting the income of rural households in this country.

Otsuka, and Estudillo 2009). The non-farm income share has increased from 21 to 74 percent in the period from 1987 to 2004. Since this region is unfavorable for agricultural production, farm households have raised their income by increasing their non-farm income share. Such a change was made possible by the increased availability of non-farm jobs in the local city of Khon Kaen and Bangkok, as farmers used to migrate to western regions to engage in the low-wage employment of sugarcane cutting. Thus, high-wage non-farm jobs have substituted low-wage farm jobs in unfavorable areas. In contrast, the non-farm income share in the high-potential areas increased more modestly from 10 to 47 percent in the same period.

Somewhat unexpectedly, the per capita income in high potential areas is lower than that in marginal areas in Bangladesh, particularly in 1988, even though rice income is higher in the former than the latter areas because of the availability of irrigation in the former areas. It is important to observe that non-farm income accounts for a much larger share of the total income in marginal areas in 1988, suggesting the decisive importance of the access to non-farm labor markets in determining the total income of rural households. Another important observation is the rapidly declining share of rice income, particularly in the marginal areas over time. The total income in the high-potential areas has caught up with the marginal areas by increasing the non-farm income share.

In India, represented by southern state of Tamil Nadu, the per capita income in marginal areas was less than half of the income in high-potential areas in the mid-1980s. However, somewhat similar to the experience in the marginal areas of the Philippines and Thailand, the households in the marginal areas have increased their non-farm income share from 7 to 27 percent. In addition, the share of non-rice farm income, which consists of income from the production of high-value crops, such as sugar-cane and milk, increased in the marginal areas of Tamil Nadu. As a result, the per capita income in the marginal areas has increased from US$228 to US$623, reducing the income gap with the high-potential areas. Therefore, as far as Asian countries are concerned, the development of non-farm labor markets appears to have increased the income of rural households significantly, particularly in less favorable areas for agricultural production.

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). In other countries, the extent to which the farm and non-farm household income gap has been reduced by the increasing nonfarm income of farm households remains to be analyzed. Yet there is no doubt that the increased nonfarm income of rural households in Asia has played an important role in distributing the benefits of overall economic growth among the population at large.

VI. Declining Comparative Advantage of Agriculture in Asia

In the process of economic development in Asia which accompanied continuous increase in real wage rate, the comparative advantage of the economy in most Asian countries has been shifting from agriculture to nonagricultural sectors, importantly because of the small farm size, which requires labor-intensive cultivation (Otsuka and Estudillo 2010). Farm size expansion, however, is difficult to realize due to the imperfection of land markets (Otsuka 2007). Moreover, as Johnson (1991) forcefully argues, agricultural support policies to reduce income inequality aggravate the income problem by increasing the farm population, part of which would have out-migrated in the absence of such policies. As a result, high income countries in Asia (e.g., Japan, Taiwan, and Korea) have been facing the third problem, viz., increasing imports of grains due to the declining comparative advantage.

If many of the high-performing Asian countries become grain importers, world grain prices will shoot up and poverty is expected to deepen, thereby creating a scenario which is unfavorable to the attainment of the Millennium Development Goals Target 1 to eradicate extreme poverty and hunger.

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 ha to 2 ha can be managed efficiently by family labor consisting of a few workers, if no machinery is used. Beyond that scale, hired labor must be employed. However, monitoring cost of hired labor arises, which increases more than proportionally with the cultivation size (Otsuka et al. 1992; Hayami and Otsuka 1993). This explains why family farm dominates in agriculture throughout the world (Berry and Cline 1979; Eastwood, Lipton, and Newell 2009). Thus, the optimum farm size in low-wage economies is bound to be small because of the limited availability of family labor and costly substitution of capital for labor.

As the real wage rate increases, labor cost increases. In order to reduce the labor cost, labor must be substituted by machineries. In order to operate machines more efficiently, farm size must expand.[7] Since large machineries are indivisible, scale advantages are bound to arise.[8] Thus, larger farms become more efficient than smaller farms, so that the land must be transferred from the smallholder farmers to the larger farmers. Renting is a practical way to transfer land to the hands of a smaller number of

[7] To my personal knowledge, farm size expansion has begun taking place in Punjab in India, Central Thailand, and the Mekong Delta region of Vietnam within South and Southeast Asia.

[8] 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.

large farms. In fact, typically landlords are small farmers and tenants are large farmers not only in high-income economies but also in South America, Eastern Europe, and Central Asia (Deininger and Byerlee 2012).[9]

When farm size is adjusted optimally by land renting as well as by land sales transactions over time, we will not observe "scale-economies," as all the existing farms are more or less equally large and efficient. Scale economies tend to be observed when small inefficient farms and large efficient farms coexist (Hayami and Kawagoe 1989).[10] This will be observed in the dynamic process of farm size adjustments and also when institutional constraints prevent such adjustments. I expect that scale economies will be observed in a high-wage economy, such as Japan, where the government regulates the land rental transactions and adopts the acreage control program, so that farm size expansion is discouraged despite the high wage rates (Hayami 2005).[11]

An Overview of Changing Farm Size in Asia

Let us briefly review the changing agrarian structure in selected developing countries in Asia in terms of average farm size and the inequality of operational landholdings (i.e.,

[9] Tenants in South America, Eastern Europe, and Central Asia are often private companies and collective farms.

[10] In our discussion of scale economies, we follow 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.

