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—The Indian Experience and Its Implications for Sub-Saharan Africa—

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The Green Revolution and Its Significance for Economic Development: The Indian Experience and Its Implications for Sub-Saharan Africa

Koichi Fujita*

Abstract

India has experienced rapid economic growth, especially since the full scale economic liberalization of the early 1990s. The emphasis in this paper, however, is the critical importance of the preceding decade, when the Indian agriculture sector was registering a high growth rate. India attained food self-sufficiency by the end of the 1970s by virtue of the first wave of the Green Revolution, but it was the second wave that contributed significantly to increased rural incomes and consequently to the economic development of the country overall. During the 1980s, this second wave washed over the whole of India, buoying a large number of individual crops, including rice. The improvement it brought in rural incomes led to an expansion of the market for non-agricultural products and services, bringing in turn rapid development of the non-agricultural sector. The 1980s also was a critical decade in which a wide divergence opened between the prospects for economic development in South Asia and sub-Saharan Africa. The main implication of this situation for sub-Saharan Africa is that improvement in rural incomes through productivity growth in agriculture is essential for the success of industrialization-based economic development.

Keywords: Green Revolution, development strategy, India, sub-Saharan Africa

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Introduction

India, as one of the so-called BRICs, has experienced rapid economic development and growth in recent years, especially since the full scale liberalization of its economy in the early 1990s. There can be no doubt that the series of economic deregulation and liberalization policies introduced after 1991 *did* contribute to the acceleration of growth in the country. This paper, however, focuses particularly on the role of Indian agricultural growth in the overall economic development process.

There are powerful arguments that modern, industry-based economic growth should be preceded by growth in the agricultural sector. New agricultural technology generates production linkages (Johnson and Killby, 1975), including backward linkages in terms of agricultural inputs and services and forward linkages through agro-processing and distribution of produce. Furthermore, increases in farm income due to new agricultural technologies create consumption linkages via increased demand for non-agricultural goods and services (Mellor and Lele, 1973). In a seminal work on the South Korean economy, Adelman (1984) completely reversed the 'industry first' paradigm of the 1950s, finding that agriculture-led industrialization generated growth and equity superior to a pure industrialization strategy. Through growth linkages, agriculture is an important engine of economic growth in developing countries.

The emphasis in this paper, as presented in detail below, is that the existence of a domestic market for non-agricultural products and services is an important pre-requisite for successful industrialization. As demonstrated by the impact of the Green Revolution, agricultural development through productivity growth can raise rural incomes and alleviate rural poverty. Since in the early stages of economic development most of the population depend for their livelihoods on agriculture and related activities, agricultural growth will have a significant impact on national income. Agricultural development through a Green Revolution, therefore, can contribute to overall economic development by raising rural incomes and creating a vast market in rural areas for non-agricultural products and services, thereby

stimulating industrialization.

The Green Revolution in India started in the late 1960s. This was the first wave, and its success allowed India to attain food self-sufficiency by the end of the 1970s. However, in this first wave the application of new technologies, consisting mainly of high-yielding varieties (HYVs), was confined to the wheat crop[1] in the northwest -- including Punjab, Haryana and western Uttar Pradesh -- and in a small part of the deltaic region of peninsular India. The first wave failed to raise incomes more broadly across the country's regions. The second Green Revolution wave reached India in the 1980s. It involved a range of crops, including rice and coarse cereals such as maize, *jowar* (sorghum) and *bajra* (pearl millet). The latter are important staple foods in some parts of central, western and southern India. The second Green Revolution wave covered a large percentage of the country, and as a result contributed to improving rural incomes, alleviating rural poverty across the country, and fostering India's economic development.

This paper is structured as follows. In Section 1 the process of agricultural development in India after its 1947 independence is traced, including a detailed delineation of the first and second Green Revolution waves and their impacts. In Section 2 the role of the Green Revolution in India's economic development is summarized and lessons for contemporary sub-Saharan Africa are discussed taking into consideration similarities and differences between the two regions. Finally, the paper's argument is summarized and concluded.

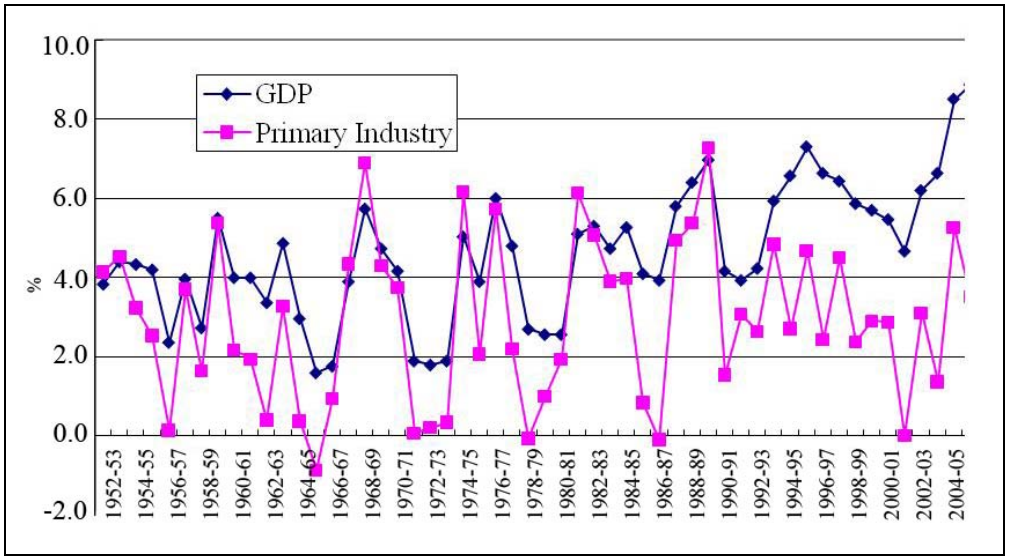
1. The Green Revolution in India

Before focusing on agricultural development in India, it is useful to look briefly at the overall process of India's economic development from independence in 1947 until recent years.

[1] HYVs initially started with wheat and extended to rice during the 1970s in some regions, though the impact was much smaller on rice compared to wheat.

Figure 1 displays the country's economic growth rates. Three-year moving averages computed from annual growth rate data are used in order to eliminate year to year fluctuations.

Figure 1. Economic growth rates in India (three year moving averages)



Note: Primary industry includes mining and quarrying in addition to agriculture, forestry and fisheries. The share of mining and quarrying is unknown but minor.
Source: Government of India, *Economic Survey*, various issues.

The figure shows that India suffered low rates of economic growth (particularly as compared to the East Asian NIEs) of around 3.5 percent per annum until the late 1970s, with large fluctuations due to the influence of agriculture which is greatly affected by seasonal monsoons. The Indian economy subsequently improved in the 1980s, a result mainly of the partial liberalization policy of the Rajiv Gandhi regime and relatively high growth in agriculture. Finally, after 1991 when full-scale economic liberalization was introduced, the growth rate of the Indian economy accelerated to a much higher level, generally exceeding 6 per cent, and even 8 per cent from the mid-2000s until recently. It is significant that agricultural growth clearly began to lag GDP growth, particularly from the mid-1990s.

