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Recent Expansion of Nonglutinous Rice Cultivation in Northeast Thailand: Intraregional Variation

Shuichi MIYAGAWA *

Abstract

In Northeast Thailand, the planting of nonglutinous rice for sale is now spreading to some villages where only glutinous rice was traditionally grown. In these villages, rice productivity has increased, due mainly to the introduction of chemical fertilizer which normally accompanied the change in the type of rice planted, rather than the higher productivity of the nonglutinous varieties. Though fertilizer application, glutinous rice production has also become sufficient for domestic consumption and a surplus has appeared. The commercialization of rice-growing was made possible by higher productivity of more than 400 kg per capita annually, and lower annual fluctuation of yields. Productivity was effectively raised by fertilizer application to all paddy fields in a village located in a area of high rainfall far from a floodplain, which escaped the effects both of severe drought due to an unreliable dry spell and of flooding. Here, the higher price of nonglutinous rice, expanding demand for cash in village life and the paucity of agricultural products other than rice promoted the villagers to plant nonglutinous rice.

I Introduction

Traditionally, farmers in all but except the southern provinces of Northeast Thailand grew mainly glutinous rice in rain-fed paddy fields for self-sufficient consumption. The cultivation of glutinous rice as the staple food for peasants was reported also to be common in North Thailand, Laos and the southern part of China [KKU-Ford Cropping Systems Project 1980; Watabe 1967]. Recently, however, the planting of nonglutinous varieties for sale has been expanding in a part of the traditional glutinous rice area [Somkiat *et al.* 1990; Kono and Nagata 1992; Nakada 1995]. This change of rice variety in a rain-fed cultivation system is generally explained in terms of the yield improvement and surplus production allowed by such technical changes as the introducing of chemical fertilizers with the improved rice varieties of higher response to fertilizers. On the other hand, there are still many villages where farmers have not increased the planted area of nonglutinous varieties, though they have adopted new technologies. I carried out surveys on such difference among villages in Northeast Thailand in the period 1991-1994. Based on the results, I shall discuss the differences in the surroundings and

* 宮川修一, Faculty of Agriculture, Gifu University, Yanagido, Gifu 501-11, Japan

rice cultivation methods between two contrastive villages. I shall then analyze the process of expansion of nonglutinous rice and the conditions necessary for such expansion in rain-fed areas in the Northeast.

II Research Sites

II-1 *Intensive and Extensive Village Survey*

Two villages, Don Daeng in Muang District of Khon Kaen Province and Na Hom in Kham Khuan Kaeo District of Yasothon Province, were selected for this intensive survey. Don Daeng is a typical village in the commercial sphere of Khon Kaen City, which has recently seen rapid growth as the core city in the midwestern part of the Northeast. The city offers villagers many opportunities for off-farm jobs and a ready market for their vegetables and other products. Na Hom is a typical village on the outskirts of Yasothon, a small city in the southeastern part of the Northeast, which is too small to provide many employment opportunities for villagers in the suburbs.

An interview survey of all households concerning the method and production of their rice cultivation was carried out in both villages in 1991 and 1992. In the harvesting season in 1991, a cutting yield survey was carried out in 17 and 11 sampled paddy plots in Don Daeng and Na Hom, respectively, which were chosen as representative of all paddy fields in the respective villages. Rice yield and yield components were measured in the same way as in the previous survey in Don Daeng in 1983 [Miyagawa and Kuroda 1988].

Besides the intensive village survey, I interviewed headmen of 334 villages in all provinces of the Northeast concerning the percentage of the village's rice land that was planted to nonglutinous rice. These consisted of 28 villages in Nakhon Ratchashima, 12 in Buri Ram, 10 in Surin, 15 in Si Sa Ket, 31 in Ubon Ratchathani, 41 in Yasothon, 35 in Roi Et, 14 in Kalasin, 22 in Maha Sarakham, 42 in Khon Kaen, 10 in Chaiyaphum, 8 in Loei, 25 in Udon Thani, 13 in Nong Khai, 13 in Sakon Nakhon, 10 in Nakhon Phanom and 5 in Mukudahan. Although the selected villages lay along highways or local major roads, the results are thought to give a fair indication of the general situation of nonglutinous rice planting in the Northeast.

II-2 *Circumstances of Rice Cultivation in Don Daeng and Na Hom*

Most of Don Daeng's paddy land lies in the floodplain of the Chi River, to the south of which are low hills where cassava is grown as a commercial upland crop. The paddy soils belong to the Alluvial Complex Soil series. Water for irrigation of rice and vegetables is available from the Chi River and the San River, a moribund channel of the Chi River.

