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Traditional Rice Cultivation Methods and a Survey of Plows in Thailand: With Special Reference to the Development of Plow Technology *

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Introduction

From late March through April 1991 I had the opportunity to visit a number of towns and villages in Thailand. This was in fact my first chance to see anything of Thailand outside of the capital city of Bangkok and I was determined to make the most of it by combining my visits to villages for the purpose of surveying agricultural methods and implements with visits to the ruins of a number of ancient cities for the purpose of expanding my thesis on the baroque development of Thailand's pre-modern royal cities. Given the brevity of the visit and the ambitious nature of my schedule, there was a clear risk of "falling between two stools." I therefore confine this report to my village-centered survey of agricultural methods.

The primary objective of my village survey was to "assess the influence of transitions in the ecological environment on traditional rice cultivation methods in a variety of geomorphological areas from the mountainous northern part of Thailand through to the flat central plain." To this end I visited a total of 11 villages in these areas; the geographical distribution of the villages is shown in Fig. 1. In seven of the villages which I visited, I discussed traditional rice cultivation methods orally with the local people, and measured and photographed their farming implements. Given the purpose of my survey, there was of course a natural tendency for the distribution of the villages I selected to be skewed somewhat towards the north of the country. For a number of reasons I was also obliged to confine that part of my survey which I conducted in the remaining 4 villages to measuring and photographing traditional farming implements, particularly plows. I was nevertheless pleased to have been able to carry out at least part of my survey in the delta of the Chao Phraya river which, as the reader will see from Fig. 1, is far removed from the mountainous northern part of the country.

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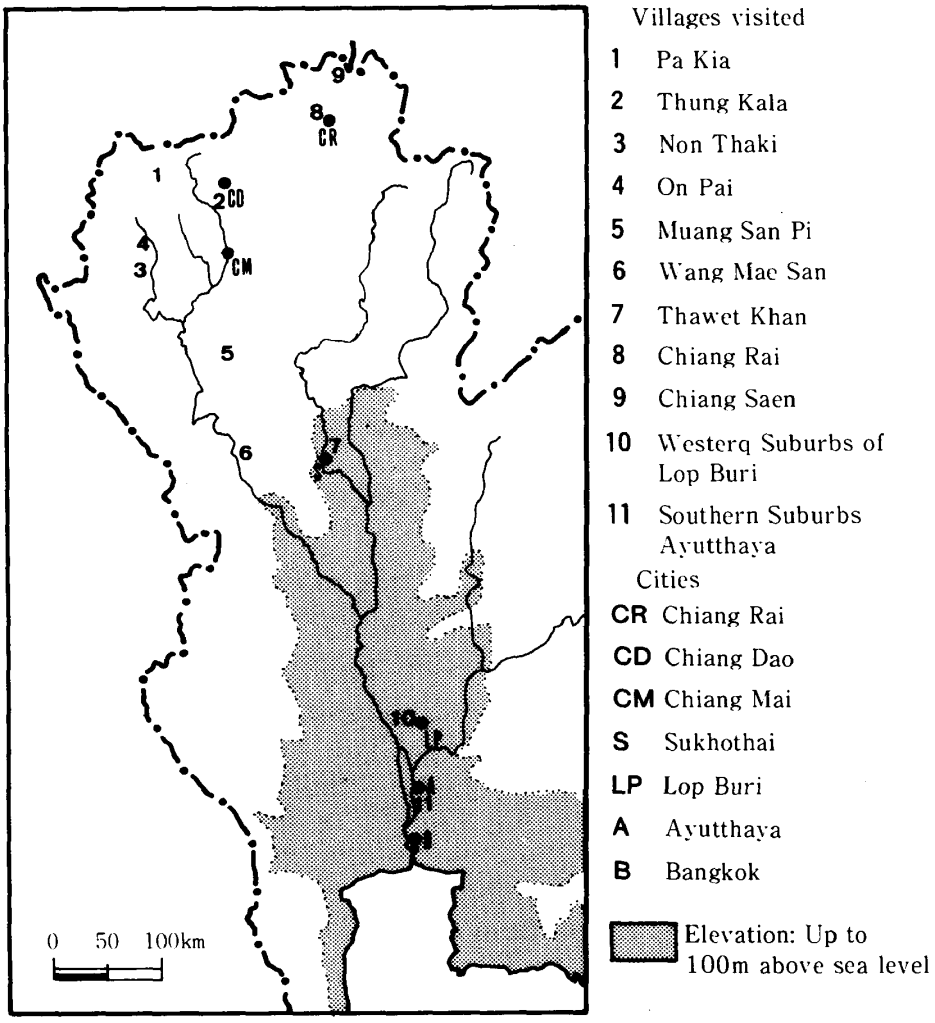

Fig. 1 Geographical Distribution of Villages Visited

Topographically the areas in which I carried out my survey of traditional rice cultivation methods can be divided into five main types. I have assigned each of these five areas a rough geomorphological description. The following list shows the villages in each geomorphological area in which I surveyed traditional rice cultivation practices in talks with the locals. The numbers in parentheses are the numbers used to denote each village in Fig. 1.

1/ Northern mountain slopes: Pa Kia (village No.1)

2/ Small northern mountain river valleys: Non Thaki (village No.3), On Pai (village No.4)

3/ Mountain basins: Thung Kala (village No.2)

4/ Areas of transition from mountain to plain: Muang San Pi (village No.5), Wang Mae San (village No.6)

5/ Central plain: Thawet Khan (village No.7)

For the purposes of the following discussion, I have chosen one village from each of the above geomorphological areas (1/ to 5/) and in Section I to V below I present the sort of information which I gleaned from talks with local farmers in each of these villages. In Section VI I offer some more general thoughts on the rice cultivation methods practiced in these villages while at the same time attempting to classify these basic practices into distinct groups. In Section VII I introduce another part of my survey with a brief discussion of the features of indigenous agricultural implements used in the villages which I visited, with particular reference to that most important of implements, the plow. Finally in Section VIII I examine the development of the plow over time and offer one or two original thoughts on how this development may have taken place.

I Rice Cultivation Methods (1): Slash and Burn — Pa Kia (village No.1)

Heading north from Chiang Mai on national highway 107 and turning left off the highway just south of Chiang Dao, I finally reached Pa Kia village in the shadow of Doi Chiang Dao mountain (2,175m) only after climbing for another three hours over mountain valleys and ridges. The village itself is located on a small ridge some 1,500m or so above sea level; from this height the observer has a good view out into the distance across an interminable ocean of mountain ridges and valleys. Although most of the villages I passed through on the way up to Pa Kia were Thai villages, Pa Kia itself has been settled by the Hmong people.

I - 1. *Types of Farm Land*

The villagers divide the farm land in the village into three main types.

A. Land adjoining the village itself (*Thei jei tei*)

B. Sloping land (*Thei pei chon*)

C. Valley land planted with bananas and sugar cane (*Thei chahan*)

Clearly, the villagers' method of classifying their land is not entirely consistent in that B and C depend on the topographical features of the land itself whilst A is dependent on geographical proximity to the village. The land farmed by the villagers can also be divided into permanent farm land irrigated with water from the river in the valley (C) and land cultivated using the slash-and-burn technique (A, B). Area A also contains a significant area of land which is in process of being converted into permanent farm land. This has been made possible by the introduction of vinyl hoses which are used to transport water from the river, which is some distance away, to irrigate the land around the village. The following are two examples of zone A land close to the village which have been converted to permanent farm land.

1) The first field was flat with a gentle slope and was located fairly close to the village. The land was originally cleared for cultivation four years before. In the first year after clearing, the villagers planted a dry field variety of non-glutinous rice and in the

second year they planted maize of the glutinous variety. In the third year they introduced peach trees and constructed a number of wide flat mounds which they irrigated by the method outlined above; the villagers sowed carrots on the mounds themselves and planted glutinous type maize in the land around the edges of the mounds. In the fourth year (1991—the year of survey), the villagers sowed carrots and glutinous maize as in the previous year while at the same time also planting sweet potatoes here and there on the mounds. It seems more than likely that the villagers will go on from here to turn the whole field over to peach tree cultivation (i.e. turn it into an orchard) and in this way convert it into permanent farm land.

2) The second field, which was located a little further from the village proper, sloped more steeply than the first field and was dotted here and there with the stumps of trees about 10 cm in diameter. These were left over from the clearing operation which was carried out some three years earlier. In the first year after clearing, the villagers planted fruit trees such as peaches and glutinous maize. In the second and third years after clearing, the villagers planted more glutinous maize in the spaces between the trees. In 1991 when I made this survey, the field was just entering its fourth year. The villagers explained that the trees had already grown quite big and they were as yet undecided what they were going to plant that year but the conversion from the earlier slash-and-burn site to a fruit orchard was clearly already well under way.

Zone C down on the valley floor was permanent farm land planted with sugar cane and a variety of fruit trees such as bananas and mangos. With the help of vinyl hoses, zone C was also being extended up the sides of the valley. Once cleared, the new sites are planted with non-glutinous rice in the first year and with glutinous rice or with non-glutinous maize in the second year; the spaces between the rows of maize are planted with fruits such as bananas. From the third year onwards, the newly farmed sites are turned over exclusively to use as fruit orchards.

As the conversion of farm land in zones A and C into permanent farm land progresses, the remaining slash-and-burn land is becoming increasingly concentrated in the more steeply sloping terrain of zone B. In terms of area, zone B is the largest of the cultivated zones in the village and is in principle "planted for two or three years and left fallow for five." The basic planting cycle involves the planting of glutinous or non-glutinous rice in the first year (both in roughly the same ratio), sweet potatoes in the second year and two crops within the year [glutinous or non-glutinous maize (generally the latter) + beans, cabbage or poppies] in the third year. Thereafter the land is rested from the fourth year onwards.

