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LONG-TERM PROSPECTS FOR THE GLOBAL RICE ECONOMY

By:

Mahabub Hossain

Lead Economist, Social Sciences

IRRI

The Philippines

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GLOBAL RICE ECONOMY: LONG-TERM PERSPECTIVES[1/]

Mahabub Hossain and Josephine Narciso[2/]

Introduction

Rice is the dominant staple food crop in developing countries, particularly for the humid tropics across the globe. Almost 90% of rice is produced and consumed in Asia, and 96% in developing countries. Rice production has increased faster than population over the last three decades, despite being produced on small and marginal and tenant farms in countries with extreme population pressure on limited land resources. Most of the growth in production originated from technological progress in the irrigated and the favorable rainfed ecosystems.

The growth in rice consumption has started slowing down because of urbanization, increases in per capita income leading to diversification of the diet, high levels of rice consumption already reached in many countries, and progress in reducing population growth. But, the growth in rice supply has also slowed down because of the yield approaching economic optimum for the irrigated ecosystem, decline in relative profitability of rice cultivation, increasing concerns regarding environmental protection, and limited progress in developing improved technologies for the unfavorable ecosystems.

Two contrasting developments may substantially affect the rice economy in the future. First, the prosperous rice-growing countries may increasingly find it difficult to sustain producers' interest in rice farming. The move towards free trade in agricultural production, begun with the Uruguay Round of GATT, will affect the sustainability of rice farming in these countries. There will be economic incentives for the movement of land, water and labor out of rice to other economic activities. Second, the potential for increased productivity for the irrigated ecosystem, created by the dramatic technological breakthrough in genetic enhancement of seeds that initiated the green revolution has almost been exploited while improved varieties for the unfavorable ecosystems expected from the on-going gene revolution are still on the horizon.

This paper aims to explain the above statements. As a background, Section I outlines some stylized facts about the global rice economy. Sections II analyzes the forces governing the trends in rice consumption in major rice growing countries. Section II assesses the trend in rice production and the factors contributing to the recent deceleration in the growth of rice production. The authors perspectives on the demand-supply balances for different regions for the near future are presented in section IV.

Characterization of the Rice Economy

Rice is grown on small family farms, except in the Unites States, Australia, Southern Europe, and parts of South America. The average size of a rice farm is typically less than half a hectare in China, Indonesian Java, and the Red River Delta in Vietnam; less than one ha in Bangladesh, eastern India, and the Mekong River Delta in Vietnam; and one to two ha in most

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[2/] Economist & Head, Social Sciences Division, and Research Officer respectively, International Rice Research Institute, DAPO Box 7777, Metro Manila, Philippines. Email: m.hossain@cgiar.org

other countries in Asia. Only in Thailand, Myanmar, Cambodia, and the Punjab, India is the average farm size over two ha, a major factor behind their comparative advantage in rice production.

A typical Asian farmer plants rice primarily to meet family needs, and hence the marketed surplus is small. Variable natural conditions cause shortages and surpluses to occur from year to year. These in turn produce wide fluctuations in marketable surplus and make prices in both domestic and international markets highly unstable. At the national level, an important political objective is to achieve self-sufficiency in rice production and to maintain stable prices for rice consumers (Timmer, 1989). Rice is seen by many Asian governments as a strategic commodity since it is the single most important element in the diet of the poor and an important source of employment and income for farmers. Large fluctuations in rice prices lead to political disturbances. As a result, governments intervene actively in their country's rice market (Anderson and Hayami, 1986; Childs, 1990). The interventions take many forms: subsidies and taxes on inputs and output, government control on international trade, and direct participation in marketing through procurement and distribution of grains.

In poorer countries, achieving self-sufficiency in food grain production is a key development objective because of the lack of foreign exchange to finance major international purchases. However, a commitment to self-sufficiency is not confined to the governments of poorer countries. Middle- and high-income Asian countries with no financial constraint to importing rice from low-cost sources have also tried to maintain self-sufficiency by providing support to rice farmers. If rice cultivation is abandoned, farming infrastructure such as irrigation and drainage facilities would not be maintained, and at times of crisis it would be difficult for the economy to revert back to rice farming. Japan and South Korea are now arguing for keeping protection for rice farming on the basis of the multi-functionality of agriculture that rice farming provides many external benefits to the society besides producing food (Kaoyama, 2001; Nishio 2001; Kato et al, 1997). At high-income levels, urban consumers complain less about paying high prices for rice to support relatively low-income farmers because the cost of rice is a small part of their food bills and a tiny fraction of their income.

As a result of all these factors, the international trade in rice has remained limited so far. About 6.3% of the world's rice production is currently traded internationally, in contrast to nearly 18.1% for wheat and 11.6% for coarse grains. The global rice market has expanded rapidly, however, over the last three decades. The value of global rice trade is US$8.6 billion about 74% of which s on account of developing countries and almost 35% on account of Africa and West Asia.

Many countries import rice, but on a very small scale. In South and Southeast Asia, the heartland of rice production, the major importers are Indonesia, Bangladesh, the Philippines, Malaysia, Japan, and Singapore. South and Southeast Asia’s imports fluctuate largely from year to year depending on the effect of natural calamities (floods, droughts, and typhoons) on domestic production. Major rice importers whose imports have been growing steadily over time are in the Middle East (Iran, Iraq, Saudi Arabia, UAE, and Turkey), western and southern Africa (Nigeria, Côte d’Ivoire, Senegal, South Africa, Sierra Leone, Madagascar, Guinea, and Benin), and Latin America (Brazil, Mexico, Cuba, Haiti, and the Dominican Republic).

