CHAPTER 2

LITERATURE REVIEW

This chapter presents an overview of the relevant literature on basic information of direct seeding and row-seeding, policy reform, a few studies using costs benefit analysis, and Cobb-Douglas production function.

2.1 Direct Seeding and Row-Seeding

Rice cultivation was practiced thousand years ago in Vietnam, and traditional rice varieties were grown nationwide because of its adaptability in different climate conditions. However, under the pressure of the population growth the traditional rice varieties were changed modern rice varieties because of their high yield. Those modern rice varieties have been a crucial factor contributing to national food security. These modern rice varieties were accompanied by direct seeding technique as an alternative traditional transplanting technique.

2.1.1 Direct Seeding

Direct seeding can help farmers reducing production costs through saving labors for seedbed preparation and transplanting (Wah, 1998). Since the early 1980s in the Mekong River Delta, along with the introduction of modern rice varieties (IR5 and IR8 in 1968), direct seeding of rice has quickly replaced transplanting because of its economic efficiencies.

Can (2002) and Chin and Mortimer (2002) identified that farmers in the Mekong River Delta have practiced four typical direct-seeding methods, namely; (1) zero-tillage seeding, (2) water seeding, (3) dry seeding, and (4) wet seeding (Table2.1). Depending on difference rice ecosystems in the Mekong River Delta, the farmers can choose a suitable direct-seeding technique.

Table 2. 1 Direct seeding technique in different ecosystem in Mekong Delta River.

Direct seeding technique	Agro-ecological zone	Crop	Land preparation method
Zero-Tillage	Irrigated lowland rice	Early wet season	No plowing, harrowing, puddling.
Water Seeding	Irrigated, rainfed lowland rice	Dry and wet season	Harrowing under wet condition
Dry Seeding	Rainfed lowland rice	Wet season	Plowing under dry condition
Wet Seeding	Irrigated lowland rice	Dry, wet, and late wet season	Harrowing under wet condition

2.1.1.1 Zero-Tillage Direct Seeding

Zero-tillage direct seeding is often applied for the early wet season crop on irrigated ecosystem consisting of acid sulfate soils with shallow flooded areas of the fresh-water alluvium zone. Both of plowing, harrowing, and puddling are not practiced in land preparation. To prepare the land for zero-tillage direct seeding fields the farmers practice as follows. After immediately harvesting the dry season rice (winter-spring) in February, the rice straw is spread evenly over the entire field, covering the dry stubbles. The straw is burned right away, leaving a film of black ash over the field. After that pre-germinated rice seeds are broadcast directly into the field, and fresh irrigation water is brought into the field simultaneously. The field is drained after 24-36 hours of flooding. And then 3 to 5 day after seeding the field is irrigated, and the water level is kept at 3-5 cm depth.

Zero-tillage and direct-seeding rice production technique represents excellent indigenous knowledge of local farmers. This technique has been widely used in acid sulfate soil areas with shallow-flooded areas because it can avoid acidity and allow the early wet season crop to start early.

2.1.1.2 Water Seeding

Water seeding has been practiced in flood-prone areas affected by acid sulfate soil in the Plain of Reeds and Trans-Bassac depression zone. It is used for the dry season crop and late wet season crop in areas subject to annual deep flooding. Land is prepared for water seeding after the flood recedes. The field is harrowed twice under floodwater. Then pre-germinated rice seeds are broadcasted onto the flood field that is about 30 to 50 cm depth of water.

This technique has practiced in these two zone shifted from deepwater rice into two rice crop per year thanks to developing of irrigation system. In these regions, the flooding period was prolonged from August to December. In order to practice two rice crops with only seven months in difficult drainage condition the farmers must apply this method for the first crop (dry season) to broadcast the seed in early November when the floodwater is receding, and to harvest the crop in early February. Applying this technique follows farmers to harvest the second crop (wet season) in late June or early July, and to avoid damage from early floods.

Rice varieties for water seeding are short-duration ones such as IR50404, IR12340-10-1, OM90-7, OM1706, and IR9729. Seed rate is usually high, from 250 to 300 kg per ha because the farmers want to ensure crop establishment and weed infestation. Weed density in water-seeding field is less because the field is flooded. However, golden snail, fish, and crabs are being a serious problem in water-seeding rice field because they damage the rice plant during the young stage. Therefore, the farmers use heavy insecticide rate to achieve successful crop establishment. Consequently, the area for water-seeding planting technique is now reducing.