Most of the Na Hom's paddy land is on elevated flat land. The soils belong to the Ubon series and have lower water-holding capacity and nutrient contents than the paddy soils in Don Daeng. Villagers have no land for commercial production of upland crops and

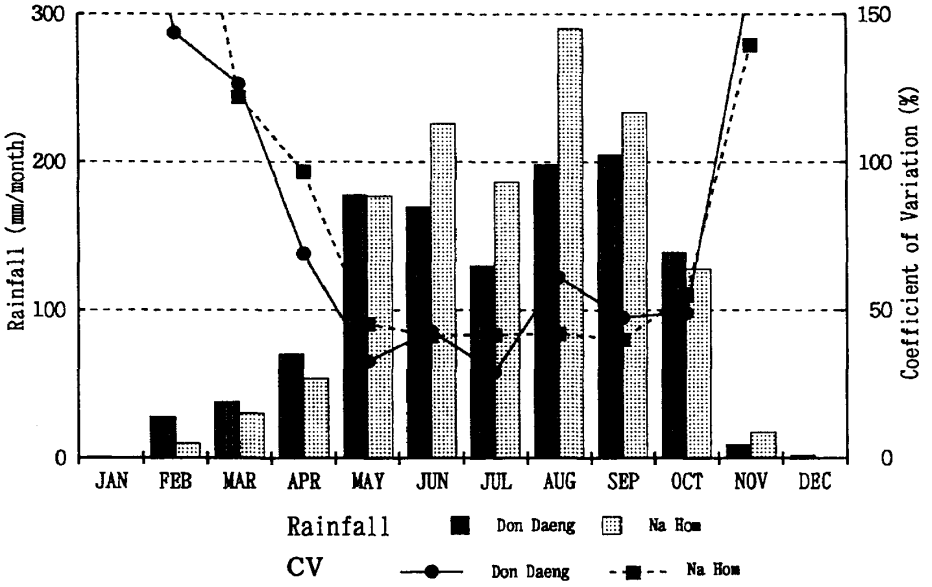

Fig. 1 Monthly Rainfall in Don Daeng and Na Hom, 1980-1991

vegetables. The Chi River is too far from the agricultural land of Na Hom to be used for irrigation.

Villagers who are Thai-Lao depend on rain-fed cultivation of glutinous rice for their livelihood. Mean annual rainfall for the period from 1980 to 1991 was 1,169 mm in Don Daeng (measured at Tha Phla, 5 km west of Don Daeng) and 1,354 mm in Na Hom (measured at Lumphuk, 9 km northwest of Na Hom). Thus Don Daeng normally has less rain than Na Hom, especially from June to September (Fig. 1). There is a dry spell in July during the rainy season in both villages. The coefficient of variation of rainfall in Na Hom is almost constant during the period from May to September, while the value for Don Daeng becomes higher than that of Na Hom in August and September. Thus the reliability of rainfall in Don Daeng in those months, which control final planting ratio of paddy fields in rain-fed rice cultivation, is lower than in Na Hom. Don Daeng is in the "rain shadow" area of the Northeast and close to the Chi River, thus crops frequently suffer from alternating drought and flooding stress. In 1991, the total rainfall from May to October in Don Daeng (1,171.1 mm) was less than that in Na Hom (1,206.5 mm), but the coefficient of variation of 10-day total rainfall during that period was 69% in Na Hom but 113% in Don Daeng. Much rain in the latter half of August around Don Daeng caused severe flooding.

II-3 *History of Agriculture in Don Daeng and Na Hom*

Brief histories of agriculture in both villages are as follows [Fukui 1993; Somkiat *et al.* 1990].

Immigrants from eastern provinces who had left in search of new agricultural land settled and reclaimed the land of Don Daeng, establishing the village in 1871. The

pioneers first cultivated the lower parts of *nong*, which are scattered saucer-shaped depressions in the floodplain of the Chi River. Many more immigrants followed and cleared the remaining *nong* for paddy fields. Clearance of lower parts of the *nong* finished in the 1930s, then the middle and upper parts were reclaimed. Rice yield in the lower paddy fields was comparatively high and stable. But expansion of rice planting to the middle and upper paddy fields lowered the average yield of the whole village and made production more unstable. From the 1930s, the village received fewer immigrants while some villagers went out looking for new fertile land.

In the 1950s, there was no space for new paddy fields, and surplus population emigrated to reclaim virgin land in the western part of the Northeast. Simultaneously, the hill area to the south of the hamlet, and shrubs along Chi and San Rivers were cleared for cultivation of cash crops, e.g., cotton, mulberry, kenaf, cassava and chili. In the 1970s, new emigrants were scarce, while villagers looking for jobs went to Khon Kaen City, which had just started to prosper.

Use of crabcide in paddy fields might have begun in the 1970s. In the 1980s, power tillers, chemical fertilizers and improved rice varieties such as RD6 started to be introduced. Small gasoline-powered pumps, which were first introduced for vegetable cultivation, began to be used for irrigation of paddy fields. And irrigation canals were extended to many *nong* from an electric-powered pump station along Chi River. Rice was sold only in bumper years in the past as well as nowadays. Recent changes of rice cultivation in this village are discussed in another article [Miyagawa 1995].

Na Hom village was established around 1880 by people from a neighboring mother village. Its reclamation history is not as clear as that of Don Daeng. In the 1920s, glutinous varieties for home consumption occupied all of the paddy fields, and holdings of paddy land per household were much larger than they are today, e.g., 50, 60 or even 100 *rai*.[1)] Farmers usually planted only half of their paddy lands because of labor shortage. In the 1940s, there remained little space to reclaim new land, though the number of households was only half of the present number. While the village population increased from the 1930s to the 1950s, per capita holdings of paddy land decreased and some villagers emigrated went to other villages looking for new land.