Only a few countries participate in the export market. Major rice-exporting countries are Thailand, Vietnam, India, the United States, China, Pakistan, Australia, Italy, Uruguay, Argentina, Egypt, and Spain. There is a high concentration in the export market. The first five countries account for nearly three-fourths of the supply in the market and Thailand alone controls about 30% of the market. Myanmar and Cambodia were major exporters in the world market before the Green Revolution began in the1960s, but since then they have lost the market because of civil disturbances, slow growth in production, and deterioration in marketing infrastructure. These countries have unused capacity for expanding supply in the market. India, Argentina,

Uruguay, and Guyana have increased rice exports substantially in recent years. In 2002 exports from India has increased substantially making it the second largest exporter after Thailand.

Perspectives on consumption

Growth in demand for a staple grain depends on (1) the level of per capita income, (2) the rate of growth of population, and (3) the change in prices relative to those of substitute crops. At low levels of income, when meeting energy needs is a serious concern, rice is considered a luxury commodity. With increases in income, people tend to substitute low-cost sources of energy such as coarse grains, cassava, and sweet potato for rice. But, at high levels of income, rice becomes an inferior good (Ito et al., 1989). As incomes rise further, consumers go for a diversified diet and replace rice with high-cost quality food with more protein and vitamins, such as vegetables, bread, fish, and meat. Growing urbanization, which accompanies economic growth and industrialization, further dampens the demand for rice with higher claims of non-food basic needs on the family budget.

Table 1. Changes in rice consumption, selected Asian countries.

Country	Rice consumption milled rice (MT)	Per capita consumption (kg/person/yr)			Change in population 2000-30 (%)	
	1999-2001	1970-72	1989-91	1999-2001	1970-2000	2000-2030
China	113.51	79	93	89	54	17
India	76.45	69	79	76	82	40
Indonesia	31.62	105	147	149	77	33
Bangladesh	21.37	150	153	155	94	43
Vietnam	13.03	157	154	167	82	41
Myanmar	9.71	160	209	203	78	31
Philippines	7.65	86	96	101	107	49
Japan	7.53	89	65	59	22	-5
Thailand	6.83	152	110	109	74	27
Korea, South	4.12	119	104	88	46	12
Nepal	2.27	82	106	99	94	81
Cambodia	2.03	163	158	155	89	82
Malaysia	1.96	123	81	88	105	48
Iran	1.89	25	31	27	144	49
Pakistan	1.78	29	14	13	128	93
Sri Lanka	1.77	95	93	94	54	21
Korea, North	1.73	82	73	78	55	19
Saudi Arabia	0.79	23	27	39	254	120

Source of basic data: FAOSTAT database, FAO 2004.

The trend in per capita consumption of rice in selected Asian countries can be seen in Table 1. Rice consumption has been declining from a high level in the middle- and high-income countries in Asia such as Japan, South Korea, China, Thailand, and Malaysia. Except for

Malaysia, population growth in these countries has also reached low levels. Over the next three decades, their population may grow at only about 1.0% per year. So, these countries may not experience any further upward pressure on demand for rice.

For low-income Asian countries, such as Indonesia, the Philippines, India, Bangladesh, Vietnam and Myanmar, per capita consumption has reached a high level and may not grow further because of very low income elasticity of demand and rapid urbanization. An increase in consumption by low-income households with a reduction in poverty may be compensated by the decline in consumption by middle- and upper-income groups. Since the unit cost of producing rice is much higher than for maize, rice will unlikely be used as livestock feed, whose demand has been growing very fast with increasing incomes. With an annual population growth from 1% to 1.5% per year, these countries may face a demand growth of 30% to 50% over the next three decades.

The major boost in demand will come from countries in West Asia and Sub-Saharan Africa, and South America (Table 2). In many countries, per capita consumption has been increasing rapidly with rural-urban migration of the population that leads to a change in food habit from Maize or root crops based diets to rice or wheat-based diets. With urbanization and women's involvement in economic activities the preference for rice as a staple food has been growing because it is convenient to cook. Also the population continues to grow at a high rate (except in South America). The population may double in many countries within the next three decades. The demand for rice may increase at 3% to 4% per year in these regions. Pressure on the world market in terms of increased demand may not be large, however, as these regions account for only 6% of the global consumption of rice.

Table 2. Changes in rice consumption, selected countries in Africa and Latin America and the Caribbean.

Country	Rice consumption milled rice (MT)	Per capita consumption (kg/person/yr)			Change in population 2000-30 (%)	
	1999-2001	1970-72	1989-91	1999-2001	1970-2000	2000-2030
			AFRICA			
Nigeria	2.89	5	24	25	137	94
Egypt	2.65	28	31	39	92	47
Madagascar	1.53	125	98	96	130	115
Côte d'Ivoire	1.05	45	54	66	190	65
Senegal	0.69	48	66	73	127	90
Tanzania	0.62	7	17	18	155	87
Guinea	0.61	50	64	75	109	91
South Africa	0.56	4	8	13	91	1
Mali	0.54	17	26	47	107	137
Sierra Leone	0.41	105	97	92	66	130
Liberia	0.16	114	107	56	110	206
Guinea Bissau	0.12	66	111	103	106	101
LATIN AMERICA						
Brazil	6.59	38	41	39	78	33
Peru	1.27	24	38	50	95	45
Colombia	1.27	24	32	30	87	47
Ecuador	0.63	23	43	49	112	47
Mexico	0.55	5	4	6	95	36
Cuba	0.50	50	49	45	31	4
Dominican Rep	0.39	30	48	47	89	34
Haiti	0.31	11	22	38	80	49
Costa Rica	0.25	38	41	62	133	55

Source of basic data: FAOSTAT database, FAO 2004.