2.1.1.3 Dry Seeding

Dry seeding has been practiced for wet season (summer-autumn) on most rainfed lowland rice fields, including coastal and acid sulfate soil areas. In this method, farmers start preparing the land during the dry season in February or early March. The field is plowed out under dry soil condition using a four-wheel tractor with a disk flow. Then dried rice seeds are directly broadcasted onto the dry soil. Broadcasting is done before the onset of rainy season, often in May. Last, the second plowing and harrowing are done after seed broadcasting to pulverize soil clods and to cover rice seeds.

Dry seeding can help farmers to practice two crops per year in rainfed lowland coastal because it permits the use of early rainfall to establish the wet season and allows this crop to be harvest in early August. This early harvest leaves enough time and rainfall to support next rainfed crop.

2.1.1.4 Wet Seeding

Land preparation is done under wet conditions, after which the field is drained. Pre-germinated rice seeds are broadcasted immediately onto puddled soil. Wet seeding is applied for the dry season and late wet season.

Wet seeding is popular in irrigated low land rice where soil and water conditions provide no constraint. Farmers can practice wet seeding for all rice crops in the year when conditions allow. However, wet seeding is currently adopted for dry crop and late wet crop because zero-tillage seeding is undertook for early crop.

Direct-seeding methods have played a crucial role in the intensification of rice production in the Mekong River Delta. These techniques facilitate crop establishment in a large area in a much shorter time than with transplanting. Rice land productivity and labor efficiency can be enhanced by the farmer's choice of a suitable direct-seeding method depending on irrigation drainage systems, availability of appropriate land preparation equipment, and soil and hydrologic condition of the field.

2.1.2 Row-Seeding

Row-seeding, in fact, is among methods of direct seeding. It is wet seeding method, using machine (row seeder) instead of hand. Row seeder was developed by IRRI, and it was introduced firstly in Can Tho province in 1995. Original form was made by iron that was so heavy. O Mon Rice Research Institute in cooperation with the private sector developed the plastic row seeder from an IRRI prototype. It weighs 8 kg without seed and 20 kg when fully loaded with seed (Figure 2.1).

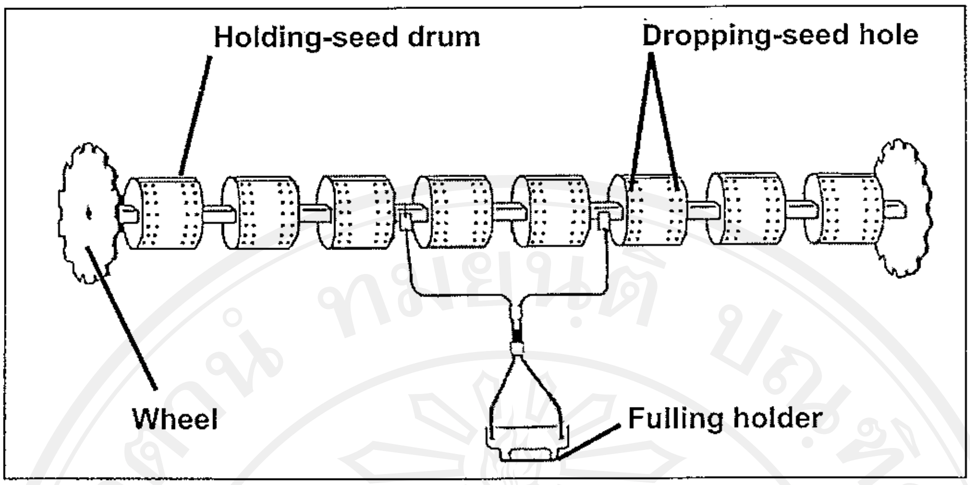

Figure 2. 1 The structure of plastic row seeder.

Source: Leaflet of Farming System Research and Development Institute.

