

## **Transformation of Rice-Based Cropping Patterns in the Mekong Delta: From Intensification to Diversification**

Koji TANAKA \*

### **I Introduction**

Rice cultivation in the Mekong delta has undergone major changes during the last two decades since the end of the Vietnam War. Keeping pace with changes in rice-growing techniques, rice-based cropping patterns have also experienced rapid changes. For example, single-cropping patterns of rice, which were dominant in the past, have been mostly converted to double-cropping systems since the introduction of modern rice varieties of short growing periods. This type of innovation in rice-growing techniques has been inducing an increase of cropping intensity and cropping diversity throughout the Mekong delta.

Under the joint research project entitled "A Study on Conventional Farming Systems and Their Development—In the Case of Southeast Asia,"<sup>1)</sup> I had a chance to observe the existing rice-based cropping patterns and to get information on the transformation of cropping patterns in the Mekong delta. Based on this research, this report presents the results of my observation of the present land use and cropping patterns, and summarizes the process of transformation of rice-based cropping patterns in the light of cropping systems development which occurred in the delta during the last two decades.

### **II Regional Division of the Mekong Delta**

#### *1. Land Unit Division*

The Mekong delta can be divided into the following five regions (land units) based on its regional characteristics of physiography, hydrology and pedology: upper floodplain, tide-affected floodplain, coastal complex, broad depression, and plain of reeds (Fig. 1).

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\* 田中耕司, Center for Southeast Asian Studies, Kyoto University

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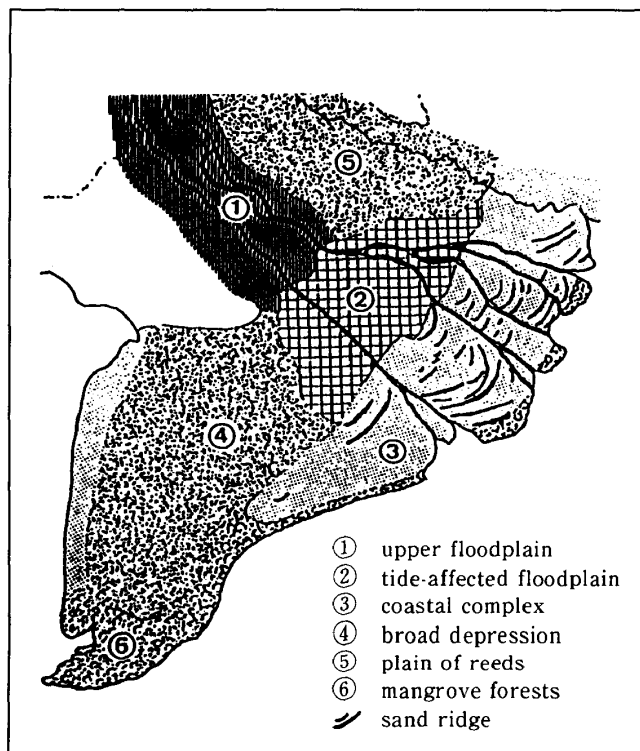


Fig. 1 Regional Division of the Mekong Delta

According to Takaya [1974], who presented a physiographic classification of the Mekong delta with respect to rice cultivation, the Vietnamese part of the delta was classified into four major land units: floodplain, modern delta, coastal complex and broad depression. Since the plain of reeds was not cultivated with rice when Takaya surveyed rice lands in the delta, it was not classified as a land unit and was not mentioned in his classification.

Chiem [1993], who recently conducted a geo-pedological survey of the Mekong delta, gave a landform classification of the delta basically similar to that of Takaya [1974]. In his case, the Mekong delta was also divided into four major landforms: high floodplain, tide-affected floodplain, coastal complex, and broad depression. The high floodplain and tide-affected floodplain are basically similar to the floodplain and the modern delta of Takaya's classification, respectively. In addition, Chiem classified the plain of reeds as a subunit, i.e., a closed floodplain, of the high-floodplain landform.

Differing from these two classifications, I took the plain of reeds as an independent land unit because this region has experienced a great change in land use. Rice fields have been reclaimed over a considerable area during the last two decades, despite the adverse

↘ interim report under the title of "Transformation of Rice-Based Cropping Patterns in the Mekong Delta of Vietnam" in the project report entitled *A Study on Conventional Farming Systems and Its Development — In the Case of Southeast Asia* (edited by Ohara and Vilas Salokhe) and published by the Faculty of Bio-Resources of Mie University in 1994.

soil and water conditions, like strong acidity derived from acid sulfate soil contained in the subsoil, poor nutrition derived from the peat deposits, and long-stagnating, deep inundation due to the specific physiography.

## 2. *Characteristics of Land Units*

The upper floodplain is situated in the northwest of the delta along the Hau Giang and the Tien Giang rivers and consists of natural levees, sandbars and backswamps. Natural levees run parallel to the banks of the Hau and Tien rivers, occupying the highest elevation in the floodplain. Sandbars lie between branches of the rivers. Although not as smoothly shaped as the natural levees, they are also an important habitat of people since they provide elevated areas in the low-lying floodplain. Backswamps lie behind the natural levees. They are low and inundated from the beginning of the rainy season. The inundation can reach as deep as two to three meters in September.