The recent projections made by the IMPACT model developed at IFPRI indicate that the demand for rice will increase by 1.1% per year over the next three decades (Rosegrant et al 1995; Sombilla et al, 2002). This is only a fraction of the actual increase in rice consumption over the last three decades (2.4%). The increase in demand will vary considerably across the regions (Table 3). It will increase only marginally in East Asia (0.4%) but quite substantially in the low-income countries of South Asia (1.6%) and Sub-Saharan Africa (2.0%).

Table 3. Projection of demand, production, and net trade of rice by region (in million tons of milled rice).

Region	Demand		Production		Net trade	
	1995	2025	1995	2025	1995	2025
East Asia	146.20	158.20	140.30	154.80	-2.27	-3.48
Southeast Asia	82.90	117.10	87.70	131.60	4.75	14.57
South Asia	103.10	161.70	106.70	161.20	3.43	-0.46
West Asia and North Africa	7.51	14.45	5.18	9.86	-2.33	-4.58
Sub-Saharan Africa	9.78	22.23	6.58	16.31	-3.21	-5.91
Latin America	14.96	25.22	13.64	23.98	-1.32	-1.24
Developed countries excluding Japan	35.10	49.03	35.07	49.03	-0.31	0.00

Source: IFPRI: 2000 Revision of the IMPACT Model

Even if the demand grows at a slower rate, global rice production must reach about 800 million tons of un- husked rice by 2030 to match the demand, an increase of about 200 million tons over the peak production level reached in recent years. Can this be done in view of the already high pressure of population on limited natural resources and the technological progress on the horizon? We take up this issue in the next section.

Perspectives on production

Economic prosperity and industrial progress are leading to rapid urbanization and the concentration of people in large cities. An important implication of growing urbanization is that some fertile rice lands have to be diverted to meet the demand for housing, factories, and roads. Also with urbanization and associated food habits, the markets for vegetables, fruits, and livestock products will grow stronger. Thus, there will be economic pressure to reduce the area under rice cultivation to accommodate agricultural diversification in favor of high-value crops.

Table 4. Rice yield and unit cost of rice production, selected countries.

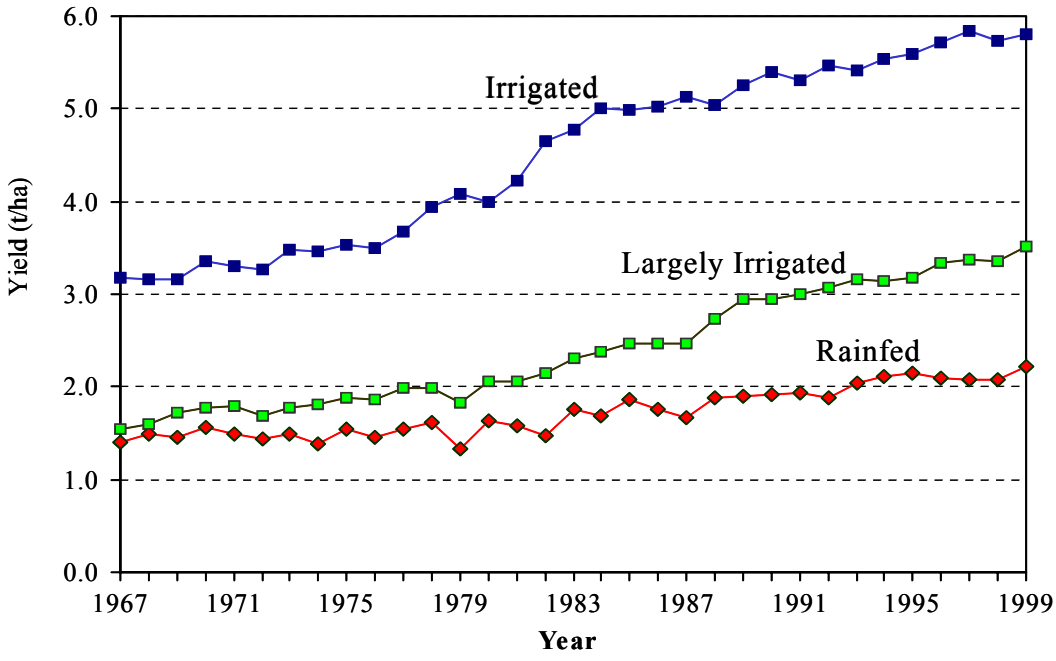
Country	Ecosystem	Year	Rice yield (t/ha)	Unit cost (US$/t)
Thailand	Irrigated	2000	4.20	70
	Rainfed	2000	2.24	103
India	Irrigated	1995-96	5.16	88
	Rainfed	1995-97	2.26	115
Vietnam	Irrigated	2000	4.18	79
Burkina Faso	Rainfed	1987-90	2.50	288
Guyana	Irrigated	1998-2000	4.00	405
USA	Irrigated	2001	7.04	331
Japan	Irrigated	1999	6.41	2290
Bangladesh	All ecosystems	2000	3.64	133
Philippines	All ecosystems	1999-2000	3.08	170
Korea, South	Irrigated	1999	6.60	868

Source: IRRI, World Rice Statistics database and farm household survey. For USA, USDA online. For South Korea, Burkina Faso, Guyana, and Japan, by country statistics online.