[11] According to a recent study of Foster and Rozensweig (2010), large farms have become more productive than small farms in India due to rising wage rate and large-scale mechanization.

Bangladesh, India, Indonesia, the Philippines, and Thailand), using agricultural census data in the 1970s, 1990s, and 2000s. Specifically, we would like to examine 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.

Table 3 demonstrates that peasants or small family farms make up a major part of the production organization in Asian agriculture. In fact, the average operational farm size was small, ranging from about 1 hectare in Indonesia to 3-4 hectares in the Philippines and Thailand in the 1970s. In high-performing Southeast Asian countries, such as Indonesia and Thailand, the reduction in farm size has been relatively modest over time because the impact of population pressure on limited land has been mitigated by the job creation in nonfarm sectors, which drives the rural labor force away from the farm to the nonfarm sector.

In contrast, the average farm size significantly declined in other economies due to rapid population growth in rural areas and also to the stagnant growth of non-farm sectors. Particularly conspicuous is Bangladesh, where the average farm size declined from 1.4 hectares in 1976/77 to 0.3 hectare in 2005.[12] In this country, about 50% of the farms were smaller than 1.0 ha in 1976/77 and this proportion increased to more than

[12] Agricultural landless households are excluded from the estimation of average farm size except in India. In Bangladesh, the average size would be small roughly be 10 percent, if the landless households are included.

80% in 1996. Large farms above 10 ha are rare in Bangladesh, confirming the absence of scale economies in low-income agriculture.

The 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 United States) despite the remarkable growth in real wages. Part of the explanation for the dominance of small farms in Japan is likely to lie in the regulation of tenancy transactions by land reform laws, even though it has been relaxed over time.

Land reform in Japan did not change the identity of the cultivators of land and, consequently, the distribution of operational landholdings (Ogura 1963; Hayami 1988). As shown in Table 4, the average operational farm size and distribution were largely the same in l940 and l960. It is also noteworthy that the average farm size did not change appreciably even from 1960 to l980; it increased from only 1.0 to 1.2 hectares, despite the continuous and rapid increases in wages and substantial progress in mechanization. There are, however, some indications that the share of relatively large farms (more than

3 hectares) increased particularly by 2005. Such a tendency seems to reflect what Hayami and Kawagoe (1989) termed as the 'polarization' of the farm structure in Japan, in which large farmers accumulate land through renting, as well as through 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 Japan (Kuroda 1989). In 1960 there was no appreciable difference in revenues and costs among farms of different sizes categorized into several groups (Table 5). Mechanization in this period was characterized by the widespread adoption of threshers and the introduction of small power-ti1lers. In 1975, however, a significant gap in production costs emerged with the introduction of large machineries; the total cost of rice production per hectare became substantially higher on small farms less than 0.5 ha than on larger ones more than 5 ha, primarily because both labor and machinery costs were much higher on the former. This tendency was further strengthened thereafter—the total cost as well as labor and machinery costs on farms of less than 0.5 hectares double that of farms larger than 5 hectares in 1988 and 2008, even though the revenue per hectare remained largely the same across different 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 earlier, 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. 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 (Hayami 1988). Such renting arrangements make the restoration of equilibrium in land rental markets an impossibility. Herein lies the durable impact of land reform, which is inconsistent with the expansion of farm size to efficient levels in contemporary Japan.

As shown in Table 1, the grain self-sufficiency ratio in Japan has declined rapidly since 1961, which clearly attests to the sharply declining comparative advantage of agriculture in this country. Although the definitions of grain self-sufficiency ratio are somewhat different from the case of Japan,[13] the self-sufficiency ratios have also declined significantly in both Taiwan and Korea almost in parallel with that of Japan. In

[13] Pulses are included in the Taiwan data, whereas coarse grains are included in Korean data.

these countries, farm size has been as small as that in Japan, i.e., around 1.0 hectare, and wage rates have been rising continuously, similar to Japan. There seems to be no doubt that the fundamental cause for the lost comparative advantage of agriculture in these three Northeast Asian countries is the preservation of 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 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, Chuma, and Hayami 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. In China, however, land is collectively owned. Therefore, 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), it appears that the provision of land rights is insufficient to achieve efficient resource allocation (Kimura et al. 2011).

Chinese economy has been rapidly growing over the last three decades and the wage rate has been rising sharply, particularly since the late 1990s (Figure 3). Thus, the agricultural wage rate or opportunity cost of family labor in farming must have been rising and will continue to rise, which will induce large mechanization, thereby creating scale advantages. Indeed, the use of riding tractors and combine harvesters is becoming common in such high wage areas 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 0.6 hectare and no appreciable expansion of farm size has been observed (Christiaensen 2011). China's real GDP per capita was still one-fifth of the Japanese level as of 2005, and comparable to the Japanese level in the 1960s. Given the existing income gap with Japan and other developed countries, it is likely that the Chinese economy will continue to grow rapidly for many years to come based on

technology transfer from abroad.[14]

As reported in Figure 4, the import of soybeans has been rapidly increasing in China, particularly since the late 1990s. The high ratio of the imports of soybeans is explained by the increasing demand for feeds for livestock production associated with the shift of diet from grains to livestock products. However, potentially also important is the preservation of small farm size, which would be becoming less efficient. The production cost of such small farms will certainly increase in the production of all major grains including maize, rice, and wheat, which will lead to an increase in the imports of these grains in the future.[15]

In the case of Japan, imports of both soybean and maize have continuously increased since 1961, in contrast to their declining domestic production. This increased dependence on imports of soybean and maize occurred despite the subsidy program of the government. There is therefore no question that Japan has lost comparative advantage in these crops almost completely over the last several decades.

