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Westernization of Asian diets and the transformation of food systems: Implications for research and policy

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Abstract

Rapid economic and income growth, urbanization, and globalization are leading to a dramatic shift of Asian diets away from staples and increasingly towards livestock and dairy products, vegetables and fruit, and fats and oils. While the diversification of diets away from the traditional dominance of rice with rising incomes is expected and observed, current food consumption patterns are showing signs of convergence towards a Western diet. The diet transition is characterized by increased consumption of: wheat; temperate fruit and vegetables and high protein and energy dense food. Globalization and the consequent global interconnectedness of the urban middle class, is the driving force behind the convergence of diets. The rapid spread of global supermarket chains and fast food restaurants is reinforcing the above trends.

The growing demand for diet diversity cannot be met solely by the traditional food supply chain. It requires the modernisation of the food retail sector, and the vertical integration of the food supply chain, in effect linking the consumers' plate to the farmers' plow. As a consequence, Asian agriculture is on an irreversible path leading away from its traditional pre-occupation with cereal crop production, especially rice, towards a production system that is becoming increasingly commercialized and diversified.

This paper describes the determinants and trends in the diversification and Westernization of Asian diets. Implications of the evolving demand trends for food supply and retail systems are presented. The paper discusses the prospects for small farmer participation in the emerging food supply system, with a particular emphasis on Asian rice production systems. Finally, the paper considers emerging challenges for food policy, small holder welfare, and agricultural research and development priorities.

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Diet and nutrition change in Asia

The process of diet transformation in Asia can be seen as involving two separate stages: (i) *income-induced diet diversification and* (ii) *diet globalization and westernization.* At the start of the process of faster economic growth, diets diversify but *maintain predominantly traditional features*. As urbanization and globalization begin to exert their influence, we see the adoption of markedly different diets that *no longer conform to the traditional local habits*.

The main determinant of the changes in the demand for food in the first stage is income growth, which leads to major shifts in demand across different types of food, from inferior foods and towards more variety and higher value foods. The processes of urbanization and global integration bring about new dietary needs and general lifestyle changes (Popkin, 1999; Regmi and Dyck, 2001). As wages increase, people are willing to pay for more convenience, which frees up their time for income earning activities. They demand more processed foods with shorter preparation times, a feature that is typically seen as more women enter the work force (Regmi and Dyck, 2001; Kennedy and Reardon, 1994). With the smaller families typical of urban areas, such convenience becomes more affordable.

The new dietary habits reflect Western patterns, and could be quite unlike the habits that had developed locally over many generations. Consumers exhibit strong preferences for meat or fish, dairy products, temperate zone foods such as apples and highly processed convenience foods and drinks all of which are readily available in the emerging supermarkets and fast-food outlets.[2] The evolving diets are distinctly higher in fat and protein content relative to traditional Asian diets that emphasize carbohydrates. Since dietary habits are acquired at a young age, these transformations are most apparent with younger generations, who are forming their lifelong habits (Parraga, 1990; Mendez et al., 2004). Many Asian countries in economic and demographic transition already exhibit these dramatic trends in food consumption patterns (Shetty, 2002; Pingali and Khwaja, 2004).

A critical implication of the second stage is the *severing of the link* between diets and the local availability of resources and local habits. Consumers in large, urban centers are more exposed to non-traditional foods as a result of their access to food retail outlets and marketing campaigns (Reardon et al., 2003). Large urban markets create the scope for the establishment of large supermarket chains, and they attract foreign investments and advertising from global corporations. Non-traditional foods are more accessible as a result of trade liberalization and declining costs of transportation and communication (Chopra et al., 2002). The broad implications of these demand trends for food supply and retail systems are discussed in the next section.

[2] The adoption of a globalized diet should be seen as a dynamic process: once the national diet opens up to the world influence, it will always be subject to ongoing changes. Thus, over a longer time horizon, we may continue to see a sequence/series of discontinuous structural breaks. Future generations may start to consider the energy dense diet as their traditional diet and move away from this to one that is more healthy with increased income (see Popkin, 1993 for a full discussion).

Characterization of the diet transition in Asia

The following five key stylised facts characterize the changes in food demand in Asia: (i) reduced per capita consumption of rice; (ii) increased consumption per capita of wheat and wheat based products; (iii) rise in high protein and energy dense diets; (iv) increased consumption of temperate zone products and (v) the rising popularity of convenience food and beverages. The first is commonly associated with income induced diet change in Asia, while the latter four characterize a diet typically consumed in Western countries (Byrd-Bredbenner et al., 2000; Hu, 2002). The following is an elaboration on the key features of the diet transition that is in progress across Asia, which are also highlighted in Table 1.