Let us now look a little more closely at the slash-and-burn approach to rice cultivation as used on the sloping terrain of zone B.

I - 2. *The Traditional Slash-and-Burn Rice Cultivation Technique*

I - 2 - 1. *Types of Rice*

Many different types of rice are grown but most of them fall into one or other of the following four groups.

a) *Sai ble la*: Red grained non-glutinous rice
b) *Sai ble brao la*: Red grained glutinous rice
c) *Sai ble krou*: White grained non-glutinous rice
d) *Sai ble brao krou*: White grained glutinous rice

According to the villagers, the best tasting rice is the glutinous red grained type (b) and for this reason they once tried growing only this type of rice. My informant advised me that the villagers' ancestors had brought both red and white grained rice to Thailand from Yunnan in China but that the land was not well suited to the cultivation of red grained rice and it had proved difficult to grow. My informant had in fact tried planting glutinous red grained rice both on the higher slopes of the valley and in the well irrigated land on the floor of the valley and had found that it flourished down in the valley but did not do so well further up the slopes.

In the case of the non-glutinous varieties of rice too, the villagers preferred the taste of the red grained variety. The main reason for this was that the red grained variety tended to retain more body than white rice when boiled, while at the same time remaining softer when left to go cold. On the other side of the coin, however, the grain of red rice is more difficult to hull and threshing consequently takes longer. For this reason, white rice tends to be preferred at planting time.

There is thus a clear tendency on the part of the villagers to prefer the glutinous strains of red rice over the non-glutinous strains. However, according to the villagers themselves, this preference is necessarily circumscribed by the soil conditions needed to grow this kind of rice and the problem of separating the grain from the husk. As a result, the most commonly planted strains of rice in this village belong to the non-glutinous white variety.

I - 2 - 2. *Clearing Land as Part of the Slash-and-Burn Process*

The clearing of the trees is carried out in February. The trees are cut down using an ax shaped tool like a battle-ax and the branches hacked off. Trees round the edge of the chosen site are left as they are and subsequently used to construct the small buildings needed around the site.

I - 2 - 3. *Burning*

The land is fired around the end of March. First the villagers set fire to the tree trunks and branches left on the site when they were cut down in February. Next, using a kind of six pronged iron rake, the villagers rake up all the bits of trunk and branch that are left

and make them into small heaps which they set alight in turn. Any particularly large trunks and branches that are still left after burning are then wedged laterally across the slope of the land to prevent the soil from being washed away. Tribes such as the Karen and the Lisu are known to hold ceremonies to celebrate the slashing and burning of a new site but the Hmong confirmed that they had no such tradition.

I - 2 - 4 . *Preparing the Land for Sowing*

By April weeds are starting to appear and these are dug up and removed using a hoe. Wire netting is used to fence off slash-and-burn sites near the edge of the village proper to prevent the village animals from wandering onto the land.

I - 2 - 5 . *Sowing*

In May the rice is sown using the dibbling method. First the men walk across the slope dibbling holes with a digging stick at intervals of between 20 and 25 cm. The digging stick itself is made of wood and is about 165 cm long with an iron blade (radius: 8cm, length: 33 cm) with a semi-circular cross-section on the end. The women follow the men inserting three or four grains of unhusked rice by hand into the holes the men have made. The grains are never mixed with other crops. When both groups reach the edge of the site, they move 25 or 30 cm down the slope and the men then start to work their way back across the site making holes the same way as before. This time, however, the men use the earth removed from the new holes to fill in the previous row of holes that has now been duly sowed. When the sowing has been completed, the villagers sometimes sow pigeon peas in the spaces between the holes into which the rice has been sowed. This has the effect of reducing the size of the final rice harvest, however, and this kind of mixed sowing is frequently avoided. Maize and other cereals are similarly not sown around the edges of the slash-and-burn site.

I - 2 - 6 . *Weeding*

The site is weeded three times. On the first occasion, which takes place about 2 or 3 weeks after the sowing, the weeding is carried out using a hoe with a widish blade. The second weeding operation is carried out about 10 days later, this time with a narrow bladed hoe. The third weeding operation is carried out another 10 weeks after the second operation again using a narrow bladed hoe. The different types of hoe each have long handles approximately one meter in length, thereby enabling the work of weeding to be carried out from a standing position.

I - 2 - 7 . *Scaring the Birds Away*

No action is taken to scare off birds. Most villagers tend to be of the opinion that birds scared off one field only find their way to another and eat the seeds there. For this reason they regard a part of their crop as being for the birds from the outset.

I - 2 - 8. *Harvest*

The whole of the new crop of rice is ready for harvesting about 180 days after planting. The villagers cut the rice plants fairly high at about 25 cm from the bottom of the stem using a sickle. Once cut, the rice plants are bound into small bundles using a thin strip of bamboo and left on the ground for between 3 and 7 days to dry.

I - 2 - 9. *Threshing, Winnowing and Storage*

Threshing is carried out by beating the rice onto something hard by hand. The villagers fit two bamboo poles at a small distance from each other between stones and beat the ears of rice on the poles to separate them from the stems and loosen the husks. An oil can or a bamboo basket (most commonly an oil can) is then used to toss the grain and winnow the loose husks away. A large rounded winnowing fan is used to create the necessary breeze; this is said to be quite sufficient to do the job. When there is not much grain to winnow, a smaller fan is used, although this is not often the case. The winnowed rice is then stored in an elevated storehouse.

I - 2 -10. *Agricultural Rites*

There are a number of agricultural rites, the most important of which are those relating to damage by disease and insect pests. When this sort of damage occurs and the crop looks to be in poor condition, the villagers pray to the spirits to make them aware of the problem. The best place in which to carry out this rite is said to be the upper left hand corner of the slash-and-burn site as viewed from the bottom of the slope. The necessary prayer is offered up in front of a makeshift altar by a villager holding the amputated tips of a pair of water buffalo's horns in his right hand. The gist of the prayer is as follows: "I have sowed this field with rice from end to end. I have a family to feed and I need this rice but the crop looks poor. Oh spirit of the field, please grant me a good harvest and in return I will give you XXX." The precise nature of the XXX offering is determined in advance by consultation with the village medicine man. The offering is in practice always either a chicken or a pig, never anything else. When the prayer has been offered, the villager throws the two tips of the water buffalo's horns in his right hand onto the ground a few feet in front of him. Due to their shape, the horns effectively have a front and a rear and the man continues to throw the horns on the ground in front of him until such time as they both land in the same direction facing either forwards or backwards. It is perfectly acceptable to change the offering with each throw of the horns but there is no obligation on the villager to increase the number of offerings with each throw.

If the villager is satisfied with the harvest when it is finally gathered in then he will fulfill his part of the bargain by making the promised sacrifices. If the prayer does not appear to have had any effect then the sacrifices need not be made. The whole business is in fact perfectly clear cut. On the day of the sacrifice, the villager builds another makeshift altar and stands in front of it; once again he throws the tips of two water buffalo horns

onto the ground in much the same way as he did earlier when offering up his prayer. He must also keep on picking the horns up and throwing them down again as he did on the previous occasion until such time as they land in the same direction. The orientation of the pair of horns on the ground indicates whether it is the spirits of the mountain or the valley or whether it is the man's ancestors that have gathered together in his field for the completion of the rite. The man then cuts the throat of the chicken or pig he is to sacrifice with a single cut from a kind of knife and drains the blood into a receptacle making sure not to spill any of it. Next he butchers the body of the dead animal and cooks part of it. When the meat is cooked, he places it in a small bowl on the altar along with some rice and blood as an offering to the spirits. The farmer does not offer up the whole animal in this way, only a very small part of it. The bulk of the carcass is taken back home and shared with the family. The following day the farmer goes back to the field and picks up the bowl from the altar. The bowl is always empty by this time.

II Rice Cultivation Methods (2) : Rice Cultivation in the Mountain River Valleys —On Pai (village No.4)

Driving southwest from Chiang Mai along national highway 108 as far as Hot and then heading north for about three and a half hours into the mountains brought me to the village of On Pai. The road passes through a number of Karen villages on the way, but On Pai itself is a Lahu village. The village lies at the upstream end of a small valley bordered by steep mountain slopes on both sides. The sloping sides of the valley were almost entirely burned and the areas immediately visible were in process of being converted to permanent farm land although the soil had already been seriously eroded. The slopes were in most cases planted with rice and cabbages alternately to produce a two crop rotation. Some parts of the slopes had also been cut into terraces in an attempt to create rice paddies.

In conversation with a man who looked to be somewhere in his forties, I learned that in his younger days everyone used the slash-and-burn technique, cultivating the same field only once every seven years; in those days the village itself had tended to shift its location regularly. The village had, however, stopped moving about 10 years ago and, as it started to cultivate the same farm land on a regular basis, it was also abandoning the slash-and-burn approach. This was partly the consequence of government incentives to settle in one place and start cultivating farm land on a regular basis and partly a consequence of the fact that other villages in the area were becoming permanent settlements, thus limiting the land available for On Pai itself to move to. This latter may well also be seen as a spread effect of the road building activity which followed soon after the permanent settlement of the village—in fact, given the complete denuding of the land and the progressive erosion which naturally followed, this might perhaps better be described as a backward effect. One way or another, however, for my informant at least, the old semi-nomadic seven year

rotation approach represented a better way of life.

I should now like to discuss the activity of rice planting as it is carried out in the long narrow rice fields of the deep mountain valleys.