In the 1960s, many villagers went to Bangkok to work and some settled there. At the same time, the emigration for land reclamation elsewhere ceased and there remained no space for new paddy fields in the village. From the 1970s, the farmers started using chemical fertilizer and crabcide. At that time, an excellent nonglutinous recommended variety, Khao Dok Mali 105 (KDML105), was introduced and its cultivation for sale began. In the 1980s, the improved glutinous variety RD6 and power tillers were introduced and farmers gradually came to depend on hired labors for transplanting and harvesting. The planted area of nonglutinous rice reached 50% of the village paddy area.

1) $1rai = 1{,}600m^2$

In 1991, the operated paddy area per household was 12.0 *rai* (range 0.3-42.0 *rai*) in Don Daeng and 16.2 *rai* (range 3.5-53.0 *rai*) in Na Hom. The mean value in Don Daeng had decreased from 17 *rai* in 1983.

III Rice Cultivation and Production

III-1 *Rice Varieties*

1) *Don Daeng and Na Hom*

The percentage planted areas of varieties are shown in Table 1. Considerable fewer varieties were planted in Na Hom than in Don Daeng. The present number of varieties in Don Daeng is also far fewer than that in the 1980s (Table 2).

The planted area of nonglutinous varieties was 51% in Na Hom but only 17% in Don Daeng, where the rate had not changed since the 1980s, as shown in Table 2. In Don Daeng, 45.5% of households did not plant any nonglutinous varieties in 1991 (Fig. 2). Although farmers normally eat glutinous rice, every farmer needs a small amount of nonglutinous rice as special food for rituals and guests. Therefore, they usually plant at least a small area of nonglutinous rice. But, because of the good harvest in the previous year, 1990, half of the households probably did not need to plant nonglutinous rice in 1991. Three farmers planted nonglutinous varieties in all their paddy fields in Don Daeng.

Today RD6 is the glutinous variety of choice among farmers not only in these two

Table 1 Percentage Planted Area of Varieties in 1991

	Don Daeng	Na Hom
Glutinous varieties		
RD6	73.9	46.8
RD8	7.7	0.0
Sampathong	0.4	2.5
Others *	0.6	0.0
Nonglutinous varieties		
KDML **	14.5	50.5
Khao Chao Daeng	0.6	0.0
RD15	0.0	0.3
Others ***	2.2	0.0
Total	100.0	100.0

* Khao Kastklang, Khao Kasetyai and Khao Ise
** Khao Dok Mali 105, Khao Chao Mali and Khao Hom Mali
*** Tho Sho Do and Khao Tahaeng

villages but in many other villages in the Northeast. Elsewhere I have discussed the process of dissemination of RD6 and its effect on the rice cultivation system [Miyagawa 1995]. Soon after the release of RD6 from the Rice Division of Thailand in 1977, farmers in Na Hom adopted it, and planted it more widely than those in Don Daeng.

Table 2　Rice Varieties of Don Daeng in 1983

Variety Group	Variety Name	% of Planted Area
Glutinous		
Late-maturing	Khao Kasetyai, Khao Kamphai	42.1
	Khao Udomyai	0.4
	Khao Khaoyai	0.1
	Khao Yai	0.0
	Others	0.7
	Subtotal	43.4
Medium-maturing	Khao Kasetklang	17.7
	Khao Dokchan	9.7
	Khao Hangnak	1.9
	Khao Ithod	2.3
	Khao Maemim	2.0
	Khao Sanpathong	0.7
	Khao Maephung	0.4
	Khao Ilongma	0.4
	RD6	0.3
	Khao Khaoklang	0.2
	Khao Bakmuaihin	0.2
	Khao Kam	0.0
	Others	4.8
	Subtotal	40.7
Early-maturing	Khao Doyuan	1.3
	Khao Makok	0.5
	Khao Do-plasiu	0.2
	Others	2.3
	Subtotal	4.3
Nonglutinous	Khao Chaomali, Khao Hommali, Khao Dokmali	7.4
	Khao Chaodaeng	3.2
	Khao Iluangtong	0.7
	Khao Iheng	0.1
	Khao Chaoloi	0.2
	Others	0.0
	Subtotal	11.6
Others (plural groups, upland rice)		0.1