Reduced per capita consumption of rice

As income increases in developing countries, consumers diversify their diets away from staples, such as rice, towards food groups with positive income elasticities of demand, such as fruit and vegetables, meat and livestock products. The trend towards diet diversification has been documented at the household level in poor and middle income countries in Asia, Africa, and Latin America (Mendez and Popkin, 2004; Hoddinott and Yohannes, 2002; Huang and Bouis, 1996; Behrman and Deolaliker, 1989). There is also substantial empirical evidence to indicate that rice consumption in Asia declines, on a per capita basis with income growth (Ito et al., 1989; Huang and David, 1993; Smil, 2000). The negative trend in rice consumption, on a per capita basis, is further exacerbated by urbanization (Huang and David, 1993). FAO projections indicate that the per capita consumption of rice will level off by 2015 and start to decline in the 2030 time period (FAO, 2003). Absolute declines in per capita rice consumption because of diet diversification in Asia are not yet widespread, but patterns established by the more advanced rice-eating countries (Japan, and the

Table 1
Changing compositions of Asian diets between 1979 and 2001 (FAOSTAT data)

		1979–1981	1984–86	1989–1991	1994–1996	1999–2001
Consumption (kg/cap/yr)	Rice	82.3	88.7	89.2	86.0	84.1
	Wheat	54.3	62.5	65.8	69.8	66.7
	Milk[a]	26.1	30.2	32.1	37.5	41.6
	Meat	11.4	14.0	17.1	22.4	26.3
	Beef	2.0	2.3	2.6	3.8	4.1
	Fish and seafood	9.6	11.0	12.6	15.9	17.8
	Animal fat	1.1	1.2	1.3	1.6	1.9
	Vegetable oil	4.6	5.8	6.9	7.8	9.0
	Vegetables	57.1	70.2	76.4	96.3	124.4
	Potatoes	10.6	11.1	12.2	14.7	22.6
	Sweet potatoes	33.3	24.3	19.4	17.6	15.4
	Fruits	27.8	30.1	32.2	40.8	46.0
	Apples	2.8	3.2	3.4	6.0	6.7
	Sugar and sweeteners	14.1	16.0	16.5	16.6	17.2
	Beer	3.1	4.0	5.9	8.3	9.3
Calorie consumption (cal/cap/day)	Total calories	2286	2463	2550	2637	2680
	% From cereals[a]	65.53	64.68	63.25	59.73	56.27
	% Animal source	7.92	8.85	9.96	12.14	13.66

[a] Milk excludes butter; cereals exclude beer; fruits exclude wine.

Republic of Korea) have started appearing in other developing countries, such as China, Malaysia and Thailand. FAO Food Balance Sheet data indicate that per capita rice consumption in China dropped from a peak of 94 kg per year in 1991 to under 90 kg in 2001. Rice's share in the average Thai diet fell from 60% to 43% between 1981 and 2001 (FAOSTAT).

It ought to be noted, though, that with income growth there will also be a significant shift into the consumption of high quality rice, such as, Japonica, Jasmine, Basmati, etc. (see Pingali et al., 1997). Chinese consumers, for example, now differentiate rice according to quality and attributes, including stickiness, fragrance, and gluten and protein content, with widely varying prices, reflecting high income elasticity for quality (Hsu et al., 2001).

Increased consumption per capita of wheat and wheat based products

While in Western societies, wheat is considered an inferior good and a decline in per capita consumption with income growth is observed, in Asia wheat is fast becoming the preferred staple (Pingali and Rosegrant, 1998). Moreover, urbanization was shown to have a positive effect on wheat consumption and a negative effect on rice consumption in Asia (Huang and David, 1993). A rise in wheat consumption is observed even as overall cereal demand per capita is stagnant or declining in many Asian countries (FAO, 2003). In Thailand, wheat consumption has tripled since 1981 while rice consumption has dropped substantially (FAOSTAT). In other words wheat begins to substitute for coarse grains and rice in daily diets. Wheat is not being used as a substitute in a traditional manner, but wheat consumption reflects western preferences. Traditional rice eating societies are consuming increasing quantities of wheat in the form of bread, cakes, pastry, pizza, and other products. In India, for example, western style bread consumption is rising as opposed to the use of wheat in *Chapati* preparation (Pingali and Khwaja, 2004). The increased value of women's time appears to be an important factor in the rising demand for bread in urban households in Sri Lanka (Senauer et al., 1986). Countries that traditionally imported rice for meeting food gaps may now be shifting towards increasing levels of wheat imports.