The tide-affected floodplain, situated in the lower reaches of the Hau and Tien rivers, is affected by the daily tides from both rivers. This floodplain also consists of natural levees and backswamps. Natural levees are low and narrow compared to those in the upper floodplain, and the maximum inundation in backswamps is also less deep, ranging from 0.5 to 1.0 meter from the end of September to mid-October, since the drainage is better due to the daily tidal movement in rivers and canals. The network of rivers and canals developed in this region maintains the freshwater sources for rice lands and the water is easily supplied into the fields during the full moon and new moon. As this new delta region benefits in various ways from the tidal movement, it has been the center of agricultural development and has the highest potential for agricultural development in the delta.

The coastal complex can be divided into four subunits: sand ridges, coastal flats, inter-ridges and mangrove swamps. Sand ridges run parallel to the coastline and provide places for dwelling since they are at the highest elevation in this low-lying region. Coastal flats have moderate relief of about 1.0 to 1.5 meters above sea level. Seawater can not intrude directly but it can invade through capillary movement from the subsoil to the topsoil in the dry season. The maximum inundation is not so deep, being as shallow as 0.2 to 0.5 meter even in the flood season. In contrast to the coastal flats, inter-ridges have more adverse conditions. Situated in the lowest-lying areas, salt water intrudes directly onto the ground surface in the dry season. Besides, actual and potential acid sulfate soils are common, although they are not as serious as those in the broad depression or the plain of reeds. The mangrove swamps develop along the seacoast, from the mouth of the Tien river to the point of Ca Mau, but due to the recent expansion of shrimp culture, this vegetation is disappearing very rapidly.

The broad depression is situated at the southwestern part of the delta but its water system is rather isolated from the delta. The topography is very flat and low, about 0.5 to 1.0 meter above sea level. The large area of this land unit was covered with dense *Phragmites* and *Melaleuca* forests growing on the peat soil. Since the end of the War,

reclamation of rice lands has been conducted by the government and spontaneous migrants.

The plain of reeds, located at the northern part of the delta, is the continuation of broad backswamps of the upper floodplain. Since it is enclosed by the sand ridges in the east, natural levees of the Tien river in the southwest, and an old alluvial terrace in the north, the flood level can rise as high as three meters. Although this region had long been unutilized and covered with natural vegetation of *Melaleuca* and *Eleocharis* due to deep inundation and strong acidity derived from acid sulfate soils, more than half of the region has been converted to rice lands by constructing canal networks which serve to wash away the acidity and convey freshwater for irrigation.

Before the war, most parts of the broad depression and the plain of reeds were not inhabited and not utilized for agricultural purposes due to their problem soils and specific hydrologic conditions. However, canal excavation allowed rice-land reclamation in both regions and, under the socialization program of agrarian issues, a large number of migrants were sent to these two regions to reclaim new rice lands and establish rice-producing farms.

### III Regional Variation of Land Use and Recent Changes

#### 1. *Regional Variation of Land Use*

The greatest part of the Mekong delta is utilized for paddy fields where wet rice is predominantly grown. However, due to the great variations in landform, soil and water conditions, land-use patterns vary greatly from region to region.

Natural levees, sandbars and artificial dikes along the rivers and canals provide space for dwelling in the upper floodplain, where house compounds, home gardens, orchards and higher-elevated paddy fields are distributed. In contrast, backswamps are fully utilized for growing rice, and this provides a rather monotonous scene of rice fields lined with house compounds or rows of trees planted on dikes of canals.

The tide-affected floodplain shows the greatest variation in land use, because it is situated in the center of the delta in terms of economic performance and is blessed with fertile soils and moderate water conditions. Although the river water is affected by daily tidal movement, salt intrusion is not as serious here as in the coastal complex. People can easily get freshwater from rivers or canals. The soils are generally fertile since this region is geographically located on a newly-formed deltaic deposit. Under these favourable conditions, intensive land use has been developed. The most intensive land use is found on natural levees in this region, where the artificial modification of ground surface, like the ditch-and-dike system, makes the intensive land use possible. The canal networks provide the transportation facilities and the source of irrigation water, and the complicated formation of dikes and platforms provides the orchards, gardens, house compounds and mixed-cropped fields. The backswamps in the tide-affected floodplain are basically used for paddy fields. However, multi-purpose paddy fields are often found in this sub-unit. A

number of rows of raised beds constructed in paddy fields are used for growing fruit-trees, vegetables and commercial crops. The ditches in between are used for rice growing and, sometimes, for freshwater fish raising. This ditch-and-dike system provides one of the most intensive rice-based cropping patterns found in this region.

The land use in the coastal complex is dependent on the degree of salt intrusion. Sand ridges, being free from salt intrusion, are most intensively used in this region for vegetable growing under multiple-cropping systems. They have also been used for dwelling from ancient times. Coastal flats and inter-ridges are basically used for rice growing mainly in the rainy season due to the salinity in the dry season. On the coastal flats, particularly on the upper parts of the flats, a significant extent of coconut gardens is found under the ditch-and-dike system.