II - 1. *Traditional Methods of Cultivating Rice in Mountain Valleys*

II - 1 - 1. *Types of Rice*

The villagers grow more non-glutinous white rice than any other kind, only growing non-glutinous red rice or glutinous rice extremely rarely. Glutinous rice is planted on a very small acreage primarily for sale on festival days and the like. The two types of non-glutinous white rice most commonly grown are the following.

a) *Khao tam*: A short-stemmed variety with a five month growing cycle

b) *Khao sung*: A long fat stemmed variety with a growing cycle of about five and a half months

The above varieties differ completely from what is commonly called upland rice and both a) and b) are said to be impossible to cultivate in dry fields. It may be noted in passing that the wet-land rice grown in paddy fields is called *ngo chuk* and upland rice *ngo ma*. Upland rice has a four month growing cycle.

II - 1 - 2. *Seedling Beds*

Seedling beds are prepared from late May through into early June. The beds are located in well watered sites close to a water course; the chosen spot remains the same from year to year. Once the selected land has been flooded it is plowed up once using a single ox drawn plow and then raked across the line of the furrows using a toothed rake to level it. Dry unhulled rice is then scattered over the prepared site. The rice is not soaked or subjected to any other preparation prior to sowing nor is manure or chemical fertilizer of any sort spread on the seedlings.

For five days or so after sowing the villagers keep the water on the site topped up. Once the new seedlings start to appear, the site is drained for two days and from there on the cycle of topping up for five days and then draining for two days is carried out repeatedly.

II - 1 - 3. *Preparation of the Main Paddy Field*

Work on preparing the main paddy field starts in June. First the field is flooded and plowed once using a single ox drawn plow. Then a few days later it is raked across the line of the furrows. The villagers make no use of animal feet to turn up the earth. As soon as the raking is completed, seedlings are transplanted from the seedling beds. Again, in the case of the main paddy field too no use is made of manure or of chemical fertilizers of any sort.

Khao tam is said by the villagers to transplant best at 28 days and *Khao sung* at 30

days. The work of lifting and transporting the seedlings from the seedling beds is carried out by the men; the transplanting of the seedlings in the main paddy field, on the other hand, is carried out exclusively by women. The approach to transplanting is basically random.

II - 1 - 4 . *Weeding*

Weeding is carried out once only after about two months, using a sickle.

II - 1 - 5 . *Harvest*

A sickle is used to cut the full grown rice plants about 20 cm from the bottom of the stem. The harvest generally yields between 20 and 25 times the amount sown. Once cut the rice is not bundled but simply left on the ground to dry for a couple of days just as it falls.

II - 1 - 6 . *Threshing, Winnowing and Storage*

First the women go round the paddy field collecting the dried rice stems and piling them into small mounds. Next the men circulate round the paddy picking up the mounds of rice stems and arranging them into bigger bundles of about 40 cm in diameter which they tie up with straw rope. Next the men spread empty fertilizer bags on the ground and, holding the large bundles of rice stems towards the base end, beat the ears on the ground to shake out the rice grains. Since this is rarely enough to dislodge all the grains, the men also use wooden sticks to thresh the ears of rice to remove the remaining grains.

The rice and chaff lying here and there on the ground is next winnowed by fanning it with a large hand-held fan. The villagers say that this is quite sufficient to complete the winnowing process successfully. In other words, there is no need to toss the grain into the air to winnow it.

When the winnowing is complete, the clean rice is carried to an elevated storehouse for storage.

III Rice Cultivation Methods (3) : Rice Cultivation in Mountain Basins —Thung Kala (village No.2)

In describing the route which I took to arrive at Pa Kia village in Section I above, I mentioned turning left just south of Chiang Dao. The village of Thung Kala is located precisely at this turning point off the main national highway. The southern extension of Chiang Dao, which includes this village, is a mountain basin incorporating a wide river valley. I therefore decided that this would be a good place to investigate the Thai approach to the cultivation of rice in a mountain basin. The village itself is strung out in a sort of ribbon development along the road and the rice paddies lie at the rear of the roadside buildings. The paddies themselves are generally small with many being no more than 10 m square. Each paddy is flooded individually and cultivation is based on the seedling

transplantation approach.

The village is inhabited by Thai people and faces onto national highway 108, the main road north from Chiang Mai. Although the method of cultivating rice employed in the village differs substantially from those found in the previous two villages, the difference is basically attributable not to any definitive difference in the ecological environment but rather to the proximity of the village to a main road and to the consequent availability of modern agricultural input materials.

III - 1. *Rice Cultivation in a Mountain Basin*

III - 1 - 1. *Types of Rice*

The main varieties of rice cultivated in the village are *Ko kho* 4, 6, 8 and similar varieties, all of which are of the glutinous white type. The graduation from traditional local rice to improved outside varieties has been extremely noticeable. The village buys in all the improved varieties of rice that it uses from the government rice bureau. The main types of traditional local rice still being grown in the area are the following.

a) *Khao mae non*: White glutinous rice with a growing season of 4.5 months.

b) *Khao rai*: White glutinous rice with a growing season of 4.5 months.

c) *Khao kuci*: White glutinous rice with a growing season of 4.5 months.

According to the villagers, all the rice cultivated in the village is now of the white glutinous type and there are no non-glutinous varieties grown at all. In the past the villagers did grow the red grained glutinous variety *Khao kam* (the grain is in fact almost black) but this was only grown in very small quantities for the purpose of making into rice cakes to offer up to Buddha on appropriate days of the month. This practice has now been abandoned, however, and there is now no red rice grown at all.

The transition from traditional local rice to improved varieties is thus taking place at very high speed. The transition in this particular village is, however, still confined to the white glutinous types of rice which it has traditionally depended on.

III - 1 - 2. *Seedling Beds*

The villagers start to prepare the seedling beds around the start of the rainy season in early June. The same site is used each year for the seedling beds. The initial preparation involves flooding the site and plowing it once with a single ox drawn plow and then plowing it once again one or two days later. The second plowing operation is carried out not across the line of the furrows created by the first plowing but along precisely the same lines again. Next the site is drained and raked across the line of the furrows using a toothed rake to break up the earth and level it. The site is now flooded once again and the seed sprouts planted. The seeds are sown in a ratio of about 30 kg to every 0.25 *rai* (approx. 0.04 hectares) of seedling bed. Around 10 *rai*'s worth of seedlings is thus sufficient to plant the main paddy field.

Rice purchased from the government rice bureau is already treated with chemical agents of one sort or another and is immediately soaked in water for two days and nights. After removing the rice from the water, it is covered with a cloth and left to dry and sprout for three days.

The seedling bed is kept dry for between three and five days after sowing. Thereafter the paddy is filled with water every five days. There is no manure or chemical fertilizer used on the seedlings.

III - 1 - 3 . *Preparing the Main Paddy Field*

About 10 days after the seedlings have been planted, work starts on the main paddy field. Traditionally this involves first flooding the paddy and plowing it once with a single ox drawn plow. The paddy field is then left for about 15 days and then raked using a toothed rake. After another two or three days the paddy is raked again, this time in a flooded condition and across the line of the original plowed furrows. Hand-tractors are also now in evidence and villagers that have access to this kind of equipment can apparently carry out both the plowing and raking operations at the same time.

III - 1 - 4 . *Transplanting*

The villagers tend generally to help each other out with this job. The lifting and transportation of the seedlings from the seedling beds to the main paddy field is carried out by men and the replanting of the seedlings mainly by women although men do sometimes also take part in the replanting work. The approach to replanting is random.

III - 1 - 5 . *Fertilization*

The villagers do not spread manure on the main paddy field either but they do use chemical fertilizers. About 15 days after the transplanting operation, the villagers spread mixed fertilizer (15-15-15) in a ratio of about 100 kg of fertilizer to every 10 *rai* of paddy. It is in fact preferable to spread about 200 kg of fertilizer to every 10 *rai* of paddy but this is an expensive operation and in practice a lot of the villagers settle for about half this optimum quantity. The ideal would be to repeat this operation a month or so later using about the same amount of fertilizer again but this is practically impossible for all but the richest members of the community. The price of a bag (50 kg) of 15-15-15 in 1991 was 300 bahts.

III - 1 - 6 . *Irrigation*

There are two main irrigation methods in use: the first involves flooding the paddy field throughout most of the growing period and only draining the water out about 10 days before harvesting the rice; the second method calls for the paddy field to be drained for 5 or 6 days when the ears start to droop.

III - 1 - 7. *Weeding*

Herbicide is spread on the paddy field along with the chemical fertilizer and the villagers do not carry out any real weeding as such. Prior to the introduction of herbicide, the villagers used to deal with weeds by wading through the paddy field pressing the weeds into the mud with their feet and making the ground soft. Even now any weeds that do grow are pressed into the ground with the feet and not removed by hand. Herbicide first came into popular use two years prior to this survey.

III - 1 - 8. *Harvest*

The rice is cut with a sickle about 30 cm from the bottom of the stem. Once cut the rice is immediately tied into small bundles using a straw rope and left in the paddy field for between three and five days to dry.

III - 1 - 9. *Threshing, Winnowing and Storage*

When the rice plants are dry, all the bundles are collected together into the same place for threshing. The rice is threshed by beating the ends of the bundles from which the ears of rice are projecting against empty fertilizer bags which are spread out on the ground for the purpose. The grain is then winnowed by tossing it into the air using a wooden scoop. The breeze required for winnowing is supplied by a large round bamboo fan. When the winnowing is complete, the clean rice is carried off for storage in an elevated storehouse.

III - 1 -10. *The Cropping Order*

On sites which have favorable water characteristics—i.e. they retain a measure of dampness even during the dry season—soy beans are often planted when the rice has been harvested. As far as I could judge from on-the-spot observation, however, the acreage planted with soy beans was fairly limited and was concentrated largely in the same area. Soy beans are sown in December and harvested in April. The ground is not plowed again after the rice has been harvested but simply dibbled to make holes into which the soy beans are sown. Little else is done except to spread insecticide and chemical fertilizer on the beans about one month after sowing. No weeding is carried out.

