Diversification in South Asian Agriculture: Trends and Constraints

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Abstract

This paper provides an assessment of the agricultural diversification trends in South Asia. In the first part food consumption and crop production patterns in the region during the last twenty years are reviewed. Next, the agronomic and economic options for and constraints to diversification in the main agricultural systems are discussed based on a framework for assessing the flexibility of ricelands and rice farmers to respond to the commercialisation trends through seasonal or permanent diversification out of various farming systems. The principal 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, the availability and quality of irrigation infrastructure, and the availability and cost of labour. Long term strategies to facilitate a smooth transition to commercialisation are recommended.

Key Words: South Asia; Agricultural Diversification; Consumption and Production Trends; Diversification Constraints; Structural Transformation.

JEL: O13; Q10; Q18;

DIVERSIFICATION IN SOUTH ASIAN AGRICULTURE: TRENDS AND CONSTRAINTS[1]

Introduction

South Asia has a long history of intensive agriculture - irrigated rice based farming systems in particular. Food self-sufficiency policies are the main basis of sector policies in the region. During the past 30 years the research and agricultural support services of the system have generated growth in food production in excess of population growth, and reduced the proportion of people living in poverty. Over the same period there has been significant income growth, diet diversification and declines in per caput cereal consumption.

South Asia has recently witnessed sweeping reforms after years of inward-looking economic policies and tight regulations. South Asian nations have reduced tariffs, removed trade barriers, dismantled restrictions on domestic and foreign private investment and reformed their financial systems. Average tariff rates have declined from around 90-100 % to the 17-32 % range (World Bank, 2002).

Although the agricultural sector has so far been left relatively untouched by these changes, the reduction in protection to industry has reduced the implicit tax on agriculture. Protection to agriculture will also have be reduced in the coming years. Farming systems in the region are thus likely to evolve rapidly during the coming 30 years as technologies, institutions and markets change in response to the integration of these economies with the international economy.

As the South Asian economies evolve there will naturally be a gradual but definite movement out of subsistence food crop production to a diversified, market-oriented production system. Initially diversification implies the addition of other crops and other enterprises at the farm household level. As the level of commercialisation increases mixed farming systems are expected to give way to specialised production units that are designed to respond rapidly to market price and quality signals. Diversification at the agricultural sector level will entail specialisation at the farm level.

The objectives of the paper are to:

[1] The authors would like to thank John Dixon, AGSF (FAO), for his valuable comments and contributions.

a) briefly review the consumption and production trends in South Asian agriculture; and,
b) identify the agronomic and economic options for and constraints to diversification in the main agricultural systems.

I. An Overview of Food Consumption and Production Trends in South Asia

Historically the agricultural sector has generated the surpluses that have supported the growth and development of other sectors of the economy. The structural transformation process, by which increasing proportions of employment and output of the economy are accounted for by sectors other than agriculture, is most advanced in Sri Lanka, where agriculture comprises about 1/5th of total GDP. In India and Pakistan agricultural GDP comprises about ¼ of total GDP. In the region as a whole, the agricultural sector contributes 26 % to GDP and generates 16% of the value of total exports. It also provides a livelihood to 55% of the total population[2].

During the 1981-2000 period GDP *per-caput* in South Asia grew at 3.3% per annum, in India at 3.5% p.a and in Sri Lanka at 2.8% p.a. Pakistan grew at 5.8% per annum; in India at 5.6% per annum. Most recently (1996-2000) India and Sri Lanka registered growth in *per caput* GDP of 3.6 % while Pakistan experienced almost negligible growth of 0.6% per annum (See Table 1).