Some countries have potential for expanding rice area if cultivation becomes profitable. In Asia, the area under rice production can be further increased in Thailand, Myanmar, Cambodia, and several states in eastern India. It is estimated that there are 20 million ha of inland river valleys in southern and western Africa, of which only 15% are currently cultivated (Alexandratos, 1995). Brazil, Argentina, Uruguay, and Guyana (South America) can increase rice area substantially if rice cultivation provides adequate returns to factors of production comparable with those of other economic activities. But the cost of rice cultivation is substantially higher in Africa and Latin America than in Asia (Table 4). If the trend in rice prices continues to move downward, additional land will unlikely be brought under rice cultivation, particularly in countries that produce a surplus for the world market.

In the irrigated rice ecosystem, which accounts for almost three-fourths of total rice supplies, most farmers have already planted high-yielding modern varieties and the best farmers' yields are approaching the potential that scientists are able to attain with today's knowledge in that particular environment (Fig. 1).

Fig. 1. Trends in rice yield (t/ha) for irrigated and rainfed ecosystems, Asia, 1967-99



Ecosystem	Average yield (t/ha) 1967-69	1984-86	1997-99	Growth rate(%/yr) 1967-85	1985-99
Irrigated	3.16	5.01	5.80	2.7	1.2
Largely Irrigated	1.62	2.44	3.42	2.2	2.5
Rainfed	1.45	1.77	2.12	0.9	1.6

Note: The figure within parentheses is the standard error of the estimated growth rate.
Source of raw data: IRRI World Rice Statistics and FAO Electronic Database, 2002.

The attainable yields are about 8 t/ha in the temperate zone and 6 t/ha in the tropics, which are about to be reached in many countries (Hossain, 1997). It is possible to increase yield by at most 1 t/ha with the adoption of improved crop management technologies for reducing the existing yield gap (FAO, 2001), but dissemination of these knowledge-intensive technologies to millions of small and marginal farmers may not be easy. As the yield plateau is reached, rice yield will remain stagnant in irrigated areas, as has already been demonstrated by Japan, South Korea, Taiwan (China) and China. Farmers in high-yield countries now look for mechanical technologies that save labor and increase labor productivity and farm profits. New technologies that merely increase land productivity may not have much appeal to farmers with high opportunity costs of labor.

Water, which is usually regarded as an abundant resource in humid Asia, is also becoming a scarce commodity (Frederiksen et al., 1993). In absolute terms, annual water withdrawals are by far the greatest in Asia, where agriculture accounts for 86% of total annual withdrawals compared with 38% in Europe and 49% in North and Central America. The per capita availability of water resources declined by 40% to 60% in most Asian countries from 1955 to1990 (Gershon and Keck, 1994). Up to one-half of the world's population lives in water-scarce environments (Huang et al 2002). Although efforts are under way to develop technologies for saving water in rice cultivation, it may take some time to get these technologies to farmers, and diffusion may be difficult under the prevailing system of pricing of irrigation water in public-sector-managed irrigation projects. With the diversion of water from agriculture to other needs,

degradation of irrigation infrastructure may follow, which may put downward pressure on both rice area and yield in the irrigated ecosystem.

The scope for further conversion of the rain fed ecosystem into the irrigated ecosystem is also becoming limited. Irrigation cost has increased substantially as easy options for irrigation development have already been exploited. Also, environmental concerns regarding adverse effects of irrigation and flood control projects on water logging, salinity, fish production, and the quality of groundwater have been growing. Already, there has been a drastic decline in investment for the development and maintenance of large-scale irrigation projects in many Asian countries (Rosegrant and Svendsen, 1992). In some Asian countries with favorable groundwater levels, the fall in private-sector investment in irrigation is however being compensated by private sector investment in shallow tube wells. This however raises the environmental concerns of depleting ground water beyond the level of recharge and contamination of drinking water with harmful chemicals.

The growing economic prosperity in Asia had an adverse effect on sustaining farmers' interest in rice cultivation (Pingali et al, 1997; Park, 1993). The expansion of the non-farm sector and the rapidly rising labor productivity have pushed up non-farm wage rates, which promoted the migration of labor from rural areas to cities and from farm to non-farm activities within rural areas. Since traditional rice farming is a highly labor-intensive activity, the increase in the wage rate has pushed up the cost of rice production and reduced profits and farmers' incomes.

The competitiveness of rice farming was maintained initially through (1) improved farm management practices that increased efficiency in the use of non-land inputs and thereby reduced the cost of production and (2) the increased use of capital to replace labor through mechanization of farming operations so that labor productivity could be continuously raised when no further increase in land productivity was possible. But these technological changes were not adequate for raising the incomes of farmers on a par with those of urban workers. The government had to come forward to protect the domestic rice market so that the price mechanism could be used to transfer income from the relatively well-off rice consumers to the relatively poor rice producers. As the cost of rice cultivation continued to increase because of the rising opportunity cost of labor and land, the government had to raise rice prices and farm subsidies to maintain the balance between rural and urban household incomes. Protection of the domestic rice industry has led to the high-cost domestic production of rice. The cost of producing rice goes up with economic progress(Table 4). Thus, having an exportable surplus of rice from the middle- and high-income countries of Asia is highly improbable. Rather,if they are exposed to international competition following the growing pressure from the World Trade Organization (WTO) to liberalize international trade in rice, the area under rice cultivation may decline. These countries may need to increase their imports of rice to meet the domestic demand if they remove quantitative and qualitative trade restrictions.

