TECHNOLOGY CHANGE IN RICE PRODUCTION AND RICE FARMER INCOME IN VIETNAM MEKONG DELTA LOWLAND

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ABSTRACT

Trends of productivity of the rice-based production systems in the Vietnam Mekong River Delta were analyzed using aggregate and on-farm panel data. The panel data set was generated from continuous farm data collection of 30 rice crops in the 10-year period 1995-2004 in 4 villages under intensive triple rice cropping of the riverine flood plain of Mekong Delta.

Aggregate data analysis show the impacts on the livelihoods of its rural population, with particular reference to the process and impacts of intensification and diversification of the rice-based farming systems, changes in the non-farm economy and the linkages between agricultural intensification and the non-farm economy. Despite the man-land ratio in the Mekong Delta has declined from a level of 0.6 ha/worker in the mid-1980s to the present value of about 0.45 ha/worker. Agricultural worker productivity grew at 4% per year during the last 25 years.

Average paddy yield growth rates of the period 1995-2004 observed at sample farms were 1.2%; 0.9% and 1.4% for the summer-autumn, autumn-winter winter-spring crops respectively. Farm overuse of urea and unbalanced fertilizer application in rice production is widespread in the intensive rice farming system. Overuse of urea often leads to a higher possibility of pest and disease incidence and as a result, farmers tend to apply more pesticides to maintain the average yield. Nevertheless, since the late half of the 1990s, the process of changing from input intensification to knowledge intensive agriculture has been forming. There have been the signals of change in fertilizer use of farmers towards a stable and balanced application. The technical measures emphasize the trends of reducing nitrogen rates and increasing potassium and phosphate application. The adjustment helped to reverse the declining trend of nitrogen fertilizer productivity observed in the late 1980s and early 1990s.

The last part of the paper provides implication and recommendations for policies to sustain the productivity of the rice production system.

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INTRODUCTION

The Mekong River Delta of Vietnam covers an area of 4 million ha with a population in 2006 of 17 million people. Eighty percent of the population in the Delta depends on agriculture. The Mekong River Delta is both the rice bowl and the most important aquaculture region of Vietnam, 30% of its the area is fertile alluvial soil with abundant water resources. Rice is the dominant crop of the Mekong Delta, planted on 2.1 million ha, contributing more than 50% of the rice production and 80% of rice export of the country.

The major factors which contribute to the fast growth of rice production in the Mekong Delta during the 1980s and 1990s are: better farmers' incentives provided by reform policy, investment in irrigation systems and land reclamation, expanded area under high yield varieties and improved farmers' knowledge of intensive farming, and the increase in supply of farm inputs under a deregulated system. The introduction of policy reforms in agriculture gives the farmers production incentives and more freedom to respond to market signals. On the other hand, over time, farm households are becoming more dependent on markets for selling their products and purchasing inputs.

The rice-based farming systems in the Mekong Delta underwent a rapid process of intensification and commercialization. As the price of rice started to decline in the later part of the 1990s, income from rice farming became stagnant or even declined, while better income could be obtained from fishery products, fruit and vegetables, and animal products. The commercialization of the farming systems has, on the other hand, led to higher risks, especially market risks. Farmers require adequate capital investment to reap the benefits of farming. Inequities have increased the income gaps between small and large farmers and landless farmers.

This paper first describes the transition of the production systems in the Vietnam Mekong Delta and the impacts on the livelihoods of its rural population, with particular reference to the process and impacts of intensification and diversification of the rice-based farming systems, changes in the non-farm economy and the linkages between agricultural intensification and the non-farm economy.

The analysis of regional aggregate data is followed by on-farm data analysis using a panel data set generated from continuous farm data collection of 30 crop seasons in ten year period 1995-2004 in 4 villages under intensive triple cropping rice cultivation of the riverine flood plain of Mekong Delta. The three rice crops were designated as summer-autumn (SA), autumn-winter (AW) and winter-spring (WS) seasons. Long-term on-farm data analysis examines the trends of input use, productivity and rice farmer income in the intensive triple rice cropping in the Mekong delta.

The last part of the paper provides implication and recommendations for policies to sustain the productivity of the rice production system.

Trends of Population and Land Use

With a natural surface area of about 4 million ha, the Mekong Delta has 2.9 million ha of agricultural land, of which 2.1 million ha of rice land, 0.4 million ha to perennial crops and the 0,4 million ha to other annual crops. Around 0.23 million ha is suitable for aquaculture.
Seventy-six percent of the total population of the Mekong Delta in 2002 worked in rural areas. Agriculture is the main source of income of the 72% of the 2.2 million households. The cultivated area per farm household averages around 1.30 ha. Vietnam has one of the lowest ratios of land per agricultural worker in the world, approximately 0.27 ha/worker. This man-land ratio in the Mekong Delta has declined from a level of 0.6 ha/worker in the mid-1980s to the present value of about 0.45 ha/worker (Figure 1).