The extremely small farm size presents a major challenge for Chinese agriculture.[16] For example, in order to establish a 10 ha farm, a typical farmer must rent

[14] In my view the key to the successful development of East Asia is technology transfer or learning technological and managerial knowledge from abroad. See World Bank (2012).
[15] So far China has been largely self-sufficient in rice and wheat.
[16] The Chinese recognize that farm sizes are too small in China to reap the economies of scale necessary for domestic production to satisfy domestic demand. The Chinese have proposed

in 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 realized. Thus, renting is unlikely to be the major means to create 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 the 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 remains to be seen.[17]

What is clear is that unless such drastic measures are adopted to enlarge the farm size, China, which is a large country, is likely to become a major importer of grains in the world market, leading to increases in world food prices. As is 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

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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 which is 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.

[17] Actually such system seems to work in land-rich transition economies (Rozelle and Swinnen 2004; Swinnen 2009).

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 farmland in Japan, Taiwan, and Korea. The problem is that the farm size is far from the socially optimum due to the protection of domestic agriculture. According to Anderson (2009, 2011), the assistance to agriculture relative to non-agriculture in terms of subsidies and trade protection in Japan, Taiwan, and Korea has been increasing (Figure 6), indicating that agriculture in these three countries has been heavily protected and subsidized. There is no question that such support policies increased the farm population by making agriculture more attractive, thereby artificially conserving the small-scale agriculture, which, in turn, increases the dependence on imports of food grains.

It may also be noticed from Figure 6 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 to 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 7, which shows the grain

self-sufficiency ratio, shown in Table 1, against the PPP adjusted per capita income. Aside from Thailand, the grain self-sufficiency ratios of Japan, Korea, and Taiwan were not significantly lower than those of Southeast and South Asian countries, when their per capita incomes were comparable. It is therefore likely that 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.

Table 6 reports the preliminary estimation results of the food self-sufficiency ratio (FSSR) function region, while using the try and year fixed-effect model from 1980 to 2010. According to equations (1), (3), and (5), PPP adjusted per capita GDP has positive and decelerating effect on FSSR in Asia up to $7,000, whereas it has no independent effects in Africa and Latin America. An interesting finding is the negative and significant effect of the interaction term between per capita GDP and land size per capita in 1980 in Asia and the positive effect in Latin America. Possible interpretation is that while labor-saving technology suitable for large-scale operation was developed in Latin America with growth in income, Asia failed to take advantage of large-scale operation. In equations (2), (4), and (6), population-arable land ratio has negative and significant effect everywhere, even though the magnitudes of coefficients are different.

Indeed, Latin America took advantage of low population-arable land ratio and increased FSSR, which is contrasting to small such effect in Asia.

V. Concluding Remarks

I argued in this paper that as an economy develops, agriculture in land-poor countries faces three distinctly different problems; (1) food, (2) income, and (3) trade problems. Asian agriculture has solved the food problem by the GR and significantly reduced the income problem by increasing the non-farm income of farm households. Richer countries of Asia have been facing and emerging Asian countries are about to face the third problem, i.e., trade deficits in agriculture due to the loss in comparative advantage. The third problem is likely to be unique to Asia (possibly to SSA as well in future), which is characterized by meager endowments of land relative to labor. Massive imports of food grains are not much of a problem, if it is a result of free market forces assisted by the prudent agricultural policies. The fact is the unfavorable endowment of land has been aggravated by agricultural protection in rich countries in Asia, which prevent farm size expansion from taking place to a significant extent.

I hereby argue strongly that the optimum farm size increases as the economy develops and wage rates increase. In most developing countries in Asia where wage rates are relatively low, the optimum farm size seems small. In all likelihood, however,

the optimum farm size increases sharply as wage rates increase rapidly. The critical land tenure issue then becomes 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 the market distortions created by government policies.

Judging from the fact that high-wage advanced economies such as the U.S. 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 for by capital and land, when they are 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 would imply that as the wage rate increases, these countries are likely to lose the comparative advantage in agriculture. The extent of loss of the comparative advantage, however, will depend on the pace of the farm size expansion. If the farm size does not expand sufficiently fast, as in the case of Japan, the comparative advantage in agriculture will be lost more seriously, 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 ought to have serious implications for climate change.

I would like to point out that what would happen to world food security depends critically on the net effect of the loss of comparative advantages in agriculture in land-poor countries and its gain in land-rich countries. In order to achieve food security and prevent the excessively negative impacts of climate change on a global scale, Asian agriculture must pursue more efficient development paths, however painful the adjustment of farm size expansion may be in the short to medium term. At the same time, I am hopeful that Latin American countries will further improve the agricultural productivity so as to keep the food demand-supply balance in the world.

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Table 1. Changes in Grain Self-Sufficiency Ratio in Selected Countries in Asia[a]

	South Asia		Southeast Asia			Northeast Asia			
	Bangladesh	India	Indonesia	Philippines	Thailand	China	Japan	Korea	Taiwan
1961	92.8	92.8	89.7	87.5	140.6	93.2	69.3	90.8	128.9
1971	89.6	96.7	96.2	84.0	142.5	97.8	45.0	69.4	109.7
1981	93.9	100.3	92.0	89.7	155.5	92.3	29.2	50.0	79.0
1991	92.2	100.9	91.6	87.8	141.8	96.5	25.4	37.1	66.2
2001	89.9	103.0	88.3	75.1	137.9	95.7	24.4	30.4	60.2
2008	93.5	103.0	90.5	80.5	134.0	90.7	24.7	26.2	59.3

[a] Grain here refers to rice, wheat, maize, and soybean. The Korean case includes coarse grains, and the Taiwan case includes cereals and pulses.