Some technologies are in the pipeline that may raise land productivity and input-use efficiency in the irrigated ecosystem (Khush, 1995) and thereby contribute to further increasing rice production from this favorable ecosystem. The most important of these are the new plant type (NPT) or “super rice,” which is expected to shift the yield frontier by another 25%, hybrid rice technology for the tropics that increases yield by 15% to 20%, and host-plant resistance against major pests using biotechnology tools that may reduce crop losses by 5% to 10%. The International Rice Research Institute (IRRI) has started distributing NPT lines to NARS for adaptation under their conditions. Poor grain quality and high seed costs were identified as major constraints to the adoption of hybrid rice (Janaiah et al, 2003). Researchers are now attempting to solve the problems by using parents and restorer lines of improved quality, and by technological improvements and training in hybrid rice seed production. However, the underdeveloped infrastructure for the production and distribution of seeds, the fear of dependence on multinationals, and negative perceptions by civil society regarding genetically modified rice may

constrain the fast diffusion of these technologies, to have a substantial effect on an increase in rice yield (Huang et al, 2002).

The potential for increasing yield in the rain fed ecosystem is still vast, as yield is now only at 1.5 to 2.5 t/ha. Indeed, this ecosystem is the dominant one in the low-income countries of South and Southeast Asia, West Africa, and Central America (IRRI, 1995). The rainfed ecosystem is subject to the vagaries of nature such as droughts, floods, and typhoons often caused by erratic monsoons and El Niño and La Niña factors. Traditional rice varieties have developed traits through centuries of evolution that help them withstand climatic and soil-related stresses, but they have very low yields. Rice scientists have so far had limited success in identifying these traits and incorporating them in high-yielding modern cultivars (Zeigler and Puckridge, 1995). Where rainfall is unreliable and drainage is poor, farmers still grow traditional varieties and use fertilizers in sub-optimal amounts because of the uncertainty of obtaining adequate returns from investments in purchased inputs. This is the main reason behind the low yield and large yield gap in countries with a predominantly rainfed ecosystem.

Recent advances in molecular biology have increased the probability of research success in developing appropriate technologies for the rainfed ecosystem (Hossain et al 2000, Khush and Brar 2002). Structural and functional genomics provide knowledge, tools, and techniques to identify important genes and their association with agronomic traits. Rice breeders have begun to use marker-assisted selection techniques to expedite breeding cycles, and to incorporate traits of drought, submergence, and salinity tolerance into high-yielding varieties. Genetic engineering has already demonstrated great potential for introducing genes from other species into rice for herbicide tolerance and pest resistance and higher micronutrient contents. It may, however, take some time for this research to bear fruits. Countries will have to enact bio-safety regulations to facilitate adaptation trials and may have to overcome hurdles regarding the enforcement of intellectual property rights if the technologies or components are developed in the private sector. Considering the above, the possibility for a substantial increase in yield from the rainfed ecosystem in the short to medium run is not that great (Huang et al, 2002).

There is one bright spot though. The West Africa Rice Development Association (WARDA) has made a breakthrough in developing “New Rice for Africa” (NERICA) based on crosses between African and Asian rice. NERICA varieties have better tolerance for most African stresses, including weeds and drought, shorter growing cycles, and high yield potential. They also perform better under both high- and low-input management systems (Defoer et al, 2002). This technological development provides an opportunity for farmers to stabilize and intensify low-input upland systems. Efforts are under way to fast-track adoption of NERICA in West Africa through the farmer participatory variety selection (PVS) approach. Faster adoption of these varieties may contribute to a substantial increase in production in Nigeria, Guinea, Côte d’Ivoire, Sierra Leone, and Liberia, where upland and rainfed lowland ecosystems are predominant. Since these countries cover only four out of 150 million ha of global rice land, the impact of this development on the global rice production will not be significant, although it will have a substantial effect on rice production for individual countries in West Africa.

A deceleration in the growth of global rice production has already set in. The annual growth in global rice production was only 1.6% per year from 1990 to 2002 compared with 2.7% from 1968 to 1990. Growth in rice yield has declined even faster, from 2.2% to 1.1% per year (Table 5 and Fig. 2). The recent growth (1990-2002) in rice production has failed to outpace population growth in several countries in Asia, where rice is grown predominantly under the irrigated ecosystem. The countries that have maintained or increased growth in rice production on a par with population in the 1990s are those that have a large proportion of area under the rain fed ecosystem.

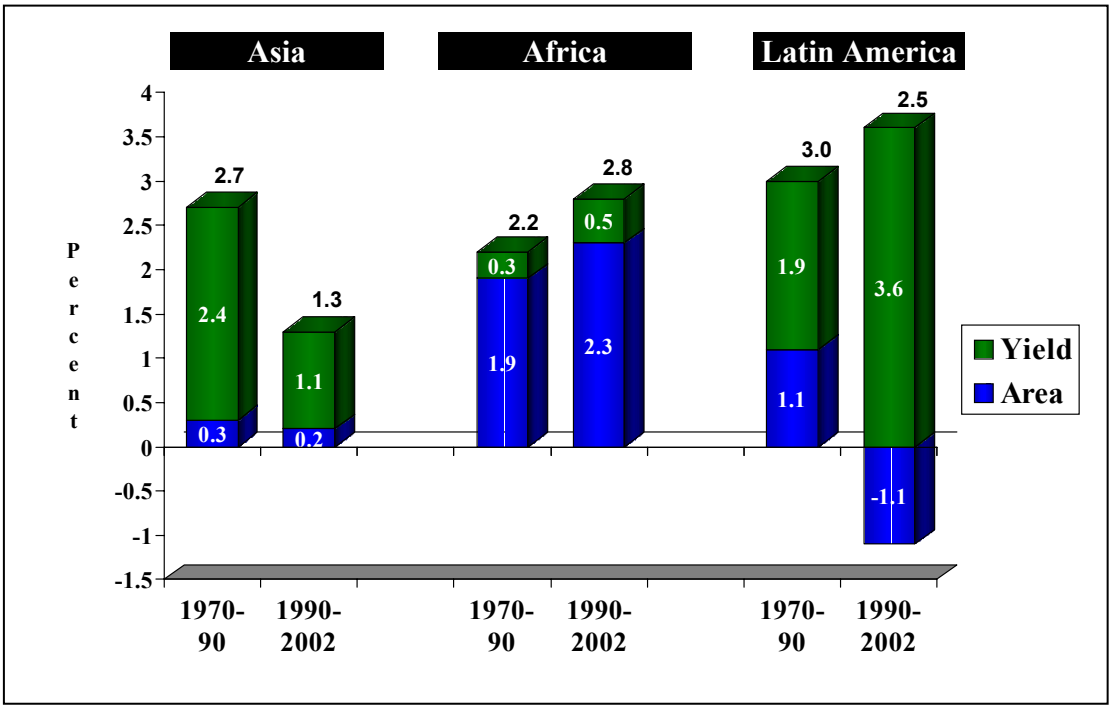
Table 5. Growth (%/yr) in rice production and its sources by region, 1970-90 and 1990-02.