A subunit of the coastal complex, the mangrove swamps, and the two land units, the great depression and the plain of reeds, were mostly covered with natural vegetation as described above. Agricultural land use was hardly found in these regions in earlier times. However, after the Vietnam War, land reclamation for various purposes began, such as rice and commercial-crop growing and shrimp culture. Therefore, these regions can be said to have experienced the greatest changes in land use over the last two decades in the Mekong delta.

## 2. *Recent Changes in Land Use*

Wet-rice fields are still the predominant agricultural land use in the Mekong delta. However, the recent changes in economic conditions, in particular, the changes derived from agrarian reforms, are expected to motivate farmers to introduce more market-oriented farming. In addition to continuous efforts to intensify rice cultivation, interest in growing commercial crops like vegetables and fruit trees, fish and shrimp is expected to grow. Such recent motivation is reflected in the recent changes in land-use patterns in various places throughout the Mekong delta.

The most drastic change in land use occurred in the great depression, the plain of reeds and the mangrove forests, despite adverse conditions like acid soil, deep inundation or salt intrusion. In the broad depression, although a considerable extent of wet-rice fields have been reclaimed on peat soil by large-scale deforestation of *Melaleuca* and canal construction, rice cropping there has not been very successful, due to both the increase of inundation derived from decomposition of the peat layer and the emergence of acid water. In recent times, reconsideration of the reclamation policy has been urged, and the reforestation of *Melaleuca* will be implemented on abandoned rice fields in order to revive the original vegetation of the broad depression.

The wide-scale reclamation has already converted the original scenery of the plain of reeds to one of wet-rice fields. Canal construction and the establishment of canal networks seem to allow rice cultivation to some extent. Wet-rice fields and *Melaleuca* plantations are the dominant pattern of land use in the lower-elevated parts of the plain, while in the

higher-elevated parts, wet-rice fields under the ditch-and-dike system are often found in addition to ordinary flat fields. As the dikes on both sides of canals are the only places for dwelling, house compounds and rows of trees lining the canals give variety to the monotonous scenery of low-lying rice lands. In both land units mentioned above, rice-land reclamation has completely changed the original land use, although it is not known yet whether this conversion will be successfully sustained.

Mangrove swamps have also experienced a drastic change. The natural vegetation has almost disappeared due to the rapid expansion of shrimp culture for export. Often the mangrove forest remains just on the fringe of coastline. On the periphery of the mangrove swamps, i.e., the border areas with the coastal flats and inter-ridges, the reclaimed lands are utilized for both rice cultivation and shrimp culture. A rice field is surrounded by ditches for shrimp culture and again by the dikes for coconut growing. The tidal water is controlled by sluice gates on the dikes and rice is grown in the rainy season after the remaining salt has been washed away by rainfall. Although such multi-purpose land use has been developed in the former mangrove-forest areas, and it is probably one of the land-use patterns that will be suitable to the region, such rapid conversion is likely to bring about serious problems with respect to environmental conservation and production sustainability.

The upper and tide-affected floodplains and the coastal complex have experienced much slighter changes in land use than the three regions mentioned above. Since the farmers' motivation is directed to higher utilization of established fields, the intensification and diversification of cropping are major concerns rather than transforming the existing land-use patterns. Therefore, the changes in cropping patterns are more significant than those in land-use patterns in the case of the floodplains and the coastal complex.

#### IV Transformation of Rice-Based Cropping Patterns

##### 1. Former Cropping Patterns

According to Fukui [1974], who conducted a field survey in the Mekong delta in 1974, traditional rice-based cropping patterns and newly-developed ones at that time were distributed in accordance with agro-ecological conditions in the delta. High-yielding varieties called *Than-Nong* had been introduced and they brought about a noticeable change in traditional rice culture. Under such circumstances, Fukui [1974] identified five types of rice-cropping patterns. He divided the whole region of the Mekong delta into five areas based on the five types; the traditional floating rice area (TRAFLO), the newly-developed broadcast rice area (NEWBRO), the double-transplanting rice area (DUBTRA), the traditional single-transplanting rice area (TRASIN), and the newly-developed single-transplanting rice area (NEWSIN).

Both types of broadcast rice, TRAFLO and NEWBRO, were distributed in the northwestern region of the delta, and the latter was generally practiced in the newly-

reclaimed rice lands in this region. Single cropping of rice by double transplanting (DUBTRA) was formerly widely practiced in the tide-affected floodplain. However, with the introduction of *Than-Nong*, this type of rice growing had mostly been replaced by double-cropping systems when Fukui surveyed. Single-transplanting methods were observed in the coastal complex, of which the traditional one (TRASIN) was dominant in coastal flats and the newly-developed one (NEWSIN) was distributed in inter-ridges in the coastal complex. The NEWSIN method was observed in the broad depression, too. The rice lands where the NEWSIN method was applied were those reclaimed rather recently at that time.

The regional division based on these rice-cropping patterns corresponds to the land-unit division given in chapter II, although there are slight differences between them. The TRAFLO area corresponds closely to the upper floodplain, and the DUBTRA area also closely corresponds to the tide-affected floodplain. The single-transplanting area including both TRASIN and NEWSIN coincides with the coastal complex. In contrast to these three regions, the broad depression is characterized as a newly-developed rice-growing area where the NEWSIN and NEWBRO methods were introduced.