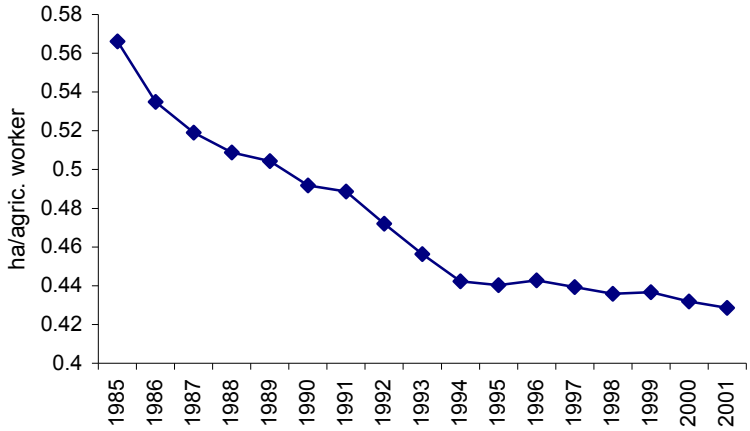

Figure 1. Agricultural land per Agricultural Worker in the Mekong Delta, 1985-2001.

Land use and cropping patterns of the Delta are strongly influenced by the natural resource conditions of soil and water. The three major soil groups in the Delta are alluvial soils in the central part, saline soils along the coast and acid sulphate soils. Twenty eight percent of the total of four million ha is affected by acid sulphate soils, 21% by saline water and about 17% by both saline and acid soils. Seasonal flooding affects 1,6 million ha. The combination of the water regimes and soil types enables the region to have the most diversified farming pattern in Vietnam. The Delta can be broadly distinguished into three ecological regions; the central region of the fresh water irrigated rice system, the flood affected North West region and the coastal region in the south east. The sample farms of this analysis were taken from villages in the rice intensive production systems in the flood affected and the central regions.

Table 1
Growth in Rice Production, Vietnam, 1976-2006.

Period	Cultivated area (%)	Yield (%)	Production (%)	Per capita Cultivated Area (%)
1976-80	1.0	-0.6	0.5	-1.0
1981-87	-0.1	3.2	3.1	-2.3
1988-96	2.4	2.8	5.1	0.5
1997-06	2.2	3.1	5.8	0.7

Source: Agricultural statistics, GSO. Hanoi. Various years.

Intensification

The growth of the rice area of Vietnam is contributed mostly by the Mekong Delta. Table 1 shows the changes in the development of the rice area cropped in Vietnam since 1975. Since 1980, two-thirds of the increase in rice production has come from the Mekong Delta which occupies 44% of Vietnam's rice land but accommodates only 24% of the population. This progress was made possible partly through massive investments in the development and maintenance of canals and embankments for flood control, drainage, and irrigation by provincial and district governments as well as by farmers.

The investments in water control in the Mekong Delta allowed farmers to change from the traditional single cropping rice to two or three irrigated lowland rice crops. The conversion of the deepwater ecosystem to irrigated lowlands has been instrumental in the spectacular growth in rice production during the 1980s, because farmers were producing nearly 10/t/ha/yr of paddy from the two irrigated rice crops compared with 2.0-2.5/t/ha they used to produce from deepwater rice. However, policy reforms through land re-allocation to individual farmers and liberalization of the input and output markets were behind the boost in rice productivity in the early 1990s (Khiem and Pingali 1995).

Figure 2 shows the trends in rice cropping of the last twenty years. From the end of the 1970s the production of rice more than doubled while the area of rice did not show the same significant growth. New policy to allow diversification of rice land into other crops initiated in 2001 had strong effect on rice area particularly in the coastal regions where large area had been converted to aquaculture production. More than 200 thousand ha formerly planted to rice were shifted to aquaculture. In fact, rice cultivated area of the whole country ceased to grow since 2001. Only yield improvement had contributed to rice production growth since then.

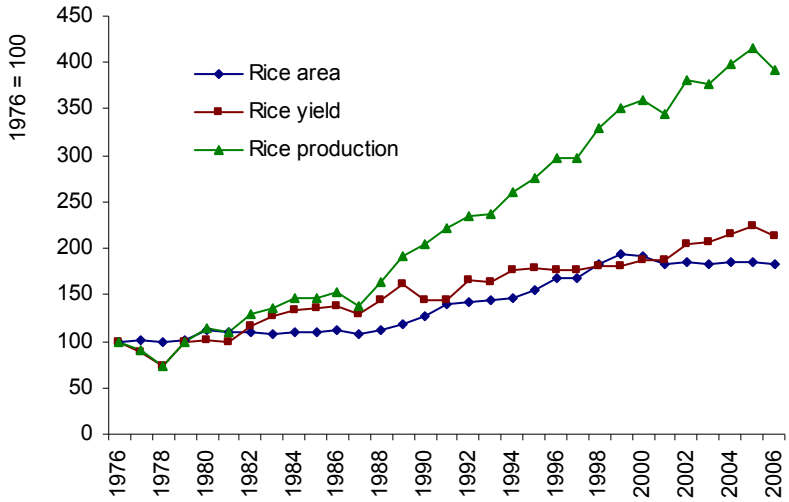

Figure 2. Trends of Rice Cropping Area, Yield and Production in the Mekong Delta 1976-2006.

The ten-year on-farm observation similarly shows a steady increasing trend of paddy yield in the main ecological regions of the Mekong Delta (Figure 3). Average rice yield of the winter-spring crop (dry season) can reach up to 6.5 t/ha, meanwhile those of the summer-autumn (rainy season) and the autumn-winter crops remain less than 5 t/ha. The yearly average growth rates of paddy yield of the period 1995-2004 observed at sample farms were 1.2%; 0.9% and 1.4% for the summer-autumn (SA), the autumn-winter (AW) and the winter-spring (WS) crops respectively (Khai 2004). While the third rice crop (AW crop) is not encouraged by the government, the rice supply elasticity comes from the third crop. Farmers tend to plant a third rice crop in location where the environment condition possible and market price is favorable.