Source: *FAOSTAT* data

Table 2. Changes and Differences in Real Rural Household Income per Capita (PPP US$) and its Compositions (%) in Selected Areas of Asia

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

Notes:

1. The Philippines: High potential agricultural areas are irrigated villages and marginal areas are drought-prone rainfed villages in Iloilo Province in 1985.

2. Thailand: High potential agricultural areas are irrigated villages in Central Plain and marginal areas are drought-prone rain-fed villages in Northeast in 1987.

3. Bangladesh: High potential agricultural areas are irrigated villages and marginal areas are drought-prone rainfed villages in 1988.

4. Tamil Nadu (India): High potential agricultural areas are canal or well irrigated districts and marginal areas are rainfed/tank irrigated districts in 1986-87.

Source: Authors' compilation.

Table 3. Distribution of Operational Farm Size in Selected Countries in Asia

Country	Year of survey	Average operational farm size (ha)	Percentage of farms and farmland[a]			
			Below 1 ha		Above 10 ha	
			Farms	Area	Farms	Area
Bangladesh	1976/77	1.4	49.7	28.8	n.a.[b]	n.a.[b]
	1996	0.5	86.7	42.7	0.1	1.7
	2005	0.3	n.a.	n.a.	n.a.	n.a.
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	61.6	17.2	1.2	14.8
	2001/03	1.3	62.9	18.7	1.0	13.2
Indonesia	1973	1.0	70.4	30.0	5.9	10.3
	1993	0.9	70.8	29.8	0.2	3.4
	2003	0.8	74.8	n.a.	n.a.	n.a.
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.

[a] Since farm size classes differ from country to country, interpolations were made.

[b] "n.a." means not available.

[c] Farm size above 3 ha.

Sources: (1) Bangladesh, *Report on the Agricultural Census of Bangladesh, 1977; 1978 Land Occupancy Survey of Bangladesh; Census of Agriculture 1996*. (2) India, *National Sample Survey, No. 215, 26th Round, 1971-72; All India Report on Agricultural Census 1980/71; Agricultural Census 1990-91*. (3) Indonesia, *1973 Agricultural Census*; *1993 Agricultural Census*. (4) Philippines, *1971 Census of Agriculture; 1991 Census of Agriculture*. (5) Thailand, *1978 Agricultural Census Report*; *1993 Agricultural Census*.

Table 4. Percentage Distribution of Farms by Size of Cultivated Area (ha) in Japan: 1940, 1960, 1980 and 2005

	Less than 0.5	0.5-1.0	1.0-3.0	3.0-5.0	Larger than 5.0	Average size (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.

Table 5. Comparison of Revenue and Production Costs per Hectare of Rice Production by Size of Cultivated Area (ha) in Japan: 1960, 1975, 1988 and 2008 (average=100)

	Less than 0.5	0.5-1.0	1.0-3.0	Larger than 3.0	Larger than 5.0	Average size
1960						
Revenue	98	97	103	104	n.a.	100
Labor costs	111	105	96	88	n.a.	100
Machinery cost	86	97	106	96	n.a.	100
Total cost	105	102	99	94	n.a.	100
1975						
Revenue	96	97	103	96	91	100
Labor costs	133	114	90	72	67	100
Machinery cost	105	108	99	84	85	100
Total cost	125	109	94	81	80	100
1988						
Revenue	99	99	103	105	91	100
Labor costs	138	114	87	69	63	100
Machinery cost	123	113	92	74	68	100
Total cost	131	111	89	75	69	100
2008						
Revenue	98	97	98	104	101	100
Labor costs	165	127	99	79	67	100
Machinery cost	137	143	94	88	66	100
Total cost	152	132	96	80	71	100

Note: “n.a.” means not available.

Source: Ministry of Agriculture, Forestry and Fisheries (Japan), *Survey of Rice Production Costs*, various issues.