An increase in rice production was resulted from (a) double cropping of short duration modern rice varieties planted in a cropping sequence that has been tailored to avoid the annual flood cycle, (b) expanding of the irrigation scheme coupled with the emboldening of production areas, and (c) using of additional fertilizers and pesticides (Xuan, 1998).

The rice production in the Mekong Delta has increased rapidly resulting from the development of new technologies and irrigation systems (Luat et al., 1998). Row-seeding is among of new technologies applying in growing rice of the Mekong River Delta. A number of experiments of row-seeding have been conducted in ten provinces and in large scale in the Song Hau State Farm. Some main results are described as follows: (1) the grain yield were increased from 0.5 to 1.5 tons/ha as compared to broadcasting, (2) the relationship between row-seeding and pest damage, row-seeding decreased damage from insects.

Heavy seed rate is a common practice of direct seeded farmers in the Mekong Delta of Vietnam. Seed rate is normally ranged between 200-250 kg/ha. An experiment in strip plot design was conducted in heavy clay soil at O Mon, Can Tho province (Tan, 2000). The objective is to study on the optimum seed rate under row seeding at difference crop management practices. The results revealed that row seeding helps the farmer to reduce the seed rate up to 50% of the present rate of seeding. Row seeding at the rates of 75-125 kg/ha can be recommended for the farmers in the Mekong Delta.

Khuong (2002) conducted an experiment in heavy soil at O Mon district, Can Tho province to study effect of row seeding under different seed rate and under different nitrogen rate. The results revealed that row seeding at 125 kg per ha and nitrogen applied at 60 kg N per ha were the optimum rates in the wet season for the modern rice varieties.

Yamada (2002) conducted an on-farm trial of row-seeding in 2001-2001 during the dry season at O Mon district, Can Tho Province. The result of this on-farm trial showed that row seeding has higher net income than the control, broadcasting.

2.1.3 Golden Snail

Golden snail, *Pomacea canaliculata* (Lanmark) can be considered as new rice pest in Vietnam, especially on the direct-seeded rice in the Mekong River Delta (Huan, 2003). It came from South America (Brazil and Argentina) via Taiwan and Philippines. Since 1988 some Vietnamese farmers introduced golden snail from Taiwan and Philippines because of its fast growth, high protein content, good taste and ease of rearing. Unfortunately, a few years after its introduction, the golden snail became a major pest of rice. Today, golden snail was found everywhere in the Mekong River Delta from the canal to rice field because it is easy to spread during flooding time and this pest is difficult to control.

The damage of golden snail is very considerable. Golden snail devours the base of young seedling from 4 days to 30 day after sowing for direct-seeded rice (IRRI, 2001). They can even consume the young plants in a whole paddy overnight. The golden snail lives for 2-6 years with high fertility. The size and color depend on the availability of food and species, respectively. The life cycle of apple snails (Figure 2.2) is determined by the availability of food and the temperature of the water. At high temperatures and abundance of food, some apple snail species exhibit a very short life cycle of less than three months and are reproductive throughout the whole year. Eggs are laid at night on any vegetation, levees, and objects above the water surface. Egg masses are bright pinkish-red and turn light pink when about to hatch. A golden snail can lay 1,000 to 1,200 eggs in a month.