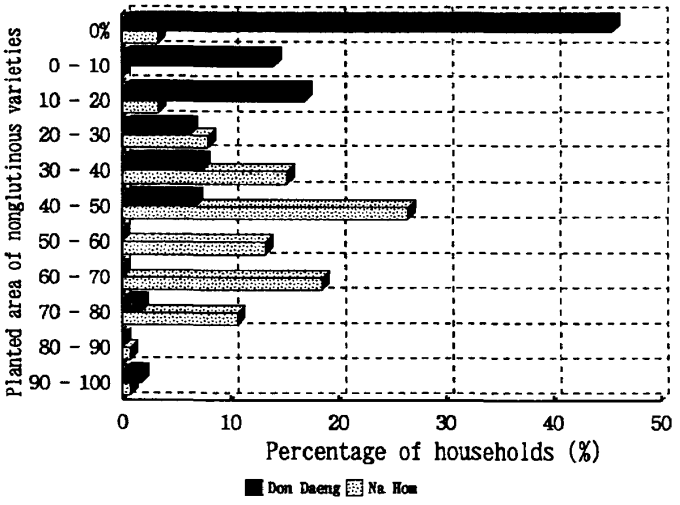

Fig. 2 Distribution of Households Planting Nonglutinous Rice in Don Daeng and Na Hom

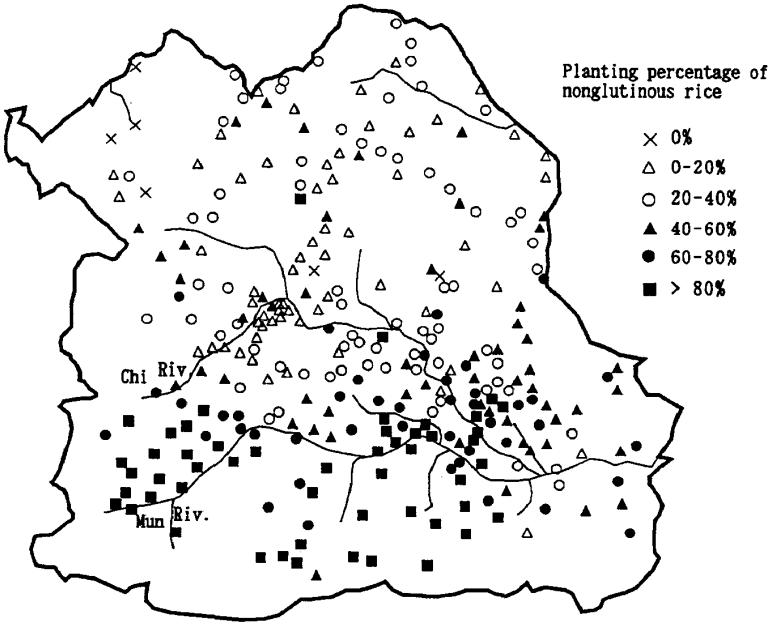

Fig. 3 Distribution of Nonglutinous Rice-Growing Villages in Northeast Thailand

2) *Northeast Thailand*

In the late 1970s, nonglutinous rice cultivation was restricted to the southeast part of the Northeast. According to a survey by Khon Kaen University [KKU-Ford Cropping Systems Project 1980], production of nonglutinous rice accounted for less than 30% of total rice production in 11 provinces, while it was higher in others: Chaiyaphum, 30-50%; Nakhon Ratchashima, 50-90%; Buri Ram, 50-90%; Surin, more than 90%; and Si Sa Ket, 30-50%.

Fig. 3 shows the distribution of nonglutinous rice-growing villages surveyed in 1991-1994. In villages in the five provinces mentioned above, nonglutinous rice is dominant, while in the northern part of the Northeast, there are villages where it occupies less than 20%. However, many villages with more than 40% are found out in Roi Et, Mukdahan, Yasothon and Ubon Ratchathani. In these provinces, nonglutinous rice cultivation increased during the 1980s. That these provinces receive higher rainfall [*ibid.*] suggests that heavy and stable rainfall is necessary for the expansion of nonglutinous rice, which will be discussed further in Chapter V. But rainfall does not seem to be the sole factor responsible for the expansion, because the expansion did not occur in Nakhon Phanom and Sakon Nakhon, where adequate rainfall is expected every year.

Of all villages surveyed, 1.8% planted no nonglutinous rice variety while 8.7% planted only nonglutinous varieties. KDML, which includes KDML105, Khao Chao Mali and Khao Hom Mali, was the main nonglutinous variety planted in 79.9% of villages, and only one in 32.4%, while 6.9% of villages (5.2% of nonglutinous rice-growing villages) did not plant KDML. Of 28 villages which were planting only nonglutinous rice, 11 villages (39.3%) were planting KDML as the main variety while 5 villages (17.9%) did not plant it at all. The latter villages are in Surin (1 village) and in Nakhon Ratchashima (4 villages). KDML is distributed widely in the Northeast, but villages which had long been planting nonglutinous varieties as their major crop had been unwilling to adopt it.

III-2 *Cultivation Methods*

1) *Direct Seeding*

Eighteen percent of all households in Don Daeng and 11% in Na Hom had paddy fields for broadcasting dry seed of RD6 or KDML. Their areas as a proportion of total paddy area were 6.7% in Don Daeng and 3.4% in Na Hom. In Na Hom, seeding in hills (*khao naa yout*)[2] was practiced in the upper paddy fields as well as the lowest paddy fields, where early growth of the rice plant is necessary.