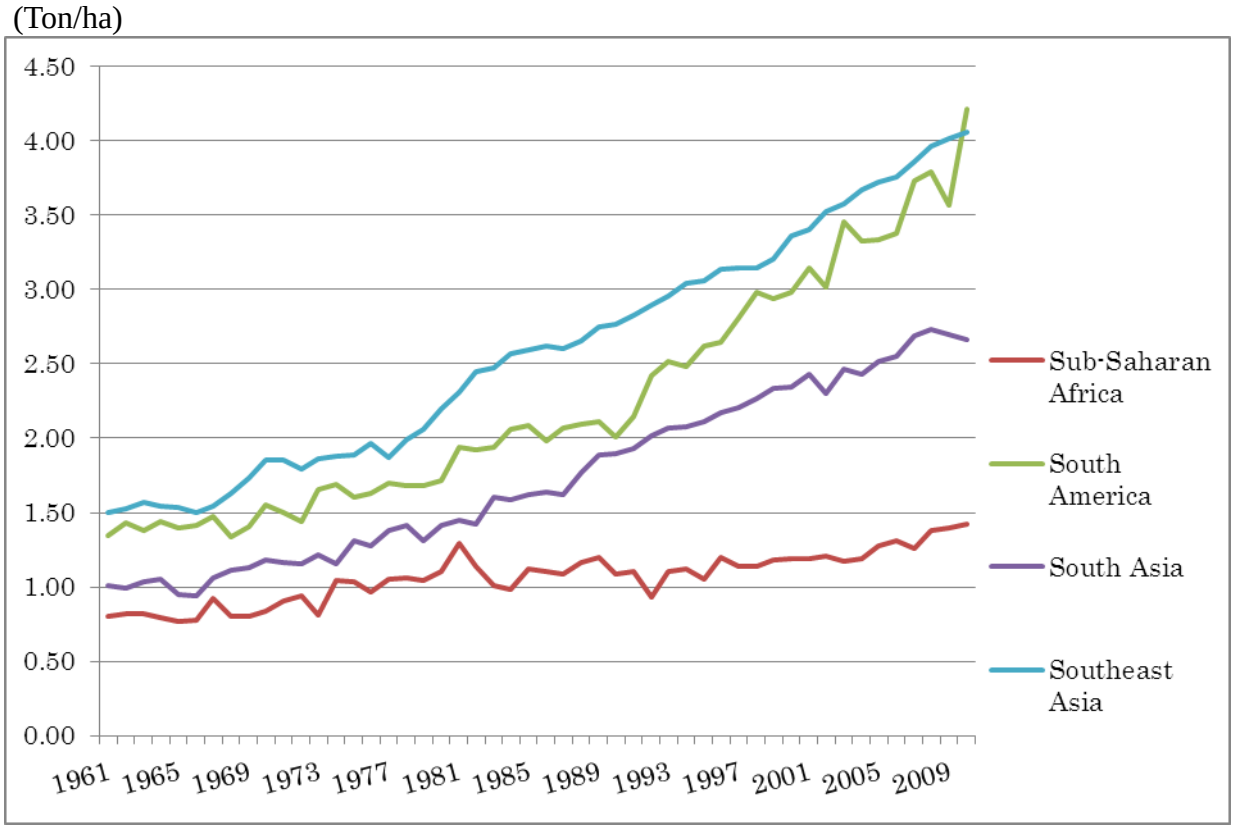
Table 6. Determinants of Food Self-Sufficiency Ratio by Major Region, 1980-2010

	(1)	(2)	(3)	(4)	(5)	(6)
	Asia		Africa		Latin America	
Ln GDP p.c., PPP adjusted	0.454**	0.225**	-0.232	-0.650**	0.134	0.731
	(4.76)	(2.42)	(-1.28)	(-3.84)	(0.08)	(0.46)
Square of (Ln GDP p.c., PPP adjusted)	-0.033**	-0.020**	0.0170	0.043**	-0.030	-0.0572
	(-5.43)	(-3.36)	(1.36)	(3.68)	(-0.34)	(-0.64)
Ln GDP p.c., PPP adjusted*landholdings p.c. in 1980	-0.051**	-0.015	-0.0369	-0.031	0.086**	0.067
	(-3.37)	(-1.00)	(-1.18)	(-1.18)	(2.10)	(1.09)
Ln yield per ha		0.057*		0.209**		0.069
		(1.90)		(13.36)		(0.32)
Square of (Ln yield per ha)		0.089**		0.0220*		0.162
		(3.81)		(2.27)		(1.09)

Ln population density (over arable land)		-0.108**		-0.241**		-0.499**
		(-3.67)		(-6.75)		(-5.88)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	638	638	623	623	588	560

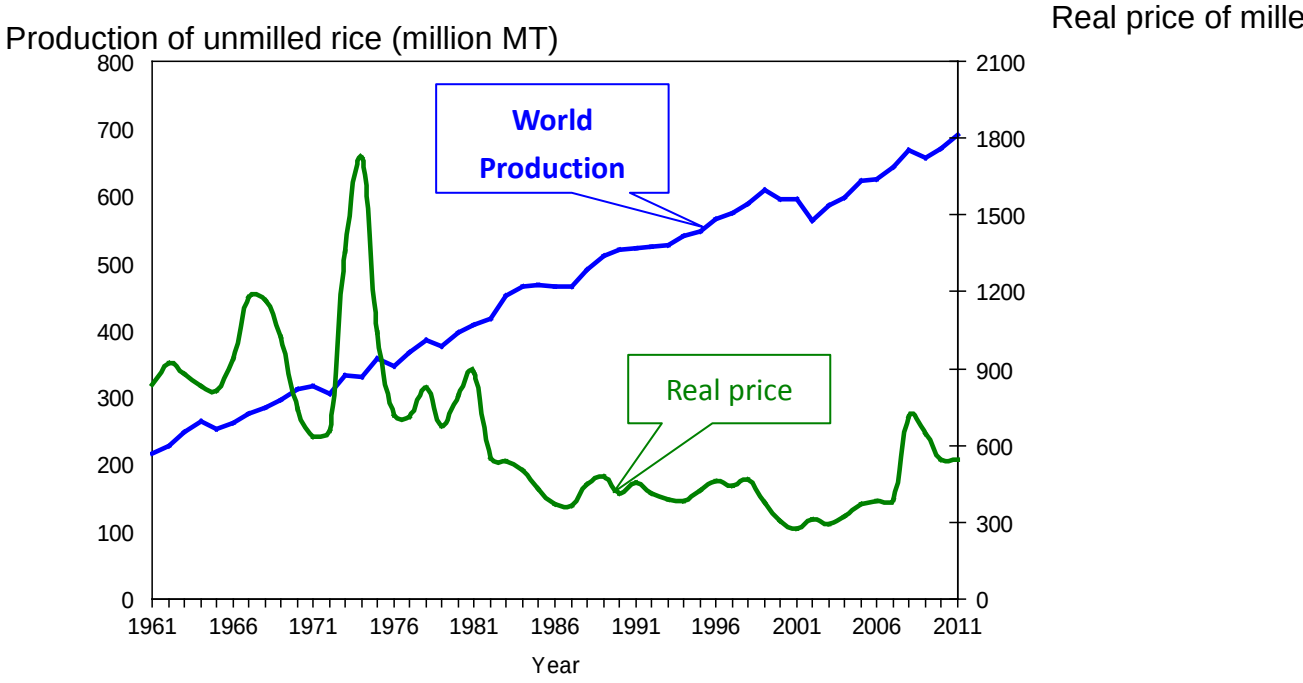
Numbers in parentheses are *t*-statistics. ** and * indicate significance at 1% and 5% levels, respectively.