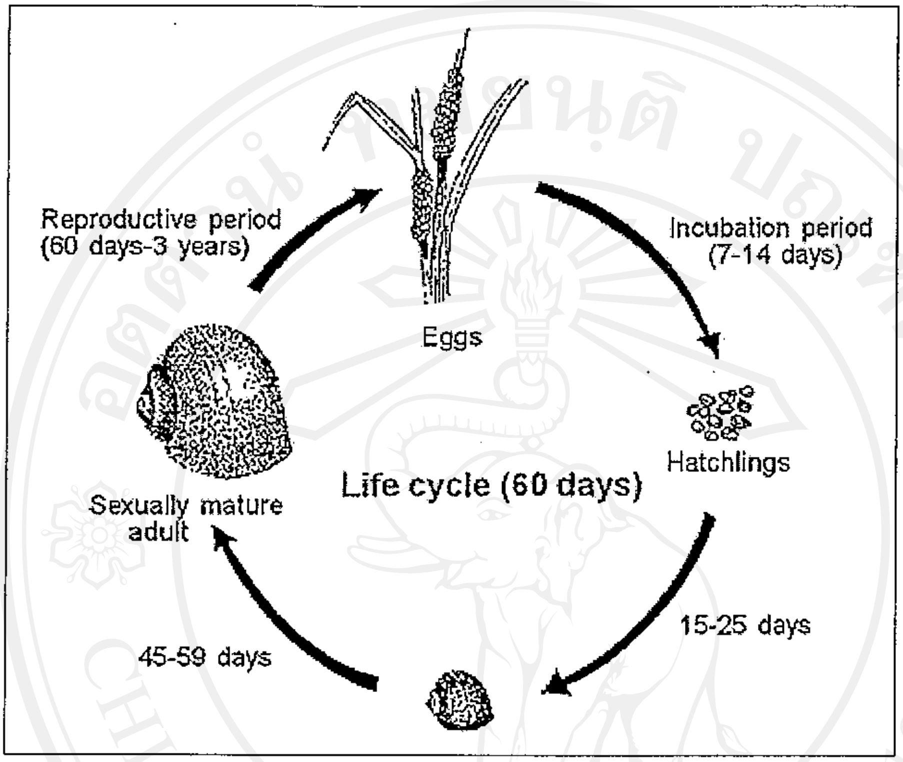

Figure 2. 2 The life cycle of golden snail.

Source: Crop Protection Division of International Rice Research Institute

The management strategy based on the principle IPM package has been popularly used in Vietnam (Cuong, 2001). This method focuses on three stages such as before sowing or transplanting, during sowing or transplanting, and after harvesting.

Before transplanting:

- Herb duck and handpick golden snail in rice paddies.
- Chemical method can be used when the water level in the paddies is 3-5 cm.
- Use botanical substances to attract golden snail and handpick them.
- Set up bamboo screen or nylon screen on the water inlet to prevent adult snail.

- Use some other physical methods like conduct small canal in the paddies.

During sowing or transplanting:

- Transplanting old seedling
- Herd duck after 30-45 days after transplanting and continue to handpick adult snails and egg masses.
- Put bamboo sticks in the paddies to attract adult snail to lay eggs.
- Continue using the botanical methods to attract snails.

After harvesting:

- Duck pasturing, handpicking and dry land preparation.
- Plant other kind of vegetable if possible to keep land dry.

Pol (2003) indicates that the insecticide Endosulfan (Thiodan) effectively eradicates snails, even heavy infestations, but Pol cannot be recommended it for golden snail control because it has long residual activity and it can kill fish, frogs, and other desirable organism, especially it accumulates in the food chain.

2.2 Policy Reform

Policy reform pays an important role in increasing rice production in Vietnam that shifted from a collectivized production system to a market-oriented production system.

Policy reform can be divided into three phases namely collectivized agricultural production system that occurred in the northern in 1958 and in the southern in 1980, contract system that initiated in 1981, and rice market liberation or the second land reform in nationwide in 1989.

2.2.1 Collective Agricultural Production System

The collectivized agriculture in the northern part of Vietnam began in 1958 and completed in 1960 with 41,000 co-operatives (Dap, 2001). These co-operatives can be described as follows: All land belonged to the State and farmers worked on the land as members of a co-operative. Each co-operative consists of about 200 hectares of land cultivated by about 400 farmers. Each co-operative was divided into 20 to 50 production groups, which were the primary work unit. A producer board consisting of a Chairman, 2 to 3 Vice-Chairmen, treasure and other officers managed a co-operative. All agricultural work was done by production groups, which were organized into teams such as transplanting team, spraying team, etc. Department of planning at National and province level plan for Crop and technologies, and set area and output targets for each crop. The District conducted and ensured the land use plans that province set for it, and set special targets for each co-operative.

All the inputs such as chemicals, chemical fertilizer, gasoline, and seed were allocated to each province by central authorities. Provincial government then granted them to district authorities, which allocated them to each co-operative and finally to production groups. This top down system of input supply resulted in high administrative overhead that was added on to the cost of inputs and in untimely input supplies. Co-operative was seldom supplied enough inputs leading to low yield of crop. The amount of output that co-operative member received at the end of harvesting depended on their accumulated points. The point was calculated based on the time that each co-operative works during the crop season. This point system resulted in many problems because it may not be equally. There were a lot of conflicts between co-operative members which lead to low quality and efficiency of work.