Table 1: Annual growth in GDP per caput

Years	1967-80	1981-2000	1981-1990	1991-2000	1996-2000
South Asia		3.3	3.2	3.4	3.2
Bangladesh	-0.5	1.8	1.1	2.9	3.4
India	1.3	3.5	3.3	3.7	3.6
Nepal	0.0	2.4	2.8	2.1	2.0
Pakistan	2.6	2.1	3.4	1.3	0.6
Sri Lanka	3.0	2.8	2.1	3.8	3.6

Source: World Bank, World Development Indicators, 2002 (CD-ROM)

[2] FAOSTAT, 2003. This estimate comprises all persons actively engaged in agriculture, hunting, fishing or forestry *and their non-working dependants* as a proportion of the total population.

GDP growth in South Asia was accompanied by a decline in the relative importance of agriculture. The share of agriculture in the total GDP of Bangladesh varied between 50 – 60 % during the stagnant growth period of 1966-78, before commencing a steady decline to 25 % in 2000. India's agricultural GDP share declined from 45 % to 25 % between the early 1970s and 2000. Both Pakistan and Sri Lanka experienced slower declines in the share of agriculture GDP from 37 % to 26% and from 28% to 19% respectively over the same period. Nepal's structural change was more marked with a decline from 71% of total GDP in the mid-1960's to 40 % in 2000.

The proportion of the population dependant on agriculture for their livelihoods declined slowly in Bangladesh and India to about 55% by 1998-2000. For Nepal and Bhutan the corresponding figure is over 90%, while in Pakistan and Sri Lanka the proportion is about 50%. This general trend in the withdrawal of labour from the agriculture sector is likely to raise agricultural wages and speed up the commercialisation and diversification of farming systems.

These shifts were accompanied by a decline in the share of agricultural exports in total exports to the extent that agricultural exports constituted no more than 15% by 2000.

A. Food Consumption

Growth in population, income and urbanisation in tandem with institutional developments have contributed to changes in the consumption patterns as well. The share of urban population has grown rapidly in all countries (See Table 2). Pakistan leads with an urban population of 37% that is growing at an annual rate of 4.3% while India's urban population constitutes 28.4 % of the total national population.

Table 2: Urban Population Growth Indicators

	As % of Total Population			Annual Growth Rate of Urban Population		
Years	1980	1990	2000	1975-1980	1985-1990	1995-2000
Bangladesh	14.4	19.3	21.2	6.8	5.2	4.6
Bhutan	3.9	5.2	7.1	4.6	5.4	6.1
India	23.1	25.5	28.4	3.7	3.0	2.8
Maldives	22.3	25.9	28.3	7.0	3.5	4.5
Nepal	6.5	8.9	11.9	7.9	5.4	5.4
Pakistan	28.1	31.9	37.0	3.9	4.6	4.3
Sri Lanka	21.6	21.3	23.6	1.3	1.4	2.3

Source: ADB (2002)

Per caput consumption of food energy in South Asia has risen from 2,000 kilocalories *per caput* per day in 1974-76 to 2,400 kilocalories per caput per day in 1997-99, representing a 21 % increase over 23 years[3].

Higher income, urbanisation and improved transportation have dramatically altered food consumption patterns in South Asia, in accordance with Engel's Law, one of the most well-established laws in Economics. Engel's Law states that the share of food in current expenditure declines as income rises. It is also frequently observed that the share of food expenditure on cereals declines with rising incomes, and often even the quantity consumed.

Data from the national sample survey (NSS) for India show that cereal consumption in rural areas declined from about 17 kilograms per person per month to about 13 kilograms per person per month between 1959-60 and 1993-94 while real *per caput* GDP roughly doubled to about US$400 in 1995 prices, over the same period[4]. Huang and David (1993) show that urbanisation leads to significantly reduced demand for cereals in higher income Asian countries and greater meat, fruit and vegetable consumption in urban areas. Pingali and Rosegrant (1998) have observed that as incomes increase rice becomes an inferior good in Asia. The income elasticity of demand for wheat is positive and rises rapidly as countries graduate from low to middle income levels, which is germane to the emerging situation in South Asia.