Figure 1. Changes in Average Cereal Yields by Major Region



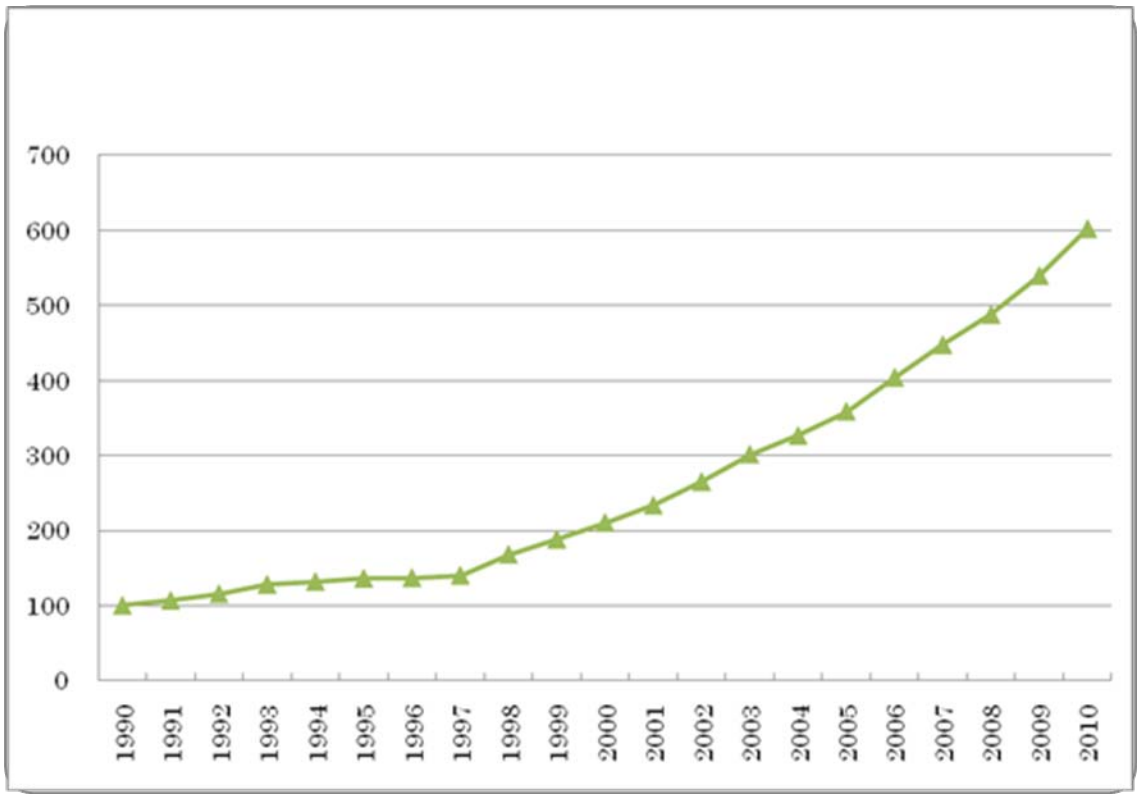
Source: Author's calculation using FAOSTAT data

Figure 2. Trends in World Rice Production and Real Rice Price, 1961-2011



Source: Production: PSD online, USDA: 21June2012
Rice Price: Relate to Thai rice 5%-broken deflated by G-15 MUV Index deflator (adjusted based on April 16, 2010 data update)
Source of data: http://www.worldbank.org

Figure 3. Changes in the Real Wage Index in the Manufacturing Sector in China (1990=100)



Source: *CEIC China Premium Database*.