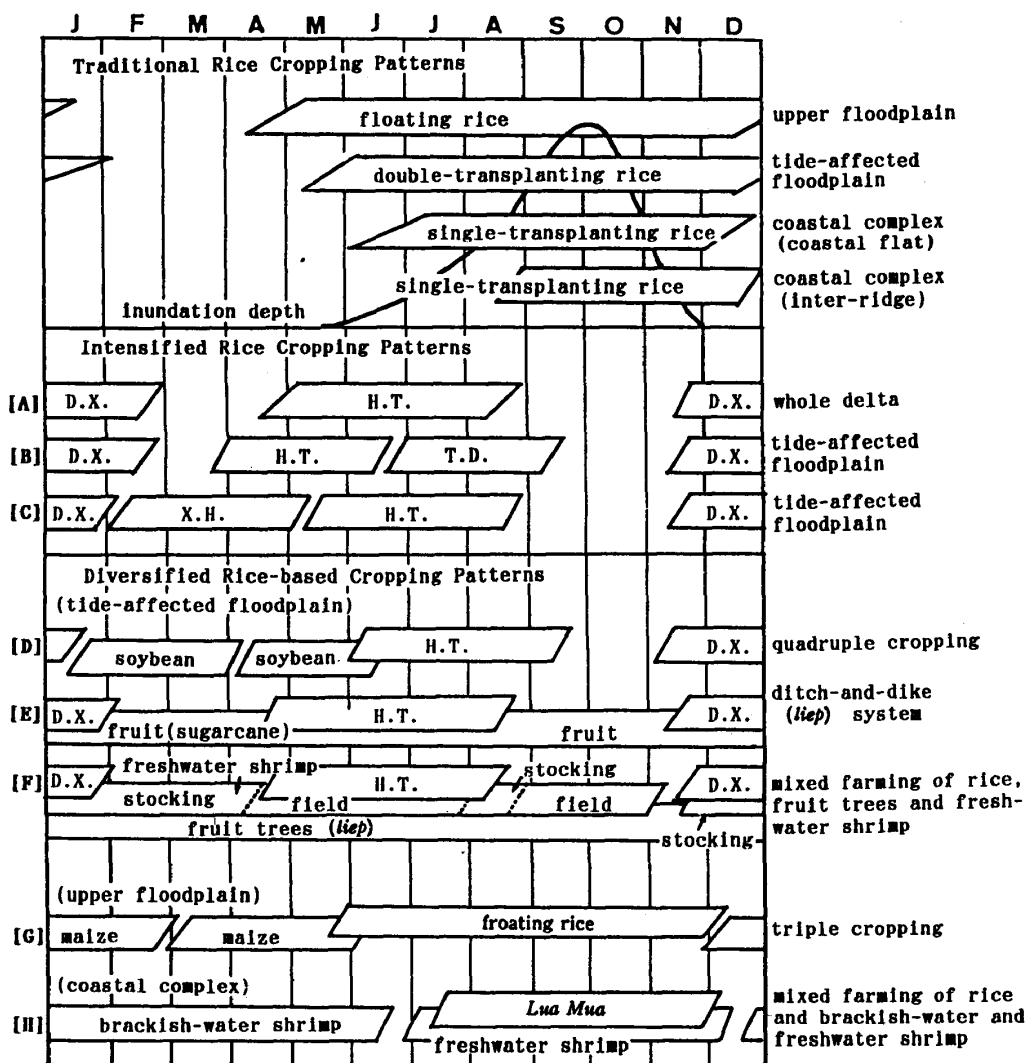
Chiem [1994] also summarized the distribution of former cropping patterns of rice, in which the "former" has been defined as the age before the first introduction of high-yielding varieties (HYVs) in 1967. According to him, the local rice varieties were divided into four groups before the introduction of HYVs: early maturing varieties, medium maturing varieties, late maturing varieties and floating varieties; and there were three main planting methods: broadcasting, double transplanting and single transplanting. These methods were closely associated with rice varieties: broadcasting was practiced only with floating varieties; double transplanting was practiced with medium and late maturing varieties; and single transplanting was practiced with early maturing varieties.

Before the introduction of HYVs, single cropping of rice was predominant, since all the patterns were dependent on rainfall and seasonal floods in the rainy season, though there were different cropping seasons, such as early, medium and late seasons, among them (Fig. 2). Broadcast floating-rice was grown from April to November/December. Although the double cropping of rice and upland crops, such as mungbeans and sesame, was partly practiced in the floating-rice zone, single cropping of rice was the predominant pattern. Double transplanting was mainly practiced in the tide-affected floodplain and the rice was grown from June/July to November/December or, in case of the latest varieties, to January/February. The first transplanting was done in June/July and the second two months later. The single-transplanting pattern was dominant in the coastal flats, and early maturing varieties were transplanted in September and harvested in December. Due to the salt intrusion, the cropping season in the coastal complex should have been delayed until rainwater washed away the salt.

Based on this interpretation of the former cropping patterns, the rice-based cropping patterns in the Mekong delta before the introduction of HYVs may be summarized as

follows:

- (1) The predominant cropping pattern in the delta was single cropping of rice.
- (2) Rice was grown in the rainy season, depending on rainfall and seasonal floods.
- (3) Multiple cropping patterns such as combination of rice and other crops were practiced in limited locations in the upper and tide-affected floodplains which had favourable conditions.
- (4) The distribution of cropping patterns and planting methods had a close relationship with regional variation in agro-ecological conditions.