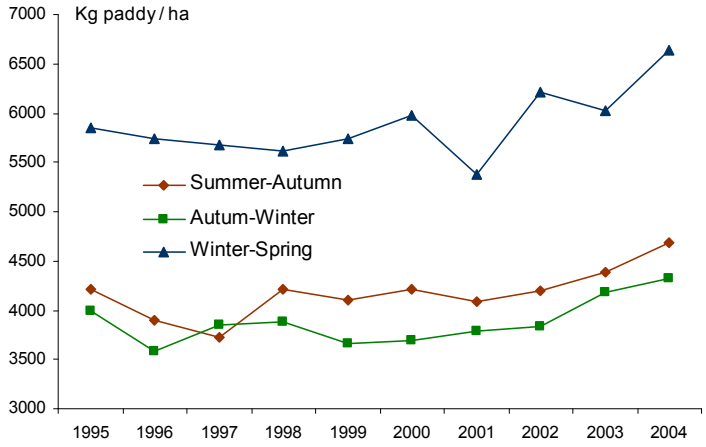

Figure 3. Trends of rice yield at farm level in the riverine flood plain of Mekong Delta 1995-2004.

Diversification of the rural economy in the delta

The recent changes in land use and farming systems since 1990 have been influenced by market forces. The area planted to fruit trees expanded rapidly in response to price and demand for fresh fruits in the domestic and export markets. Most rapid conversion of rice area into other uses has been observed in the coastal region. A large shift from rice to shrimp was seen in the saline and brackish water environment in Ca Mau peninsula. Farmers were attracted by the lucrative shrimp price and were facilitated by a policy shift allowing them to grow shrimp on rice land. Within two years from, 2000-2001, nearly 200 thousand ha of rice land were converted to either mono-shrimp or rice-shrimp cropping.

Table 2
Structural Change of the Rural Economy of the Mekong Delta, 1991-2000.

	Farming (%)	Industries (%)	Services (%)
1990	80	10	10
1996	72	15	14
2000	70	16	14
Average change	-10	6	4

Table 3

Composition of Rural Production Value of the Mekong Delta 1995-2001.

	Crops (%)	Animal (%)	Services (%)
1995	85	10	5
2000	81	12	7
2001	78	14	8

Source: GSO. Various years.

In terms of product value, the crop sector accounts for more than 75% of the gross value of agricultural production excluding the fishery sector. Within the rural economy, the value of agricultural production accounted for 80% of GDP, rural industries 9% and services 10% in 1990. Ten years later in 2000 these ratios were 70%, 16% and 14% respectively (Table 2). The value of crop production declined from 85% of total agricultural production in 1995, to 78% in 2001 (Table 3). Over the same period the value of animal production increased from about 10% to 14% and agricultural services from 5% to 8%. Lower rice prices after 1990s accounted for the decrease in the proportion of value attributable to the crop sector. Production values of agriculture (crop and livestock) and fishery (in 1994 constant price) are shown in Table 4. The value of crop and livestock production grew at 6% per annum during the last 25 years. The value of fishery production grew at 9% per year. Table 5.4 shows the overall structural changes of the rural economy in the Mekong Delta. The percentage of farming has declined 10% in the last ten years, but the total production has been increasing for the period 1993-2002 with 6%. The shares of industries and services in the rural economy have risen, 6% and 4% respectively.

Table 4
Production Value[1] of Agriculture and Fishery of the Mekong Delta.

	Agriculture (VND[2] million)	Fishery (VND million)	Aquaculture (VND million)	Capture Fishery (VND million)
1986	18,4	3,4	1,2	2,4
1990	22,1	4,8	2,0	2,8
1995	31,2	7,9	3,1	4,9
2000	40,6	13,1	5,6	7,5
2001	43,6	15,8	7,8	8,0

Source: GSO. Various years.

Productivity of Inputs in Rice Production

The productivity of two major inputs, *viz*, labour and urea fertilizer, are examined in this section. The production value added per agricultural worker (in 1994 constant prices) since 1985 is shown in Table 5. Agricultural worker productivity grew at 4% per year during the last 25 years. Rough estimates of agricultural worker productivity were based on the total value of agricultural production and the total number of people working in agriculture.

Table 5
Value added per agricultural worker, Mekong Delta, 1985-2001 (million VND/person).

1985	1988	1990	1993	1996	1997	2000	2001
3.6	3.7	4,0	4,3	5,4	5,6	6,5	6,9

Source: GSO. Various years

However, this process of structural change has not seen a parallel decline in the labour force engaged in agriculture. During the same period, the agricultural labour force was declining from 74% in 1991 to 62% in 2000. That implies that productivity is growing more slowly in the agricultural sector than in the rest of the economy. By considering the ratio of the agricultural share of GDP and the agricultural labour share, we obtain a value of 0.54 in 1991, declining to 0.37 in 2000. This implies that in 2000, the productivity of the labour force in agriculture was only 37% of the value in the rest of the economy. The lower productivity of agriculture is reflected through rural incomes that are substantially lower than urban incomes and suggests that many Vietnamese farm households continue to exist at a subsistence level. Figure 4 shows the percentage growth of agricultural productivity up to 2001, with the base year 1985. The agricultural productivity is estimated as a ratio of the net agricultural production and economically active labour population working in agriculture.