In the 1980s, paddy was not directly seeded in Don Daeng. Even floating rice was transplanted, though it was seeded directly in other villages. It is apparent that direct seeding is expanding to save labor in transplanting, because the average wage for farm labor had increased to 50 or 70 baht per day in 1991 from 20 or 25 baht in 1983 [Funahashi 1990].

2) *Raising of Seedlings in Nursery Beds*

In the average households, 8.6 *thang*[3] of seed was sown in 1.25 *rai* of nursery land in Don Daeng, and 10.3 *thang* of seeds in 1.77 *rai* of nursery land in Na Hom. The seeding

2) One method of direct seeding. After making sowing holes by hoe at intervals of 30 cm (in drought plots) or 50 cm (in deep water plots), about twenty seeds are sown into each hole.

3) 1 *thang* = 20 liter = ca. 10 kg unhusked grains

density in Don Daeng, 7.4 *thang/rai* (4.6 kg/a), was slightly higher than that in Na Hom, 6.4 *thang/rai* (4.0 kg/a) because a longer duration of seedling raising was required in Na Hom due to lower soil fertility. The area ratio of nursery land to transplanted paddy land in Na Hom (11.5%) was thus higher than in Don Daeng (10.5%). Glutinous varieties were sown earlier than nonglutinous varieties in both villages. According to farmers, the main problem during the nursery period was water shortage in Don Daeng, while it was insect attack in Na Hom.

3) *Transplanting*

The farmers' opinions on optimum water depth and age of seedlings at the time of transplanting were slightly different between the villages. In Na Hom, deeper water, i.e., 21 cm (range 1-50 cm) and longer period of nursery, i.e., 38 days (range 25-60 days), are preferred, compared with 19 cm (range 5-40 cm) and 31 days (range 14-60 days) in Don Daeng. But the opinions on the optimum length of seedling were the same, 44 cm (range 20-60 cm in Don Daeng, and 28-60 cm in Na Hom). Seedlings grow slower in Na Hom than in Don Daeng due to the difference in soil fertility.

In 1991, the difference in peak time for transplanting between the villages was 1.5 month (Fig. 4). Na Hom received enough rain for transplanting during June and July. Although irrigation was partly available in Don Daeng, most farmers could not transplant or broadcast satisfactorily until much later owing to the long dry spell in those months.

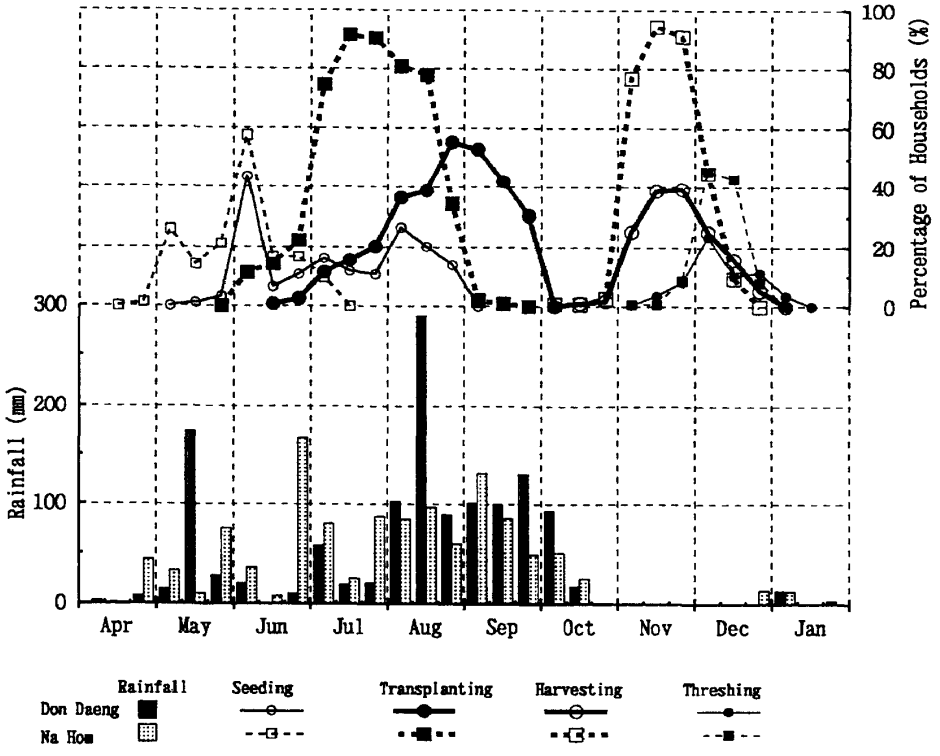

Fig. 4 Rainfall and Cropping Calendar in Don Daeng and Na Hom, 1991-1992

The transplanting sequence in relation to the location of paddy fields and the variety planted was similar in the two villages. The percentage of farmers who began to transplant from the lower paddy fields was 67.8% in Don Daeng and 98.8% in Na Hom. The same relationship was also observed in Don Daeng in the 1980s. The percentage of farmers who began to transplant with glutinous varieties was 92.9% in Don Daeng and 84.1% in Na Hom. Of their holdings of rice land, the average planted area of glutinous varieties was 77.2% in Don Daeng and 51.0% in Na Hom. The corresponding figures for farmers who began to transplant with nonglutinous varieties were lower: 72.7% in Don Daeng and 40.6 % in Na Hom. It is characteristic of the technology applied in rain-fed paddy fields that farmers start planting from the waterlogged and fertile soil area with their principal rice varieties, which differ depending on whether their major purpose in growing rice is self-sufficiency or commerce. In Don Daeng, more farmers now begin transplanting from the upper paddy fields than in the 1980s, because the water regime has been improved considerably near the irrigation canals.