Abbreviations: H.T. (*He-Thu*, summer-autumn rice), D.X. (*Dong-Xuan*, winter-spring rice), T.D. (*Thu-Dong*, autumn-winter rice), X.H. (*Xuan-He*, spring-summer rice)

Fig. 2 Transformation of Cropping Patterns: From Tradition to Diversification



## 2. Present Cropping Patterns: From Intensification to Diversification

### 1) Intensification of Rice Cropping

The introduction of HYVs with short growing periods brought about a drastic change in cropping patterns. As Fukui [1974] mentioned, double cropping of rice with local varieties and HYVs was about to replace the traditional single cropping in the early 1970s, particularly in the TRAFLO and the DUBTRA areas. This means that double cropping of rice was introduced into the regions having rather favourable soil and water conditions at the beginning stage of intensification.

The present cropping patterns can be explained as an expansion or continuation of such a trend of changes observed in the early 1970s. At present, double cropping of rice, consisting of both HYVs, has been widely disseminated to every region in the Mekong delta, including the plain of reeds, where rice cultivation was not practiced during the early 1970s. In the tide-affected floodplain, even triple cropping of rice has already been established, although its distribution is still limited to specific areas with favourable water and soil conditions. Not only the varietal improvement but also the introduction of various technical components, such as chemical fertilizers, pesticides, low-lift pumps and machinery, played important roles in developing such intensified cropping patterns of rice. Of these technologies, the introduction of low-lift pumps seems to have played the most prominent role in disseminating double cropping over the whole of the Mekong delta.

As mentioned above, rice was traditionally grown in the rainy season, depending on rainfall and floods in the rainy season. However, the most marked difference between intensified cropping patterns and traditional ones is that the former avoid the highest-flooding period (Fig. 2). For example, the most popular double cropping of rice is the combination of the *He-Thu* (summer-autumn) and *Dong-Xuan* (winter-spring) rice (Fig. 2 [A]). The *He-Thu* is grown from May to August and the *Dong-Xuan* from November to February. An inevitable consequence of avoiding the highest-flooding period from September to October is that supplementary irrigation, while not always necessary, is often used in both the early-growing stage of *He-Thu* and the later-growing stage of *Dong-Xuan* in many locations with limited water sources. Low-lift pumps and canal networks furnished the solution to this problem.

The triple cropping of rice has been introduced mainly in the tide-affected floodplain. According to a farmer in Long Ho district, one of the major triple-cropping areas in Vinh Long province, single cropping of seasonal rice (*Lua Mua*, traditional rice grown in the rainy season) had been practiced in the rainy season until mid-1970s and double cropping of *He-Thu* and *Dong-Xuan* rice became the major pattern by 1975. Triple cropping consisting of *He-Thu*, *Thu-Dong* (autumn-winter) and *Dong-Xuan* rice (Fig. 2 [B]) was first introduced by him in 1990, although he had wanted to intensify rice cropping with this pattern before that. The people's committee of the village at that time did not allow farmers to practice triple cropping of rice, being anxious about the increase of pest damage derived

from year-round continuous cropping of rice. However, the restoration of land-use rights from the cooperative to farmers in 1988/89 enabled farmers to try triple cropping on their own initiative. With the introduction of triple cropping, farming techniques also had to be transformed. For example, the method for planting rice was converted from transplanting to broadcasting. Under the triple cropping system, rice in all seasons is planted by the *xa ouc* method, in which germinated seeds are broadcast on the mud surface of the field after puddling and draining the remaining surface water. According to the farmer, broadcasting is inevitable to sustain this system due to labour shortage under the present economic conditions. Despite such great changes in farming practices, the area under the triple-cropping system increased very quickly and was said to have reached 3,000 ha out of 3,700 ha of total rice land in his village.

Another type of triple cropping consisting of *He-Thu*, *Dong-Xuan* and *Xuan-He* (spring-summer) rice (Fig. 2 [C] ) is practiced in Tien Giang province. In this system, *He-Thu* and *Dong-Xuan* are grown by the *xa ouc* method while *Xuan-He* has to be broadcast by the *xa chai* method. *Xa chai* is a broadcasting method without tillage, in which the field is neither tilled nor puddled before seeding. Instead, rice straw from the previous crop is spread over the field and burnt just before the seeding, and water drawn artificially by low-lift pump or naturally by gravity from a nearby canal is irrigated immediately after the seeding. Since the period for growing *Xuan-He* rice between the *Dong-Xuan* and *He-Thu* seasons is very limited and, in addition, the seeding is done at the peak of the dry season, the timing of land preparation and seeding is very crucial. The *xa chai* method is, therefore, one of the solutions to establishing triple cropping of rice.<sup>2)</sup>

## 2) *Diversification of Cropping Patterns*

Various types of intensified cropping patterns of rice, as mentioned above, have been established in the Mekong delta during the last two decades. However, the delta seems to be facing the second stage of transformation, i.e., a new trend of change to agricultural diversification after the agrarian reform under the new economic policy. For a long time before 1988, under the "food self-sufficiency" policy, thousands of hectares of *Melaleuca* and mangrove forests were cut to reclaim rice lands, and market-oriented perennial crops like fruit trees were not allowed to occupy rice lands, even if the lands were not highly suitable for rice [Xuan 1994]. But the current has changed since 1988.