	Production		Area		Yield	
Region	1970-90	1990-02	1970-90	1990-02	1970-90	1990-02
Developing countries						
China	2.7	0.0	-0.5	-1.0	3.2	1.0
India	2.9	1.4	0.6	0.1	2.4	1.4
East Asia & Pacific excl China	2.7	2.3	0.8	1.2	1.9	1.1
South Asia excl. India	2.4	3.0	0.7	0.5	1.8	2.5
West & Central Asia	1.6	0.2	0.9	1.4	0.7	-1.2
Africa	2.2	2.8	1.9	2.3	0.3	0.5
Latin America & the Caribbean	3.0	2.5	1.0	-1.1	1.9	3.6
Developed countries	0.4	0.3	-0.1	-1.0	0.5	1.3
World	2.7	1.4	0.5	0.3	2.2	1.0

Source of basic data: FAOSTAT database, FAO 2004.

Note: The growth is estimated by fitting the trend lines to the time series data for 1970 to 2002 period :

Fig. 2. Changes in the sources of growth in rice production in developing countries, 1970-2002.



Perspectives on trade

The world trade in rice is generally dictated by the demand for imports. The supply in the market responds to it by drawing down stocks. Imports have had a consistent upward trend because of increasing demand from countries in West Asia, Sub-Saharan Africa and the Central and South America. This upward trend in rice trade is likely to continue. The pace of expansion of the world trade in rice in the future may depend on the production and domestic policies for the middle and high-income rice-producing and -consuming countries in Asia.

China's rice consumption is expected to remain stagnant and may even fall in absolute terms in the near future because of the decline in per capita consumption, and the slow and declining population growth. But China's entry into the WTO may have an adverse effect on the domestic production of rice, unless it is compensated by incentives through removing prevailing distortions caused by overvaluation of the exchange rate and under-investment in agricultural research and extension. The production of japonica rice in the northeastern provinces may get a boost, however, from the diversion of maize land into rice production. Chinese economists predict that China will remain a marginal net exporter of rice by substantially increasing the export of japonica rice, and will maintain imports of high-quality indica rice (Huang, personal communication).

India continues to expand rice production mainly because of technological progress in the irrigated ecosystem, the provision of input subsidies for irrigation and chemical fertilizers (this makes India a low-cost rice producer in the world), and providing price support to large commercial farmers through compulsory procurement of surplus rice at pre-determined prices. The growth of production has started slackening, however, in the northern and southern states where the irrigated ecosystem predominates. Consumption will continue to grow, however, because of fairly high population growth rates. India's rice stocks have been growing because of continued government procurement at the minimum support prices but reduced off take under the public food-grain distribution system following recent policy changes. Recently, the government has started providing incentives to the private sector for exporting rice. With domestic production growing in the traditional rice-deficit states of eastern India, and with continued policy support for maintaining low-cost domestic production, India may remain a major exporter of rice in the world market.

Vietnamese farmers have responded favorably to the economic liberalization introduced in recent years (Pingali and Xuan, 1992), and Vietnam has become the second most important exporter of rice in the world market because of rapid growth in production since the mid-1980s. Vietnam has almost exhausted its capacity for increasing rice production and has started adopting a policy of agricultural diversification to boost farmers' incomes. Rice production will grow at a much slower rate than in the past while domestic consumption will continue to increase with the addition of about 1.2 million people every year. Thus, Vietnam may gradually reduce its rice exports, but will remain a major rice-exporting country in the near future.

Thailand, Myanmar, and Cambodia have considerable excess capacity for increasing rice production. Their rice yield remains at a low level and additional land could be brought under cultivation, particularly through increasing rice-cropping intensity. Thailand has continued to increase exports even when rice prices remained low in the world market. Farmers have maintained a low cost of production despite increasing wage rates through consolidation of farm holdings and mechanization of agricultural operations. If rice prices go up, farmers will be encouraged to increase production by investing in irrigation and increasing area under dry season rice, and reducing the yield gap for the wet season. Myanmar and Cambodia has favorable endowments of land, and are likely to increase their exports substantially in the future if the government can afford to invest in irrigation and marketing infrastructure.

Outside Asia, there is a large potential for increasing rice production and exports from Argentina, Uruguay, and Guyana. The exploitation of this potential will depend, however, on the rate of increase in the world price of rice; the valuation of their currencies vis-à-vis the U.S. dollar and the currencies in Thailand, India, and Vietnam. The U.S. is their major competitor for exports in the markets for Central and South America. The recently enacted U.S. farm bill has that provides substantial income support to rice farmers already had a negative effect on the export potential of these countries.