For a better understanding of the changes in the pattern of food consumption in the region the available data from household surveys for some of the South Asian countries were examined for this study[5]. Differentiated rural and urban data on household expenditure on different food groups in some of the South Asian countries, as presented in Table 3, indicate the following trends:

a) share of cereals in total expenditure on food is higher for rural areas;
b) rural residents consume relatively more cereals than their urban counterparts who tend to have a more varied diet;
c) both groups tend to reduce their cereal consumption over time in favour of more income elastic foods such as fruits, vegetables and dairy products[6];

[3] FAO (2003), p. 55.
[4] Suryanarayana (2000).
[5] The information was extracted from FAO (1993).
[6] The slightly anomalous results for Sri Lanka—the relatively high share of cereals in expenditure and its failure to decline—can partially be explained by noting that there were significant subsidies on the consumption of

d) after cereals, which account for about half the household food budget, the next major item of expenditure is on milk products in the case of India and Pakistan whilst for coastal countries such as Bangladesh and Sri Lanka the next major expenditure item is fish and sea foods;
e) expenditure on oils and fats is a significant item of expenditure for both groups and tends to increase with income; the ratios in Table 3 mask the fact that there have been dramatic increases in the quantities consumed of oils and fats;
f) for all the countries there is a significant growth in the expenditure on fruits and vegetables; and
g) growth in the share of expenditure on meat is not as significant as one would expect but this may be due to the prevalence of vegetarians in some of these countries which also explains the strong growth in expenditure on dairy products; however growth in demand for poultry meat has been strong.

The national level figures naturally mask the intra-community and intra-household differences that exist significantly in South Asia.

Shetty (2002) points out that although changes in energy intake in Asian countries have been small there have been large changes in consumption of animal products, sugar and fats. The net effect has been a marked shift in the diet with energy from fat (both animal and vegetable) increasing every year. Data from India show that higher income groups consumed a diet with 32% of the energy from fat while the lower-income groups consumed only 17% energy from fat. The reduction in cereal consumption between 1975 and 1995 was accompanied by an increase in the intake of protein, and fats. The latter is due to a phenomenal increase in the consumption of milk and milk products and of animal products and fats and oils. Marked differences in the intakes of vegetables and fruits and fats and oils exist between urban and rural populations.

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cereals which were abolished in the 1980s in addition to the lack of economic growth between the time of the two surveys: 1973 and 1982.

Table 3: Changes in food consumption expenditure (%) patterns in South Asia[7]

	Bangladesh		India		Pakistan		Sri Lanka		
Early 1970's	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Estate**
Cereals	51	61	49	56	25	30	27	35	40
Fruits/Vegetables	6	6	8	7	10	9	8	9	8
Meat	4	2	4	3	9	6	3	2	1
Fish/Seafood	8	7	-	-	1	1	10	7	3
Milk & Dairy	4	2	10	10	18	19	4	2	3
Oils and Fats	7	6	7	5	14	15	8	9	5
Late 1980's[8]	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Estate**
Cereals	42	55	26	41	22	28	35	41	50
Fruits/Vegetables	11	10	13	11	13	11	8	8	8
Meat	5	3	7	6	11	7	4	1	1
Fish/Seafood	12	8	-	-	1	1	11	8	4
Milk & Dairy	4	3	18	15	20	20	6	3	3
Oils and Fats	4	4	9	7	9	13	9	9	8

Source: FAO (1993).

The past, present and projected changes in the commodity composition of food consumption in South Asia are as presented in Table 4.

Table 4: Changes in commodity composition of food consumption in South Asia (kg/cap/year)

	Cereals	Roots/ tubers	Sugar (raw equivalent)	Pulses (dry)	Vegetable Oils (oil equivalent)	Meat (carcass weight)	Milk&Dairy (fresh milk equivalent)
1979-81	151	20	21	11	6	4	42
1997-99	163	22	27	11	8	5	68
2015	177	27	30	9	12	8	88
2030	183	30	32	8	14	12	107

(Source: FAO (2003).