### a) *Tide-affected Floodplain*

In this second stage, beginning at the end of 1980s, the tide-affected floodplain has again

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2) Chiem [1994: 370-371] discusses the significance of the *xa chai* method from the agro-ecological viewpoint. According to him, "this technique stimulates air explosion in soil clods. The soil has to be treated by a different physical method to improve its structure because it is not ploughed or puddled. Furthermore, burning of ground surface helps to kill grasses, insects and pests from the previous crops."

taken the lead in developing diversification, making use of its comparative advantage over other regions in terms of economic and agro-ecological conditions.

In the higher-elevated rice fields located on natural levees in this region, multiple cropping of rice and upland crops such as soybeans and mungbeans has developed from the former double-cropping of rice. Rice fields situated close to the right bank of the Tien river, northwest of Sa Dec city, in Dong Thap province are planted with four crops a year; *He-Thu* and *Dong-Xuan* rice, and two crops of soybeans and/or mungbeans (Fig. 2 [D] ). According to a farmer, single cropping of seasonal rice (*Lua Mua*) was practiced by the double-transplanting method until the mid-1970s. Double cropping of *He-Thu* and *Dong-Xuan* was introduced in 1975, of which *Dong-Xuan* was grown by broadcasting. On this basis, one crop of soybeans began to be introduced around the mid-1980s. It was seeded after the harvest of *Dong-Xuan* rice and the straw was used for mulching the fields. Soon after the establishment of triple cropping, one more crop of soybeans or mungbeans began to be combined.

In the case of the farmer interviewed, the second crop of soybeans was first introduced in 1988. In this quadruple system, the *He-Thu* rice is intercropped with the second soybeans without tillage, and the *Dong-Xuan* rice is also broadcast without tillage after the harvest of *He-Thu*. Such intensive cropping was made possible by the introduction of a low-lift pump, because irrigation is necessary for soybeans and *Dong-Xuan* rice grown in the dry season, and is not always but often necessary for the early growing stage of *He-Thu* rice. The pump is borrowed from a bank at a rent of two million *dong* (US\$ 1.0  $\doteq$  10,500 *dong* in mid-1993) per ha. Such changes in farmers' economic behaviour are worthy of note as a background to the introduction of diversified cropping patterns.

Fruit trees grown in the ditch-and-dike system within rice fields are also increasing in area and production in both subunits, the natural levees and the backswamps, in the tide-affected region. The ditch-and-dike system, called the *liep* system, is about to expand, with fruit trees like orange or commercial crops like sugar cane grown on the dikes, and rice in the ditches (Fig. 2 [E] ).

Mixed farming of rice and freshwater fish or shrimp is also being developed. The *liep* system is usually employed for this farming, too. The ditches surrounding a rice field are used for raising freshwater fish, such as carp and tilapia, or shrimp, and the rice field is used for growing commercial crops under the *liep* system. Fig. 3 indicates the arrangement on a farm located in a village of Phung Hiep district near the border of Cantho and Soc Trang provinces, which practiced mixed farming of rice, commercial crops and shrimp. Before this system was introduced in 1989/90, double cropping of *He-Thu* and *Lua Mua*, and partly of *He-Thu* and *Dong-Xuan*, had been practiced since 1978. An artificial pond system, in which natural fish remaining after flooding were raised in the pond, was traditionally employed to raise freshwater fish in the past. But after this mixed-farming system was developed by a farmer in this district, it was quickly disseminated through the farmers' own efforts and through extension services.

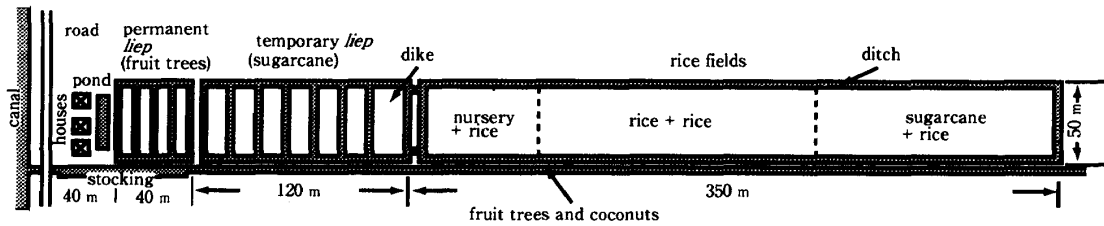


Fig. 3 Mixed-Farming Field in My Xuyen District

In the case of mixed farming shown in Fig. 2 [F] and Fig. 3, fry of shrimp are bought from fishermen from outside in December/January and raised in a stocking pond until April. After the seeding of *He-Thu* rice is over in April, the bigger shrimps are harvested in the stocking pond and the rest are freed to the *He-Thu* fields, where they are raised until the rice is harvested. Before the harvest of *He-Thu* rice, the water is drained through sluice gate and the bigger shrimps are again harvested. The remaining shrimps are kept in the stocking pond for a while, then again released into the ditches until the final harvest, which occurs before the land preparation for *Dong-Xuan* rice in December. In such ways, all the components of the farm are fully utilized all year round; the stocking pond and the ditches are alternately used for raising shrimp, the fields are cultivated with rice twice a year, the semi-permanent *liep* are filled with fruit trees like mango, banana, jackfruit, orange, starfruit and coconut, and the temporary *liep* are alternately used for growing sugar cane and rice. Here, it is also worthy of note that farm-level water management techniques using sluice gates make full use of the natural conditions of the tide-affected region, which are specific to this agro-ecological region.

