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AGRICULTURAL DIVERSIFICATION: OPPORTUNITIES AND CONSTRAINTS

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Agricultural Diversification: Opportunities and Constraints

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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. The tendency for rice consumption, per capita, to decline with income growth and with urbanization has been widely documented in the literature (Ito, 1989; Huang and David, 1992). 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, Republic of Korea, and Taiwan Province of China) have started appearing in other developing countries, such as China and Thailand.

The aggregate demand for rice will grow at a much slower rate than in the past, from 2.6% per annum in the 1980s to 1.6% in the 1990s to 1.2% in the period to 2015 and on to 0.8% per annum after 2015 (FAO, 2003). Even if the demand grows at a slower rate, global production must reach about 800 million tons of un-husked rice by 2030 to match demand, an increase of about 200 million tons over the peak production levels in recent years (Hossain and Narciso, 2004). With the slowdown in yield growth in recent years, and the growing scarcity of factors of production, maintaining growth in aggregate rice production even at much lower rates will be no mean task and may require no less effort (in terms of research, infrastructure investment, policy, etc) than in the past.

The rice sector in Asia is facing the dual challenge of sustaining high rates of rice productivity growth while at the same time transforming itself from a subsistence oriented monoculture system to a diversified market oriented system. This paper examines the scope for the diversification of rice-based farming in Asia. Economic, agro-climatic and technological constraints to the commercial transformation of subsistence rice systems are identified. Priorities for research, and the primary components of a policy agenda, are described.

The Diversification of Rice-based Farming Systems

As economies grow, there is a gradual but definite movement out of subsistence food crop production, generally in a monoculture system, to a diversified market-oriented production system. The process of diversification out of staple food production is triggered by rapid technological change in agricultural production, improved rural infrastructure, and diversification in food demand patterns. The need to provision the rapidly growing cities of Asia also acts as a trigger for the transformation of food production systems. Declining profitability of rice cultivation, acts as a further incentive for seeking alternative means of sustaining incomes. In fact, a recent FAO/World Bank study on farming systems and poverty has suggested that diversification is the single most important source of poverty reduction for small farmers in South and Southeast Asia (FAO and World Bank, 2001).

Yet, in almost all South and Southeast Asian countries, agricultural policies and institutions have favored self-sufficiency in cereals and the inertia in this system would act as a strong disincentive for diversification unless drastic changes in policies and institutions are adopted. An example of this is the fact that the share of cereals in the value of agricultural output has generally remained unchanged in South Asia as a whole. In general, the export prospects are unlikely to affect a majority of farmers even if some specialized production for niche export markets were to take place. Such production would be on a limited scale at least with respect to the total agricultural population. Therefore, the dynamics would largely be driven by the domestic demand.

In this section the focuses on the scope for the diversification of rice farming systems in Asia. The FAO-World Bank Study (2001) characterised 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 1), 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).

Table 1: Main Rice-Based Farming Systems in Asia

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

Source: Tables 5.1 and 6.1 *Farming Systems and Poverty, FAO 2001*
Note: Population figures in millions, area figures in million hectares.

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 monoculture systems has been developed by Pingali et al. (1997)[1]. 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 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

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

(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 specially 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 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.

The above discussion leads to the conclusion that irrigated environments, while providing an absolute advantage (relative to the other environments) in a rice-rice cropping pattern, may also have a comparative advantage in a rice-non-rice cropping pattern. The extent of comparative advantage for the irrigated lowlands in dry season diversification would depend on the physical constraints and the market opportunities for non-rice commodities. On the other hand, during the wet season, the upland environments have both, an absolute and a comparative advantage in non-rice commodities, as well as in a range of complementary livestock activities.

Diversification Constraints

Diversification out of rice is constrained by market availability and size, land suitability and rights, irrigation infrastructure and labour 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.

a) Diversification and Risk

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. However, the opening up of markets also exposes producers to increased risk due to the greater volatility of world prices. Governments have historically intervened heavily in domestic markets to protect and stabilize the prices of agricultural commodities, with the result that domestic producer prices have varied substantially less than international prices. The relationship between diversification and risk is thus crucial in the context of trade and macroeconomic reform designed to align domestic prices more closely with international prices.

Diversification from a rice-monoculture system to non-rice crop system could lead to increased variability in farm household incomes, which basically come from yield or price fluctuations. Timmer (1992) has argued that the two sources of income variability are seldom negatively correlated to a sufficient degree for individual farmers to produce income stability and neutrality of decision making by the farmer. Timmer has cited the case of Indonesia, where price risks from growing rice are significantly smaller than for other crops.

Risk aversion is a significant impediment to what would seem to be a rational diversification on the basis of average profitability of alternative crops. Behaviour in the face of risk aversion is affected by attitudes of farmer and the nature of technology. But the fundamental problem is the failure of local credit and risk institutions to provide any potential to farmers for transferring their risks to other parties. Risk avoiding thus becomes an internal household strategy, and many households concentrate on growing a familiar crop with known technology and yields and guaranteed prices rather than risking their livelihood on new crops with untested price patterns.

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.

b) Land Suitability and Land Rights

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. Investments in land improvements are likely to be made only where secure rights to land exist.