[7] Note that percentages do not add to 100% as other food expenditures such as stimulants and miscellaneous account for the balance. The years of the surveys are as follows: Bangladesh (197/74 and 1988/89); India (1972/73 and 1986/87); Pakistan (1979 and 1987/88); and Sri Lanka (1973 and 1981/82).
[8] Except for Sri Lanka, where the latest survey data relate to 1981/82.

B. Production

Fertiliser consumption has grown rapidly in all the South Asian countries in the last decade with rates of annual increases of up to 9% and 6 % respectively for Bangladesh and India. This is an indication of the increase in the commercial orientation of agricultural production in the region affecting both primary staple cereals as well as for higher value crops. The stock of tractors grew most rapidly in India and significantly in Pakistan over the same period. Commercialisation of agricultural systems leads to greater market orientation of farm production, progressive substitution of non-traded inputs in favour of purchased inputs and the gradual decline of integrated farming systems and their replacement by specialised enterprises for crop, livestock, poultry and aquaculture products.

The diversification pattern can be judged at the aggregate level by the pattern of production growth of staple cereals compared to other high value crops. Cereal production over the last two decades in South Asia has been growing at about 2 % per year whilst livestock production as well as production of fruits and vegetables grew at more than double the rate of 4.5 % per year. In terms of change in the value of output the value of vegetable production as a percentage of cereal production in the region increased gradually from 10% in 1980 to 15 % in 1993.

Table 5: Average annual growth rates (%) in irrigated area, fertiliser consumption and number of agricultural tractors in use (1989 to 1999)

Country	Irrigated area	Fertiliser consumption	Stock of agricultural tractors
Bangladesh	3.5	9.0	0.5
India	2.8	6.2	5.3
Nepal	2.1	3.0	0.6
Pakistan	0.8	5.0	2.7
Sri Lanka	2.6	2.3	1.8

Source: FAO (2001), Selected Indicators of Food and Agriculture Development in the Asia-Pacific Region, 1999-2000, RAPA Publication: 2001/17, Bangkok, Thailand.

In terms of growth in the area harvested in the last two decades wheat showed the greatest annual growth (See Table 6) – exceeding population growth rates in Nepal in the 1980s and in Bangladesh in the 1990s. Rice area harvested grew negligibly but remained positive. The area expansion of rice and wheat was accompanied by fast growth in average yields, consisting of an average annual increase in production of 2.5% and 4.3% per annum

respectively since the 1970s[9]. The greater increase in wheat production as a result is associated with the growth in urbanisation where consumption of wheat is higher than in rural areas. The area under pulses declined or stagnated in all the countries. For example, in Sri Lanka the liberalisation of imports led to a major decline in potato sowing from 4,430 ha in 1996 to 1,119 ha in 2000 due to cheaper imports (FAO 2001). Conversely banana plantations increased from 251 ha in 1986 to 4,000 ha in 2000 (FAO 2001).

Table 6: Average annual growth rates (%) in area harvested

Country	Paddy		Wheat		Pulses	
	79-89	89-99	79-89	89-99	79-89	89-99
Bangladesh	0.1	0.4	1.9	4.4	-3.5	-1
India	0.4	0.6	0.6	1.5	0	0
Nepal	1.4	1.2	5.2	1.1	0.8	0.6
Pakistan	0.8	1.8	1.1	0.7	0	-1.1
Sri Lanka	-1.3	0.2	-	-	4.7	-3.7

Source: FAO (1991 & 2001*), Selected Indicators of Food and Agriculture Development in the Asia-Pacific Region*, 1980-1990 and 1990-2000, RAPA Publication, Bangkok, Thailand.

In the last two decades production of fruits and vegetables generally registered strong annual growth in South Asia, as shown in Table 7. Fruit production grew at a rapid rate in India in the last decade of the last century, coming close to the overall Asian average growth rate of 6.9 % per annum. Vegetable production also increased significantly in all the countries and the expansion of onion production in particular was most marked in Pakistan. Both India and Pakistan witnessed strong growth in the production of soybeans and other oilseeds.