[1] The period average market price in 1986: 22.74; 1990: 6482.8; 1995: 11038.25; 2000: 14167.75; 2001: 14725.17.
[2] 1994 constant prices

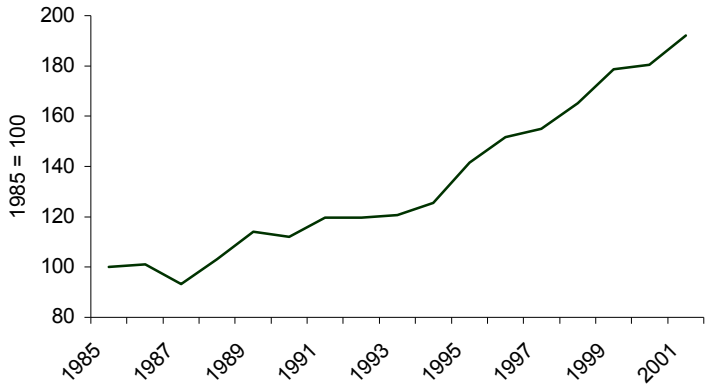

Figure 4. Agricultural Labour Productivity of the Mekong Delta 1985-2001.

Intensification of agricultural production of the Mekong Delta happened mostly in the rice sector. The rice cropping index has almost doubled within the last 30 years. Inorganic fertilizer is a major imported input. The application of urea in rice production has increased from a level of 40 kg/ha of urea in 1976 to 150 kg/ha of urea in 1994 (Figure 5). Fertilizer productivity in rice production shows a steadily declining trend. The average amount of paddy produced per kilogram of fertilizer declined from 50 kg in 1976-81 to 22 kg in 1991-92.

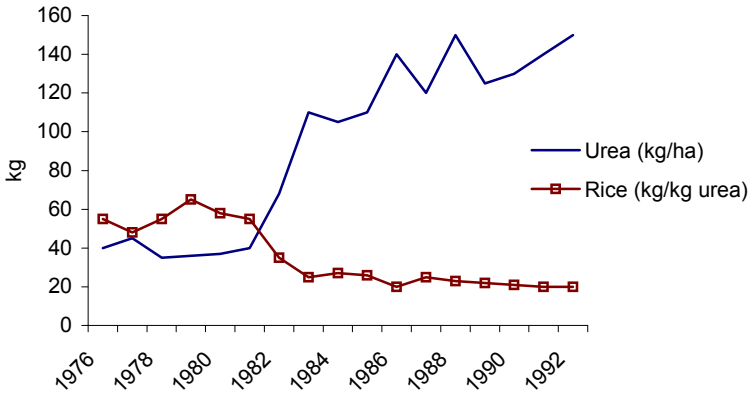

Figure 5. Fertilizer Use per ha and Productivity of Fertilizer in Rice Production.

The phenomenon of overuse of urea and unbalanced fertilizer application in rice production is widespread in the intensive rice farming system (Xuan 2003). Not only in the Mekong Delta, but also in other rice producing regions. Overuse of urea often leads to a higher possibility of pest and disease incidence and as a result, farmers tend to apply more pesticides to maintain the average yield.

Nevertheless, since the late half of the decade 1990, the process of changing from input intensification to knowledge intensive agriculture has been forming. There have been the signals of change in fertilizer use of farmers towards a stable and balanced application. The technical measures emphasize the trends of reducing nitrogen rates and increasing potassium and phosphate application. In average, nitrogen use per area unit decreased by 0.4 - 1.4% per year while phosphate use increased by 0.4 – 0.7% and potassium use increased by 8.0 – 11.6% per year in the period 1995-2004. The adjustment helped to stabilize fertilizer costs, increased productivity of fertilizer and fertilizer use efficiency as well (Figures 6 & 7). Technically, the change of nutrient structure helped to improve grain quality and stabilize paddy yield.