IV Rice Cultivation Methods (4): Rice Cultivation in Areas of Transition from Mountain to Plain —Wang Mae San (village No.6)

Heading south from Chiang Mai along national highway 106 took me down through a landscape of wooded hills. En route I passed along the side of Lake Doi Tao and, from there on, the valley began to open out and the land became progressively flatter. The feeling was very much one of emerging from the end of the valley. In one corner of this wide valley mouth lay the village of Wang Mae San. The village cultivates rice using the transplantation method. The hand-tractor is rapidly replacing the more primitive plow as

the main means of turning the earth but I would like to concentrate here on the plow based method of rice cultivation carried out in earlier days.

IV－1．*Rice Cultivation by Transplantation in a Wide Valley Paddy Field*

IV－1－1．*Types of Rice*

High yielding varieties of rice are becoming increasingly common and are replacing the traditional local strains. Two popular new varieties are *Ko kho* 23 and *Ko kho* 27, both of which are non-glutinous varieties of white rice and both of which also have short growing seasons of just four months. These high yielding varieties of rice were first introduced about 1983. The transition to high yielding strains with short growing seasons has made it possible for farmers to produce two crops a year. The new rice growing seasons are as follows.

Season 1: First sowing in early June; transplantation of seedlings to main paddy field in early July; harvest in early October.

Season 2: First sowing in early March; transplantation of seedlings to main paddy field in late March; harvest in late June.

In the years before the new high yielding rices were introduced the two main varieties of local rice cultivated in the village were as follows.

a) *Khao pi*: A white non-glutinous rice with a five month growing cycle.

b) *Khao bunma*: A white non-glutinous rice with a five month growing cycle.

When these were the main varieties of rice grown, the farmers were unable to grow more than one crop a year. Varieties of traditional glutinous rice were also apparently grown but only very rarely.

I should now like to look in more detail at the method used in the village for the cultivation of two crop paddies in the days when the traditional plow was still in regular use. The method I shall describe below relates specifically to the first crop of a two cycle season.

IV－1－2．*Seedling Beds*

In the first growing cycle of the year, the villagers await the onset of the rainy season in June before starting to prepare the seedling beds. The same easily irrigated site with good water facilities is selected and used each year. The basic sowing routine consists of flooding the chosen site and then, while the land is still under plenty of water, of plowing and raking the site to break up the earth and level it all in the same day. The water is then drained from the site and the seeds are sown the following day. Once the sowing operation has been completed the seedling beds are reflooded for a day and then drained again for a further three days. The beds are subsequently reflooded and drained repeatedly for periods of one day and four or five days respectively. The seeds are never soaked prior to planting but are always planted dry. The villagers spread neither manure or chemical

fertilizers on the seedling beds.

IV - 1 - 3. *Preparing the Main Paddy Field*

When the sowing of the seedling beds has been completed around the middle of June, the villagers turn to the preparation of the main paddy field. The land is still rather damp from the early rains and the first plowing is carried out without first flooding the site. Only when the plowing is finished is the field flooded. Next, the land is raked over to break up the earth and level it. If the earth proves too hard for the regular toothed rake, the villagers use a kind of rotating cylinder-like rake on wheels similar to the *kurubasha* used in the Sakishima islands (Southwestern part of Okinawa Prefecture).

IV - 1 - 4. *Transplantation*

As soon as the job of raking and leveling the site has been completed, the seedlings are transplanted at random. Some of the seedlings are also transplanted to old seedling beds. The seedlings are apparently best transplanted at 30 days during the first growing cycle and at 20 days during the second cycle. Almost all the work associated with the lifting of the original seedlings, transporting them and replanting them in the main paddy field is carried out by the women. In fact, to be more precise, in this village the work of growing rice is almost all carried out by women.

IV - 1 - 5. *Fertilization*

The villagers spread neither manure nor chemical fertilizers on the main paddy field. The only additional fertilization these paddy fields get is the cow dung left on them when the villagers turn their animals onto the paddy fields after mowing. This is an extremely limited amount of extra fertilization considering the paddy fields are required to produce two crops a year.

IV - 1 - 6. *Irrigation*

The paddy fields are flooded for about 10 days after the seedlings are transplanted. They are then drained for two or three days and then flooded again right through until about 10 days before the harvesting is due to begin.

IV - 1 - 7. *Weeding*

Weeding is carried out once only by hand about one month after the seedlings are transplanted.

IV - 1 - 8. *Scaring the Birds Away*

The villagers do not take any steps to frighten the birds away now but in the past they used to do this for about 15 days. The normal approach was to set up a look-out post at the side of the paddy field and to wave rags at the birds or shout at them to scare them

away.

IV - 1 - 9. *Harvest*

A small sickle is used to cut the rice plants off about 25 cm from the bottom of the stem. The cut plants are laid out on the ground as they are cut and left to dry for about three days.

IV - 1 -10. *Threshing, Winnowing and Storage*

When the cut plants are dry, they are gathered together into bundles of about 20 cm in diameter. In a corner of the field, a mixture of ox dung, earth and water is plastered over the surface of the earth and allowed to dry; this is then used as a kind of threshing floor. The villagers grip the stalks of the rice plants close to the cut ends and beat the ears on the hard threshing floor to shake the seeds loose. In the days when only traditional varieties of rice were cultivated, the villagers also had a method of separating the grains from the stalks of the plants using the hooves of the water buffalo but these days only the hand threshing method is used. Once the threshing has been completed, the rice is winnowed by tossing it into the air from a wooden scoop and winnowing it in the breeze. The clean hulled rice is finally loaded onto an ox cart for transportation to an elevated storehouse.

V Rice Cultivation Methods (5) : Rice Cultivation in the Central Plain —Thawet Khan (village No.7)

Leaving the low hills and broad valley floor behind me, I traveled on south into the central plain and the town of Tak. Although the land in this area is still somewhat undulating, it nevertheless constitutes the northern edge of the central plain. From there I turned east towards Sukhothai. In his topographical classification of the Chao Phraya river valley, Yoshikazu Takaya describes this area as fan-terrace complex [Takaya 1982: 15]. On the other hand, for anyone emerging from the upper into the lower reaches of the valley, the impression is most certainly that of emerging onto a broad plain. The village of Thawet Khan lies to the east of Sukhothai and it was this village that I selected as representative of the northern edge of the central plain.

The method of cultivation used in this village is again different from those used in the mountain villages discussed earlier and in practice comprises a variety of different techniques. Not only do the villagers use both the transplantation method and the direct sowing method side by side, they also employ two different methods of transplanting rice seedlings while at the same time using both wet and dry seedling beds. The variety of methods of cultivation used in the present village stands in stark contrast to the uniformity of the traditional agricultural methods used in the mountain villages described above. I will now describe two main methods of rice cultivation, one by seedling transplant and the

other by direct sowing, as used in Thawet Khan and with particular reference to the points of difference outlined above.

V - 1. *Types of Farm Land*

The villagers classify their farm land into the following three types.

A. *Na dam*: A fertile loamy soil field with better irrigation facilities.

B. *Na ka thum*: A slightly sandy soil field which has for long benefited from irrigation making it a close runner up to zone A.

C. *Na yo*: This zone has only recently started to benefit from irrigation and up till then was entirely dependent on rain for soil moisture. The soil also contains a large amount of sand making it the worst of the three main zones.

Zone A is the largest of the zones in the village. This would appear to have some connection with the village's location on a plain quite remote from the fan area.

V - 2. *Traditional Rice Cultivation Method 1 — Transplantation Method*

The term "traditional rice cultivation" is actually applied to two different methods of rice transplantation and is in practice open to further subdivision into the wet transplantation method and the dry transplantation method. For the purposes of describing the transplantation approach, however, it would be overly laborious to describe the wet and dry methods separately and I have therefore decided to cover them both at the same time.

V - 2 - 1. *Types of Rice*

The village cultivates a variety of different strains of rice, the most commonly planted type being *Khao khon krua,* a non-glutinous white rice with a growing season of five months.

V - 2 - 2. *Seedling Beds*

The seedlings beds are prepared in June. There are two main ways of preparing the beds.

a) Wet seedling beds — The chosen site is first filled with water and then [plowed → raked with a toothed rake to break up the earth and level it → plowed again → raked again, this time with a ladder shaped horizontal rake to break up the earth and level it → the seeds are sown].

b) Dry seedling beds — The seedling beds are in this case prepared without watering the land at all. The basic order of operations is the same as in a) above except for the first watering. The only observable difference between the two methods other than the use of water is that in the case of the dry method, the second hoeing operation is carried out once again with a toothed rake and not with a ladder shaped rake as in the wet method. When the sowing is finished, a levee is carefully built around the seedling beds to catch and retain rain water.

The most commonly used of the above two methods of seedling cultivation is the wet

method a). In the case of the wet method, the seed treatment and the water management are carried out in the following way. First the seeds that have been selected for planting are placed in a bamboo basket and soaked overnight in water. The basket is then removed from the water and, without this time adding water, the basket with the seeds in is now placed in a darkish hole in the ground for two days and nights. This is sufficient for the first white sprouts to appear. The sprouting seeds are then transferred to the seedling bed. Two days after sowing, the seedling bed is filled with water. On the third day the water is drained away again and well dried cow dung is spread thinly over the bed. From the fourth day the water is kept extremely low for about a week and from that point on the water level is raised and kept at about 10 cm for the rest of the time until the seedlings are ready. The only fertilizer used is the cow dung referred to above.