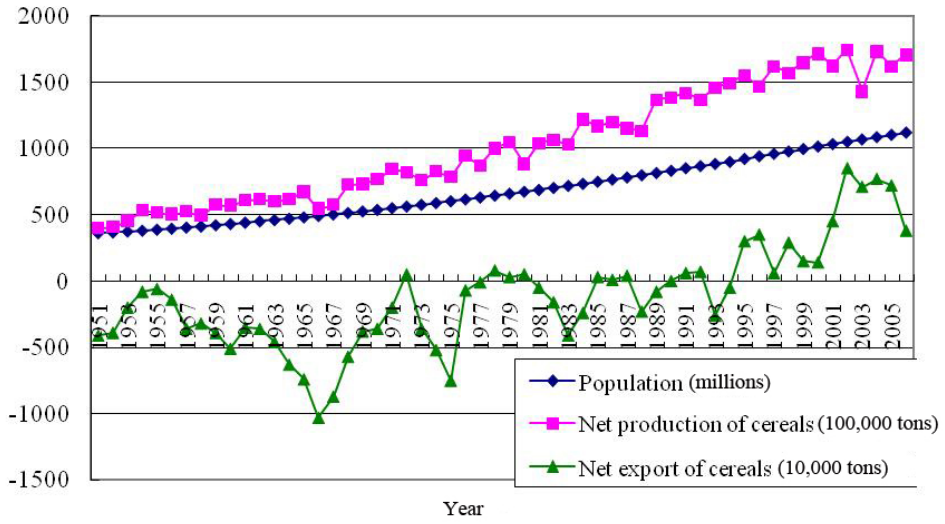
This indicates that during and after the decade of 1990s the Indian economy was entering a new development phase, one in which a widening disparity between agriculture and

non-agricultural sectors (or between rural and urban sectors) would become a major problem. Subdividing the entire period into several shorter units of time allows a closer look at India's agricultural development process.

(1) From Independence to the mid-1960s

It is well known that agriculture, especially the crop sector, of British colonial India stagnated or even experienced slightly negative growth through the entire first half of the 20th century (Blyn, 1966; Kurosaki, 1999), but this pattern reversed following independence in 1947. Food grains (defined in India as cereals plus pulses) production registered a high growth rate of 4.13 percent on average during the period 1951-52 to 1960-61 (Kurosaki, 1999). Both expansion of the sown area and increase in the crop yield contributed to this growth. As shown in Figure 1, however, agricultural growth decelerated towards the mid-1960s. Agricultural policy priority was given primarily to major irrigation projects and institutional reforms, such as land reform and promotion of farmers' cooperative societies. As a Socialist country, India strongly promoted heavy industrialization, especially after the second Five Year Plan (1956-57 to 1960-61), leaving the agricultural sector relatively neglected.

Figure 2. Population movement and cereal production and trade in India



Source: Government of India, *Economic Survey*, various issues.

Two severe and consecutive droughts struck India in the mid-1960s, shattering its agricultural economy. The agricultural sector recorded substantial negative growth and India faced a serious food problem. Since the share of agriculture in GDP was still very high, at around 50 per cent, the slump in agriculture hit the economy as a whole and even affected the political regime. India was obliged to import 10 million tons of food (mainly wheat) for two years (Figure 2).

(2) From the mid-1960s to the end of the 1970s

The serious economic and political crisis which India faced in the mid-1960s triggered a complete restructuring by the government of its agricultural policy. It now emphasized technological innovation and the introduction of new agricultural technologies from abroad.

India was fortunate that the mid-1960s was the time when new seed-fertilizer technologies started to diffuse in the tropical developing world. The wheat HYVs developed at CIMMYT in Mexico (Mexican semi-dwarf wheat varieties) were found to be quite suitable for conditions in north-western India: Punjab, Haryana and western Uttar Pradesh. This was followed by the introduction of rice HYVs from IRRI. But the most important factor underlying the dissemination of the new technologies was the diffusion of private tube-wells[2].

The new seed-fertilizer technologies, especially for wheat, started to spread very rapidly in the northwest followed by rice HYVs in parts of peninsular India, Andhra Pradesh and Tamil Nadu. Within a decade or so, interrupted by some drought years, India had moved

[2] In addition to favorable climatic conditions, there were also important socio-economic conditions contributing to the rapid diffusion of new agricultural technologies in northwestern India: It was an area newly settled by medium-sized farmers following the construction of a canal irrigation network during the British colonial era; land consolidation was successfully completed in most of the area soon after independence, solving the land fragmentation problem; and, finally, and most importantly, private tube-wells which exploited groundwater were introduced for irrigation solving the problem posed by unreliable water supply from government canals. After the first Green Revolution wave, the cropping pattern was changed as follows: In the dry season (*rabi* season), HYV wheat was substituted for pulses (or the mixed cropping of pulses with local wheat). In the monsoon season (*kharif* season), HYV rice was substituted for coarse cereals such as maize, *jowar* (sorghum) and *bajra* (pearl millet), albeit this process lagged some years behind the diffusion of HYV wheat in *rabi* season.

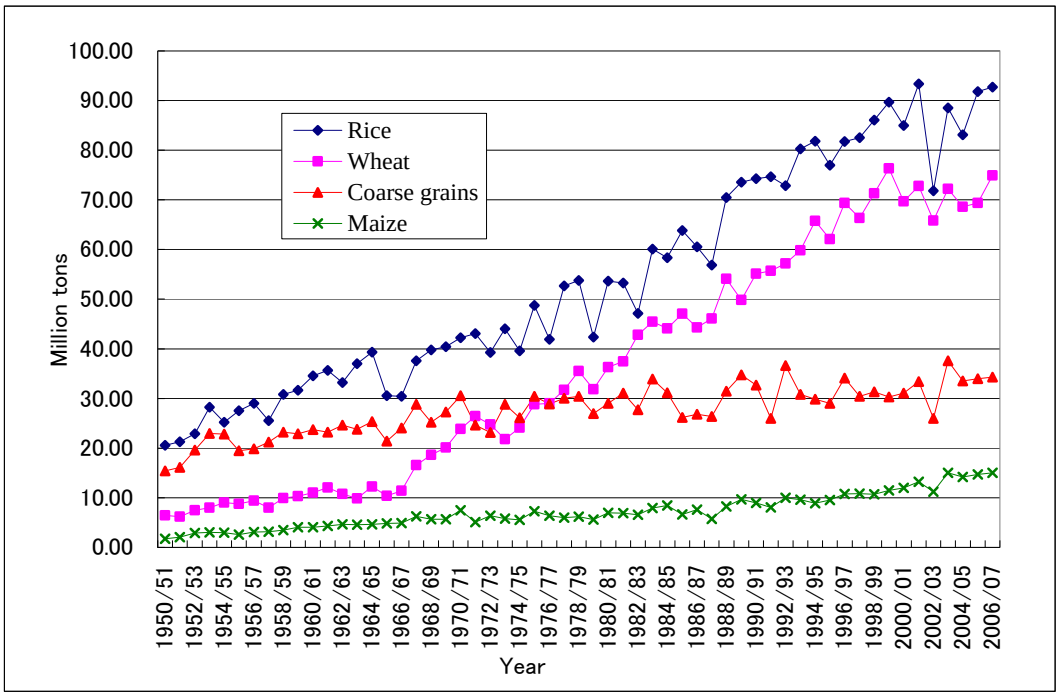
closer to food self-sufficiency (Figure 2). In this paper, this is referred to as the first wave of Green Revolution in India.

The Indian economy as a whole, however, experienced a bitter “lost decade” from the mid-1960s to the mid-1970s, mainly because of stagnation in the import-substitution industrial sectors due to the shortage of foreign exchange (Ohno, 1999). Despite the Green Revolution large quantities of food had to be imported for several years, as did chemical fertilizers and agricultural machinery. India had to pay a huge price for its neglect of agriculture during the preceding period, a typical case of the development economics “Ricardian trap” (Hayami, 1997).