Table 7: Average annual growth rates (%) in production of fruits and vegetables

Country	Fruit (excluding melons)		Vegetables	
	79-89	89-99	79-89	89-99
Bangladesh	-0.3	0.2	1.8	2.8
India	3.6	6.4	2.5	2.4
Nepal	2.0	-1.6	2.0	3.0
Pakistan	3.9	3.9	6.3	4.6
Sri Lanka	-7.9	2.1	8.1	0.8

Source: FAO (1991 & 2001), *Selected Indicators of Food and Agriculture Development in the Asia-Pacific Region*, 1980-1990 and 1990-2000, RAPA Publication, Bangkok, Thailand.

[9] See FAO/World Bank (2002), Table 5.2.

Livestock production increased throughout South Asia in the last two decades as well as is shown in Table 8 – poultry flocks expanded very rapidly. Milk production rose most rapidly in Pakistan. Bangladesh and India had growth rates well above population growth rates thus enabling an increase in the *per caput* supply of milk. Whilst meat production increased rapidly in Bangladesh and Sri Lanka most of the growth in meat production was due to increased poultry production which was highest in Sri Lanka and Pakistan with high rates of increases recorded also for Bangladesh and India. Growth in aquaculture was most pronounced in Bangladesh with high responses also recorded for India, Pakistan and Sri Lanka.

Table 8: Average annual growth rates (%) in production of major livestock products

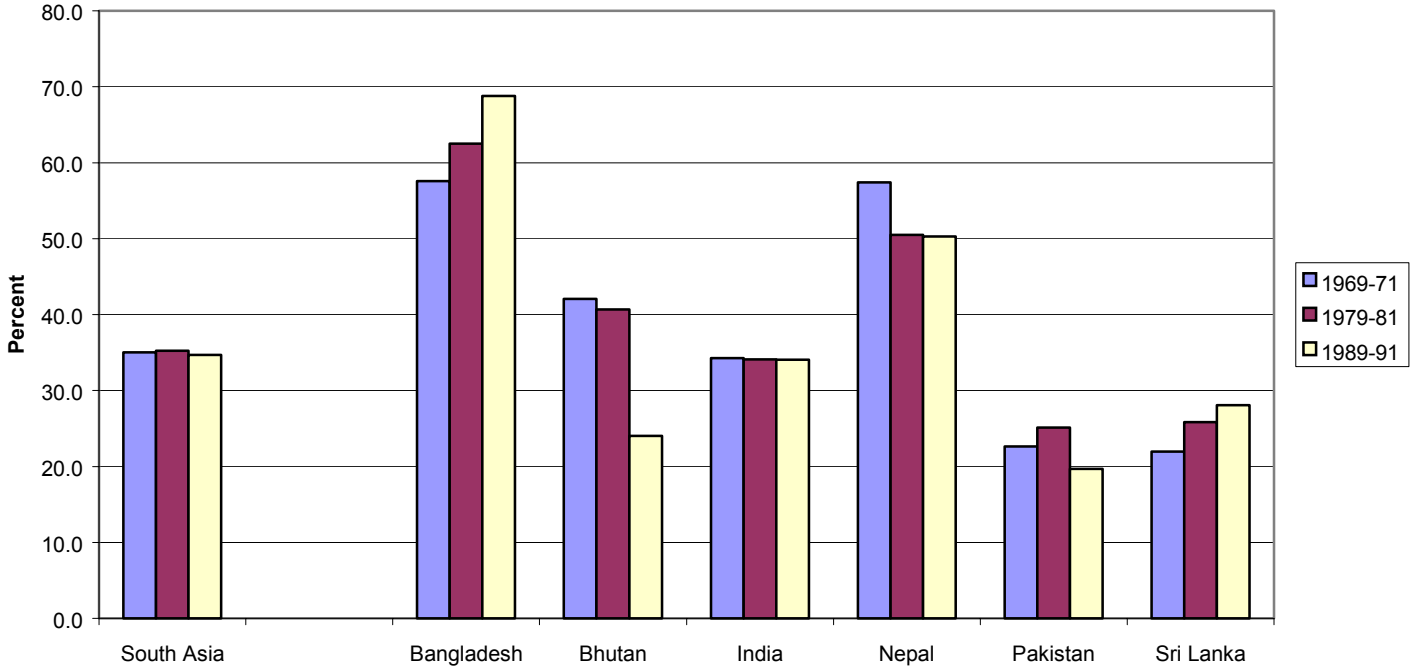
Country	Meat		Poultry		Milk		Aquaculture	
	79-89	89-99	79-89	89-99	79-89	89-99	79-89	89-99
Bangladesh	4.1	5.5	7.5	4.0	-0.1	3.1	6.6	13.0
India	5.1	1.5	10.7	4.6	5.1	3.7	1.9	7.8
Nepal	3.3	2.7	2.7	3.6	2.6	2.7	18.8	4.7
Pakistan	6.4	2.4	15.2	8.4	5.1	6.9	1.6	6.2
Sri Lanka	-1.0	5.7	2.2	10.5	-2.7	1.3	5.0	4.7