Rise in high protein and energy dense diets

A particularly striking feature of dietary transformation is the rising share of daily consumption of meat, milk and other animal products across Asia (FAO, 2003). Data from China shows that the declining intake of cereals and coarse grains during the past two decades in both urban and rural populations was accompanied by a dramatic increase in the consumption of animal foods over the same period, illustrating a shift away from carbohydrates to fat and protein[3] (Mendez et al., 2004; Ma et al., 2004). As a result of the consumption of more energy dense foods, calorie intake has typically gone up substantially, particularly for higher income groups. A similar, but less dramatic change is also observed in India with figures that suggest a doubling in the intake of fat calories over a 20 year period. In India, per capita consumption levels in 2001 indicate that, relative to 1979–1981

[3] An issue that is not dealt with in this paper, but which is of growing importance, is the health consequences of the diet transition. Increased consumption of highly-calorific and more energy-dense food could lead to an increased incidence obesity and of diet-related diseases, like diabetes, coronary heart disease and certain types of cancer (see Shetty, 2002). Popkin (2001) carried out an analysis of diet trends and nutritional status in India and China and calculated the economic costs of these changes. Whilst the incidence of undernutrition by their estimates is declining, the incidence of obesity, diabetes and hypertension is rising.

average, eggs and vegetable oil consumption doubled, while milk intake rose by 50% (Pingali and Khwaja, 2004; USDA, 2001). Meat consumption has also been growing in India, although not as fast as in China (Delgado et al., 1999). Across Asia, per capita meat consumption increased from 11 to 26 kg per year between 1980 and 2000 (Table 1). Consumption of sugars and sweeteners increased from 14 to 17 kg per person during the same period.

Increased consumption of temperate zone products

Products in this category include: temperate zone vegetables, such as potatoes; dairy products, such as cheese; meat, particularly beef and temperate fruit, such as apples. Rising consumption of potatoes is an indicator of the Westernization of Asian diets. In Thailand, per capita consumption of potatoes has increased tenfold since 1981, from less than 0.5 to 5 kg per person per year. Asians have been substituting temperate potatoes for sweet potatoes. Even as Asian per capita consumption of vegetables and potatoes has doubled since 1980, sweet potato consumption has fallen by half (Table 1). Bouis and Scott (1996) found potatoes to have positive income elasticities of demand in Bangladesh and Pakistan. Rising incomes have stimulated a demand for Western style fast food, including fried potato chips. Accordingly, Asia's share of global potato output jumped from 7.5% in 1961–1963 to 28.2% in 1995–1997 (Scott et al., 2000).

Cheese consumption is still lower in Asia than in any other region (FAOSTAT), but it has dominated growth in dairy consumption in both Malaysia and Japan (James et al., 2004). Urban Asians are relying more heavily on convenience foods and restaurants, which paves the way for cheese consumption in the region (Beghin, 2005). Similarly, per capita beef consumption remains lowest in Asia, although the region boasts the highest growth rates in beef consumption, 100% increase between 1980 and 2000 (Table 1). Asia is also the world's most dynamic market for apples. In China alone, per capita apple consumption has quadrupled over the past two decades. It seems given these figures that these trends will create irreversible changes in dietary habits.

The rising popularity of convenience foods and beverages

Urban areas are centres of economic opportunity and have a greater percentage of women working outside the home. The evidence clearly shows that women are participating more in the labor force, especially in the services sector (Elder and Schmidt, 2004). Given that the services sectors tend to be urban in nature, this explains why there is increased demand in urban areas for certain foods that reduce the preparation time of food in general and are also associated with lifestyle and income improvements. Studies have indicated that increased opportunity cost of women's time increases the demand for non-traditional "fast food" in many countries. Smaller family size, due to reduced fertility rates for working couples, may enable families to eat outside the home on a more regular basis and demand more convenience processed food.

In general, we expect to see an increase in the consumption of processed food, ready-made meals, or meals that cut the long preparation time of traditional dishes. There is evidence that diet transition is also witnessed in smaller and poorer households, especially with increased reliance on street foods (FAO, 2002; Ruel et al., 1998). Purchase of street foods frees up time for income-earning activities. Urban slums are often characterized by copycat street foods, that is, food stalls that seek to mimic the branded products of fast

food outlets (Pingali and Khwaja, 2004). Per capita beer consumption has tripled in Asia since 1980 (Table 1).

Transformation of food supply systems

Asia is observing a dramatic transformation in its food supply systems in response to rapid urbanization, diet diversification, and the liberalization of foreign direct investment in the food sector. The observed changes are in both the retail sector as well as in the production sector. This section describes the changes in food supply systems, with a particular emphasis on provisioning the cities and meeting the needs of the changing Asian diet.

Feeding the burgeoning urban masses is one of the most important food policy challenges facing Asia today and for the foreseeable future. There are three specific dimensions to the issue of feeding the cities. The first stems from the quantitative aspect. As mentioned earlier, urban populations are rising extremely rapidly, this requires not only increases in total urban food supply, but also the establishment of large suppliers in order to manage the increased level of activity in the market. The second dimension draws from the location of urban centres. Asia's most populous cities and towns tend to be located on the coast. Importing food to satisfy the changing food demand could be relatively easier and less costly than acquiring the same food from the domestic hinterlands. There will be a growing choice, at the margin, between domestic supply and imports, although one would suspect that both would rise in absolute terms. The third dimension derives from the qualitative aspect of demand changes in cities. The rapid diversification (and Westernization) of the urban diet cannot be met by the traditional food supply chain. It requires in effect the modernisation of the food retail sector, and the vertical integration of the food supply chain, including the diversification of cereal based farming systems of Asia. The above quantitative, qualitative, and organizational changes in the urban food supply drive the process of commercialization and diversification of domestic production systems.