There was another limitation to the first wave Green Revolution in India from the viewpoint of the country’s overall economic development. Since its diffusion was limited to wheat and to the northwest and small deltaic regions of peninsular India, the first wave could not raise rural incomes and alleviate rural poverty over a wider area. Rural India continued to be poor, except in some particular spots.

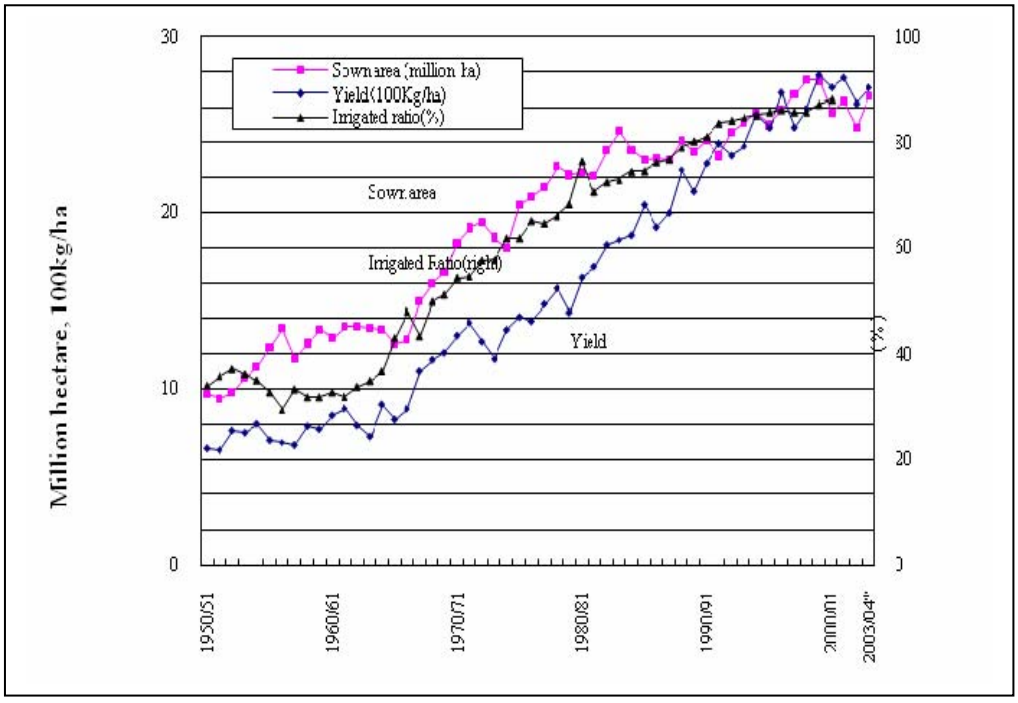
As a result of the rapid growth of wheat, which had been a minor crop at the time of independence, by the end of the 1970s wheat production exceeded that of the coarse cereals (such as *jowar* <sorghum>, *bajra* <pearl millet>, *ragi* <finger millet> and maize) (Figure 3). And because its rapid growth continued (Figure 4), wheat has now become one of two major cereals produced in India, alongside rice. In other words, the rapid and broad production substitution of wheat (and rice) for coarse cereals and pulses as a staple food resulted in a shift in food grain consumption towards wheat (and rice) not only in urban areas but also in India’s rural areas (see Figure 9 below).

Figure 3. Production trend of major cereals in India



Source: Government of India, *Economic Survey*, various issues.

Figure 4. Sown area, yield and irrigated ratio of wheat in India



Source: Government of India, *Agricultural Statistics at a Glance 2004.*

(3) The decade of the 1980s

The decade of the 1980s witnessed very favorable agricultural growth in India, including almost all regions and almost all the important crops (Table 1). The rapid increase of rice production during the 1980s (Figure 5) was fundamental to the economic development of hitherto poverty-stricken rural areas.

As mentioned above, the most important factor supporting this rapid agricultural growth was the widespread diffusion of private tube-wells, especially small-scale shallow tube-wells. Shallow tube-wells, equipped with 5.0-7.5 horsepower diesel or electric engines, can pump groundwater from 25-45 meters below the surface and can irrigate a maximum of 15-25 acres; deep tube-wells can pump groundwater from 50-90 meters below the surface and can irrigate a maximum of 60-80 acres (Fujita, 1990). Shallow tube-wells, which are much cheaper than deep tube-wells, were introduced in India by individual farmers whereas deep tube-wells usually were installed by the public sector, such as state governments (Fujita et al, 2003). The diffusion of tube-wells in rain-fed areas (or areas unreliably irrigated by government canals) enabled farmers to grow HYV wheat instead of *rabi* crops, such as pulses, in the dry season (*rabi* season) and to improve the rice yield substantially by switching from traditional to modern varieties (HYVs) in the monsoon season (*kharif* season). Thus a highly productive double cropping system of HYV rice and HYV wheat was established over broad rural areas, especially in the Indo-Gangetic Basin. Furthermore, in some places with plentiful rainfall, such as West Bengal[3], double cropping of HYV rice became predominant.

[3] Double cropping of HYV rice (*aman* in *kharif* season and *boro* in *rabi* season) was widely expanded in neighboring Bangladesh as well.

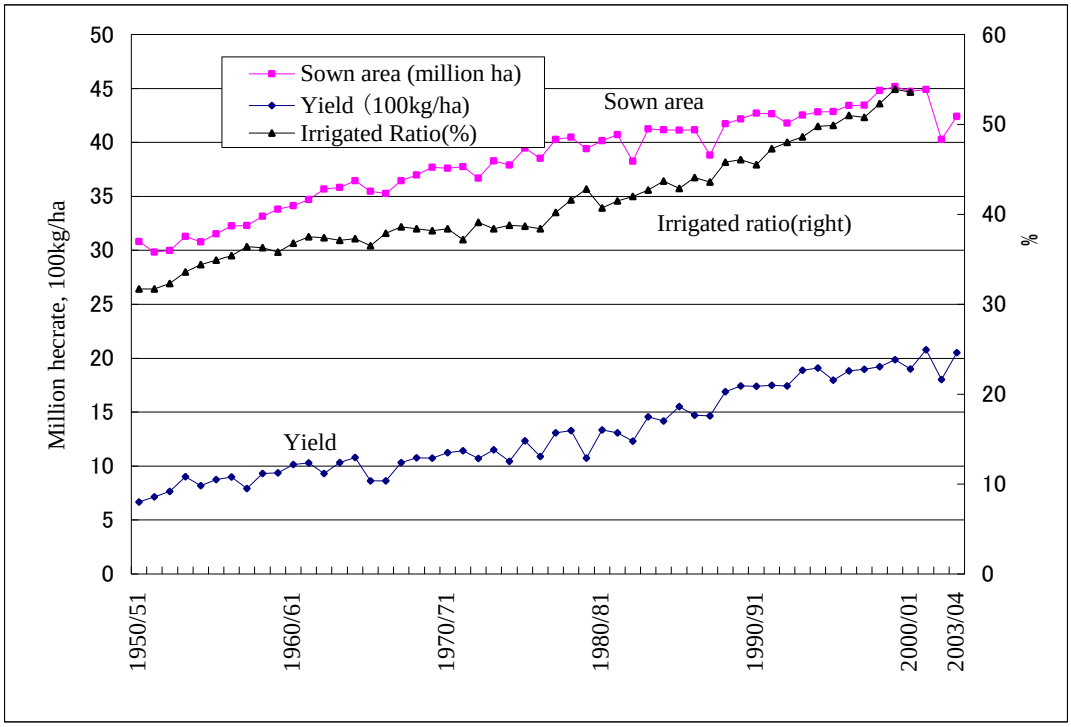
Table 1. Growth rate of crop production in India