In Don Daeng, plowing is followed by puddling with a comb harrow before transplanting. In contrast, farmers in Na Hom use a plow rather than a harrow for land preparation just before transplanting. A wife is often seen transplanting part of a paddy field plot while her husband is plowing another part. Soil particles settle and become hard rapidly after plowing, so transplanting must be done immediately after plowing, which is becoming very difficult due to labour shortage. If there is not enough water, they transplant seedlings in holes made with sticks. This is called *saklung*. These methods are necessary in Na Hom and other villages with extremely sandy soil.

The period of transplanting per household was 3.1 × 10 days (range 1.0-7.1 days) in Don Daeng and 5.1 × 10 days (range 1.0-9.0 days) in Na Hom. The difference between the villages was due to differences in planted acreage per household and working efficiency. The transplanted area per 10 days per household was 3.9 *rai* (range 0.004-14.3 *rai*) in Don Daeng and 3.2 *rai* (range 1.1-6.3 *rai*) in Na Hom. The higher working efficiency in Don Daeng was the result of lower planting density and larger labor force than in Na Hom, as will be described.

Planting distances between seedlings were variable: some farmers plant at a fixed distance regardless of topographical or varietal differences (Type 1), while some adjust the distance according to topographic location (Type 2) or according to variety (Type 3). In the first type, the distance was greater in Don Daeng (24 cm on average with min. of 15 cm and max. of 40 cm) than in Na Hom (21 cm, 10 cm and 30 cm, respectively). In the second type, farmers transplanted seedlings more densely in upper fields (23 cm in Don Daeng, 21 cm in Na Hom) than in lower (36 cm in Don Daeng, 31 cm in Na Hom). In the third type, farmers transplanted glutinous varieties at greater distance (38 cm in Don Daeng, 23 cm in Na Hom) than nonglutinous varieties (24 cm in Don Daeng, 19 cm in Na Hom). In each case, farmers transplanted rice more densely in Na Hom than in Don Daeng. This conclusion is supported by the yield survey as described in III-3. Planting

density in Don Daeng has increased during the last decade due to the change in variety [Miyagawa 1995]. Since the plant types of rice varieties were same in the two villages, the dense planting in Na Hom is an adaptation to poor soil fertility. Based on the planting density, it can be calculated that transplanting labor required per unit area in Na Hom is 1.3 times greater than that in Don Daeng.

Of available family labor, 99.2% of farmers was used for transplanting in Don Daeng and 96.9% in Na Hom. Some farmers hired labor or asked others for help. In Don Daeng, 46.3% of farmers depended on only family members, while in Na Hom 41.4% did so; 44.8% of farmers in Don Daeng and 51.6% in Na Hom hired labor from outside, and 13.0% of farmers in Don Daeng and 13.2% in Na Hom asked others for help.[4)]

The average number of family laborer per household was 2.6 (range 1-7) in Don Daeng and 2.9 (range 1-5) in Na Hom. The average number of man-days of labor given as help per household was 24.3 (range 1-120) in Don Daeng and 1.7 (range 1-2) in Na Hom, while the average number of man-days of hired labor per household was 24.0 (range 1-118) in Don Daeng and 28.0 (range 4-100) in Na Hom. The cost of hired labor per household was 1,396 baht (range 200-5,000 baht) in Na Hom, higher than that in Don Daeng, which was 1,146 baht (range 50-5,900 baht). The unit price was 56.3 baht/man/day in Don Daeng and 50.0 baht/man/day in Na Hom.

The mean values of labor in the villages are given in Table 3. If *het nam kan* labor estimated from labor of harvesting is added to the data above, the number of family and *het nam kan* laborers per household would be 3.3 in Don Daeng and 2.9 in Na Hom. The labor force per unit planted area becomes 0.28 man/*rai* (family and *het nam kan*) and

Table 3 Average Labor per Household in Don Daeng and Na Hom

Work	Village	Family Labor (man)	*Het nam khan* Labor (man)	Help Labor (man-days)	Hired Labor (man-days)
Transplanting	Don Daeng	2.6	n.a.	3.2	10.5
	Na Hom	2.8	n.a.	0.5	14.7
Harvesting	Don Daeng	2.1	0.7	2.3	4.4
	Na Hom	2.8	0.1	3.3	5.2
Threshing	Don Daeng	1.6	0.5	1.8	0.2
	Na Hom	2.2	0.1	3.6	0.4

4) Besides outside help with labour, the mutual help with labour among kinship households (*het nam kan*) ought to have been evaluated, but it was overlooked in the survey. *Het nam kan* is mutual help system involving households of parents and children or siblings before dividing farmland for inheritance. In Don Daeng, many variations of *het nam kan* were recognized and their social functions were discussed by Takemura [1990].

outside labor input 1.14 man-days (help and employment) in Don Daeng, with corresponding figures of 0.18 man/*rai* (family and *het nam kan*) and 0.91 man-days (help and employment) in Na Hom. Hence, rapid completion of transplanting in Don Daeng, as mentioned above, might be the result of the lower planting density, more desirable soil texture and adequate labor. Rapid transplanting work is necessary to plant as many seedlings as possible as long as inundation of field in rain-fed rice growing villages in area of unreliable rainfall.