b) *Upper Floodplain*

The most diversified cropping patterns have developed in the tide-affected region, as mentioned above, but similar types of diversification have also been developed in other regions. For example, in the former floating-rice areas in the upper floodplain, double cropping or triple cropping combining floating rice and upland crops is expected to be developed due to the higher benefit of upland crops over rice. In a village in Chau Phu district in An Giang province, upland crops had been introduced since the mid-1960s but only one crop was combined with floating rice. Triple cropping consisting of floating rice and two upland crops began to be introduced in the mid-1980s.

In the case of a farmer interviewed, who has 6.8 ha of cultivated fields, 1.5 ha are managed by triple cropping systems and the rest by double cropping systems. A number of upland crops and vegetables like hybrid corn, watermelon, melon, squash, cucumber, soybeans and red grams are grown in the dry season (Fig. 2 [G]). After the harvest of floating rice in December, the seeds of upland crops are dibbled and the seedlings of vegetables are transplanted without tilling the soil. After the first crops have been harvested in March, all of his fields are ploughed and harrowed by a four-wheel tractor,

then in April, the parts of his fields located close to a canal are seeded with the second crops. Since irrigation is indispensable for the second upland crop, pumping capacity is one of limiting factors for extending the triple cropping. Floating rice is broadcast in the stand of the second crop in the middle of May, because its growing period is long and the seedlings should be tall enough to cope with the flood commencing in July. The second upland crops are harvested from late June to the middle of July before the flood comes.

According to the agricultural office of Thoai Son district in An Giang province, about 40,000 ha, the total acreage of rice land in this district, was entirely planted with floating rice in the past. After the introduction of HYVs in 1978, double cropping of rice, *He-Thu* and *Dong-Xuan*, was introduced and its acreage increased to 7,000 ha by 1987. From 1988, double cropping of rice spread rapidly and became the predominant cropping pattern, showing the following increases: 12,500 ha in 1988, 33,000 ha in 1989, 35,500 ha in 1990 and 37,500 ha in 1993. This drastic change was achieved through the rehabilitation program of canal systems; the restoration and maintenance of 3 main canals were financed by the central government, 47 secondary canals by the provincial government, and 321 tertiary canals by farmers in the district. This rapid increase of double cropping coincided with the dissolution of agricultural cooperatives in 1988, which were organized in 1976 in this district.

Recently, in 1993, a new change in cropping patterns appeared over an area of 100 ha in Thoai Son district: the change from double cropping of *He-Thu* and *Dong-Xuan* rice to the double cropping of *He-Thu* and hybrid corn or of hybrid corn and *Dong-Xuan* rice. Since hybrid corn is more profitable than rice, these diversified cropping patterns are expected to increase quickly in future. The former floating-rice areas in the upper-floodplain region have also experienced a great change in the last two decades, and diversification of cropping patterns has become the exigent concern for farmers seeking more profitable operations.

### c) Coastal Complex

A similar diversification has also appeared in the coastal complex, in particular on coastal flats and inter-ridges, where many rice fields are being converted to mixed-farming fields by constructing ditches and dikes around the fields, in which the *Lua Mua* rice or HYVs are combined with both freshwater and brackish-water shrimp culture. In a village in My Xuyen district in Soc Trang province, a pioneer farmer began to introduce brackish-water shrimp culture in his rice fields, although the local government at that time did not allow the introduction of shrimp culture because the brackish water would inevitably be drawn onto the rice fields in the dry season and this might cause salinity damage to the rice grown in the following rainy season. However, after the success of the first venture, shrimp culture was approved by the local government, and mixed farming of rice and brackish-water shrimp began to expand very quickly among farmers. In 1985, freshwater shrimp culture was first introduced by the same pioneer farmer, and the year-round

shrimp culture system with rice was established, in which rice and freshwater shrimp were cultivated in the rainy season and brackish-water shrimp in the dry season (Fig. 2 [H]). By 1993, this mixed-farming system occupied 1,070 ha out of about 2,040 ha of rice fields in the village.