Rising food imports

FAO' study on Agriculture towards the year 2015/2030 indicates that the trends in international trade of foodstuffs, which have seen developing countries turn from net exporters to net importers of food commodities, are expected to continue in the future. In 1961/1963 developing countries as a whole had an overall agricultural trade surplus of US$6.7 billion, but this gradually disappeared so that by the end of the 1990s trade was broadly in balance, with periodic minor surpluses and deficits. The outlook to 2030 suggests that the agricultural trade deficit of developing countries will widen markedly, reaching an overall net import level of US$31 billion (FAO, 2003).

Data on the structure of imports of temperate-zone commodities (wheat, coarse grains and livestock products) are revealing as to the changing dietary patterns in developing countries (FAO, 2003). Net imports of this category of products increased by a factor of 13, over the last 40 years, rising from a minor deficit of US$1.7 billion in 1961/1963 to US$24 billion in 1997/1999. What is important for the purposes of the discussion on the food economy is the expected pattern of food imports within the class of temperate zone products. While the cumulative increase in imports of those products is expected to be 154% between 1997/1999 and 2030, meat imports are expected to increase by 389% during the same period, while a cumulative increase of 17% is expected for vegetable oils and oil-

seeds. Where agro-climatically and economically feasible, one should anticipate an increase in domestic production of the more temperate zone commodities, such as wheat, potatoes, temperate fruit and vegetables, etc.

Recently, the most dynamic components of global trade have been non-bulk packaged products, which consumers differentiate by their unique brands and labels. These high-value commodities, including pastries, prepared foods, and chocolates, have grown in global trade by nearly 105% per year over the past 15 years. These commodities alone account for more than $15 billion in world trade, a value exceeding the value of world wheat trade. Trade in wine, a highly differentiated product, has grown at a rate of 6% a year and is now $7.4 billion and likely will surpass corn trade in value terms (Gehlhar and Coyle, 2001).

Emergence of super markets and fast food chains

Supermarkets and fast food chains arise from and reinforce the Westernization of demand that results from economic development and urbanization. Trade liberalization greatly facilitates their rapid spread. Supermarkets tend to replace central food markets, neighbourhood stores and street sellers of food in urban areas. Retail food trade in developing country urban centres will be characterized by the co-existence of major distribution chains and small-scale, ill-organized commercial outlets (De Haen et al., 2003). Reardon et al. (2003) argued that the supermarket revolution is taking off across Asia. By 2002, the share of supermarkets in processed/packaged food retail market was 33% in Southeast Asia, and 63% in East Asia. The share of supermarkets in fresh foods was roughly 15–20% in Southeast Asia and 30% in East Asia outside China. The 2001 supermarket share of Chinese urban food markets was 48%, up from 30% in 1999. Supermarkets are also becoming an emerging force in South Asia, particularly in urban India since the mid-1990s (Pingali and Khwaja, 2004).

Along with the growth in supermarkets, Asia has over the last decade observed a rapid rise in the number of Western fast food chains serving the big cities, and increasingly spreading out into smaller towns. Table 2 presents, as an example, the case of the spread of McDonald's in Asia between 1987 and 2002. Mc Donald's is a very visible indicator of the rapid change in diets in the Asia region and the evidence clearly shows that since 1987, the number of restaurants has grown quite markedly in Asia and the trend seems set to continue. The observed growth in fast food chains is not just from multi-national corporations, such as McDonald's, but also from domestic firms that begin to copy the products and operational procedures of the foreign companies. Although most visible in big cities, supermarkets and fast food chains are also making in roads into smaller towns, especially in East and Southeast Asia.

The vertical integration of the food supply chain

The change in urban food demand is almost simultaneously accompanied by consolidation in the retail sector. A vertically integrated food supply chain that links input suppliers, producers, processors, distributors and retailers becomes essential for meeting the changing demand requirements as efficiently as possible. From the consolidation of the retail sector, integration of the food supply chain has begun to move downwards towards the farm

Table 2
The spread of fast food chains in Asia/Pacific: Incidence of McDonald's outlets, 1987–2002 (from McDonald's Corporation Annual Report)

Asia/Pacific	1987	1997	2001	2002
Japan	604	2437	3718	3891
Australia	204	642	711	726
Taiwan	22	233	341	350
China	3	184	392	546
Philippines	13	157	231	236
South Korea	0	114	289	357
Hong Kong	36	140	185	216
Other	69	549	656	813
Total Asia/Pacific	951	4456	6523	7135
USA	7567	12,380	12,953	13,491
Europe	755	3886	5622	6052
Latin America	99	1091	1546	887
Global other	539	1319	2773	3543
Global total	9911	23,132	29,417	31,108

producers. Vertically integrated food supply systems are serving both the domestic as well as the export market. There are numerous examples across Asia of successfully integrated food supply systems that are managed from the farm to the consumers' plate.