Source: FAO (1991 & 2001), *Selected Indicators of Food and Agriculture Development in the Asia-Pacific Region*, 1980-1990 and 1990-2000, RAPA Publication, Bangkok, Thailand.

The rapid pace of production diversification is even more apparent in the pattern of change in the value of output. In South Asia, the value of vegetable production as a percentage of cereal production increased from 10 % in 1980 to 15 % in 1993[10].
Figures 1 and 2 below present the picture of the changes in the shares of cereals and livestock products in the aggregate value of agricultural output for the countries of the region. From Figure 1 it appears that the share of cereal production remained more or less unchanged in South Asia as a whole, though there were differences between countries. However, the share of livestock products rose in most of these countries. A comparison with the data on consumption shares points to a potential problem for the future. While the share of cereals in consumption appears to be declining, its share in production is still being retained.

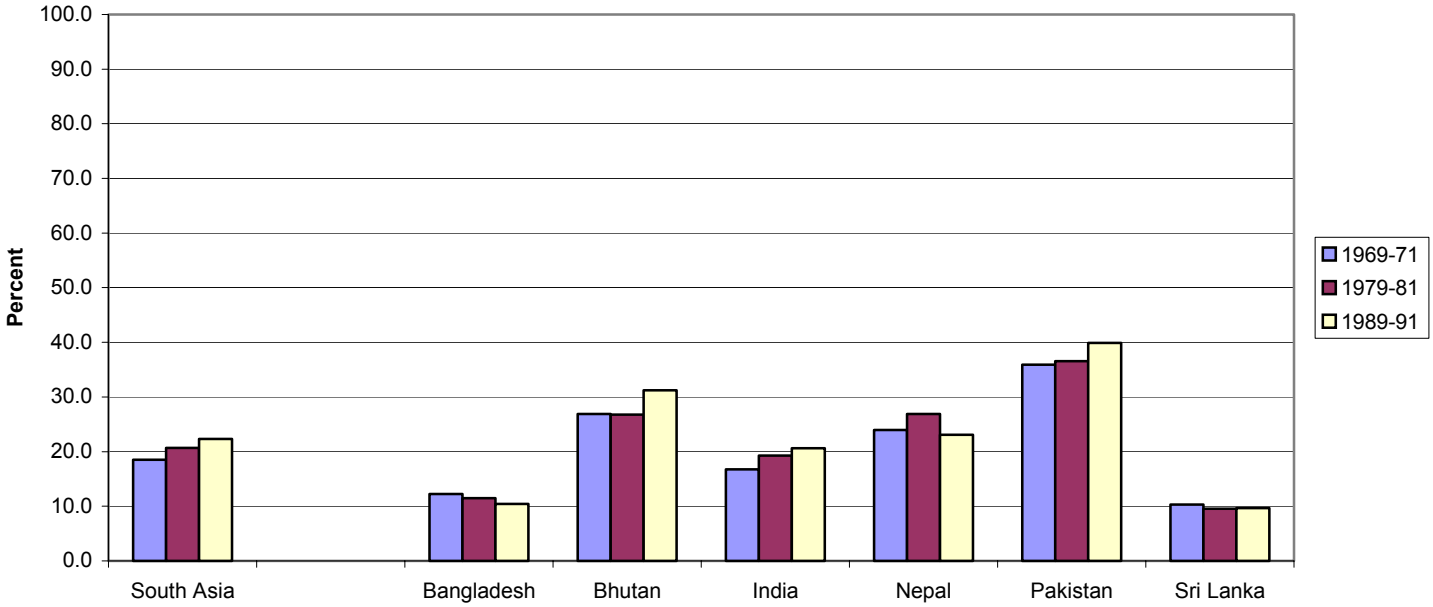
[10] In East Asia the percentages changed much more rapidly from 22 % to 40 % over the same period. See ADB (2000).