	1950-60	1960-70	1970-80	1980-90	1990-96
Rice	4.53	2.12	1.73	4.08	1.60
Wheat	5.79	7.73	4.15	4.29	3.64
Coarse grains	3.76	1.67	0.55	0.71	-0.99
Maize	7.84	3.90	0.64	3.20	1.30
Total Cereals	4.45	3.10	2.07	3.38	1.81
Pulses	3.80	-0.47	-1.18	2.45	-0.07
Total Foodgrains	4.35	2.63	1.76	3.31	1.66
Oilseeds	3.05	2.41	1.34	6.01	4.16
Sugarcane	5.62	2.54	2.27	4.38	3.72
Cotton	4.54	2.03	2.69	3.23	4.51
Jute/Mesta	5.60	0.32	2.13	1.28	2.18

Note: First the annual growth rate was calculated, then the three year moving average for each year. Figures in the table are the averages for each decade. (Also note that 1980-90 means 1980/81-1989/90… and so on.)

Source: Government of India, *Agricultural Statistics at a Glance 1997.*

Figure 5. Sown area, yield and irrigated ratio of rice in India



Note: Yield of rice is in terms of milled rice.

Source: Government of India, *Agricultural Statistics at a Glance 2004.*

There is an interesting debate ongoing among Indian economists regarding the reasons why new agricultural technologies were not accepted for so long in eastern India, in sharp contrast with the northwest and some other parts of the country. Some Marxist economists attribute this to a ”semi-feudal mode of production” characterized by an extremely unequal agrarian structure with a small number of big, wealthy landlords dominating a large number of indebted, poor sharecroppers (Bhaduri, 1973). This argument, however, has been refuted theoretically by Newberry (1974) and empirically by Bardhan and Rudra (1978).

An investigation of the factors which critically determined the diffusion of new seed-fertilizer technologies clearly indicates that the key factor was the private tube-wells. The basic question remains then, why was the introduction of private tube-wells delayed in eastern India until the 1980s. One answer may be that there was a shortage of capital to purchase the wells due to the dominance in eastern India generally of small-scale poor farmers with fragmented land parcels. After the 1980s, the real cost of tube-wells declined to the extent that even the poor farmers in the east could now purchase them. Another factor seems to have been the delay in the rural electrification of eastern India. The cost of irrigating by diesel-driven tube-wells is much higher than the cost by electric ones[4].

On the other hand, often the extreme land fragmentation in eastern India and the lack of a successful land consolidation program were attributed to the delay in tube-well introduction (Bardhan, 1984). The experience in eastern India after the 1980s suggests, however, that this hypothesis is incorrect; tube-wells *did* diffuse rapidly, even under the land fragmentation conditions, because a water market emerged and developed widely[5].

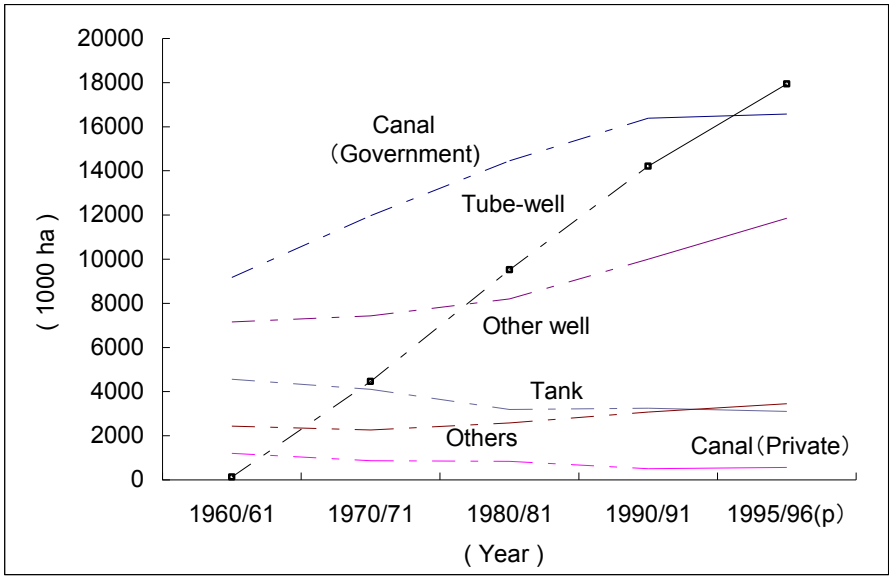
In sum, rural India witnessed widespread agricultural development in the 1980s, mainly due to the diffusion of private tube-wells (Figure 6). As a result of this diffusion the production of rice, the main staple food in eastern and southern India, increased rapidly and contributed to higher

[4] However, even in a situation of no rural electrification during the 1980s, tube-wells were rapidly diffused in rural Bangladesh (Fujita, 2010).

[5] See, for example, Kahnert and Levine (1993), Pant (1992), Fujita, Kundu and Jaim (2003). See also Fujita (2010) regarding Bangladesh.

rural incomes and lower poverty[6].

Figure 6. Net irrigated area by source of irrigation in India



Source: 1960/61, 1970/71, 1980/81, 1990/91: Central Water Commission, *Water and Related Statistics 1994*, p.81 1995/96: Fertilizer Association of India, *Fertilizer statistics 1998/99*.

In many Indian regions, agricultural growth during the 1980s was accompanied by a substantial increase in labor productivity[7] (Bhalla and Singh, 1997). Consequently, along with an increase in off-farm job opportunities in the rural areas, agricultural wages started to rise (Lanjouw, 2004; Yanagisawa, 2008). In fact, as shown in Table 2, from 1977/78 to 1987/88 agricultural wages in India grew by 47 per cent for male workers and 37 per cent for female workers in real terms. Accordingly, National Sample Survey (NSS) data show that the poverty situation in India improved sharply after the mid-1970s; the poverty head count ratio declined from more than 55 per cent in 1973-74 to 35 per cent in 1989-90 (World Bank, 2000).

[6] In the coarse cereals production regions (mainly central India), as farmers faced decreased demand, they substituted more remunerable oil seed crops for coarse cereals, which contributed to higher rural incomes in this region as well. The increase of oil seed crop production continued until the mid-1990s. See Sugimoto and Usami (2004).

[7] The increase in labor productivity during the 1980s was, it may be supposed, attained by an increase in land productivity, with the land-labor ratio remaining at almost the same level, rather than by the introduction of labor saving technologies.