In Thailand, international retailers such as 7-eleven, Royal Ahold, Tesco, Makro, and Sainsbury have been establishing supermarkets to serve the growing domestic market for fruit and vegetables. Small farmers have been integrated into the fresh food supply chains via networks of contract farmers and buyers who are preferred suppliers, and via informal farmers' associations (Van Roekel et al., 2002). Similar cases of agricultural diversification and the emergence of contracts between farmers and large food outlets can also be observed in India (see Sabharwal, 2003; Deshingkar et al., 2003). In India, companies such as McCain (major supplier to McDonalds') negotiate with small farmers directly for the provision of potatoes (see Sabharwal, 2003). In these types of agreements, the large food outlet undertakes the required investment necessary to produce the specific product.

Vertically integrated supply chains have also been focussing on the export market. Chen et al. (2003) provides an excellent example from China of the development of a vertically integrated vegetable export supply system in response to Japanese demand. Increasing proportion of Chinese vegetable exports to Japan has been produced under tightly coordinated supply chains. One of the possible reasons is that, while China has almost no quality standards on vegetables, Japan has one of the strictest standards in the world. Because of this difference in quality standards, Japanese vegetable importers conduct business very differently in China. For example, Japanese trading companies have typically provided the seeds, spores, and techniques of production and packing, and imported the harvest for Japanese retailers. The increasing demand for better quality and safety control has lead to larger-scale farming, using more automation in production, packaging and transportation, and ultimately lead to the creation of significant vegetable supply companies. This is likely to become a significant trend as more growers become actively involved in supplying the fast-growing supermarket and hypermarket chains that are spreading across China. There is a growing convergence between export standards and domestic retail product standards (Reardon and Farina, 2001; Bredahl et al., 2001).

New standards require better screening and monitoring precisely to ensure quality and safety requirements (Boehlje, 1999). These informational requisites incur costs that tend to diminish with farm size. Thus, entering the food system on a competitive basis is problematic for small farmers because of physical investments needed to enter but also because of the transaction costs associated with the new agricultural market. The next section discusses the prospects for small farmer participation in the emerging food supply system.

Commercialization of the small holder agriculture

The issue of agricultural commercialization and the small farmer is by no means new. Most developing countries have witnessed agriculture "moving away from traditional self-sufficiency" to an activity where "farm output is … more responsive to market trends" (Pingali and Rosegrant, 1995). It has long been understood that with increasing economic growth, small farm production systems could not remain static and would need to gear themselves to some degree of commercialization for their survival. The commercialization process today has a very different face from even that of 10 years ago. What is new in the story of commercialization is the focus on agribusiness, and the scale at which agribusiness is influencing the process of change. There is a much greater degree of integration between producers and the output market, with a strong emphasis on standards in relation to quality and safety. In this section we ask whether small farmers can be successfully integrated into the new agrifood system.

Small farmers face two main difficulties in trying to adapt to modern food systems. The first concerns their ability to commercialize from production systems that are often semi or fully subsistence, and the second concerns the actual crop or enterprise choice.

With respect to the first, we ought to recognize that Asian smallholder agriculture has gone through a significant process of commercialization and structural transformation (Timmer, 1988). For recent reviews of agricultural commercialization, see Reardon et al. (2004), Pingali et al. (1997), and Pingali and Rosegrant (1995). Empirical evidence on commercialization trends is provided by Dyck et al. (1993) for East Asia; Huang and Rozelle (1994) for China; Koppel and Zurick (1988) for Southeast Asia and Naylor (1992) for Indonesia. There is also a considerable literature (see Eastwood et al., 2005) that testifies to the productive efficiency of small farms, which argues that small farms, if they can overcome some constraints, are well-placed to enter markets. However, that efficiency is often rooted in traditional crop production, often for own consumption purposes.

The difficulty for small farmers is whether the existing production structures can be geared toward the market and at what cost. The players, rules, and relationships within new commercialized food systems are often alien to the small farmer (Napier, 2001) and raise the cost of entry into the market in two ways. First, there are increased costs of production stemming from the investments needed to meet the requirements of the output market. Second, there is a greater level of exchange with new players in input and output markets, which is inevitably more costly (Pingali et al., 2005). Not surprisingly, the new food systems tend often to favor scale. Moreover, poor public good provision and the absence of adequate regulation can interact with the specific requirements of commercial markets to exacerbate transaction costs further.

In the case of livestock and poultry production systems the evidence points to specialization and rapidly increasing scales of production. In China, for example, while livestock production was traditionally a sideline activity for farm households, more farms are now

specializing in livestock production. Chinese households that specialize in livestock production accounted for 15% of national livestock production in 2000 (Fuller et al., 2001). Both global analyses and country case studies (conducted by FAO in Brazil, India, Thailand and the Philippines) confirm that advanced technology embodied in breeds and feeds appears to be critical to the success stories for poultry around the world, and the same is likely to become true for hogs over time. Much of this technology appears to be transferable, but only at relatively large-scales of operation, at least for poultry. Thus there is strong reason to believe that technology itself is a prime driver of the displacement of smallholders from the livestock sector. Small-scale producers obtain lower financial profits per unit of output than large-scale producers, other things equal. This suggests that, in the absence of deliberate action, small-scale producers will eventually be put out of business by competition from large-scale producers, especially since the better-off producers will scale up (De Haen et al., 2003).