4) *Harvesting*

Harvesting was carried out at almost the same time in both villages, notwithstanding differences in transplanting time (Fig. 4). Their peak periods nearly coincided, because the same strongly photosensitive varieties were planted in both villages. In 1991, because of flooding, many households in Don Daeng could not get any harvest, as described in detail in III-3. As a result, harvested area per household averaged only 4.3 *rai* in Don Daeng, but 15.9 *rai* in Na Hom. Households excluding with no harvest, harvesting took 2.5 × 10 days (range 1-6 × 10 days) in Don Daeng while as 3.2 × 10 days (range 1-5 × 10 days) in Na Hom. The harvested area per 10 days per household in Don Daeng which was 2.7 *rai* (range 0.2-8.1 *rai*) was smaller than that in Na Hom as 5.1 *rai* (range 1.1-13.3 *rai*).

Of available family labor, 98.1% of farmers was used for harvesting in Don Daeng and 100% in Na Hom. The number of family laborers per household was 2.1 (range 1-7) in Don Daeng and 2.8 (range 1-7) in Na Hom. Fifteen percent and 24% of households received help with labor in Don Daeng and Na Hom, respectively. Also, 27.6% of households in Don Daeng and 36.4% in Na Hom used hired labor for harvesting. In addition, *het nam kan* was carried out by 24% of households in Don Daeng and 3% in Na Hom. As regards the households which used labor from outside the family, the help with labor accounted for 15.3 man-days per household (range 2-60 man-days) in Don Daeng and 13.8 (range 1-2 man-days) in Na Hom. Hired labor accounted for 16.4 man-days per households (range 3-80 man-days) in Don Daeng and 14.3 (range 3-50 man-days) in Na Hom. The cost for hiring labor per household in Don Daeng was 791 baht (range 150-3,200 baht), almost the same as the 744 baht (range 150-2,500 baht) in Na Hom. The unit price was 49.7 baht/man/day in Don Daeng and 50.5 baht/man/day in Na Hom. The number of *het nam kan* laborers was 2.0 (range 1-6) in Don Daeng and 2.8 (range 1-5) in Na Hom.

From these data, the mean values in the villages are again given in Table 3. In both villages, harvesting required less labor than transplanting. The more effective harvesting work in Na Hom was dependent on more abundant labor in the village, although *het nam kan* labor was less.

5) *Threshing*

Almost 20 days after harvesting, threshing was carried out in both villages. The period

of threshing per household was 1.0 × 10 days (range 1-1 × 10 days) in Don Daeng and 1.1 × 10 days (range 1-2 × 10 days) in Na Hom. The amount of rice threshed per 10 days in Don Daeng, 2,006 kg (range 75-8,685 kg), was less than that in Na Hom, 3,758 kg (range 1,000-9,000 kg).

Family labor accounted for 95.3% of labor input for threshing in Don Daeng and 97.4% in Na Hom. The number of family laborers per household was 1.7 (range 1-4) in Don Daeng, slightly less than the 2.3 (range 1-6) in Na Hom. Households that adopted *het nam kan* labor, received help with labor or hired labor amounted to respectively 32%, 34% and 1% of households in Don Daeng, and 3%, 46% and 8% in Na Hom. As far as such households are concerned, *het nam kan* labor accounted for 1.7 man-days (range 1-4 man-days) in Don Daeng and 2.4 man-days (range 1-5 man-days) in Na Hom. Help with labor accounted to 5.5 man-days (range 1-20 man-days) in Don Daeng and 7.7 man-days (range 1-40 man-days) in Na Hom. Hired labor accounted to 20 man-days (only one case) in Don Daeng and 5.3 man-days (range 3-9 man-days). The cost of hired labor per household was 1,000 baht in Don Daeng and 671 baht (range 150-1,600 baht) in Na Hom. The mean values in the villages are given in Table 3. Helping and hiring for threshing as well as harvesting were more popular among farmers in Na Hom than in Don Daeng. Effective threshing work as well as harvesting in Na Hom was dependent on abundant labor in the village.