V - 2 - 3. *Preparing the Main Paddy Field*

There are two methods of preparing the main paddy field. Elements of the operation such as the time of year when it is started differ depending on the method chosen.

a) Wet preparation method—Work starts in the middle of June when water for irrigation becomes plentiful. First the paddy field is well filled with water and then it is plowed using a large plow drawn by two oxen and raked using a toothed rake. A few days later the whole operation is carried out once again. As soon as the second plowing is finished, the farmers start to transplant their seedlings. This method of preparing the paddy field is used in conjunction with the flooded paddy hand plantation method outlined below.

b) Dry preparation method—Work using this method starts earlier than that using method a) above and actually gets under way early in June as soon as the first rains fall. When the ground has acquired a bit of moisture, it is plowed up using a big twin ox drawn plow and raked over with a toothed rake to break up the earth and level it. The farmers then wait for the next rainfall and repeat the whole operation. Then they wait for rain again and when the ground is damp enough, they carry out the transplantation operation. This method of preparing the paddy field is used in conjunction with the dry field dibble plantation method described below.

V - 2 - 4. *Transplantation*

The work of transplantation—i.e. lifting, transporting and replanting the seedlings—is all carried out by women although the men are said to lend a hand occasionally. There are two basic transplantation methods in use. These are:

a) The flooded paddy hand transplantation method—This is the regular transplantation method involving the random replanting of the seedlings by hand in a main paddy field prepared in accordance with the wet preparation method described above.

b) The dry field dibble plantation method—In this case a digging stick with a pointed end is used to make rows of holes into which the prepared seedlings are planted

by hand. This method is used in rain-fed paddy fields with poor sandy soils. On fairly good soils—i.e. soils with relatively good water retention characteristics—the dibbled holes are spaced at intervals of about 25 cm whereas in soils with poor water retention characteristics, the holes tend to be spaced more widely at about 40 cm from each other. This latter method is the one used when transplanting seedlings from dry seedling beds.

In both the above cases, the best time to transplant seedlings is at 20 days after sowing.

V - 2 - 5 . *Fertilization*

Traditionally there has been no additional fertilization using either manure or chemical fertilizers. Now, by contrast, chemical fertilizers are used.

V - 2 - 6 . *Irrigation*

When using the flooded paddy hand plantation method, the paddy field is kept in a flooded condition from the point of transplantation and is only drained 10 days before harvesting is due to begin. The paddy field is never drained in mid-cycle. In the case of the dry field dibble plantation method, the site is watered by rainfall alone and is not subject to other forms of irrigation.

V - 2 - 7 . *Weeding*

In the case of the flooded paddy hand plantation approach, weeding is carried out using a small sickle just once about a week after transplantation. The villagers explained that this was because the ground has already been turned over when preparing the main paddy field and there are consequently not so many weeds to be removed.

V - 2 - 8 . *Harvest*

The rice plants are cut about 30 cm above the ground with the help of a small sickle. The cut plants are laid out on ropes stretched out on the ground and left to dry for about three days. The ropes are then cut to suitable lengths and the dried rice plants drawn together in bundles of about 20 cm in diameter. The harvest normally works out at between 17 and 20 times the amount of seed planted.

V - 2 - 9 . *Threshing, Winnowing and Storage*

First the farmers level a part of the paddy field which has already dried out. Then they mix water buffalo dung with water and spread it smoothly over the leveled ground. Next a wooden table is set up and a board leaned up against it; the farmers then thresh the ears of rice against the board in such a way that the grains of rice roll down it as they are released from the stalks. The farmers push two wooden sticks into each bundle crosswise to each other such that they create a sort of scissors effect; they then grip the sticks with both hands in order to get a firm hold on the sheaves which they then beat against the

board. When the threshing operation is finished, the sheaves are laid out in a circle on the ground where it has been smoothed and dried. Five or six water buffalo are then yoked together crosswise and walked round and round the circle to squeeze the remaining grains of rice off the stalks with their hooves. During the course of this work, those sheaves which have already released all their grain are yanked out of the circle using a hook-like implement made of bamboo. A rake-like implement is then used to comb out the worst of the chaff and other rubbish that is still mixed in with the grain. The grain is then placed in a wooden scoop and tossed to winnow out the remaining chaff in the breeze.

V－3．*Traditional Rice Cultivation Method 2—Direct Sowing*

The direct sowing approach is the one used by the villagers to plant the *Na yo* farm land—the worst of the three main types of land in the village. The basic preparation of the land for planting, including the timing of the preparation, is identical to that of the dry preparation method. When the land is sufficiently damp and rain is again imminent, the seeds are planted. The method used is to plow the site inwards in a spiral from the border to the center and then to plant along the resultant ditch by hand. The unhulled rice seeds are sown by taking them in one hand and rolling them into the prepared ditch by opening the fingers out one by one in the direction of the ground starting with the little finger, then the ring finger, the middle finger and finally the index finger. When the sowing is finished, the farmers use a short toothed rake to rake across the line of the ditch to cover the seeds and tamp down the earth on top.

Weeding is carried out just once about 15 days after sowing using a trowel or rake. Subsequent reaping and threshing is carried out in the same way as in the transplantation method.

VI　An Examination of the Rice Cultivation Techniques of Northern Thailand

As explained above, the area which forms the subject of the present research can be divided into five distinct geomorphological zones. In the previous sections I took one village from each zone as an example of the methods of rice cultivation undertaken in that zone and presented a mass of data in connection with each of the chosen villages. In the present section, I would like to present an overview of the rice cultivation techniques of northern Thailand and to highlight features of particular interest as suggested by the data presented so far.

Using the common features of their rice cultivation methods, as discussed in Sections I to V above, it is possible to subdivide the five villages described above into three main types. The first type consists of the village of Pa Kia, which I described in Section I; this is what we might call the "slash-and-burn direct sowing method for sloping fields." The second type comprises the villages of On Pai in Section II, Thung Kala in Section III and Wang Mae San in Section IV, and might reasonably be described as the "wet paddy

transplantation method for mountain valley fields." The third type consists of the village of Thawet Khan in Section V. Unfortunately, although it was relatively easy to come up with descriptive labels to sum up the traditional approaches to rice cultivation preferred in the first two types of village, the techniques in use in Thawet Khan were so many and varied that I was unable to come up with a single cover-all label that would adequately cover them all. I have thus decided to call the third type of approach the "varied rice cultivation methods of the plains." I should like to elaborate briefly on each of these three types below.

The first "slash-and-burn direct sowing method for sloping fields" is basically just one example of a more general slash-and-burn approach used in the cultivation of a variety of cereals in the sloping farm lands of Thailand's northern mountain ranges. This area belongs, as the reader will be well aware, to the "glutinous rice culture sphere." However, insofar as may be gleaned from talking with the villagers, despite their preference for red glutinous rice, in practice they grow mostly white non-glutinous strains of rice. It might also be noted in this connection, however, that the Hmong people, who live in the glutinous rice culture sphere, also grow mostly non-glutinous rice of one sort or another [Iwata 1963: 38]. Thus the choice of a non-glutinous white rice may not simply be due to the nature of the land and to the rice's easy threshing characteristics, as described by the villagers of Pa Kia, but may also have something to do with the fact that Pa Kia is a Hmong village. The use of the slash-and-burn approach to rice cultivation, coupled with the villagers' preference for growing non-glutinous strains of rice, has much in common with the customs of the Hmong people of northern Laos as reported by Lemoine [Lemoine 1972: 49-69].

Let us turn now to the second or "wet paddy transplantation method for mountain valley fields" type of cultivation. This approach to rice cultivation was found in mountain river valleys, in basins in the mountains and in the rolling country that marks the transition from mountains to plain. Thus, while there may well be differences in valley width from one zone to the other, all these zones fall into the broader basic category of river valley zones. As is frequently pointed out, topographical conditions of this type are extremely conducive to the development of water management techniques based on irrigation from small rivers. It is not clear whether it is directly attributable to this factor or not but, the existence of a number of minor differences in technical detail notwithstanding, the traditional approaches to rice cultivation identified in the three villages included in this type were remarkably similar to each other. A number of features which these villages typically had in common include, for example, the simple "plow once and rake over with a toothed rake once or twice" approach to paddy field preparation, the use of the transplantation method, the limited resort to weeding and the high cut approach to harvesting. However, in the case of Wang Mae San, the village in the wide mouth of a valley opening onto the central plain studied in Section IV, I also found evidence of the use of a rotating cylindrical rake to break the earth up and level it and of the use of oxen as part of the rice hulling process, neither of which techniques were to be found further up in

the mountains proper. The first of these was probably the villagers' way of dealing with the heavier, more tightly packed soils of the area and the second was probably their way of countering the more difficult hulling characteristics of the strains of rice which they grew. Out in the villages of the central plain, these latter techniques are a more common feature. As such, they clearly indicate the transitional nature of the rice cultivation techniques used in this village.

Although not in evidence in On Pai, there was a clear tendency in the other two villages situated alongside national highways to replace traditional input materials with more modern ones. There are also noticeable differences starting to develop between villages, which are clearly due to the degree of ease with which the villagers have taken to such new inputs.

Of the villages targeted in the survey, On Pai was the village that showed the least evidence of change. On Pai is a village settled by the Lahu people who were previously a semi-nomadic slash-and-burn farming community. In earlier days when the village was still on the move, their approach was by and large to cultivate land by the slash-and-burn method once every seven years or so. Judd reports the slash-and-burn method of cultivation used by the Lahu villages of the Nan region of northern Thailand [Judd 1961: 116-172]. Judd also reports a similar six or seven year rotation for any given cultivation site. Although the villagers of On Pai grow mainly non-glutinous white rice, in contrast to the Nan villagers who prefer the glutinous variety of white rice, this may well be a reflection of the transition of the village of On Pai from its earlier semi-nomadic slash-and-burn existence to a settled way of life and the concomitant shift towards a transplantation approach to cultivation.