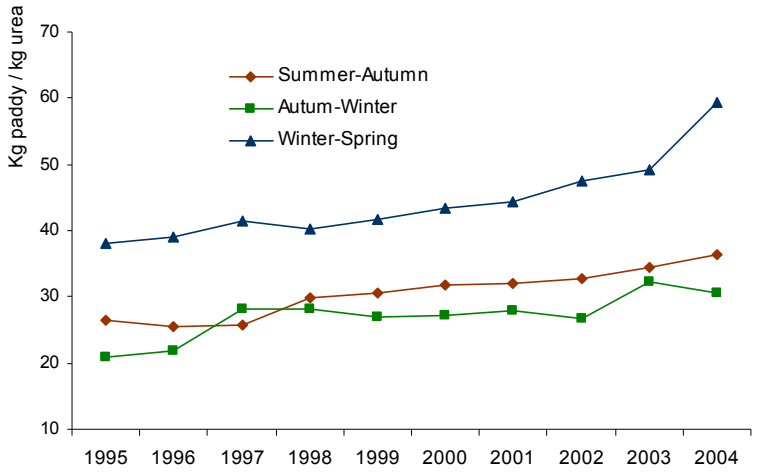

Figure 6. Evolution of productivity of fertilizer

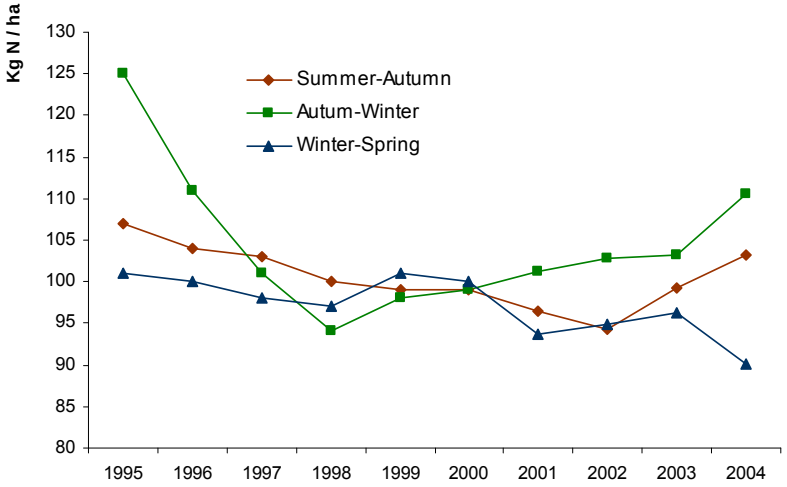

Figure 7. Evolution of nitrogen use efficiency

Adoption and change in use of pesticides

The changes in pesticides use was characterized by the application of selective types in replacing for wide-spectrum ones thanks to extension activities and availability of the products on domestic pesticide market. In particular, selective herbicides were increasingly adopted for weed control in different ecosystems. Fixed spraying regime has become common for herbicides and fungicides.

Pesticide application appeared to be influenced by different factors. The most important factors probably are farmer knowledge, farmer perception about efficiency of pesticides, farm economic situation, marketing activities of companies and dealers, local extension services and farmer awareness and application level of integrated pest management. Therefore, the efficiency in use of pesticides broadly varied among farms. High variation of pesticides costs, especially for insecticides illustrated that problem.

The increase of pesticide application and their prices lead to the costs significantly increase of pesticides costs in the period 1995-2004 at the average rate of about 12.0% per year. Particularly, the proportion of herbicide expenses tended to become the most important due to labor saving requirement and the wide application of direct-seeded method.

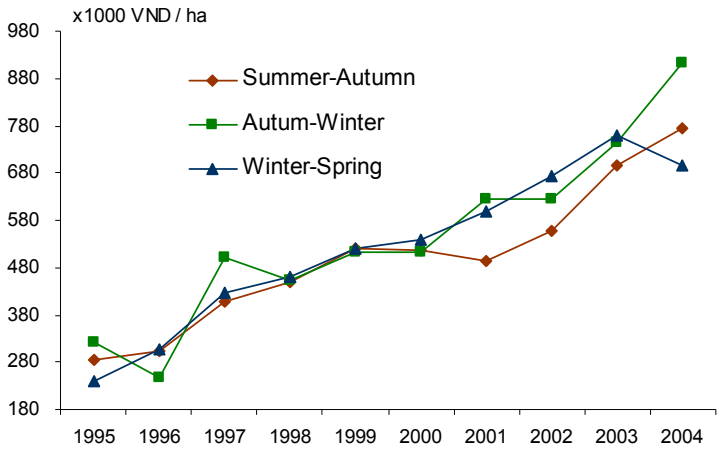

Figure 8. Pesticides cost trend in the period 1995-2004

Trends of labor use and mechanization

A very important characteristic of rice farmers in the Mekong region is the combination of manual labor and mechanization in response to the economic and technical conditions. Although family labor is abundant, the market supply of labor and equipment is very common in rural regions. Dependence on external labor and equipment services are common particularly during peak periods. The supply of mechanization services have helped to reduce the individual investment and created an agricultural labor market in rural region. As a result, the mechanization of rice production in Mekong Delta has two specific attributes: the low-equipped condition of individual rice farmers but fair-equipped at community level and the popularity of marketed mechanized services.

To keep pace with the increasing cost of hired labor and to meet demand of intensive cropping systems, rice farmers have broadly applied the labor-saving techniques to reduce manual labor investment (Figure 9a, 9b and 9c). The most common measure is the selection of mechanization in accordance with labor availability in rural regions. The mechanization of rice production in the study period concentrated only on some main works as land preparation, water pumping and threshing and recently more on mechanized harvester. Increasingly use of other measures such as direct seeding method and application of herbicides are common.

The combination use of mechanization and manual labor helped rice farms toeconomize rice production costs. However, cost of hiring labor and machine has been increasing sharply since 2002 due to the increase of labor wages and petrol cost in local market (Figure 9a, 9b and 9c). About one half of labor need in rice farming operation is provided by hired labor and the trends are similar for all three crop seasons. During the last ten years, the labor input per ha had reduced from 90 person days to 70 person days. The cost of hired labor and machine service increased rapidly particularly in the past few years (Figure 10).