In the southern, the collectivization process was initiated in 1980. The Central Coastal provinces and Western Plateau provinces moved very rapidly towards collectivization 90% and 52% of the farmers in each of these regions joined the co-operatives, respectively. The Mekong River Delta provinces seem dislike to join the collectivization. It was not until 1986 less than 6% of the Mekong River Delta farmers belonging to an agricultural co-operative. The remainder of the Mekong River Delta farmers were only re-distributed the land depending on main labor and number of member of each family. The family with more persons was allocated more land. Although they also received the inputs from district authorities through trade store at village and sold surplus output at there with the low price, they still owned their land and production equipment. Prior to land reform in the southern the rice output was seven million tons of paddy per year. Post-reform of land the rice output decreased by one million ton. Therefore, rice output growth has not kept pace with population growth threatening food security of the Delta.

2.2.2 Contracted System

Faced with large food deficits and declining productivity, Vietnam switched from a collectivized agricultural production to a household-oriented contract system of production in 1981 (Pingali, 1997). Individual households enter into a contract with the collective to produce a certain level of output on their land. The contracted output had to be sold to the state at a fixed price, and all output beyond the contracted amount may be kept for home consumption or may be sold to private traders.

Table 2. 2 Rice production performance during the period from 1950 to 1987.

Time period	Percentage of cultivated area (%)	Percentage of rice output (%)	Percentage of yield (%)
1950-55	1.4	0.4	-1.0
1956-65	0.27	2.9	2.6
1966-75	0.87	3.0	2.1
1976-81	0.9	1.4	0.5
1982-87	0.2	2.1	1.9

Source: Pingali and Xuan, 1989.

The introduction of the Contract system had a significant impact on food output growth between the years 1981 and 1987 when it started to level off. Total rice output grew annually at the rate of 2.1% during 1982-1987 as compared to 1.4% during the 1976-1981 periods (Table 2.2). In the Southern provinces total rice output grew by over 2.5 million tons in the period from 1980-1987. The corresponding increase in the Northern provinces was around two million tons for the same period.

2.2.3 Rice Market Liberation

The success of the contract system could not be sustained over long term due to the following reasons (Pingali and Xuan, 1989): (1) The decisions of land use and crop choice were still being done by the Planning Department in the traditional top down approach, without consideration of farmer preferences and local market conditions; (2) The government often failed to procure all the grain it had contracted to procure at harvest time due to financial difficulties; (3) as a consequence of (2) seasonal surpluses at the farm gate lead to a crash in the private rice price in several regions, which while benefiting the urban poor had severe incentive effects on the farmer; (4) the persistence of centralized input supplies resulted in inadequate and untimely provision of inputs to the farmers; and (5) lack of security of land tenure resulted in inadequate farm level investments for maintaining long term land productivity.

These shortcomings were corrected through a series of reforms in 1988 and 1999. The most important reforms were privatization of output markets and decentralization of input supplies.

2.2.3.1 Privatization of Output Market

In early 1989, farmers no longer are required to sell a contracted amount of rice to the State. With ordinance number 170 was issued by the council of ministers on November 14, 1988, states that the individual family have the right to own all products generated by them after subtracting taxes and other commissions to the board of collectives. Farmers are required to pay tax in food grain based on the assessed value of their land. In the Mekong River Delta provinces the land tax is based on land classification. There are seven land categories based on soil acidity, elevation and irrigation assess.

Private traders now have equal rights to the state in the purchase of food grains from the farmer by the ordinance number 193, issued on December 23, 1988. The government also stopped subsidy food grain for government employees and the army by the ordinance number 169, issued November 14, 1988.

2.2.3.2 Decentralization of Input Supplies

Up until 1988, the supply of fertilizers, fuel and other agricultural inputs was control through the Central government. Input allocations to the provinces were made on the basis of the National Land Use Plans, which determined the crops to be grown in each region. After that the provincial allocations were distributed to the co-operatives, which then distributed them to the various production teams. This system of input supply often leads to inadequate and untimely input access. Therefore, on December 23, 1988 the government issued an ordinance number 193 indicating that individual traders can also handle input marketing. However, input imports have still to be done by the state export import agency.