Indonesia and the Philippines, Malaysia, and Singapore are the major rice importers in Southeast Asia. In Indonesia and the Philippines, rice production has remained almost stagnant in the 1990s, while consumption has been growing on account of the increase in population as well as the increase in per capita rice intake. Malaysia and Singapore have been following a policy of self-reliance by importing rice from low-cost sources rather than sustaining high-cost domestic production. These countries may follow market liberalizing policies, particularly free trade within the ASEAN region. In that case Singapore and Malaysia, Indonesia and the Philippines may increase their rice imports in the future. They will remain major markets for rice from Thailand and Myanmar and Cambodia.

Bangladesh has reduced the yield gap in the irrigated ecosystem and has greatly reduced its imports through a substantial increase in domestic production over the last decade. The production growth may slow down in the future because of the plateau in yield in the irrigated ecosystem and slow technological progress in the large flood-prone and salinity-prone coastal areas. Rice consumption will continue to grow, however, mainly because of the increase in population of about two million people every year. Bangladesh is likely to remain a marginal rice importer. Nepal has the capacity to achieve self-sufficiency in rice production, but Sri Lanka may remain a minor importer because of high production costs from labor scarcity and higher wage rates.

Some major rice-importing countries are located in West Asia and North Africa. Only Egypt is a rice exporter. The region does not have a comparative advantage in growing rice but demand has been growing because of the increase in per capita consumption and rapid population growth. Iran and Iraq now import more than a million tons per year, and Saudi Arabia, Yemen, and Turkey from 0.5 to 1.0 million tons. The region will increase its share of the global market for rice, particularly for the aromatic Basmati-type rice produced in India and Pakistan.

In Sub-Saharan Africa the growth in domestic production may accelerate in the future because of new technological breakthroughs for upland rice (NERICA, the new rice for Africa) and expansion of rice area. But consumption may grow faster because of high population growth, and changes in food consumption patterns away from coarse grains and root crops to rice and wheat with rapid rural-urban migration. There will be faster boosts in imports against the domestic production of rice if the price in the world market remains low. The countries with sizable markets and an upward trend in imports are Nigeria, Senegal, Côte d'Ivoire, South Africa, Namibia, Madagascar, Guinea, and Benin.

In South and Central America, Brazil, Mexico, Cuba, and Haiti may remain important rice importers. In south America per capita rice consumption has been growing because rice is found to be a healthy and convenient (require less time for preparation compared to other food staple) food, but the growth of population is slowing down. Colombia, Peru, Ecuador, and Costa Rica have been able to keep imports at a low level despite the increase in per capita rice consumption, because of respectable growth in domestic production. Brazil's rice production remained stagnant in the 1990s despite the increase in yield for the irrigated rice. The reason is that the upland rice production became less competitive with the government following a policy of trade liberalization. The Imports of rice from South America may decline in the future with several countries adopting policies favoring domestic production.

Conclusions

The growth in demand for rice will slow down substantially with economic growth and success in population control, particularly in the middle- and high-income countries in Asia and Latin America. But, the growth in production may also slow down because of the growing scarcity of land, labor, and water. Demand may increase substantially from West Asia and Sub-Saharan Africa because of high growth of population and the increase in per capita consumption. The domestic production of rice may increase in Sub-Saharan Africa due to the recent technological breakthrough in developing NERICA, but it is unlikely to offset the increase in demand. These regions will remain the major market for rice, along with Indonesia, the Philippines, Malaysia, and Singapore in Southeast Asia. The U.S., Italy, Spain, Argentina, Uruguay, and Guyana will continue to serve the limited rice market in Central and South America and Europe.

The world rice market will continue to remain segmented because of the overwhelming importance of rice as a staple food and its political and cultural significance. Large rice-consuming countries will continue to protect rice producers' and consumers' welfare through inward-looking policies.

Any upward pressure on the price of rice will provide incentives to exploit the excess capacity for rice production in Thailand, Eastern India, Myanmar, and Cambodia, and some countries in South America. The domestic rice price may recover to the level of the mid-1990s, but a reverse upward trend is unlikely to happen. The trend in price in the world market will be determined by the relative value of the currency of the major rice exporters and the long term change in the unit cost of production from technological progress.

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Appendix Table 1. Growth rate (%/yr) in production of rice in major rice growing countries.