Figure 4. Changes in Domestic Production and Imports of Maize and Soybean in China (semi-log scale)

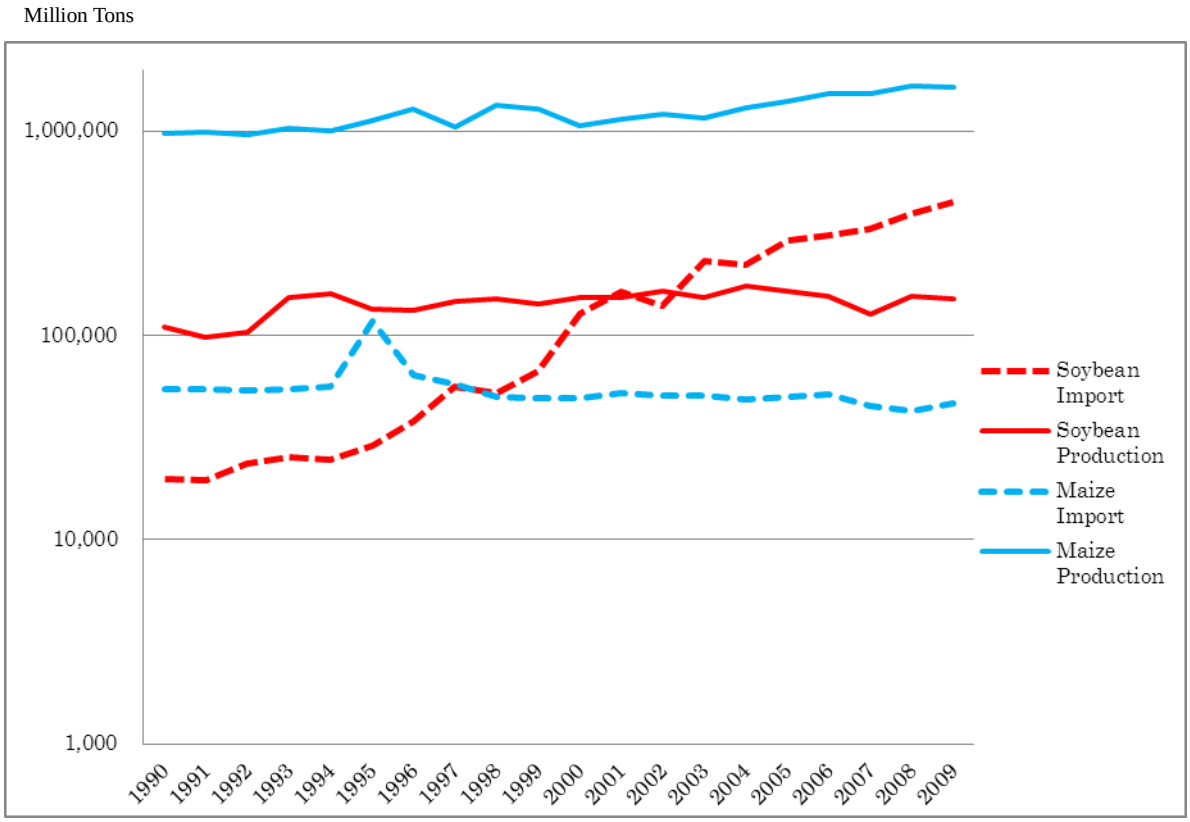


Figure 5. Changes in domestic production and imports of Maize and Soybean in Japan (semi-log scale)