These policy reforms impacted greatly to rice production in Vietnam. It is a motivation, which help increase rice production year after year. Now, Vietnam was ranked second in export of rice.

2.2.4 Rice Development Strategy

Vietnamese rice is available worldwide and accounting for 12-15% of the market share. Therefore, Vietnam is not only committed to food security but also become the world biggest rice exporter. The rice output not only meets the demand of country increasing population of nearly 1.5 million people a year but also supports the bigger export.

Government focuses on applying science and technology for intensive cultivation and introducing high-yield rice varieties. Moreover, Vietnamese Government issued the plan for upcoming years as follows (The magazine of the Vietnam Chamber of Commerce and Industry).

There are three objectives in this plan: Firstly, ensuring stable food security, increasing rice reserve and meeting the demand of home consumption in all cases; Secondly, securing food for the development of animal husbandry with average growth rate of 8 -10% a year and sufficient materials for the industrial production; Thirdly, stabilizing the export with high efficiency. The rice output will be 34 million tones in 2003, 35 million in 2005, and 36 million in 2010.

According to the plan, 4,000,000 hectares are for the production of 35-36 million tones of rice including 1,000,000 hectares in the Mekong River Delta for high quality export rice. Contracts will be signed between farmers and businesses for home consumption and export. 2.3 million hectares (1 million in the Mekong River Delta and 0.3 million in the Red River Delta) will produce 13-14 million tones of high quality rice including 7-8 million tones for export. In particular, Vietnam will combine rice production with processing industry and post-harvest preservation. Beside the expansion of markets and increasing rice outlet, Vietnam will continue international co-operation in technical and financial projects.

2.3 Cost Benefit Analysis

The purpose of Cost Benefit Analysis (CBA) is to help social decision making and to facilitate more efficient allocation of resources. Because resources are limited and needs unlimited, it is necessary to set priorities. Priorities are ranked according to their net benefit. CBA has the advantage of balancing the beneficial aspects of a policy or project against the real resources society must give up to implement the policy or project.

Rice production in the Mekong River Delta had shifted tradition varieties to modern rice varieties. Khiem (2002) compared production cost between modern rice varieties (Irrigated rice) and traditional varieties (Deep-water rice) in the Mekong River Delta. This study was conducted by IRRI and Can Tho University in 1992 (Table 2.3). Production cost of modern varieties was about two times higher than that of traditional varieties. On the contrary, the yield of modern varieties was about two times higher than that of traditional varieties. This was resulted in the income of modern varieties' growers were higher than that of traditional varieties' growers.

Table 2. 3 Costs and returns in rice farming in the Mekong River Delta, 1992.

Item	Unit	Deep-water rice	Irrigated rice	
			Autumn harvest	Spring harvest
Yield	Mt/ha	2.4	4.9	5.9
Labor	Manday/ ha	48	84	98
Fertilizer	Kg/ha	27	195	219
Paid out cost				
Total	US$/ha	103.4	240.5	249.1
Current inputs	US$/ha	27.6	124.2	145.6
Capital rental charge	US$/ha	23.9	57.1	48.4
Wage bill	US$/ha	34.2	40.8	37.1
Land tax	US$/ha	17.7	18.1	18.1
Imputed cost				
Total	US$/ha	85.1	123.2	134.2
Family labor	US$/ha	22.8	53.1	61.4
Family capital	US$/ha	0.9	7.0	7.4
Interest charge	US$/ha	61.4	63.1	65.4
Total cost	US$/ha	188.5	363.7	383.3
Gross return	US$/ha	242.5	406.0	488.9
Evaluation of benefits	US$/ha	214.9	281.8	343.3
Value added	US$/ha	139.1	165.5	239.8
Family income	US$/ha	139.1	165.5	239.8
Operating surplus	US$/ha	54.0	42.3	1.5.6
Unit cost of production	US$/mt	79	74	65
Labor productivity	US$/day	2.3	1.6	1.7

Source: Young et al., 2002.