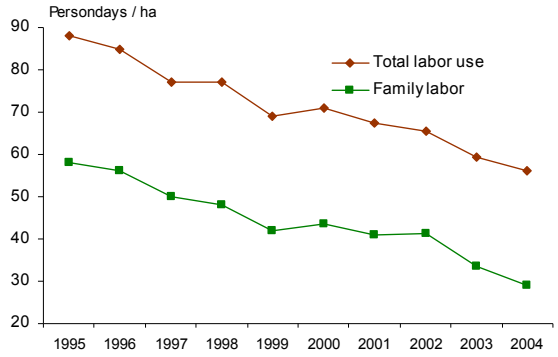

Figure 9a. Trend of manual labor use, SA crop crop

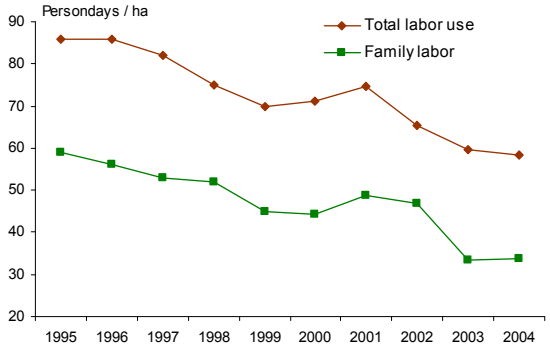

Figure 9b. Trend of manual labor use, AW

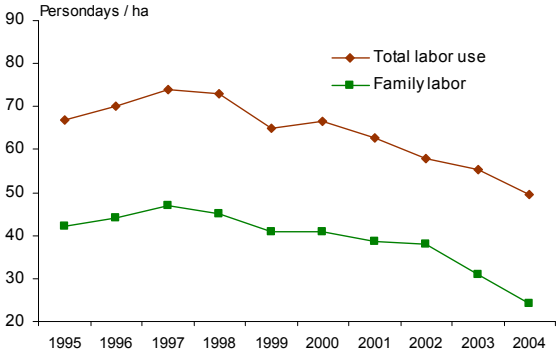

Figure 9c. Trend of manual labor use, WS crop

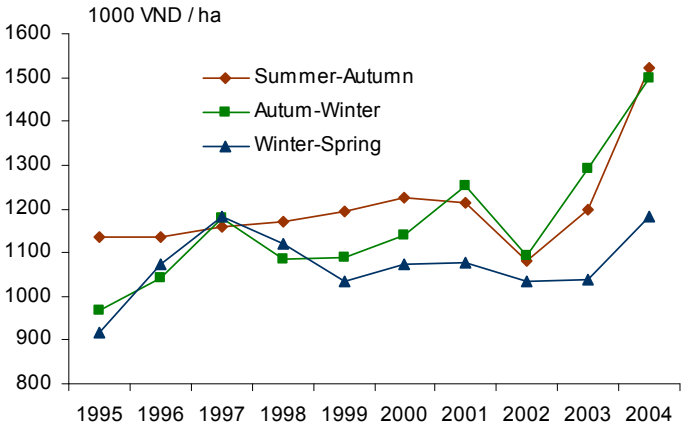

Figure 10. Trend of external labor & machine costs

Change in production costs, unit cost and farm income

Trend analysis of rice production costs using farm level data in the riverine flood plain of Mekong Delta in the period 1995-2004 showed that farmers were able to stabilize the investment into rice production despite the profound structural changes. The rice production cost increase was not remarkable in this period. On the average, total production costs in VND increase at the rate of 2.0 – 2.4% per year in period 1995-2004. However, in comparison to the local prices at the end of 2007, average prices of principal fertilizers increased by 10.7 – 19.5% per year due to sharp rise in petrol

prices, and local labor wage increaseed by 6.9% in the same period. Meanwhile, paddy price at farm gate increased 9.4% per year. In the same period, the devaluation of the domestic currency had positive effects on strengthening the competitiveness of Vietnamese rice. Figure 11a and Figure 11b show the trends production costs by season in the period 1995-2004. The paddy unit costs and farmgate paddy prices both in VND and in $US are shown in Figures 12a and 12b.

Due to reasonable change in production technology, rice farmers in Mekong Delta are able to manage paddy unit cost. On the average, the unit costs decreased by 4.5 – 5.4% per year during the last 10 years. The devaluation of the domestic currency to $US helped to further lower the unit cost more, by 8.1 – 8.9 % per year (Figure 12a and 12b). However, the much higher rates of input prices in recent years will push up the paddy unit cost.

On the other hand, the net farm income and benefit depend on fluctuation of rice price in international market. The strong increase of petrol prices in international market in the recent years has posed a remarkable pressure on rice farm income as well as competitiveness of rice production in comparison to other alternative cash crops and off-farm activities.

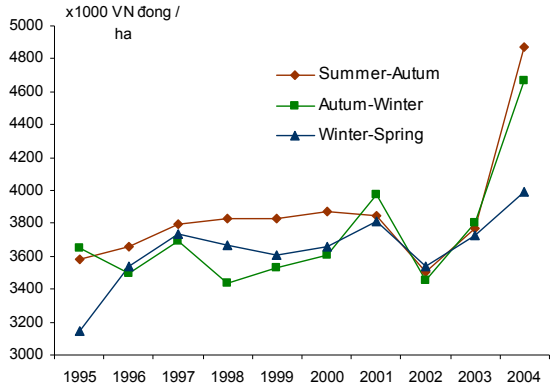

Figure 11a. Trend of total costs (in VND, current price)

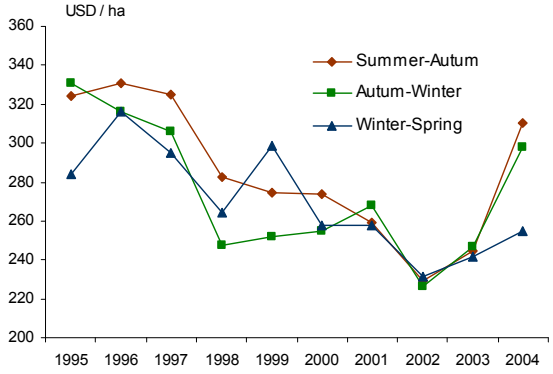

Figure 11b. Trend of total costs (in $US)