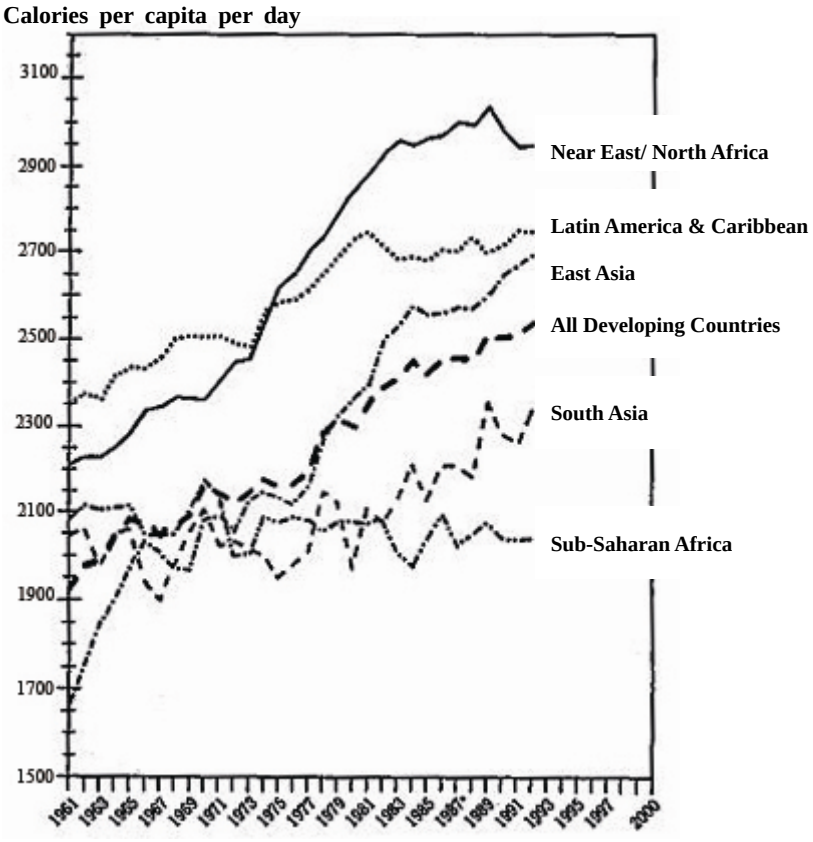
Table 2. Rural Real Wages in India (Rs/day)

	Agriculture		Non-farm	
	Male	Female	Male	Female
1977/78	3.81	2.69	5.26	2.83
1987/88	5.59	3.69	7.82	4.53
1993/94	6.26	4.38	8.74	5.37

Souce: Bhalla and Singh (1977)

If we look at per capita caloric intake (FAO, 1995), South Asia and sub-Saharan Africa were at almost the same level of about 2100 calorie/day until the late 1970s. By the end of the 1980s, however, the level in South Asia had improved to 2300 calorie/day whereas in sub-Saharan Africa it remained constant (Figure 7). The decade of 1980s was the critical period for significant divergence in the economic development of South Asia and sub-Saharan Africa.

Figure 7. Per capita caloric intake of developing regions



Source: FAO, 1995.

With regard to the impact of higher agricultural growth on the demand for non-agricultural goods and services, I-O analysis-based research by Sastri et al. (2003) estimates the coefficient of increased demand for manufactured goods induced by one unit increase of agricultural production. The coefficient was only 0.087 in 1968-69, but in 1993-94 it had increased to 0.297. In other words, by the mid-1990s the demand for manufactured goods had become much more sensitive to agricultural growth as compared to the late-1960s even though the GDP share of agriculture declined continuously over the same period.

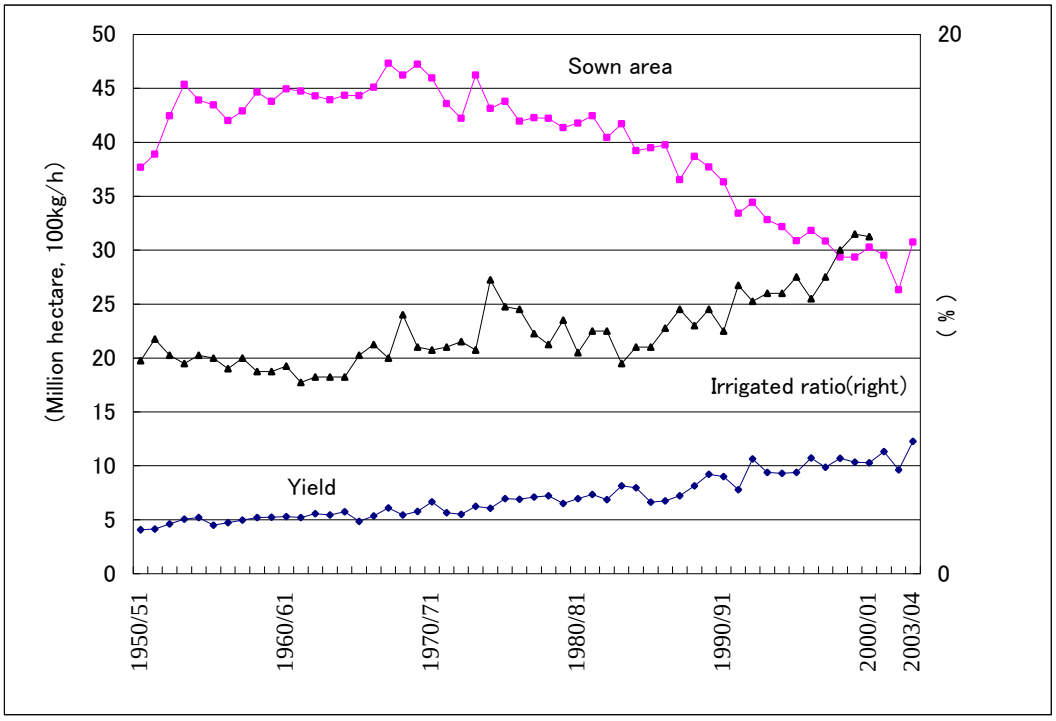
Additional evidence supporting this hypothesis is found in a series of market surveys conducted between the mid-1980s and the mid-1990s by the Indian Council of Applied Economic Research (ICAER). Yanagisawa analyzed the results of these surveys and concluded the following: 1) After the 1980s more than half of consumer durables were owned by rural households and the rural market for consumer durables expanded faster than the urban market. 2) The consumer durables were at first cheap products such as bicycles, radios and watches, but gradually transitioned to more expensive ones like TVs, electric fans, and motorbikes. 3) This phenomenon can be explained by the increase in incomes in rural areas, especially among the lower income groups, since during the 1980s income distribution improved more rapidly in rural areas than in urban areas. 4) Those who expanded their purchase of consumer durables the most were people who belong to the lower income groups in rural areas. 5) They were not university graduates. 6) Their purchase of consumer durables apparently exceeded the increase in their incomes (Yanagisawa, 2008).

Lastly, it should be noted that yield increase was observed not only in rice and wheat but also in coarse cereals. According to Figure 8, during the 1970s the average yield of coarse cereals hovered around 650 kg, but by 1989-90 it had increased to 920 kg and in recent years to more than 1200 kg. Areas sown with coarse cereals began a rapid decline after the early 1970s due to decreased demand for direct human consumption[8]. As indicated in Figure 9, the

[8] As mentioned, in an earlier footnote, income could be increased in the coarse cereals production areas

demand for human consumption has become minimal except for some particular areas (mainly rural and urban Karnataka, rural Maharashtra, rural Gujarat and rural Rajasthan). At present, however, there is increasing demand for animal feed, especially for maize and *jowar* (sorghum).