The variety of approaches to the cultivation of rice manifested in the "varied rice cultivation methods of the plains" stands in stark contrast to the uniformity of approach described under type 2 above. This is in part explained by the wider environmental variety of the plains, which reflects a transition from the uniformity of the river valley floor conditions further north to the wider variety of topographical and soil conditions represented by the fan shaped northern reaches of the central plain and its terraced landscape. Thawet Khan, the village on which I reported in this zone, provides a perfect example of the subtle way in which villagers have adapted to these differences in topographical and soil conditions; this type of subtlety is one of the characteristic features of Asian rice cultivation.

I should like now, taking the village of Thawet Khan as an example, to look a little more closely at some of the different elements that go make up the "varied rice cultivation methods of the plains."

The first is the coexistence of the transplantation and direct sowing approaches in the same village due to differing soil conditions. The former approach is used on the fertile soils of the irrigated farm land that is found throughout most of the village while the latter approach is used in the sandy soils of the remaining rain watered farm land. With the

extension of irrigation to more and more land in the village, the transplantation approach is coming to be used more frequently on the traditionally rain watered farm land too.

Technically speaking, the transplantation method can also be divided into two distinct approaches, namely (a) the [wet seedling bed—flooded paddy preparation—flooded paddy hand plantation] approach, and (b) the [dry seedling bed—dry field preparation—dry field dibble plantation] approach. Approach (a) is the same as the second type of traditional rice cultivation method described above and is in fact the regular approach to rice cultivation found all over Asia. Approach (b), on the other hand, is distinguished principally by the use of a digging stick as part of the transplantation method. It is not clear whether this represents, as is often suggested, a link with the older slash-and-burn technique but there is no doubt that it is very similar to the Indonesian *gogoranca* or dibble transplantation technique described by Koji Tanaka [Tanaka 1987: 243-246]. I too have reported on a digging technique used by farming communities on the southern rim of the Deccan plateau of southern India, albeit in this case a technique used for the planting of millet rather than rice on rain-fed fields [Ohji 1981: 76-78]. In other words, this approach to planting finds its origins not only in slash-and-burn cultivation but also in the traditions associated with the cultivation of permanent farm land.

The direct sowing method used in Thawet Khan village is a sowing in row by hand method. As you travel down the central plain towards the delta, the broadcasting method of direct sowing is much more commonly used; the fact that Thawet Khan uses the hand plantation approach to direct plantation is thus one of the distinguishing features of this village's approach to rice cultivation. The rice cultivation techniques of the delta are in fact commonly understood to belong to the Indian tradition centering around "dry field scatter sowing and animal powered weeding." Why then did this village opt for the hand plantation technique? Although this is not an easy question to answer, we could probably do worse than to start our investigation with the fact that weeding in the village is carried out not by hand or with the help of a sickle but as part of a mid-cycle land breaking procedure using a trowel or hoe of some sort. For the time being, however, I should like to leave on one side the question of whether we can legitimately regard this as part of the Indian rice cultivation tradition or not.

VII An Investigation of Indigenous Plows —Types of Plow and Applications to Differing Ecological Conditions

I took the opportunity afforded by my survey of rice cultivation techniques described in the preceding sections to measure and photograph indigenous agricultural implements, starting with plows, and to question the villagers in each of the same 11 survey villages shown in Fig. 1 on the ways in which these tools were used. On my way back to Bangkok I also visited two villages in the lower reaches of the Chao Phraya river delta for inclusion in this part of my survey. During the course of my survey I found that the mechanization

of agricultural operation was far more advanced in the villages situated on the central plain and in the delta regions than it was in the other villages visited. As a result I was obliged to allow myself considerably more time in the central plain and delta villages to trace traditional agricultural implements such as the plow which are now no longer used in these villages.

In the following section I will confine my report to the most important indigenous agricultural implement, the plow.

VII－1．*Plows Types and Distributions*

The plows observed in the 11 villages which I visited appeared at first glance to be a fairly motley collection but, on observing them more closely, I found that they could be divided into three basic types as shown in photos 1, 2 and 3. I have labeled each of these types type A, type B and type C respectively. Table 1 tabulates the measurements of the various parts of each of these types of plow and summarizes their main features. Let us look first at the principal distinguishing features of each of these three types of plow.

Photo 1　Plow Type A)

Photo 2　Plow Type B)

Photo 3　Plow Type C)

Table 1 Features of Indigenous Plows Observed in the Survey Villages

Plow Type	Survey Village	Oxeu per Plow	Handle Length (cm)	Shaft Length (cm)	Base Length (cm)	Plow Share		Relationship between Plowshare and Moldboard	Structure of Plowshare and Materials Used		Remarks
						Max Length	Max Width		Structure	Materials	
A	2. Thung Kala	1	100	145	28	18	14	Single integrated unit	Iron piece Socket type	Cast iron	Type B also in use.
	3. Non Taki	1	81	140	50	22	14	〃	〃	〃	
	4. On Pai	1	65	153	45	15	13	〃	〃	〃	
	5. Muang San Pi	1 and 2	112	145	30			〃	〃	〃	One-ox plow. Not seen: word of mouth only.
	6. Wang Mae San	2	90	198	79	17	15	〃	〃	〃	Type C also in use.
B	2. Thung Kala	1	101	137	31	24	12	〃	〃	〃	Type A also in use.
	8. Chiang Rai	1	94	147	33	25	14	〃	〃	〃	
	9. Chiang Saen	1	100	115	25	13	14	〃	〃	〃	
C	6. Wang Mae San	1	90	146	45	14	15	Separate	〃	〃	Measurement of plowshares only. Moldboards made of iron piece. Type A also in use.
	7. Thawet Khan	2	70	231	58	13	12	〃	〃	〃	As above (except that type A) not used.
	10. Western Suburbs of Lop Buri	2	115	350	60	15	13	〃	〃	〃	Measurement of plowshares only. Moldboards made of wood only, no iron piece.
	11. Southern Suburbs of Ayutthaya	2	100	140	76	16	13	〃	〃	〃	As above

Notes 1) Number labels of villages corresponds to those in Fig.1.

2) In the case of plow types A and B, the indicated measurements of plowshares include the moldboard where incorporated as a single integrated unit.

Type A: As the reader will see from Photo. 1, of the four main parts of the plow (the handle, the base, the shaft and the pillar), the handle and the base are formed from the same curved piece of timber. We can therefore classify this as a square type plow, although it should be noted that, viewed from the side, the basic shape of the plow is that of a triangle rather than a square. When describing the distribution of plow types in China, I labeled this type of plow the southern Chinese type in view of its broad distribution right through from the east to Yunnan in the west [Ohji 1987: 203]. Plow type A was observed in the five villages numbered No.2 to No.6, creating a distribution covering an area extending from the western region of the northern mountain zone through to the transitional zone where the mountains shade into the central plain. The type of plow, its distribution and the underlying arrangement of tribal cultures in the region all tend to suggest that there may be link between this type of plow (type A) and the southern Chinese plow referred to above. Most of the plows seen were of the single ox drawn rolling type although examples of plows drawn by two oxen harnessed by a double yoke into which the shaft of the plow is secured directly were observed in villages No.5 and No.6. This is a lightweight plow made of softwood. This type of plow appears well suited to the wet paddy farming environment of the mountain valleys where there is a low level of humidity all the year round with the result that the land rarely bakes hard. The fact that the handle and the base blend seamlessly into each other makes it difficult to make independent measurements of the base. Both long and short based plows have consequently been included in Table 1.

Type B: As will be evident from Photo. 2, this type of plow resembles the Indian type in which the handle and the base are made from a single straight piece of timber into which the shaft is fitted at around the mid-point. The point at which the shaft is fitted in the case of the Thai plow, however, is generally higher than that of the traditional Indian plow. The base of the plow is also short, consisting of nothing more than the end of the handle or else of the end of the handle extended slightly to front and rear; the former of these two types is close to being a baseless plow. The shortness of the base is thus one of the principal features which distinguishes this type from the other two main types of plow in Table 1. This type of plow was observed in three villages (No.2, No.8 and No.9) in the eastern part of the northern mountain region. All the plows of this type which I observed were of the single ox drawn rolling type. This type of plow is made of harder wood than type A and is suited by virtue both of its type and of the materials of which it is made to the plowing of heavier soils. Thus, unlike type A, its distribution extends over the wide river plains where it is suitable for use on paddy sites where the weather is sometimes very dry and the land is inclined to bake hard.

Type C: In that part of my earlier discussion of plow types in which I outlined the distribution of the plow in Asia, I classified this type of plow as a cross between an Indian plow and a crook plow [*ibid.*: 204]. As shown in Photo. 3, the two features which most clearly distinguish this plow from the other types of plow are (1) the way in which the

shaft is fitted into the handle about mid-way along, as is the case with the Indian plow, and (2) the way in which the bottom of the handle is fitted into a long base made of a separate piece of wood, as is the case with the crook plow. I find it difficult, therefore, to go along with Yasumitsu Ienaga's classification of this type of plow as a Malay plow with an Indian shape [Ienaga 1980: 68]. The tip of the base is bent up and back to form a moldboard. This upturned part is sometimes fitted with a piece of iron to act as the moldboard and is sometimes left uncovered to function simply as a wooden moldboard. This type of plow was observed in villages No.6, No.7, No.10 and No.11 in a distribution extending from the central plain to the delta formed by the lower reaches of the Chao Phraya river. With the exception of a rather smaller iron plow observed in village No.6, all the plows seen in these villages were large long based plows drawn by two oxen yoked together, the long wooden shaft of the plow being secured directly to the middle of the yoke. At its longest the shaft can be as much as 3.5 m in length. This large-scale plow is thus well suited for use on the paddy fields of the delta which can be baked completely hard in the dry season. Most of the villages have, however, dispensed with the use of this type of plow.