	Consumption		Production		Area		Yield	
COUNTRY	1970-90	1990-01	1970-90	1990-02	1970-90	1990-02	1970-90	1990-02
China	2.8	0.3	2.7	0.0	-0.5	-1.0	3.2	1.0
India	2.8	1.4	2.9	1.4	0.6	0.1	2.4	1.4
Indonesia	4.0	1.6	4.7	1.1	1.4	1.0	3.3	0.1
Bangladesh	2.7	2.1	2.5	3.2	0.4	0.6	2.1	2.7
Vietnam	2.3	2.1	3.2	4.9	1.1	2.0	2.1	3.0
Thailand	0.7	1.3	2.2	3.3	1.7	1.2	0.6	2.1
Myanmar	3.5	1.1	3.5	3.9	-0.2	2.3	3.8	1.6
Philippines	3.2	3.3	3.3	2.5	-0.2	1.8	3.5	0.7
Japan	-1.0	-0.6	-1.2	-1.0	-1.6	-2.1	0.5	1.1
Brazil	2.7	0.9	1.9	1.3	0.2	-2.8	1.7	4.2
USA	5.3	3.7	2.8	2.4	1.6	1.2	1.2	1.2
Korea, South	0.9	-0.6	1.8	-0.3	0.3	-1.2	1.6	0.9
Pakistan	0.1	2.5	2.1	3.1	1.8	1.0	0.3	2.1
Egypt	2.2	3.3	0.2	4.6	-0.8	2.5	1.1	2.1
Nigeria	12.0	3.7	11.0	0.9	8.8	5.4	2.2	-4.5
Nepal	3.7	2.4	1.8	2.8	1.1	1.1	0.7	1.7
Korea, North	-0.7	1.1	-1.4	-5.1	0.8	-0.4	-2.1	-4.7
Cambodia	1.3	2.3	2.1	5.5	1.9	1.4	0.2	4.1
Sri Lanka	1.8	1.1	3.6	1.1	0.9	-0.5	2.7	1.7
Madagascar	1.6	2.8	1.0	0.8	0.7	0.4	0.3	0.4
Iran	3.8	-0.5	2.3	-0.4	1.5	-0.3	0.7	0.0
Malaysia	-0.1	2.4	-0.5	0.5	-0.7	0.0	0.2	0.6
Colombia	3.8	2.0	3.5	2.4	2.4	0.5	1.1	1.9
Australia	6.3	5.0	5.8	4.6	4.9	4.3	1.0	0.2
Cote d'Ivoire	6.4	4.5	2.9	5.6	3.2	-1.9	-0.3	7.5
Guinea	2.6	3.4	-0.4	5.5	-0.4	2.8	0.0	2.7
Italy	1.1	1.7	1.8	0.4	0.6	0.2	1.2	0.3
Laos	1.4	2.3	3.1	5.2	-0.4	2.0	3.5	3.2
Peru	5.2	4.7	4.3	8.3	3.2	5.9	1.2	2.4
Sierra Leone	1.3	0.3	-0.1	-7.7	0.2	-6.6	-0.3	-1.0

Source of basic data: FAOSTAT database, FAO 2004.

Note: The growth is estimated by fitting the trend lines to the time series data for 1970 to 2002 period : LnY=a+bT+cD+dDT. where Ln is the natural logarithm of the variable, Y is the variable

for which the rate of growth is estimated, T is time, and D is a dummy variable, taking value one for 1990-02 and zero otherwise. The rate of growth for 1970-90 is given by b and that for 1990-2002 is given by (b + d) . The value of d is expected to be positive if there has been acceleration of growth during 1990-02. The coefficient of the dummy variable, c, will indicate whether any adjustment has been made in the time series since 1990.

Appendix Table 2. Trend in rice imports (000 tons), major importing countries, 1970-2002.

Country	1970-72	1989-91	2000-02	2000	2001	2002
Indonesia	732	163	1323	1355	642	1972
Nigeria	3	273	1268	786	1770	1248
Iran	53	711	926	1129	778	869
Philippines	275	263	883	642	811	1196
Iraq	44	407	812	1200	950	286
Saudi Arabia	176	261	790	937	765	668
Korea, North	0	62	771	795	684	834
Senegal	159	387	670	537	682	792
Japan	43	17	651	656	646	651
Brazil	4	515	640	660	699	562
South Africa	83	328	605	523	544	748
Côte d'Ivoire	84	336	601	441	645	718
Malaysia	268	366	547	596	525	521
UAE	39	317	541	432	583	607
Cuba	245	250	473	417	452	551
UK	134	261	455	419	472	476
Mexico	6	148	455	426	462	478
Bangladesh	513	153	452	260	152	943
Singapore	325	214	433	355	448	497
France	106	285	430	417	435	439
Russian Fed	-	-	388	351	347	466
USA	32	146	373	305	406	410
Ghana	38	124	348	167	368	508
China, Hong Kong	391	391	323	310	321	338
Turkey	6	181	298	342	226	325
China	3	472	286	245	275	340
Germany	208	321	284	287	278	288
Canada	75	159	262	263	269	254
Haiti	0	84	254	253	198	312
Guinea	21	187	252	172	252	332
Yemen	35	145	238	232	220	261
Afghanistan	1	3	237	220	272	218
Netherlands	70	206	218	209	219	226
Papua New Guinea	47	147	218	151	106	397

Cameroon	23	66	205	158	251	207
Syria	48	104	190	162	231	179
Palestine	0	0	170	165	171	175
Namibia	0	44	170	246	259	5
Uzbekistan	-	-	143	142	100	185
Madagascar	43	58	143	208	158	62
Korea Rep	842	2	139	172	93	151
Libya	19	177	138	165	125	125
Tanzania	8	38	136	192	139	77
Kenya	4	40	127	106	137	138
Oman	20	82	120	136	110	115
Kuwait	49	51	116	132	113	104
Jordan	21	91	105	98	112	105
Burkina Faso	1	78	104	167	127	19
Italy	12	67	101	137	76	89

Source of basic data: FAOSTAT database, FAO 2004 (Trade data update 08Jan2004).

Appendix Table 3. Trend in rice exports (000 tons), major exporting countries, 1970-2002.

Country	1970-72	1989-91	2000-02	2000	2001	2002
Thailand	1589	4887	7055	6141	7685	7338
Vietnam	9	1359	3480	3477	3721	3241
India	19	535	2927	1533	2194	5053
USA	1752	2593	2875	2736	2622	3267
China	1576	535	2383	3071	2011	2068
Pakistan	203	934	2041	2016	2424	1684
Uruguay	50	276	735	741	811	652
Myanmar	659	188	640	251	939	730
Italy	381	579	608	666	563	593
Australia	135	396	523	622	615	331
Egypt	542	87	505	393	656	464
Argentina	72	83	355	467	366	231
Spain	56	199	308	300	272	351
Guyana	68	50	250	207	367	174
Japan	564	0	209	42	561	24
UAE	15	165	201	104	201	297

Source of basic data: FAOSTAT database, FAO 2004 (Trade data update 08Jan2004).