In the case of the crop sector, rapid changes in the food system have put increased pressures on small farmers to diversify away from staples and harness the lucrative gains that derive from the production and trade of high-value crops. This often seems to imply that small farmers face an either/or option in terms of their crop choice. Small farms either stay in staples, which are regarded as unprofitable, or they make the changes to shift to alternative high-value production. The potential gains from high-value crops tend on average to be higher than those for staples even though production of high-value crops can be accompanied by greater uncertainty and risk. For small farmers specializing in high-value output, a critical question remains as to whether their size can profitably support such activities long-term. In addition, to a large extent crop choice is determined a priori by the land potential available to small farmers. So, while high-value crop production may promise higher rewards, that option is not open to all small farmers. For some small farmers, at best, commercialization can offer the possibility of some diversification into non-staples, but not a total specialization. The case of rice farming systems is illustrative of how small holders adjust to the process of commercialization and diversification.

The diversification of rice-based farming systems

Commercialization and diversification pressures are leading to a dramatic transformation of the rice monoculture systems of Asia. The FAO-World Bank Study (FAO, 2001) characterized developing country agriculture in terms of eleven broad farming systems. The three most important systems described in the study are all rice-based farming systems (see Table 3), and generally smallholder systems, these are: the tropical lowland rice system; the rice–wheat system and the rainfed uplands. They account for about 80% of the agricultural population and some 50% of the total agricultural area in Asia. The tropical lowland and the rice–wheat systems are the dominant sources of rice supply in Asia, these systems witnessed rapid productivity growth during the Green Revolution and their productivity continues to be high in the post-green revolution period. Yet, the pressure to diversify out of rice is also the greatest in these systems, primarily because of low returns to rice relative to high-value alternatives such as vegetables (Pingali et al., 1997).

A framework for assessing the flexibility of rice lands and rice growers to respond to the commercialization trends through seasonal or permanent diversification out of rice mono-

Table 3
Main rice-based farming systems in Asia

	Tropical lowland rice	Rice–wheat	Rainfed uplands
Agricultural population			
Millions of people	604	416	636
% of region	32	22	26
Cultivated area			
Million hectares	93	93	189
% of region	11	9	30
Irrigated area			
Million hectares	42	158	38
Principal livelihoods			
	Irrigated and rainfed rice, vegetables, legumes, off-farm activities	Irrigated rice; wheat, vegetables, livestock including dairy, off-farm activities	Cereals, legumes, fodder, livestock, horticulture, seasonal migration and off-farm activities

Source: Tables 5.1 and 6.1, *Farming Systems and Poverty* (FAO, 2001).

culture systems has been developed by Pingali et al. (1997).[4] According to them, the potential for diversification out of cereal production depends on both physical and economic factors. The feasibility and cost of substituting other crops vary across the three farming systems: lowland rice, rice–wheat and rainfed uplands. Each of these systems presents different rainy and dry season profiles and requires different levels of physical and human capital investment to switch from rice to non-rice crops and vice versa. The flexibility of growing temperate zone crops is also severely restricted, and would be generally feasible only in the sub-tropical rice–wheat production zone, and in the mountain agricultural systems.

The flexibility of farmers to respond to the changing relative prices and relative profitability in their crop choice decision-making can be described in terms of the level of investments (both physical and human capital) required in switching from rice to non-rice crops and vice versa. Flexibility is low, during the rainy season, for the tropical lowlands and the rice–wheat zone, because the drainage costs for growing non-rice crops can be prohibitive (Pingali et al., 1997). Upland areas, however, can oscillate between rice and non-rice crops with minimum additional investments.

Access to markets and the relative prices of rice and non-rice crops, especially horticulture, are additional determinants of diversification. Whilst roads and market places are important, proximity to the urban areas expands the range of non-rice diversification options especially for fresh produce.

During the wet season, rice will continue to be the dominant source of income in all but upland environments. This is not to imply that rice is not an important source of income for the uplands, but rather to stress the fact that the uplands have always been diversified because they do not face the drainage constraints.

In the irrigated lowland rice and rice–wheat systems, dry season rice and/or wheat would continue to be the major source of income. Areas with good market access and

[4] This section draws heavily from Pingali et al. (1997, Chapter 8).

those near urban centres would increasingly diversify to non-rice crops and vegetable production. The dominant dry season activity for the rainfed lowlands would essentially be non-crop activities, off-farm employment, livestock production and cottage industries. There is a scope for post-rice crops on residual moisture, or pre-rice crops during the early wet season. However, the share of total income from this activity would be relatively lower than from the other activities. Dry season cropping activities in the rainfed areas are limited because of technical problems related to timely and effective crop establishment, limited moisture (or excessive moisture in some cases), and generally modest or high yield instability. Off-farm activities are often more dependable sources of income, suggesting that dry season cropping intensities would remain low even if technical problems in crop production were solved.