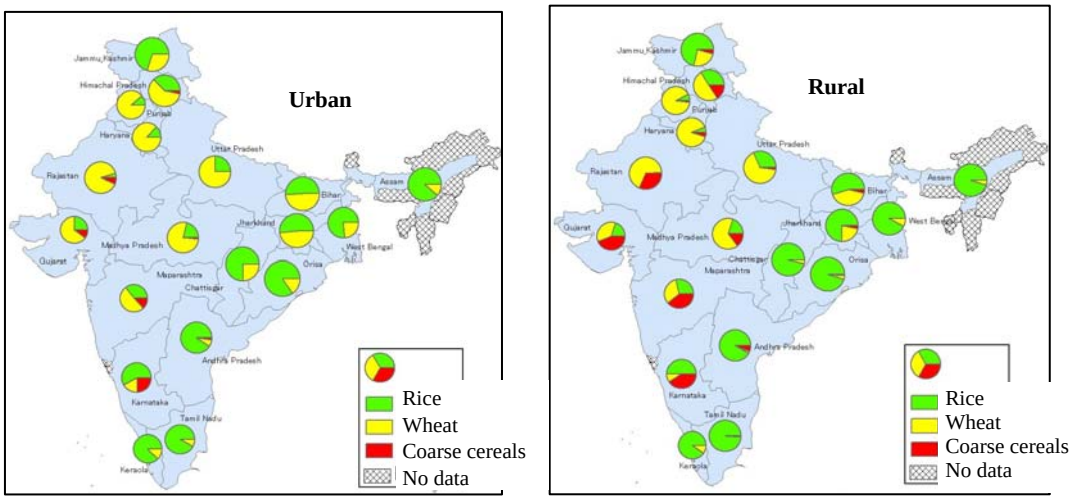
Figure 8. Sown area, yield and irrigated ratio of coarse cereal production in India



Source:. Government of India, *Agricultural Statistics at a Glance 2004.*

by switching to oil seed crop production.

Figure 9. Per capita consumption of cereals and its composition in India



Source: National Sample Survey Organization, 2006.

(4) After the 1990s

The Indian economy went into a new developmental phase after the early 1990s. The critical period of preparation for full-scale development of non-agricultural sectors was completed by the end of 1980s with the achievement nation-wide of agricultural development. Since the trend of per capita consumption of foodgrains (rice and wheat) has been declining, the growth rate in agriculture will not be high even if, as is expected, demand for higher value-added commodities such as livestock products, vegetable, fruits and flowers increases in the near term. This means that the disparity between the agricultural and non-agricultural sectors will become a serious problem for the economy.

A few of the key facts and challenges facing Indian agriculture during and after the 1990s are briefly noted here:

1) After 1990, the agricultural growth rate declined to 2.5 per cent on average. “Fatigue” in the agricultural and rural economy is becoming a serious social problem, in contrast to rapid growth in urban areas. Although the government set an agricultural growth target of 4 per cent, after the mid-1990s the actual rate decelerated to below 2 per cent (Chand et.

al., 2007).

2) Because of the declining per capita consumption of cereals (especially rice) and the failure of food management policy[9], since the mid-1990s India has become a major exporter of rice (very recently wheat, as well) (Figure 2), particularly to Bangladesh and sub-Saharan Africa. Due to the excess buffer stock accumulation, the Indian government was forced to export rice at a price lower than the domestic market price. The two periods of extremely excessive stock accumulations -- in the mid-1990s and at the beginning of the 2000s -- coincided with the two peak rice-export periods.

3) Subsidies for agricultural inputs such as chemical fertilizers, irrigation (canal) and electricity (for electric pump sets such as tube-wells) have been rapidly increased since the 1980s. Agricultural subsidies now constitute serious fiscal burdens for both the central and state governments. The subsidies mainly benefit advanced agricultural areas and wealthy farmers while public investment for disadvantaged rural areas is being neglected, a situation which perpetuates the disparity between more and less advanced areas.

2. The Indian Experience and Its Implications for Sub-Saharan Africa

(1) The Role of the Green Revolutions in Economic Development

The most important lesson to be learned from the Indian experience is that agricultural growth should precede modern economic growth based on industrialization. The reasons are as follows.

In the early stages of economic development, a large portion of a population depends for its livelihood on agriculture and associated activities. These people have low incomes and the share of their household expenditures going to food and beverages (Engel's coefficient) is

[9] The Indian government created a system of procurement and distribution, mainly of rice and wheat, during the mid-1960s and has maintained the system until the present, though there have been several modification. After 1991 the government rapidly and for several years raised the minimum support price (MSP) for procurement and the central issue price (CIP) for distribution, eventually resulting in an accumulation of foodgrain stocks (especially rice) such that the government was obliged to sell the excess at very low prices to private traders for export.

usually very high, around 70 percent. In such a situation, even if the government tries to promote industrialization (especially heavy industrialization) while neglecting agriculture, it is unlikely to succeed due to of the lack of a domestic market for non-agricultural sector products. Nonetheless, since in the early stages of development it is difficult to secure external markets for industrial products, it is still more feasible for entrepreneurs to focus on the domestic market with which they are familiar before attempting to enter an unknown export market. Thus, the existence of a domestic market for domestic products and services is essential when promoting industrialization. The key is to raise incomes and reduce poverty among people in the vast rural areas where the majority live during the early development stage. To accomplish this objective, the development of agriculture, especially the staple food sector, should come first because most rural dwellers depend on it for their livelihoods. If increased income is the key objective, then agricultural growth should be led by productivity growth, rather than by a horizontal expansion of farmlands.

In reality, as noted above, India has had to pay a huge price for having neglected its agricultural sector until the mid-1960s. The period between the mid-1960s and the mid-1970s is called the Indian economy's "lost decade."

The second Green Revolution wave in India that occurred during the 1980s was vital in creating a market in rural areas for non-agricultural products and services, thereby establishing a foundation for rapid economic growth after the 1990s based on development in the non-agricultural sector. While accepting the importance of backward and forward linkages, the emphasis in this analysis is on the "final demand effects" of the 1980s agricultural growth.

(2) Challenges for sub-Saharan Africa

What are the lessons of the Indian experience for the development of contemporary sub-Saharan Africa? In terms of the living standard of the mass populations, the two regions diverged significantly in the 1980s when India began to escape from its hitherto "low-level

equilibrium" while sub-Saharan Africa continued to stagnate. The major argument of this paper is that the critical difference between the two regions was the performance of their agricultural sectors during the 1980s. The growth rate of agriculture in sub-Saharan Africa during the 1980s was less than 2 per cent, meaning that it lagged behind even the rate of population growth[10]. Per capita food production decreased and food imports (mainly rice and wheat) rose rapidly after the 1980s. Per capita caloric intake in sub-Saharan Africa is still stagnating at around 2100 calorie/day (FAO, 2009). Even worse, while the population growth rate in India has largely slowed in recent years to less than 1.5 per cent, in sub-Saharan Africa the recorded growth rate is 2.3% (World Bank, 2007). The major reason why India has been able to reach the last stage of demographic transition (when the birth rate starts to decline substantially) is its successful economic transition from an agriculture-based to a non-agriculture-based economy. In the latter economic stage, people prefer to have a smaller number of children and invest more intensively in human capital.

The most important lesson for sub-Saharan Africa from the Indian experience, therefore, is that it should take steps to raise rural incomes and thereby to strengthen rural markets for non-agricultural products and services. Once this has been realized, sub-Saharan Africa will be in a position to proceed to the next stage of economic development: industrialization. To raise rural incomes to a certain level, productivity growth in agriculture should be increased, especially in terms of staple food output, rather than the horizontal expansion of farmland that has been the practice in most of sub-Saharan Africa. This argument is basically in line with that of Eswaran and Kotwal (1994).