In two of the villages which I visited, there were a number of different types of plows in use alongside each other. The villages in question were villages No.2 and No.6; this is indicated in the Remarks column in Table 1. In Thung Kala (village No.2), plow types A and B were both in use. According to the villagers, type A was used exclusively on soft soils but type B was also used on grassy sites (i.e. on sites on which grass has grown because the soil is dry and hard). The selective application of these plows described by the villagers seems all the more obvious once account is also taken of the overall appearance of these two types of plow.

In Wang Mae San (village No.6), plow types A and C were both used. As indicated in Table 1, all the type A plows which I actually observed in Wang Mae San had the longest shafts and bases of their type that I saw anywhere and were each drawn by two oxen, the plow itself being secured directly to the center of the yoke. Of all the villages in which I saw type A plows in use, all were of the single ox drawn type with the single exception of those used alongside the two ox drawn plows of village No.5 immediately to the north of Wang Mae San. Wang Mae San is thus not simply representative of the geographical transition from mountains to plain but also represents the transition from the mountain plow to the plains plow in that both type A and type C plows are in use side by side with type A plows being harnessed to two oxen rather than one. The type C plows used in this village were also made entirely of iron with the exception of the wooden base and, as such, they belong to the "improved" type of plow. The type C plow was introduced to the village about 20 years previously and rapidly replaced the type A plows used up until then. The simultaneous use of these two types of plows side by side is thus a relatively recent phenomenon. Today, however, both these plows are being overtaken by the hand-tractor. In other words, over the past 20 years the village has witnessed a transition which might be summarized as: [indigenous wooden long-based square type plow → modern iron short-

based plow → hand-tractor]. This transitional process is in many ways akin to the process of change in farming methods which took place in Japan too.

VII - 2. *Types of Plow*

In his pre-Second World War survey of Thai plows, Shuroku Mori lists one further type in addition to the three types of plow described above [Mori 1940: 45]. As shown in Fig. 2, the main features of this fourth type of plow include: (1) the handle and the shaft both extend out of the base; (2) the shaft passes through the handle to form an X pattern above the base; (3) the handle is secured nearer the front of the base than the shaft. In my earlier discussion of the distribution of plows in China, I noted that this type of plow was commonly found in northern China and I consequently classified it as the northern Chinese plow [Ohji 1987: 201]. Werth represents this type of plow as a "Thai plow" [Werth 1968: 222]. On my present visit, however, I found no evidence for the use of this type of plow although it may well be that it is in regular use in north eastern Thailand, an area which I was unable to visit on the present occasion.

In his report published in 1961, Chancellor identifies three main types of Thai plow [Chancellor 1961: 6].

i. Two ox plow: Corresponds to the two ox version of the type C plow described above.

ii. One ox plow with pillar: Corresponds to the type A plow described above.

iii. One ox plow without pillar: Corresponds to the one ox version of the type C plow described above.

Also includes a variety of plow types such as the northern Chinese type also referred to above.

Chancellor thus takes as his classification criteria the number of animals used to draw the plow and the presence or otherwise of a pillar. Unfortunately, this leaves type iii as a sort of catch-all classification for a wide variety of differently shaped plows. Chancellor's classifications are thus of little help in a study of plow types.

One point which is of particular interest in examining these earlier studies is that none of them make any mention of type B plows. Chancellor does incorporate a photograph of a type B plow [*ibid.*: 38] into his study but makes no allowance for it in his classification.

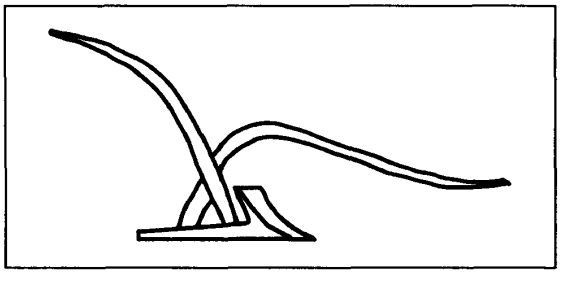

Fig. 2 Thai Plow Similar to Northern Chinese Plow [Mori 1940]

He may possibly have intended that this type of plow should be subsumed under type iii above.

One of the benefits to emerge from the present survey of farm implements has thus been the placing of the existence of the type B plow firmly on record and the clarification of its distribution within Thailand. An important difference between type B plows and plows of the other two types is that the type B plow has a direct link with the Indian plow; in other words, it incorporates a number of technical elements which are clearly characteristic of Indian plows. This fact also tends to undermine the heavy emphasis placed on the influence of Chinese agricultural implements in Thailand by both Mori and Teiichi Nihei [Nihei 1943: 149]. At the same time, the present study has also managed to define the distribution of the type B plow as the northern mountain region and the eastern region along the border with Laos, as can be seen from Fig. 1. In short, the geographical distribution of the type B plow coincides more or less with that of the Chinese origin type A plow in its proximity to the Chinese border. Why the type B plow, which is very much in the Indian tradition, should be in such common use in this area is clearly a matter deserving of further consideration.

VII - 3. *Thoughts on the Subject of Plowshares*

One important characteristic of the Thai plow is its plowshare. An examination of this subject by reference to Table 1 reveals the following points.

a) The plows of continental southeast Asia are primarily distinguished by the fact that their plowshares come complete with moldboard. In other words, they are moldboard plows. All the plows that I saw on my recent visit to Thailand were fitted with moldboards. However, as will be evident from the entries in the columns headed "Relationship between plowshare and moldboard" and "Remarks" in Table 1, there is more than one structural relationship possible between these two elements; the following three relationships are much in evidence.

1/ Both elements are incorporated into a single integrated unit made of iron; this is commonly to be seen in plow types A and B. In this sort of arrangement, the after part of the blade of the plow curves outwards and upwards. Treating the whole as a single unit, the maximum (straight-line) length of the combined element is generally around the 20 cm mark as shown in Table 1.

On the other hand, all the type C plows that I saw had separate plowshares and moldboards. The nature of the separation between the two elements can once again be divided into two clear types.

2/ The separate plowshare and moldboard are both made of iron. In effect it is as if the single unit described in (above had simply been broken into two to make a separate plowshare and moldboard. This type of arrangement is commonly found in the northern part of the central plain and surrounding regions. The improved iron plow used in the village of Wang Mae San, which was earlier cited as a village in which several different

types of plow exist side by side, also falls within the scope of this description.

3/ The moldboard is made of hardwood and has no iron attachment of any sort fitted to it. It is almost as if the tip of a wooden moldboard had been fitted with an iron plowshare. This type of plow is commonly found in the villages of the lower river delta.

In short, the [1/ → 2/ → 3/] transition from one type of plow to another corresponds both to the topographical transition from [mountains → central plain → delta] and at the same time to the transition in soil types from [voluminous soft light soil → sandy soil → hard baked heavy soil]. The precision with which these different transitions match each other is in part related to the sort of materials used to make the plowshare. I shall consider this question next.

b) As shown in Table 1, all the plowshares are made of cast iron. This is a major point of divergence between the plows of continental southeast Asia and the plows of southern and western Asia. With only a few rare exceptions, the plowshares of these latter regions are made by forging iron. One important exception to this rule is the east west expanse of Turkestan, which extends from northern Afghanistan in the west through to the Sin-kiang Uighur Autonomous Republic (Xin-jiang Uigur Zizhiqu) in the east. The farmers of this region use an Indian type plow with a cast iron socket plowshare—I call this the Turkestan type Indian plow. In my search for the origins of this plow I have argued for a kind of cross-fertilization mediated by the Silk Road between the Indian type of plow from the west and the cast iron socket type plowshare from the east [Ohji 1993: 1-14]. The cast iron plowshare used in Thailand is similarly based on iron founding technology which derives originally from China.

However, while cast iron plowshares are cheap to make, they have a serious drawback in that they break more easily than their forged iron counterparts. Thus the changes in the structural relationship between plowshare and moldboard, which seem so perfectly in tune with changes in the topographical features and soil conditions of the land on which they are used, as described in a) above, would appear in reality to be closely bound up with this problem of the ease with which a cast iron structural element—particularly the moldboard—can be broken.

c) Another feature of plowshares is the way in which some of them have a hole like a socket in the rear of the blade into which the front end of the base is fitted to secure it. As shown in Table 1, in all but one case, the plowshares I observed during the course of my survey were structured in this way. This kind of joint-free socket type plowshare must generally be made of cast iron since it is difficult to make by forging iron. Although differing in size, the cast iron plowshare of the Turkestan type Indian plow is also of the socket type.

The plowshares and moldboards which I observed were thus the result of the dissemination of iron founding technology from China. Even with the help of such founding technology, however, this type of plowshare never really gained the upper hand over nature in general and over soil conditions in particular due to its inherent breakability. In

view of the more recent introduction of the hand-tractor, would it now be fair to say that the land has finally been tamed by the emergence of agricultural implements made of steel?

VIII Plowing Techniques and the "Indianization of Rice Cultivation"

A number of theories have already been put forward to account for the historical development of plow farming in Thailand and, by extension, the history of Thai agriculture as a whole. All these theories make the implicit assumption that "plowing techniques existed prior to the Angkor period." In the present section, with the help of the survey data relating to indigenous plows discussed in the previous section and with the added help of some new materials of my own, I should like to try to demonstrate the veracity of this assumption.