Constraints to diversification out of rice systems

Diversification out of rice is constrained by market availability and size, land suitability and rights, irrigation infrastructure and labor supply. Where output demand is relatively elastic, the returns from investments in land, technology, and time spent in learning about new crops, are relatively higher.

Liberalization of domestic markets, through removal of quantitative restrictions on trade, and opening up of economies to internal trade opportunities is often a key step in starting or accelerating the process of commercialization. Many low-volume markets are associated with high-price volatility. Moreover, the diversification "start-up" phenomenon, of high prices for several seasons leading to over-supply and a consequent collapse of prices, is all too common. This can be countered by measures to expand the market by lowering transaction costs, improving external linkages or providing storage and processing technologies. Effective rural financial institutions will also assist in risk spreading and in the sharing of the benefits of commercialization more widely across the community and region.

The ability to profitably convert ricelands to non-rice crops is constrained by the drainage requirements for the lowlands and erosion control investments in the uplands. It is important to understand that not all lands can be converted to non-rice production. Even for lands that can be converted, substantial investments in land improvements need to be made to sustain long-term productivity and profitability of non-rice crop production.

Secure rights to land create the incentives farmers need to invest in land improvements that conserve and increase the long-term productivity growth which can be induced by the start of commercialization (Pingali and Rosegrant, 1995). Secure land rights increase the probability that farmers would recoup the benefits from long-term investments (e.g. land development, orchard development, etc.), thereby increasing their willingness to make investments on them. Land titles act as collateral to loans and thereby enhance lender's willingness to offer credit, leading to easier financing of purchased inputs and land improvements.

Large-scale diversification of cropping systems necessarily involves diversified production in the irrigated lowlands, because of the importance of irrigation to overall agricultural production. Many observers have argued that the existing irrigation systems constrain diversification because of the rigid designs of infrastructure and inflexible water delivery systems (Schuh and Barghouti, 1988). It is argued that this inflexibility prevents appropriate allocation of water to non-rice crops, constraining farmers to rice monocul-

ture. Based on these arguments, technology-based solutions to diversification within irrigation systems are advocated, mainly capital investment in improved conveyance, diversion, and drainage systems. An alternative argument would be that the failure to diversify within the irrigation systems is the result of incentive failures resulting from centralized allocation of un-priced irrigation water. Policies that establish markets in tradable water rights could create incentives to economies on water and choose less water-intensive crops (in the dry season); by inducing water users to consider the full opportunity cost of water (Rosegrant et al., 1995). Establishment of transferable water rights can provide maximum flexibility in responding to changes in crop prices and water charges as demand patterns and comparative advantage change and diversification of cropping proceeds (Rosegrant and Binswanger, 1994).

Does diversified cropping increase labor requirements? Yes; relative to rice, the per hectare labor requirements for onions, vegetables and other high-value crops are substantially higher (Pingali et al., 1997). Provision of temporary drainage structures immediately following rice harvest is an essential, labor-intensive activity. Planting, weeding, harvesting and post-harvest operations are also extremely labor-intensive for these crops. Given the higher labor requirements for crop and drainage, non-rice crops on irrigated lands are grown on extremely small plots, in general about a fourth of the rice area.

In addition to crop labor requirements, the supervision time required from the farmer is also significantly higher: this may be the dominant labor constraint to high-value non-rice crop production given the highly inelastic nature of management labor available in the farm household, compared to the hired labor augmented by seasonal migrants. The problem of adequate supply of family and hired labor is further exacerbated by rising off-farm employment opportunities with economic growth.

Challenges for food and research policy

The persistence of hunger in most Asian countries means that ensuring adequate and nutritious food for the population will remain the principal challenge facing policy makers in the years to come. However, the rapid transformation of diets and the changes in food systems at all levels (production, processing and distribution/retail) pose a number of important additional challenges to food security and food policy, small holder welfare, and agricultural research and development priorities.

Dealing with emerging health and food safety concerns

Changes in diets towards higher fat and sugar content are expected to result in higher incidence of diet-related non-communicable diseases (NCDs). Already, a number of countries experience what is termed "epidemiological transition", i.e. a gradual shift from a prevalence of infectious diseases to the prevalence of chronic ones associated with changing diets and a sedentary lifestyle. NCDs take an enormous toll in lives (33 million premature deaths worldwide) and account for 58.5% of premature deaths due to heart disease, stroke, cancer, diabetes and lung diseases affecting the most productive age-cohort of the population (World Health Organization, 2002). The paradox lies in the fact that the incidence of nutrition-related NCDs can occur alongside high prevalence of hunger and malnutrition in the same context (country, city, district or household). In China, 8.1% of households had an underweight and an overweight member within the same household

(Doak et al., 2002). The poor may be even more prone to obesity due to predisposing factors associated with low birth weight and childhood undernutrition (Stamoulis et al., 2004).