In the irrigated lowland rice and rice-wheat systems, when the dry season returns to non-rice crop production dominate the returns to rice production the demand for and the price of land with the least constraints to diversification out of rice will be the highest. If market access is good, the profitability of diversified field crop production on soils not highly susceptible to erosion, is high. For soils susceptible to erosion, profitability of field crop production is determined by the level of erosion control investments. Where such investments are high, tree crops may be a more viable option than field crops, particularly when land degradation has been allowed to occur through field crop production. In upland areas with poor market access, the returns from diversification out of subsistence rice production are limited in areas of either type of soil.

The relationship between the flexibility of crop choice and erosion control investments becomes pronounced on the sloping uplands, which are extremely susceptible to soil erosion. There are various options for erosion control to maintain permanent cropping on these lands, ranging from grassy strips to stone wall terraces. Farmer's choice of erosion control strategy depends on population pressure on the land, market access, and the appropriate erosion control techniques available. Pingali (1990) and Fujisaka and Garrity (1998) have argued that farmer's interest in erosion control measures is directly related to land values and market access and is conditional on availability of suitable technologies.

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.

c) Irrigation Infrastructure as a Constraint to Diversification

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 monoculture. 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 establish incentives to economise 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).

d) Labour Constraint

Does diversified cropping increase labour requirements? Yes; relative to rice, the per hectare labour requirements for onions, vegetables and other high-value crops are substantially higher. Labour requirements, for providing temporary drainage structures, is an essential activity immediately following rice harvest. Planting, weeding, harvesting and post-harvest operations are also extremely labour-intensive for these crops. Given the higher labour

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.

Does diversified cropping aggravate labour peaks between the harvest of the rice crop and the planting of the non-rice crop? As discussed above, additional labour is required for constructing temporary drainage structures; and additional labour or mechanical power is required for land preparation. The land preparation activity for non-rice crops following rice would require breaking the paddy hardpan (the compact soil surface caused by puddling paddy soils). If this hardpan is not broken, there would be problems with root penetration and hence the establishment of a non-rice crop. The power requirements for this soil modification are higher on heavy clay soils than on lighter soils. Mechanization to an extent can alleviate this labour peak. However, the machine power required for upland crops is substantially higher than that required for puddling rice paddies. The incompatibility in machines for tillage of rice versus upland crops can be overcome by contract hire operations, which however would be profitable only when large areas are grown to non-rice crops.

In addition to crop labour requirements, the supervision time required from the farmer is also significantly higher: this may be the dominant labour constraint to high-value non-rice crop production given the highly inelastic nature of management labour available in the farm household, compared to the hired labour augmented by seasonal migrants.

Implications for Research

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. 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 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 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.

To what extent should the research system be concerned with technological developments in marginal or unfavourable environments? In large countries, such as India and China, with high domestic demand for cereals, the answer is relatively clear: investments in marginal environments are absolutely essentially for ensuring food security, even if the countries are integrated into the global economy. Cost-effective research investments would be in areas where the spill-over benefits from the favourable environments are high. Identification of strategies for diversifying the income and livelihood base of the farm households in these environments should also be an important area for research and policy.

Agenda for food and agriculture policy

Commercialization and diversification of agricultural systems is a universal phenomenon that is triggered by economic growth. While the rate at which this transformation occurs varies by continent and by country within continents, the direction of change is the same across the world. Structural adjustments and trade liberalization policies that are currently being implemented in much of the developing world can be expected to further enhance the speed at which the commercialization process is occurring.

South and Southeast Asia are no exception. The process of income growth accompanied by urbanization has led to a significant shift in consumption patterns away from cereals and towards high-value agricultural products such as vegetables and fruits, oils and fats, and livestock products.

Commercialization trends require a paradigm shift in agricultural policy formulation and research priority setting. The paradigm of staple food self-sufficiency that has been the cornerstone of agricultural policy in most developing countries is becoming more and more obsolete with economic growth. This can be demonstrated with the example of South Asia where the share of cereals in agricultural output has remained unchanged despite a marked

decline in the share of cereals in consumption. The principal reason is inappropriate government price support policies and associated institutions for cereals in some countries.

The relevant development paradigm for the 21st century is one of food self-reliance, where countries import a part of their food requirements in exchange for diverting resources out of subsistence production. Future emphasis of agricultural policy ought to be on maximizing farm household incomes rather than generating food surpluses.

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. The tendency of governments to react to short-term `crisis situations' may be counter-productive in terms of meeting long-term goals of food security and income growth. "Ultimately the process of rural diversification must be consistent with the longer-run patterns of structural transformation" (Timmer, 1988).

The process of agricultural diversification should not be expected to be a frictionless process. The main contribution of this paper is to draw attention to some neglected aspects of diversification, especially the biophysical and economic constraints to the process in different farming systems. The flexibility of farmers in responding to diversification opportunities is constrained by the size of markets and price risks, soil suitability and land rights, availability and quality of irrigation infrastructure, and availability and cost of labour.

Significant equity and environmental consequences can arise in the short-to-medium term unless appropriate policies are followed. For example, the absorption of rural poor in the industrial and service sectors involve significant costs in terms of providing training in new skills and family dislocations. Also, where property rights are not clearly established, high-value crop production in the upland environments could lead to higher risks of soil erosion and land degradation.

Appropriate government policies can alleviate many of the possible adverse transitional consequences arising from the process of commercialization and diversification. 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 crop improvement research to increase productivity, and crop management and extension to increase farmer’s flexibility and reduce the possible environmental problems from high input use; and establishment of secure rights to land and water to reduce risks of farmers and provide incentives for investment in sustaining long-term productivity.

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