Dercon (2009) has criticized the analytical framework of Eswaran and Kotwal, arguing that their model is applicable only to a closed economy, such as India's before 1991. He classified the sub-Saharan African countries into three categories: 1) resource-rich economies,

[10] Agricultural growth rate in sub-Saharan Africa during 1980-90 was 1.8 per cent, much lower than the population growth rate of 3.0 per cent (World Bank, 1996).

2) coastal and other well-located economies, and 3) landlocked, resource-poor economies. His conclusion is that Eswaran and Kotwal's model is applicable only to the last category. For most of the sub-Saharan African countries, he argues, a development strategy which takes advantage of trade opportunities with the rest of the world rather than an agricultural growth first strategy is more appropriate.[11] His policy recommendation for the second category countries, therefore, is to build infrastructure, improve institutions and regulations, invest in skills, and support export-oriented industrialization.

Countering Dercon's analysis, the present analysis questions whether it is possible to export manufactured goods to external markets before exploiting the more familiar domestic market. In today's globalized world economy, this many not be impossible if competitive foreign companies can be successfully wooed. But it should be noted that labor wages are relatively high in sub-Saharan Africa due to the favorable land-labor ratio as well as *the low productivity in the staple food sector*. It is doubtful that export-oriented foreign manufacturers will invest substantially in sub-Saharan Africa.

The domestic market, however, does have limitations. The market size of most sub-Saharan African countries may be too small to support sustained industrialization even if rural incomes can be raised by a Green Revolution. Indian development is, after all, built on its huge population base. Only a few African countries have relatively large populations: Nigeria (145 million in 2006 according to the World Bank, 2007), Ethiopia (73 million), Zaire (59 million), Tanzania (39 million), Sudan (37 million), Kenya (35 million), and Uganda (30 million). One possible way to overcome the market-size problem might be to promote regional common markets.

A more critical question regarding the applicability of the Indian model is how to effect a Green Revolution in the context of sub-Saharan Africa's existing natural and

[11] Regarding the first category countries (resource-rich economies), one of the most important lessons learned from past experience is that an industrialization strategy based on plentiful foreign exchange from mineral and/or oil exports is not successful in most cases. The recommendation here, therefore, is to use such foreign exchange for agricultural development, especially the staple foods sector.

socio-economic environment. There are several challenges to be faced:

First, staple food crops are much more diversified in sub-Saharan Africa. Rice and wheat, the crops that globally have most benefited from the Green Revolution, account for only a small share of Africa's total staple food supply. Since technologies for root crops and coarse cereals (except maize for animal feed) are less advanced, it may not be easy to raise the productivity in these traditional sub-Saharan food crops.

Second, although irrigation is the most important pre-requisite for the introduction of rice and wheat, as well as for the diffusion of new seed-fertilizer technologies, African agriculture mostly depends on rainfall. The irrigated farmland ratio is less than 4 per cent (roughly 60,000 hectares out of a total 1,580,000 hectares). Moreover, approximately 60 percent of the irrigated land is concentrated in three countries; South Africa, Sudan, and Madagascar. Fifty-five per cent of irrigated rice production is concentrated in Nigeria and Madagascar, and 75 per cent of irrigated wheat production is concentrated in South Africa and Ethiopia (Riddle et al, 2006).

Third, the share of urban population is already higher in sub-Saharan Africa than in South Asia (including India). In other words, a large-scale rural-urban migration occurred in sub-Saharan Africa before it attained any substantial increase in agricultural productivity and before sufficient non-agricultural job opportunities were created in urban areas. Labor scarcity has worsened in the rural areas, posing another constraint on a Green Revolution which would usually be based on labor-intensive technologies.

Fourth, rural and urban populations consume different staple foods in sub-Saharan Africa. Urban dwellers prefer rice and/or wheat,[12] mainly because of the ease of preparation,[13] whereas rural dwellers continue to rely on traditional staple foods such as coarse cereals and

[12] In Côte d'Ivoire, for example, about two-thirds of imported rice was consumed in urban areas and the per capita consumption of rice in 1980 was 97 kg in urban areas compared to 52 kg in rural areas (Miyane, 1984).

[13] Personal interview in 1987 with Dr. Norio Nozaki (JIRCAS: Japan International Research Center for Agricultural Sciences, at that time Tropical Agriculture Research Center).

root crops. Since the market is split between these two kinds of staple foods, traditional food producers have little incentive to increase their production. They only maintain self-sufficiency, mainly through the expansion of cropped areas, even through the reliance of the urban population on imported rice and wheat continues to be high.

Despite the several challenges mentioned above, the prospect for a Green Revolution in Africa is not low, especially for rice[14]. Although there appears to be little room for an expansion of wheat production in sub-Saharan Africa, the situation is quite different for rice. West Africa has a long history of experience in rice production. According to Sakurai (2006), rice production for urban commercial sale can be expanded through exploitation of the considerable unutilized swampland still available. This means that there may be little incentive for farmers to introduce new technologies so long as unutilized land remains. It is expected, however, that once the land frontier is exhausted, new technologies may spread quickly and contribute to substantial increases in farmers' incomes.

Finally, it should be recalled that India achieved rapid yield increases even for coarse cereals. The transfer of related technologies from India to sub-Saharan Africa should also be explored.

Conclusion

In this paper, the importance of the Green Revolution (especially the 1980s second wave) for India's economic development has been emphasized. The main message is that the accelerated economic growth since the 1990s in India has been due not only to the full-scale

[14] See, for example, the articles which were incorporated into the special issue "Rice Green Revolution in Asia and Its Transferability to Africa" of *The Developing Economies* Vol. 44, No.2 (June 2006), especially Otsuka, K. and K.P. Kalirajan (2006). Another possibility is a maize Green Revolution. Like rice, maize is a major crop consumed in both rural and urban areas in eastern and southern Africa. The average yield of maize in sub-Saharan Africa is only one-third of the world average and it seems that there should be a lot of room for improvement. However, it should be noted that hybrid maize which is diffused widely and which contributed to the yield increase is for animal feed and not for direct human consumption such as in most of sub-Saharan Africa. It is apparent from the fact that the maize yield is not high in Mexico, where as in sub-Saharan Africa it is the staple food, that new technologies applicable to maize for human consumption are not very developed.

economic liberalization policy implemented after 1991, but more fundamentally to the growth of its domestic market for non-agricultural goods and services, especially in rural areas. The income improvement achieved in rural India during the 1980s through the spread of new agricultural technologies was vital to its nation-wide economic development.

This paper supports the argument that agricultural growth should precede broader economic growth based on industrialization. The basic factor underlying the inadequate economic development in sub-Saharan Africa has been the industrialization-first strategy pursued in that region, with its relative neglect of agriculture, especially the staple food sector.

At the same time, it is recognized that there are many differences in initial conditions between India and many sub-Saharan African countries, including climate, land-labor endowment, population size, diversification of staple foods, and food consumption patterns in rural and urban areas. The applicability of the Indian model must be carefully assessed. However, it is important to bear in mind that without income increases generated by productivity improvements in agriculture, successful industrialization and modern economic development will be quite difficult.

How to introduce a Green Revolution in sub-Saharan Africa in the midst of its many disadvantages poses a major challenge. Despite its high population growth, the region has attained self-sufficiency of staple foods in rural areas through the horizontal expansion of farmland rather than through productivity growth. Seeking better opportunities, rural people are increasingly migrating to urban areas where they consume rice and/or wheat, most of which is imported. In this situation, per capita income is stagnant and industrialization strategies are failing because the domestic market is lacking and because of low competitiveness globally. Furthermore, failure in the transition from an agrarian to an industrialized economy means that the population growth rate has not decelerated as would be expected.