Urbanization is likely to increase the "effective demand" for food safety. In developing countries, the informal sector is often a significant producer, processor, distributor and preparer of food and food products (e.g. street foods). On one hand, there is a need for greater regulation and food safety control. On the other, public systems to ensure food quality and safety suffer from lack of organization and adequate funding. When imposing standards that are difficult and costly to achieve, policy makers need to be wary of the implications for low-income food producers, sellers and consumers. Regulation has to be accompanied by capacity building, nutrition education and other means of support.

To the extent that developing country governments do not impose international-level standards, private standards are being implemented by the leading players in retail and food processing (Reardon and Farina, 2001). Hazard Analysis and Critical Control Point (HACCP), ISOs, traceability systems and private quality labels are becoming entry tickets to international markets and increasingly the reference for quality in the domestic market of developing countries. This has led to an acceleration of obligational contract relations with raw material suppliers, involving detailed specification of production and delivery conditions. There is much evidence to suggest that this is leading to a considerable degree of exclusion of small farms and firms (Wilkinson, 2003).

Creating an enabling environment for smallholder transformation

The challenges faced by smallholder agriculture should be seen in the context of the general trends that will influence the structure of agricultural production. Namely, the transformation of diets and rising import competition will contribute to the increasing commercialization of the farm sector in Asia. Governments ought to help create an enabling environment for smallholder commercialization through infrastructure investments and institutional reform. "Retooling" smallholders with appropriate technology and knowledge that makes them able to face the requirements of the changing market conditions will be a formidable challenge for research and extension systems.

Rural infrastructure investments play a crucial role in inducing farmers to move toward a commercial agricultural system. The emphasis for public investments should be on improving general transport, communications, and market infrastructure, while allowing the private sector to invest in commodity-specific processing, storage, and marketing facilities. Accessible and cost-effective communication systems such as mobile telephones can help generate information and other market-related services. The Internet explosion and related technologies have drastically reduced exchange and search costs in many Organisation for Economic Co-operation and Development countries and may be highly indicative of the potential benefits to developing countries (Bussolo and Whalley, 2002).

Efficient land markets and secure property rights are essential to capture agricultural growth (Binswanger et al., 1993). Where land rights are secure, farmers have the greater incentive needed to invest in land improvements. Moreover, land ownership is an important source of collateral that can improve the credit status of farmers, leading to easier access to funding for inputs and so forth (Feder et al., 1988). Individual farmers and house-

holds need to be assured "stable engagement" with other resources, such as water, water use rights that are flexible enough to promote comparative advantage in food staples and cash crops. Those rights must be matched by access to rural credit and finance and the dissemination of technology and good practices in water use (De Haen et al., 2003).

Re-orienting agriculture research and development priorities

The primary objective of the research system during the process of commercialization and diversification remains to generate new technologies that improve productivity and farmer income. Governments have a difficult task to perform: on one hand, continued food security needs to be assured for populations that are growing in absolute terms; on the other hand, research and infrastructural investments need to be made for diversification out of the primary staples. In responding to diversification trends, the research should not abruptly shift from an exclusive focus on one set of commodities to another set of commodities. In addition to the productivity objective, the focus of research should be to provide farmers the flexibility to make crop choice decisions and to move relatively freely between crops.

Both substantial crop-specific research and system level research effort will be required to provide farmers the flexibility of crop choice. Crop-specific research includes increases in yield potential, shorter duration cultivars, improved quality characteristics and greater tolerance to pest stresses. System-level research would include land management and tillage systems that allow for shifts of cropping patterns in response to changing incentives and farm level water management systems that can accommodate a variety of crops within a season. Also important at the system level is research on the carry over effect of inputs and management practices across crops, for instance, high insecticide and herbicide applications, or the effects of intensification in terms of prolonged water saturation, the build up and carryover across crops of pest populations, rapid depletion in soil micronutrients and changes in soil organic matter could lead to reduced productivity of rice monoculture systems over the long-term.

Given growing populations and income induced demand for increased cereal consumption (for populations at low income levels) there continues to be a strong need to seek higher productivity levels for the staple cereals. The need for increasing the productivity of cereals is higher the greater the diversion of high potential irrigated lands to non-cereal pursuits.

In summary, the process of commercialization should not be expected to be a frictionless process. Significant equity and environmental consequences can arise in the short-to-medium term unless appropriate policies are followed. Long-term strategies to facilitate a smooth transition to commercialization include investment in rural markets, transportation and communications infrastructure to facilitate integration of the rural economy; investment in research, to increase productivity and improve resource management, and extension to increase farmer's flexibility in crop and enterprise choice and establishment of secure rights to land, water and other resources.

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