Figure 1-Share of cereals in value of agricultural output



Source: http://usda.mannlib.cornell.edu//data-sets/international/

Figure 2-Share of livestock in value of agricultural output



Source: http://usda.mannlib.cornell.edu//data-sets/international/

II. Options and constraints in the diversification of farming systems

This section will focus on the options and constraints in the diversification of agricultural systems in South Asia. For the purposes of the FAO-World Bank Study (2001) on farming systems and poverty eleven broad farming systems were identified. The four most important systems that represent the core components of the most populous farming systems are briefly described below (see Table 9). They account for about 87 % of the agricultural population and some 67 % of the total agricultural area of the region.

Table 9: Main Farming Systems in South Asia and Principal Livelihoods

Farming System	Basic Data	Land Area (% region)	Agricultural. population (% of region)	Principal Livelihoods
Lowland Rice	Agricultural population (263m) Cultivated Area (22m ha) Irrigated area (10m ha)	7	17	Wetland rice (both seasons), vegetables, legumes, off-farm activities
Rice-Wheat	Agricultural population (254m) Cultivated Area (62m ha) Irrigated area (148m ha)	19	33	Irrigated rice; wheat, vegetables, livestock including dairy, off-farm activities
Rainfed Uplands[11]	Agricultural population (279m) Cultivated Area (106m ha) Irrigated area (17m ha)	41	37	Cereals, legumes, fodder, livestock, horticulture, seasonal migration & off-farm activities

The opportunity for diversification of agricultural production away from cereals arises from the rapid growth in the domestic demand for fruits, vegetables, dairy products and fats and oils in the subcontinent largely as a result of economic growth and urbanisation. The response to this opportunity will largely depend on the new technologies becoming available to farmers as well as rural infrastructure, markets and incentive systems. In fact the FAO/World Bank Study suggested that diversification is the single most important source of poverty reduction for small farmers in South Asia. It is reasonable to assume that most farmers in South Asia, over the next thirty years, will become semi-commercial in nature with a progressive increase in the share of output marketed; the proportion of high value cash crops and livestock products; purchased inputs and hired labour.

In almost all the South Asian countries the agricultural policies and institutions have favoured cereal self-sufficiency and the inertia in this system will act as a strong disincentive for diversification unless drastic changes to policies and institutions are adopted. As noted above, 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, export prospects are unlikely to affect the majority of farmers in that even if some specialised 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 will largely be driven by the domestic demand.

A framework for assessing the flexibility of ricelands and rice farmers to respond to the commercialisation trends through seasonal or permanent diversification out of rice monoculture systems has been developed by Pingali et al (1997)[12]. 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 also 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 back.

Flexibility of farmers to respond to 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 back. Flexibility is low because moving out of monoculture rice to upland crop production on elevated dikes or moving back into monoculture rice production involves high physical investments. Upland areas however can switch 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.