To escape from this vicious cycle, the introduction of new technologies in agriculture,

especially in the staple food sector, is necessary. There is hope for this in the rice-based Green Revolution in West Africa. NERICA (New Rice for Africa) varieties promoted by JICA may offer a similar hope for upland rice areas. Technical cooperation from all over the world is needed, especially from East Asia (Japan, Korea, Taiwan and China) and from tropical Asia where the rice Green Revolution has been successfully realized.

References

Adelman, I. 1984. Beyond Export-led Growth. *World Development* 12 (9): 937-49.

Bhalla, G. S., and G. Singh. 1997. Recent Developments in Indian Agriculture: A State Level Analysis. *Economic and Political Weekly* 42 (July 14): 27-28.

Bardhan, P. K. 1984. *Land, Labor and Rural Poverty: Essays in Development Economics*. Oxford: Oxford University Press.

Bardhan, P. K., and A. Rudra. 1978. Interlinkage of Land, Labour and Credit Relations: An Analysis of Village Survey Data in East India. *Economic and Political Weekly* (February): 367-84.

Bhaduri, A. 1973. A Study of Agricultural Backwardness under Semi-Feudalism. *Economic Journa*l (March): 120-37.

Blyn, G. 1966. *Agricultural Trends in India, 1891-1947: Output, Availability and Productivity*. Philadelphia: University of Pennsylvania Press.

Chand, R. 2008. India's Agricultural Challenges and their Implications for Growth of its Economy. In *Economic Integration in Asia and India*, ed. M. Fujita, 145-171. New York: Palgrave MacMillan.

Chand, R., S. S. Raju, and L. M. Pandey. 2007. Growth Crisis in Agriculture Severity and Options at National and State Levels. *Economic and Political Weekly* 42 (26): 2528-33.

Dercon, S. 2009. Rural Poverty: Old Challenges in New Contexts. *World Bank Research Observer* 24 (1).

Eswaran, M., and A. Kotwal. *Why Poverty Persists in India: A Framework for Understanding the Indian Economy*. Oxford: Oxford University Press.

FAO (Food and Agriculture Organization). 1995. *World Agriculture: Towards 2010*. Rome: FAO.

———. 2009. *The State of Food Insecurities in the World 2009*. Rome: FAO.

Fujita, K. 1990. Kangai Kaihatsu to Seido teki Shomondai [Irrigation development and institutional problems]. In *Banguradeshu: Teikaihatsu no Seiji Kozo* [Bangladesh: Political structure of underdevelopment], ed. H. Sato, Tokyo: Ajia Keizai Kenkyuusho.

Fujita, K. Forthcoming. *Re-thinking Economic Development: Green Revolution, Agrarian Structure and Transformation in Bangladesh*. Kyoto: Kyoto University Press and Trans Pacific Press.

Fujita, K., A. Kundu, and W. M. H. Jaim. 2003. Groundwater Market and Agricultural Development in West Bengal: Perspectives from A Village Study. *Japanese Journal of Rural Economics* 5: 51-65.

Hayami, Y. 1997. *Development Economics: From the Poverty to the Wealth of Nations.* Oxford: Oxford University Press.

Johnson, B. F., and Killby. 1975. *Agriculture and Structural Transformation: Economic Strategies in Late-developing Countries*. London: Oxford University Press.

Kahnert, F., and G. Levine. 1993. *Groundwater Irrigation and the Rural Poor: Options for Development in the Gangetic Basin*. Washington D.C.: World Bank.

Kurosaki, T. 1999. Agriculture in India and Pakistan, 1900-95: Productivity and Crop Mix. *Economic and Political Weekly* 34 (52): A160-A168.

Mellor, J. W., and U. J. Lele. 1973. Growth Linkages of the New Food Grain Technologies. *Indian Journal of Agricultural Economics* 18 (1): 35-55.

Miyane, K. 1984. Zouge Kaigan no Beikoku Seisaku (2) [Rice policy in Cote d'Ivoire (2)]. *Shokuryo Kanri Geppou* 36 (9).

National Sample Survey Organization. 2006. *Level and Pattern of Consumer Expenditure,*

2004-05. NSS 61st Round (July 2004-June 2005). New Delhi.
Newberry, D. M. G. 1974. Crop-Sharing Tenancy in Agriculture: A Comment. *American Economic Journal* 64.
Ohno, A. 1999. Indo: Kyozou wa Tachiagarunoka? [India: The big elephant will stand up?]. In *Ajia Keizai Ron* [Asian economies], ed. Y. Hara, 381-415. Tokyo: NTT Publishers.
Otsuka, K., and K. P. Kalirajan. 2006. Rice Green Revolution in Asia and Its Transferability to Africa: An Introduction. *Developing Economies* 44 (2): 107-22.
Pant, N. 1992. *New Trend in Indian Irrigation: Commercialisation of Ground Water*. New Delhi: Ashish Publishing House.
Riddle, P. J., M. Westlake, and J. Burke. 2006. *Demand for Products of Irrigated Agriculture in Sub-Saharan Africa*. FAO Water Reports 31. Rome: FAO.
Sakurai, T. 2006. Intensification of Rainfed Lowland Rice Production in West Africa: Present Status and Potential Green Revolution. *Developing Economies* 44 (2): 232-51.
Sastry, D. V. S., B. Singh, K. Battacharya, and N. K. Unnikrishnan. 2003. Sectoral Linkages and Growth Prospects: Reflections on the Indian Economy. *Economic and Political Weekly* 38 (24).
Sugimoto, D., and Y. Usami. 2004. Gurobaru Sijyoka no Indo Dekan Kogen Han Kansochi Noson [Semi-arid Deccan Plateau rural India under a globalized economy]. *Keizaigaku Zasshi* 105 (1): 3-20.
World Bank. 1996. *World Development Report 1996: From Plan to Market*. Washington D.C.
———. 2000. *India: Reducing Poverty, Accelerating Development*. Oxford: Oxford University Press.
———. 2005. *India: Re-Energizing the Agricultural Sector to Sustain Growth and Reduce Poverty*. Oxford: Oxford University Press.
———. 2007. *World Development Report 2008: Agriculture for Development*. Washington D.C.
Yanagisawa, H. 2008. Gendai Indo no Keizai Seicho to Noson Shakai no Henyo [Economic growth and transformation of rural society in contemporary India]. *Chiba Daigaku Keizai Kenkyu* 23 (3): 283-314.

Abstract (in Japanese)

要約

インドは、1991 年の経済自由化政策以降、急速な経済成長軌道に乗っている。しかし著者は、その経済成長が 1980 年代の農業の急成長に基礎をもっていたと主張したい。インドの「緑の革命」は 1960 年代半ばに始まり、約 10 年で食料自給を達成したが、その成長は一部地域そして小麦に偏ったものであった。しかし上述の 1980 年代のいわば第２の「緑の革命」は、全国の主作物のほぼ全体に及んだため、農村の所得が底上げされ貧困削減が大きく進展し、したがって 90 年代以降の非農業部門の発展を「市場の提供」という側面から支えた非常に重要な要因であった。現在では大差がついたといえるサブサハラ・アフリカとインドの経済発展の分岐点が、両地域の農業部門に差がついたこの 1980 年代にあったとすれば、サブサハラ・アフリカの経済発展のためには、生産性向上を伴う農業発展が必要不可欠ということになり、本稿の後半ではその可能性について吟味を行った。