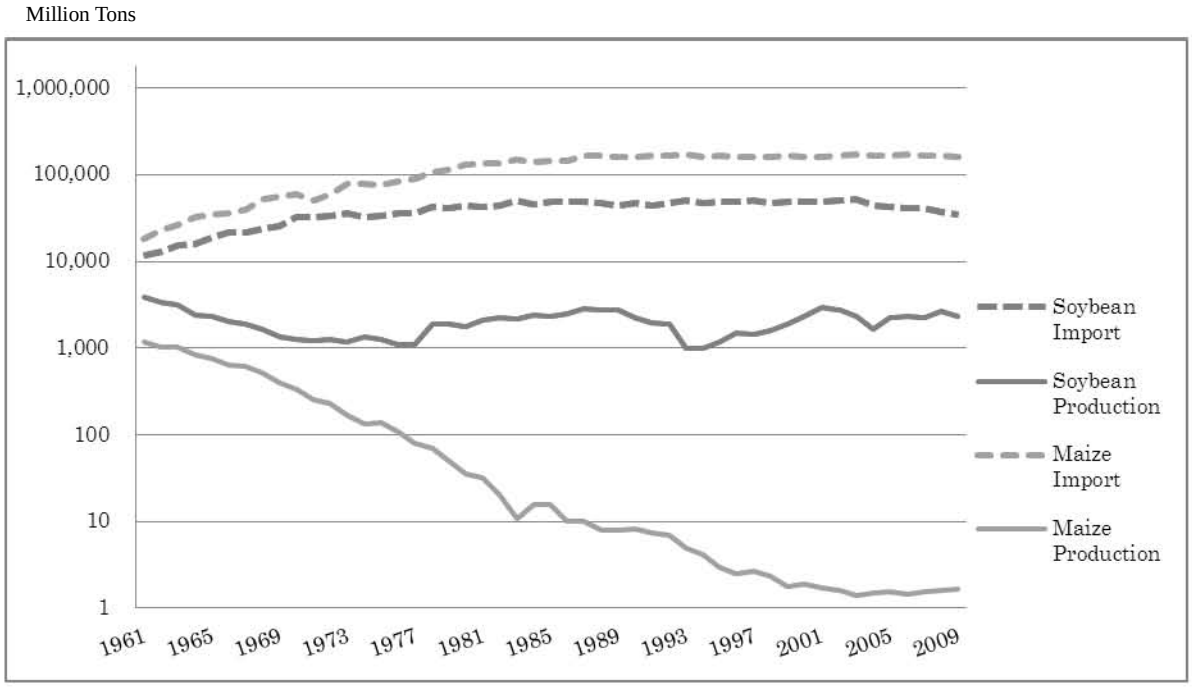
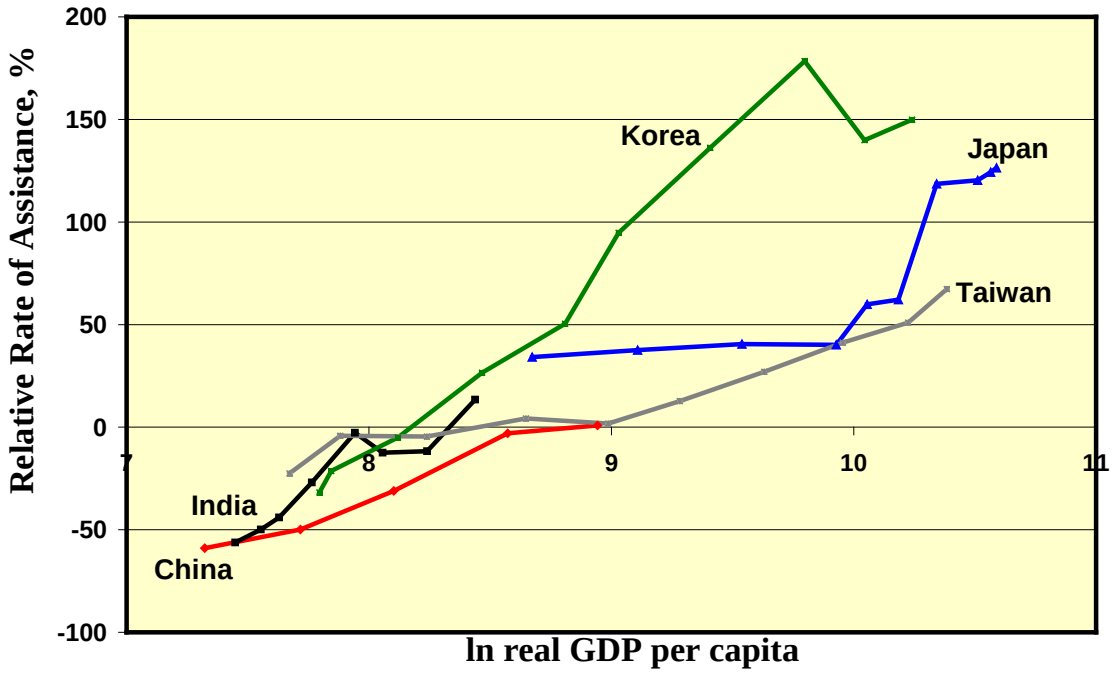
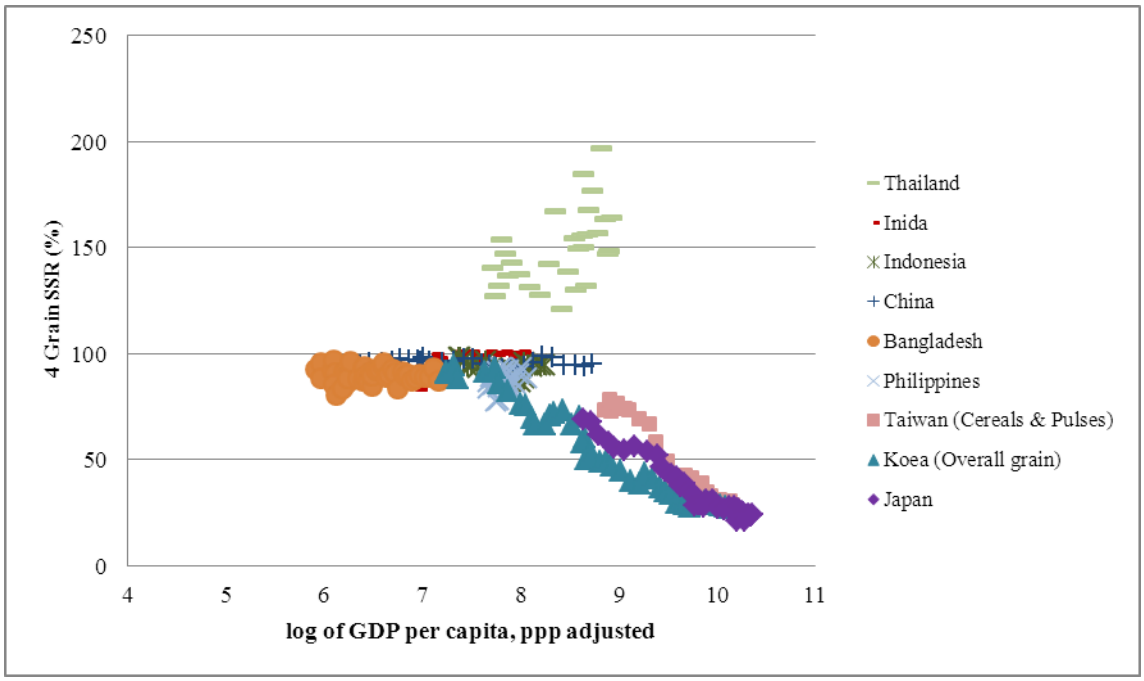


Figure 6. Relative Rate of Assistance to Agriculture and Log of Real Per Capita GDP in India, China, Japan, Korea, and Taiwan, 1995 to 2005



Source: Anderson (2011)

Figure 7. Changes in Self-Sufficiency of Grains and Real GDP per capita in Asian Countries



Source: Korea data - *Annual Yearbook*; Taiwan - *Annual Yearbook, COA data*.