In one of my earlier efforts to pinpoint the precise historical relationship between the plow technologies of continental Southeast Asia and those of other regions, I suggested that the introduction of Indica rice into the region (i.e. the Indianization of rice cultivation) may well have been followed by the introduction of the moldboard plow (i.e. the introduction of Chinese plow technology) [Ohji 1987: 209-210]. I further suggested that, to judge from the Angkor Wat wall paintings, this "introduction of Chinese plow technology" must have been complete by the 12th century AD. However, although the 12th century wall paintings provide us with a firm yardstick by which to date the "introduction of Chinese plow technology," this line of argument nevertheless fails to answer one extremely important question with respect to the development of plow technology in this part of Southeast Asia. In short, it tells us nothing about the period prior to the 12th century; this is a shortcoming of which I have always been keenly aware. More specifically, it is not clear whether the "introduction of Chinese plow technology" replaced an earlier plow technology or whether it arrived on the scene as a completely new technology. The origin of the problem is more than anything a lack of materials. However, during the course of the present survey, I did manage to unearth one clue which should be of considerable value in any re-examination of this issue. The clue in question is to be found in the Lop Buri museum.

One of the rooms in the museum has been set aside for an exhibition of relics unearthed from ruins in the area and in one of the showcases is the row of iron artifacts shown in Photo. 4. The items of particular interest to us here are the two smaller ones on the left of the photograph. The explanatory caption describes these items as "Spear points from the 7th and 8th centuries AD unearthed at U-Thong." However, these artifacts do not look to me in the slightest bit like spear points.

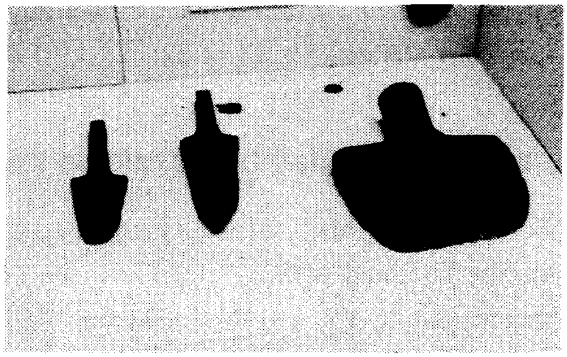

Photo 4　"Spear Points" (The Two Left Hand Exhibits) on Display in the Lop Buri Museum (Circa 7th or 8th Century AD)

The main problems militating against these items being spear points include the following: (1) their points are not sharp enough; (2) they are too bulky and lack the finely honed quality of a spear; (3) if a person were to attempt to attach one of these artifacts to a shaft, it would surely have to be one that widened out towards the end rather than the straight shaft of a conventional spear. One way or another, it is difficult to see these iron artifacts fitting the description of an actual spear point.

So what are they then? The first and most obvious possibility is that they are agricultural implements of some sort, probably used for tilling the soil. Could they be hoe blades, for example, or tips for digging sticks or plowshares? Clearly, the shape of the unearthed artifacts would be unsuited to use either as flat hoe blades, forked hoe blades or wooden-base hoe blades. Again, if these artifacts were to be used as tips for digging sticks, the problem outlined at (3) above arises once more. Even without resorting to this sort of elimination procedure, it is surely quite obvious that these artifacts were designed for use as plowshares. An additional piece of evidence which supports the veracity of this thesis emanates from a source geographically far removed from the present site. This is the plowshare shown in the sketch in Fig. 3 above, which was unearthed in Sanchi in western India. Also shown in Photo. 5 is a photo of the sort of plow with blade attached that is still used in villages near Gwalior in northern India. Both of these plowshares clearly bare a close resemblance to the iron artifacts unearthed at U-Thong.

U-Thong is situated to the west of Ayutthaya in the transitional zone between the plain and the mountains. The geomorphological environment here is much the same as that of the village of Thawet Khan (village No.7), which is located in the suburbs of Sukhothai in the fan-shaped area of terraced hills on the edge of the central plain. In other words, just like Sukhothai, this area also has a longer history of development than the delta region. Seen in this light, there is nothing that need unduly surprise us in the discovery in the area of plowshares dating back to the 7th or 8th century.

These plowshares are of particular significance for any consideration of the development of Thai plow technology prior to the introduction of Chinese plow technology.

Photo 5 A Forged Iron Plowshare from a Village near Gwalior in Northern India

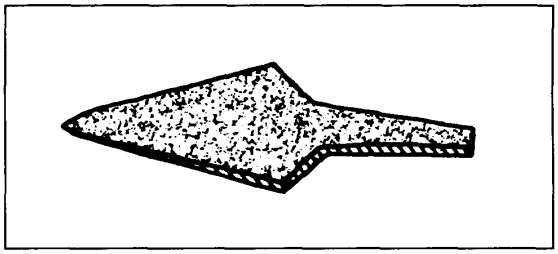

Fig. 3 Skectch of a Forged Iron Plowshare Excavated in Sanchi in Northern India (Circa 2nd or 3rd Century AD)

The three main reasons for this are as follows.

1. They are made by forging iron. As noted in the "Structure of plowshare and materials used" column of Table 1 and as Chancellor also points out, the plowshares in use today tend to be made of cast iron and it was China that pioneered the use of this particular material. Plowshares have been discovered almost all over China dating back to the days of the Han dynasty. Ichisada Miyazaki notes the explosive growth of iron founding in China and the rapid inroads made by this technology to the west via the south sea trade routes during the Tang and Sung dynasties [Miyazaki 1992: 420]. The "introduction of Chinese plow technology" formed part and parcel of this basic pattern. The forged iron plowshares unearthed at U-Thong represent a pattern of development quite distinct from this "introduction of Chinese plow technology" based on the more fundamental expansion of cast iron production techniques.

2. To judge from their shapes, these plowshares could well have been secured to the main body of a plow by slotting them into a shallow groove cut into the front part of the wooden base of the plow in much the same way as the one shown in photo. 5. As will once again be clear from the contents of the "Structure of plowshare and materials used" column in Table 1, however, this method of connection differs from the socket type of joint which is used in almost all cases today. A joint-free socket type plow really needs to be made of cast iron. This type of joint-free socket type connection method is in fact one of the

characteristic features of Chinese plows. The plowshares of U-Thong thus once again represent a pattern of development quite distinct from that which I have represented during the course of this paper as the "introduction of Chinese plow technology."

3. Plowshares of this shape are found along with spear points over a wide area of the Indian subcontinent. In other words they form part of the Indian plowing tradition. Moreover, with the exception of a very small number of plows introduced at a later date from continental Southeast Asia, all the plows of this region are fitted with forged iron plowshares. If forged iron plowshares of this shape were to be found over a wide area of modern Thailand, the museum would surely not have mixed them up with spear points. The way in which they were mixed up in fact represents a kind of proof in itself of the rarity of this type of plowshare in Thailand today.

The three points outlined above, together with a comparison of the chronological references, would appear to provide reasonable evidence for the existence of Indian plow technology prior to the "introduction of Chinese plow technology." We can thus clearly establish the following three propositions: (1) plow technology based on use of the Indian plow was in use in the 7th and 8th centuries in areas such as U-Thong in the fan-terrace complex area on the edge of the central plain; (2) agricultural activity centered around the cultivation of rice using ox-drawn plows; (3) the "Indianization of rice cultivation," to which I referred above, brought in its wake the use of the Indian plow. In short, we can state with certainty that a sophisticated form of agriculture based on the use of plowing techniques using the Indian plow was practiced in and around the U-Thong region in the 7th and 8th centuries.

From the archaeological point of view, Masayuki Yokokura makes the following points with respect to the "Indianization of rice cultivation" and the use of plows [Yokokura 1992: 308-309].

1) There is no concrete evidence for the use of Indian rice cultivation techniques in Indochina which can be dated to the period prior to the painting of the wall reliefs of Angkor Wat.

2) There is, however, a strong possibility that ox-drawn plows were widely used in the 6th and 7th centuries, a period which also saw the construction in the Chao Phraya delta and surrounding plains of groups of large earthworks in the shape of circular ditches enclosing compounds whose inhabitants made use of sets of Indian type earthenware utensils.

As explained earlier, point 1) makes basically the same point that I previously took as evidence for the "introduction of Chinese plow technology." The pieces of evidence which support the "possibility" referred to in point 2) are the iron plowshares unearthed at U-Thong. The points which I have developed in the present section are thus perfectly consistent in both factual and chronological terms with the above points as made by Yokokura.

Yoshikazu Takaya presents what is essentially the same argument as Yokokura

[Takaya 1985: 215-217]. According to Takaya: "From the 5th and 6th centuries through to the 12th and 13th centuries, rice cultivation on the plains of Indochina was carried out almost entirely in accordance with the Indian approach." "The Indian approach to rice cultivation involved a set of associated techniques which included the sowing of the long-grain type of rice, use of the plow, scatter sowing, use of a sickle for reaping, and ox-hoof hulling." However, "there is unfortunately no evidence to confirm the existence of these techniques as a complete set in the Angkor period." Takaya's "unproven" thesis, at least insofar as it relates to plows, finds the support it requires in the iron plowshares of U-Thong. If account is also taken of the centrality of plowing in the Indian approach to rice cultivation, the "evidence" unearthed at U-Thong in the form of iron plowshares may reasonably be seen as increasing at a stroke the possibility that the "full set of Indian rice cultivation techniques" existed all together at that time.

The discovery at U-Thong of the spear points which have turned out in practice to be plowshares thus conjures up a scenario whereby the ox-drawn Indian plow, which constitutes the foundation of the "Indianization of rice cultivation," is slowly but surely replaced by the Chinese type of plow, which was introduced at a later date in the form of "Chinese plow technology" as part of a wave of iron founding technology emanating from China.

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