Young et al (2002) also studied on rice production costs in different agro-ecological environments with different crop production seasons of Vietnam in 1996 (Table 2.4). The result showed that the average cost per ha planted ranging from US$ 384 to US$ 638 or from US$ 85 to US$ 130 per ton of rough rice.

Table 2. 4 Production costs of the Mekong River Delta and Red River Delta by season, 1996.

Region/crop	Yield (mt/ha)	Price ($/mt)	Income ($/ha)	Cost ($/ha)	Net return ($/ha)
Mekong River Delta					
Winter-spring	6.02	$131	$789	$394	$395
Summer-fall	4.80	154	748	408	340
Rainy season	4.01	173	693	384	309
Red River Delta					
Winter-spring	5.15	180	926	638	288
Rainy season	4.36	190	828	569	259

Source: Young et al., 2002.

The Red River Delta has relatively high cost of rice production compared to the Mekong River Delta because of smaller farm size and labor-intensive farms. In the Mekong River Delta the production cost of summer-fall crop is the highest because of more water management, pesticide and herbicide. Net return of winter-spring is the highest due to suitable climate and low pest.

2.4 Cobb-Douglas Production Function

Agricultural production involves the use of various interlinked inputs. The inputs included conventional, physical, biological inputs, and environment factors. Conventional inputs consist of land, labor, capital, and management; physical inputs compose fertilizer, pesticide, and irrigation; biological inputs comprise seeds and others genetic resources; and environmental factors contain soil, rainfall, temperature, and water supply are those mostly used in agricultural production. Therefore, the increase in agricultural production necessitates choosing the appropriate inputs at the right time and in the right quantities. The decision relating to input-output relationship is crucial to make the farm business profitable. Production functions are used to pinpoint the output-input relation and rational decision-making in agriculture. A production function represents a schedule or mathematical formation expressing the relationship between inputs and outputs.

Production functions were used widely in various studies in agricultural production, especially in comparing between conventional and new technologies as well as between different agro-ecosystems. Thanh (2002) used profitability approach and Cobb-Douglas production function to compare and assess the resource use efficiency of three selected farming systems namely rice monoculture, shrimp monoculture, and rice-shrimp system in the coastal areas of the Mekong Delta of Vietnam. The study revealed that for the total household income the farm size variable had high significant positive effects on total annual household income and for the production function analysis the varieties of capital input, labor input and ownership of machine had significant impact on gross return of three farming systems.

Nhan (2003) carried out a study to evaluate and compare economic performance of shrimp farming systems in Thua Thien Hue of Vietnam. The research surveyed 118 farmers, which were divided into two groups semi-intensive and intensive shrimp. Profitability and productivity performance were used to evaluate the two systems. The results indicated that in terms of productivity semi-intensive shrimp farming system was better than intensive shrimp farming system and in term of profitability intensive shrimp system was better than semi-intensive shrimp farming system.

Trung (2003) using the profitability approach to compare between organic tea farming system and conventional tea farming system in the north mountainous and mid-hill regions of Vietnam. The results based on a survey of 110 households (56 for conventional tea and 54 for organic tea) in 2002, shown that though the yield of organic tea was lower than the yield of conventional tea, but organic tea received one and a haft times higher price than conventional tea resulting in net margin of the organic tea was be 135 percent of the conventional tea.

Tippathorn (1995) using production function to explore the relationships between yield per rai of wheat and barley in different agro-ecosystems (irrigated lowland, irrigated upland, rainfed upland) in northern of Thailand and determining input variables such as farm size, seed rate, nitrogen, phosphorous, and labor. Dummy variables were assigned in this model such as mulch dummy, planting date dummy, and crop management dummy. This study used Generalized Least Square (GLS) and Ordinary Least Square (OLS) methods. The results revealed that farm size had a negative effect on yields of both wheat and barley in lowland system. High seed rate tended to cause reduction in yield for wheat in lowland system, but it provided positive response to barley yield in upland system. Nitrogen fertilizer had positive effect on yields in all production systems. Barley yield only showed significant response to phosphorous nutrients. Furthermore, the dummy variable of crop management suggested that the extension services should pay more attention in correcting farmers' technical errors. This may help to improve productivity of wheat and barley.