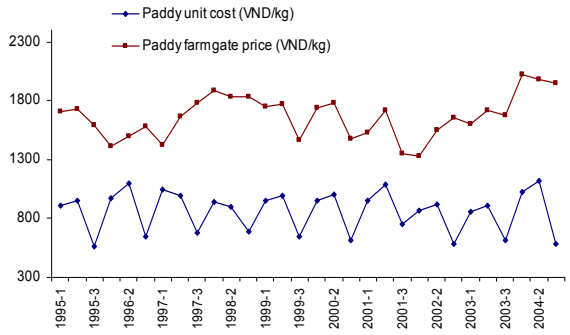

Figure 12a. Trend of paddy price & unit cost (in VND)

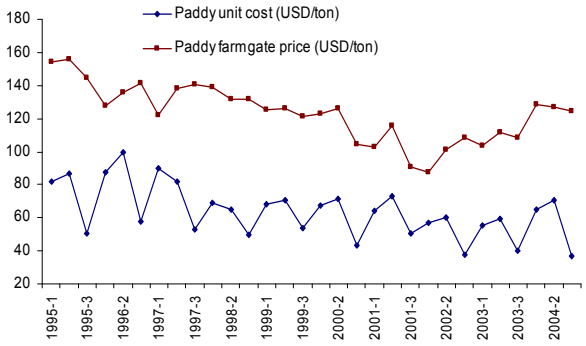

Figure 12b. Trend of paddy price & unit cost (in $US)

IMPLICATIONS FOR VARIETIES, TECHNOLOGIES, INSTITUTIONS AND POLICIES

Varieties and Technologies

The major factors contributing to the fast growth of rice production and productivity in the Mekong Delta are attributed to the development of technology which includes high yielding rice varieties, chemical fertilizers and assured irrigation. The average rice yield has almost doubled in the past 30 years, from about 2 t/ha in 1976-77 to 4.2 t/ha in 2002. The rice cropping index has almost doubled within the last 30 year period. The area under rice has expanded from 2.06 million ha in 1976 to 3.97 ha in 2002, accounting for 82-85 % of total crop area**.** The application of urea fertilizer in rice production has increased considerably from 40 kg/ha in 1976 to 150 kg/ha in 1994.

The implications of technological innovation are clearly seen from the enormous increases in paddy yields by close to five times with a change to irrigated lowland rice cultivation from traditional single rice crop, and considerable increases in household income through diversification towards aquaculture and other rice based cropping systems. These technological innovations have obviously contributed to the non-farm economy by increasing backward and forward linkages for input services and creating increased employment. The marketed rice surplus creates value-added and employment along the rice value chain. The market for non-farm goods and services expanded as a result of increased expenditures of increased farm households: the expenditure linkages in the Mekong Delta average around 26%. These have also contributed significantly in generating additional employment and income in the rural trade, transport and service sectors. The growth in the rural agricultural sector created additional employment in the non-farm sector.

The application of integrated farming and improved knowledge of nutrient mangement can maintain the sustainability of productivity of fertilizer use. The deceasing efficiency of nitrogen fertlizer use seen during the 1970s and 1980s showed a reverse trend. More balanced fertilizer application had improved efficiency of fertilizer use.

Institutions and Policies

Institutions and policies were key milestones in achieving significant growth in rice production in Mekong Delta. For example, the reallocation of land and the market liberalization boosted the rice productivity. In 1989, the transition to the market economy started. Land use rights were allocated to individual farm households. Land was allocated for 20 years to farmers cultivating annual crops and undertaking aquaculture, and for 50 years to those planting perennial crops including horticulture. Land use rights were further strengthened by the information of the land Law in 1993. Under this law, land use rights can be inherited, transferred, rented or exchanged. The land transaction market was implicitly recognized and the operation of land transactions has many features similar to those in other countries.

In parallel with the policy transition initiated in 1989, the marketing system including export markets was also gradually liberalized, thereby lengthening the value chains and enlarging the forward linkages. The dual price system was abolished and replaced by a “one-price” system. A two-tier banking system was introduced under which commercial banking functions were taken away from the State Bank. The distribution of material inputs and farm products, particularly the retail markets, was passed to private traders. The latest package of policy reforms, and in particular the opening up of the rice export market, has boosted rice production. Within the four years period from 1985 to 1989, rice production increased almost 20%. Vietnam changed from a rice deficit state to become one of the largest rice exporters in the world. Vietnam has consistently exported 3-4 million metric tons of rice every year since 1990. The bulk of the increase in rice production and export has been brought about in the Mekong Delta.

A second important institutional and policy contribution is the high priority according to investment in irrigation systems and land reclamation. The introduction of policy reforms in agriculture provided farmers with incentives and more freedom in rice production to respond to market signals, leading to increased input use, market surpluses and size of backward and forward linkages.

The lowland rice farming in the Mekong Delta is highly dynamic. Rice farmers sell about an average 80% of their harvest and they depend totally on the market for material inputs and thus create strong but simple backward and forward linkages between agriculture and the non-farm economy. The marketed proportion of other farm produce is even higher. However, in recent years, in response to the declining rice price and the prospects of increasing demand and price for non-rice farm products, the rice farming system is being diversified in those areas with suitable natural conditions. However, the diversification process is constrained by undeveloped post-harvest facilities and the marketing system.

Although marketing channels are often fragmented, the marketing system is dynamic and able to provide a linkage between farmers and markets. There are some problems such as, lack of standardization of the production processes, and dependency of processors and exporters on the multiplicity of small traders for their source of supply.