Various types of shrimp culture are found in the coastal complex at present. Some are combined with rice and others involve only raising shrimp in artificial ponds. Intensification and diversification of cropping with shrimp culture are expected to increase farmers' income but, in turn, the rapid expansion of this systems has brought about new technical constraints, among which shortage of shrimp fry and feeding materials are urgent issues to be solved. In addition, rapid reclamation of shrimp ponds which occurred on a large scale during the last decade causes environmental problems like pollution and soil erosion.

d) *Plain of Reeds and Broad Depression*

The plain of reeds and the broad depression are also about to enter the age of diversification, after an age of intensifying rice cultivation in the last decade. The Dong Cat State Farm was established by the army in the plain of reeds in Dong Thap province with the reclamation of about 5,000 ha in 1976, after the Vietnam War. At present, the farm occupies 1,400 ha of this area, since in 1984 the greater part of the farm land was returned to the farmers who had returned and settled there after the end of the War. In the state farm and the surrounding farmers' fields, single cropping of floating rice or seasonal rice (*Lua Mua*) was predominantly practiced until 1988, when double cropping of rice, *He-Thu* and *Dong-Xuan*, began to be introduced. With the expansion of double cropping of rice in recent years, freshwater fish culture in the rice fields is expected to be implemented. In addition, the former rice fields which were less suitable for rice growing have been converted to plantations of *Melaleuca*. In the state farm, 600 ha of fields have been planted with *Melaleuca*, of which areas of 60 ha will be cut for timber annually under a ten-year rotation system. The combination of the mixed farming of rice and freshwater fish culture, and *Melaleuca* forest for timber production is expected to be the most suitable farming system in this region from the viewpoint of economic performance and environmental conservation. Reforestation of *Melaleuca* is also being implemented in the broad depression for the purpose of conserving the environment and increasing farmers' income.

The intensification of rice cultivation, which was strongly promoted by the central and local governments to increase the self-sufficiency in foods during the last two decades after the Vietnam War, is giving way to diversification over the entire region of the Mekong delta. As shown in the case of the plain of reeds and the broad depression, the former reclaimed rice fields which were not suitable for rice cultivation are being restored as production forests planted with trees like *Melaleuca*, which is more suited to the adverse conditions. On the other hand, more intensified and more diversified modes of cropping have been developed in regions like the tide-affected floodplain, which have more

**Table 1** Transformation of Cropping Patterns in the Mekong Delta

Regional Variation of Land Use			Transformation of Cropping Patterns		
Region	Topography	Land Use	Stage I	Stage II	Stage III
(1) Upper floodplain	natural levees	house compounds			expansion of fruit gardens
		orchards			
		wet-rice fields	floating rice (F.R.)	H.T. - D.X. H.T. - F.R.	U.C. - H.T. - D.X.
	backswamps	wet-rice fields	F.R.	F.R.	U.C. - F.R. - U.C.
(2) Tide-affected floodplain	natural levees	house compounds			expansion of fruit gardens
		vegetable gardens			
	wet-rice fields	seasonal rice (double trans-planting)	H.T. - D.X. seas. rice	H.T. - T.D. - D.X. X.H. - H.T. - D.X. "liep" system	U.C. - H.T. - D.X.
	backswamps	wet-rice fields	seasonal rice (dbl. transpl.)	H.T. - D.X. seas. rice	H.T. - D.X./fish H.T./shrimp/fish
(3) Coastal complex	sand ridge	house compounds			expansion of fruit/vegetable gardens
		vegetable gardens			
	coastal flats	wet-rice fields	seasonal rice (single trans-planting)	seas. rice H.T. - D.X.	H.T. - D.X. H.T. - seas. rice H.T./shrimp
	inter-ridges	wet-rice fields	seasonal rice (single trans-planting)	seas. rice	H.T./shrimp/fish shrimp/fish
	mangrove swamps	mangrove forests	—	rice-land reclamation	shrimp pond
(4) Broad depression	backswamps	swamp forests	—	rice-land reclamation	seas. rice H.T. - D.X.
				rice-land reclamation	reforestation of <i>Melaleuca</i>
(5) Plain of reeds	backswamps	plain of reeds	—	rice-land reclamation	H.T. - D.X. "liep" system
				seas. rice H.T. - D.X.	plantation of <i>Melaleuca</i>

Note: Stages I, II and III coincide respectively with the age of traditional cropping patterns before the introduction of HYVs, the age of intensification from the early 1970s, and the age of diversification from the late 1980s.

Abbreviations: seas. rice (seasonal rice planted in the rainy season)

H.T. (*He Thu*, summer-autumn rice), D.X. (*Dong-Xuan*, winter-spring rice),

T.D. (*Thu-Dong*, autumn-winter rice), X.H. (*Xuan-He*, spring-summer rice),

U.P. (upland crops)

favourable conditions. As Xuan [1994:15] also mentioned, such diversified agricultural development based on each particular agro-ecosystem should be more feasible in the future.

## V Historical Overview: Concluding Remarks

After two decades of agricultural intensification, in other words, the age of intensification of rice cultivation from the early 1970s, the Mekong delta seems to be entering a new age of agricultural development, i.e., the age of agricultural diversification from the late 1980s. On the basis of double cropping of rice established by avoiding the highest-flooding period, market-oriented crops other than rice are being combined with these intensified rice-based cropping patterns.

The changes in cropping patterns observed in the last two or three decades are summarized in Table 1, in which the entire period is divided into three stages: I, the stage of traditional farming; II, the stage of intensification; and III, the stage of diversification. The table shows the most typical cropping patterns in each stage for individual regions.

Drastic changes in socio-economic conditions may push forward the diversification of cropping patterns more quickly and widely than before. Under such a drastic drive, the balance between agricultural development and environmental capacity is an urgent issue yet to be considered in order to promote the sustainable development of crop production in the delta.

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