III. Dominant Crop and Non-Crop Options by farming systems

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

[11] For the purpose of this paper the two mixed farming systems (Highland Mixed & Rainfed Mixed) have been amalgamated and called Rainfed Uplands.

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

the uplands, but rather to stress the fact that the uplands have always been very diversified because they do not face the drainage constraint.

In the irrigated lowland rice and rice-wheat systems dry season rice will continue to be the major source of income. Areas with good market access and those near urban centres will increasingly diversify to non-rice crops and vegetable production. The dominant dry season activity for the rainfed lowlands will essentially be non-crop activities, off-farm employment, livestock production and cottage industries. There is 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 excess moisture in some cases), and generally modest yields and high yield instability. Off-farm activities are often more dependable income sources, suggesting that dry season cropping intensities will remain low even if technical problems in crop production are solved. For the flood-prone environments, fish production in the wet season followed by dry season irrigated rice production could be the dominant activity, especially in areas where tubewell irrigation is feasible.

The above discussion leads to the conclusion that irrigated environments, while having 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 depends on the physical constraints and the market opportunities for non-rice crop production. On the other hand, during the wet season, the upland environments have both an absolute and a comparative advantage in non-rice crop production, as well as in a range of complementary livestock activities.

A. Diversification Constraints

Having dealt with some considerations relating to the *scope* for diversification, this section deals with the *profitability* of diversification. This is constrained by market availability and size, land suitability and rights, irrigation infrastructure and labour supply. Where output demand is relatively elastic, the returns to investments in land, technology, and time spent learning about new crops are relatively higher.

a) Size of Market and Price Risk

Diversification from a rice monoculture system to a system that includes non-rice crops could lead to increased variability in farm household incomes. Variability in incomes 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 farmer decision making. Timmer cites 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 rational diversification on the basis of average profitabilities of alternative crops. Behaviour in the face of risk aversion is affected by farmer attitudes and the nature of technology, but the fundamental problem is the failure of local credit and risk institutions to provide any potential for farmers to transfer their risks to other parties. Avoiding risk 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 risk 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. Tables 12 and 13 indicate common interactions between market access and technical or environmental constraints to diversification.

b) Land Suitability and Land Rights

The ability to profitably convert ricelands for non-rice crops is constrained by drainage requirements for the lowlands and erosion control investments in the uplands. It is important to understand that not all lands can be converted out of 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 required. Where high levels of erosion control investments are required tree crops may be a more viable option than field crops, particularly after land degradation has been allowed to occur through field crop production. In upland areas with poor market access the returns to 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, on market access, and on the appropriate erosion control techniques available. Pingali (1990) and Fujisaka and Garrity (1988 CHECK YEAR) argue that farmer interest in erosion control measures is directly related to land values and market access and is conditional on suitable technologies being available to them.

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 commercialisation (Pingali and Rosegrant, 1995). Secure land rights increase the probability that farmers recoup the benefits from long term investments, thereby increasing their willingness to make them[13]. Land titles act as collateral to loans and thereby increase lender 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 existing irrigation systems constrain diversification because of the rigid design 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 irrigation

[13] For example, land improvements and orchard development.

systems is the result of incentive failures resulting from centralised 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 values 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 crop and drainage labour requirements non-rice crops on irrigated lands are grown on extremely small plots, in general about a fourth of the paddy 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 is higher on heavy clay soils than on the lighter soils. Mechanisation to an extent can alleviate this labour peak. However the machine power required for upland crops is substantially greater 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 of the farmer is 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 with hired labour augmented by seasonal migrants.

Conclusions

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

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

Commercialisation 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 becomes increasingly 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 maximising 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 principal 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, the availability and quality of irrigation infrastructure, and the 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 has significant costs in terms of learning 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 commercialisation and diversification. Long term strategies to facilitate a smooth transition to commercialisation 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 flexibility and reduce possible environmental problems from high input use; and establishment of secure land rights to land and water to reduce risks to farmers and to provide the incentives for investment in sustaining long term productivity.

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