Nonetheless, technological innovation has led to an positive impact on the intensification of irrigated lowland rice cultivation. This has had considerable impacts on the growth of the non-farm economy. The key policy instrument that promoted growth of both farm and non-farm economies is the enabling policy environment for private sector investment and incentives. In this context, future policy strategies for the sustainable intensification of farming and farm enterprises should be public/private partnerships for the development of technology, markets, investment in the service sectors and targeted priority investments from the public sector for resource poor farmers.

Trend analysis of rice production costs using farm level data in the riverine flood plain of Mekong Delta in the period 1995-2004 showed that the rice production cost per area unit in VND increased at the rate of 2.0 – 2.4% per year in period 1995-2004. In the same period, the devaluation of the domestic currency had positive effects on strengthening the competitiveness of Vietnamese rice. Due to improved efficiency in input use, rice farmers in Mekong Delta were able to manage paddy unit cost. On the average, the unit costs decreased by 4.5 – 5.4% per year during the last 10 years. The devaluation of the domestic currency to $US helped to further lower the unit cost more, by 8.1 – 8.9 % per year. However, the much higher rates of input prices in recent years will push up the paddy unit cost.

Because the rice market is highly connected to the export market, the net farm income and profit depend on fluctuation of rice price in international market. The strong increase of petrol prices in international market in the recent years has posed a remarkable pressure on rice farm income as well as competitiveness of rice production in comparison to other alternative cash crops and off-farm activities.

Research Perspectives

Long-terms farm observations was able to supply a better understanding on the efficiency, the use of inputs in relation to output, the affection of price factors and the overall evolution of rice production in Mekong region in the 1900s. The findings can contribute to better understandings on rice production in relation with the impacts of agricultural policies at farm level.

Key observations and policy implications:

- Intensification is the key contribution to rice production growth in Mekong region. The main rice bowl of Viet nam.
- Rice farmers in the Mekong region have rapidly responded to the changes of production environment as well as the changes in the international rice market, depend strongly on the fluctuation of input and output prices in the market.
- The role of technology wss behind the productivity growth in rice production by transforming from land augmentation to knowledge and management intensification.
- The tendency of application of the labour-saving techniques in combination with input-saving techniques. Technology transfer from research institutions.
- Market for farm operation service – land preparation, crop establishment, harvest are gradually developed.

- Heterogeneity in use of rice varieties makes the standardisation of rice product for export more difficult. Consequently, the access of Vietnamese rice to the international market is less efficient.
- Increasing dependence on the chemical fertilizer and pesticides lead to the increase in production costs and safety of rice products. On the other hand, the fater rise of market input prices compared with rice price affect rice farm income.
- Lack of machines specialised for mechanised harvest on submerged land, especially in wet season causes high post-harvest loss and increase in rice production costs when the manual labour shortage occurs. Land fragmentation is a constraint to mechanization.
- Low income from rice in comparison to the competing crops (e.g. fruits, vegetables) and aquaculture (e.g. fresh-water fish, shrimp) lead to diverisification, particularly in coastal regions.
- Farm differentiation in terms of production efficiency is another constraint. The disparity in property and use of farm resources, knowledge, know-how and accessibility to market causes the existence of a great percentage of low efficient rice farms. In consequence, it leads to overall reduction of the production efficiency of the regional rice production. Variation of farm yield is large within the same location implying the potential of productivity improvement can be achieved by extension.
- Rice production in Mekong region is likely to face potential risks of natural disaster. In recent years, the more frequent occurence of unpredicted inundation, drought and saline intrusion, in combination with deforestation in watershed mountainous regions. Abnormal inundation and drought can badly harm rice crops because of the dependence on water supply of Mekong River. The meteorological and hydrological changes affect the agricultural production of all countries in the river basin. High international competition for Mekong River water, especially in dry season may rise as potential conflict in the future. Inefficient use of water resource as well as high application of chemical products may contaminate and pollute the water used for human consumption.

- Demand of high quality rice and change of international market standards, especially food quality and safety will be the barriers for low-developed rice industry in Vietnam. Standard of chemical residues is also a potential challenge. The choice of yield and grain quality is a problem that Vietnamese scientists have to overcome. The potential application of biotechnology may alleviate constraints for paddy yield improvement and reduction of rice production costs. Improvement of rice grain quality through breeding is very promising for obtaining high product value. The improvement should focus in both grain shape and cooking quality.
- Improvement of the accessibility to formal credit for small farms is also an appropriate measure to reduce financial pressure on small farms. Credit support for other farm activities than rice production will permit farmers to seek the opportunities of income diversification. To enhance a better allocation of farm resources, the establishment of different co-operation types among farms would be suitable as a measure that helps to make use of cost economies. Improve banking sector - more appropriate credit lending to agriculture.
- Technologies that can reduce production costs as integrated nutrient and pest, water and weed management, breeding for abiotic stress tolerance and bio-farming would help rice production to meet international food safety standards and increase product value.
- Encourage private investments (leveled playing field with SOEs). Restructure or equitize the inefficient SOEs in rice marketing and rice export. Create specialize Export Promotion agency.
- Further revise the Land Law. Improve regulations on agricultural cooperatives; organize farmers to join cooperatives or groups for better bargaining power.
- Restructure the national agricultural research system and redefine the activities of the national agricultural extension system. Integrate research and extension program at the provincial level.

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