6) *Cultivation and Labor*

Villagers in Na Hom depend more than those in Don Daeng on hired labor and outside help with labor for all operations except transplanting. In Don Daeng, they also depend on such labor, but they also have *het nam kan* labor. *Het nam kan* has remained effective as far as lower and unstable rice production continued in Don Daeng and also in Na Hom. In such conditions, households of married children could not farm independently without many kinds of aid from the parental households. Today, rice yields have increased and young couples go to Bangkok to work, so the *het nam kan* relationship cannot exist in Na Hom. Households of children who have enough money can inherit farmland from their parents without the mutual help stage. They supplement the lack of *het nam kan* labor with hired labor in transplanting, and help and hired labor in harvesting. In Don Daeng, on the other hand, the *het nam kan* relationship is effective against the unstable rice production. Children, even active parents, who get off-farm jobs in Khon Kaen City can cultivate rice with their family at the weekend.

III-3 *Production*

1) *Year-to-Year Variation*

The extreme instability of rice production in Don Daeng has been reported based on actual survey [Kaida *et al.* 1985; Miyagawa 1991; Hoshikawa *et al.* 1991] and a long-term simulation study by Kono [Fukui 1993]. In contrast, the year-to-year variation in rice

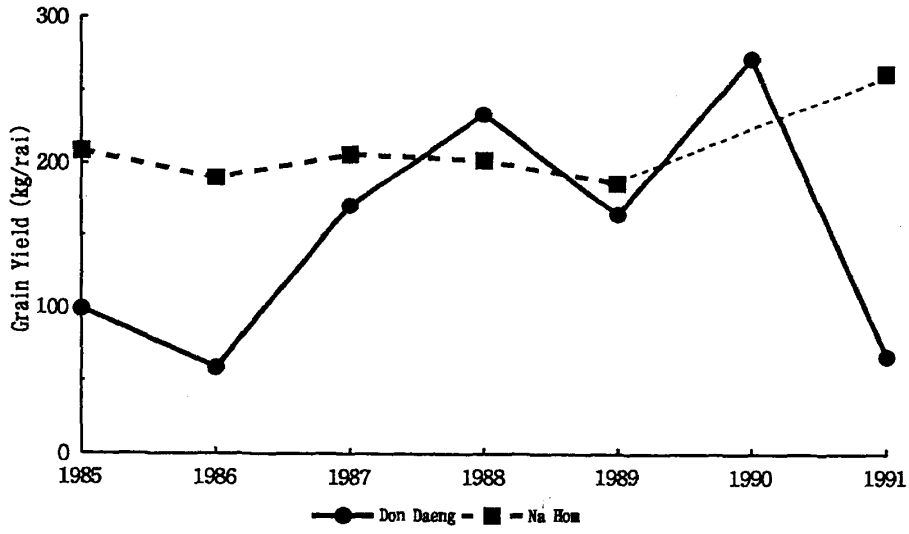

Fig. 5 Rice Yields in Don Daeng and Na Hom
Data on Na Hom for 1985-1989 are from [Somkiat *et al.* 1990].

production was very small in Na Hom and neighboring villages [Somkiat *et al.* 1990]. According to Fig. 5, which shows rice yields for the period 1985-1991 as determined by interviewing all rice-growing households, the yield in Na Hom varied around the mean value of 209 kg/*rai*, ranging from 191 to 262 kg/*rai*. In the same period, the yield in Don Daeng ranged from 59 to 272 kg/*rai*, with a mean value of 131 kg/*rai*.

2) *Variation among Paddy Fields*

In September 1991, severe flooding destroyed the rice crop in the floodplain of the Chi River in Ubon Ratchathani, Yasothon, Roi Et, Maha Sarakham, Khon Kaen and Chaiyaphum. No harvest was recorded in 65% of the planted paddy area and 39% of households in Don Daeng. Part of the paddy land in Na Hom was also inundated, but damage was slight.

The rice production per household in Don Daeng was almost one-third of that in Na Hom (Table 4). Moreover, the yield per unit planted area in Don Daeng was less than half of that in Na Hom. However, the yield per unit harvested area in Don Daeng was more than that in Na Hom. This value was also more than that in 1983, which was a rare bumper year in Don Daeng.

Table 5 shows the yield distribution among households. Sixteen percent of households in Don Daeng produced less than one metric ton in 1991. In Na Hom, almost half of the households harvested 2-4 ton. The most frequent yield per harvested area was in the range of 200-300 kg/*rai* in both villages. The range of distribution in Don Daeng was broader than in Na Hom. More than 10% of households in Don Daeng recorded yields of more than 500 kg/*rai*, while there were few households in this range in Na Hom. It could be concluded that rice growing in Don Daeng was characterized by higher yield but higher risk, and that in Na Hom by lower yield but higher stability.

Table 4 Rice Production per Household in 1991

	Village	Mean	Minimum	Maximum	CV(%)
Planted area (*rai*)	DD	12.0	0.3	42.0	67
	NH	16.2	3.5	53.0	49
Harvested area (*rai*)	DD	4.3	0.0	31.5	142
	NH	15.9	3.3	53.0	50
Percent of harvested area	DD	34.5	0.0	100.0	112
	NH	97.6	50.0	100.0	7
Yield per household (kg)	DD	1,214	0	8,685	141
	NH	3,913	1,000	10,000	42
Yield per unit planted area (kg/*rai*)	DD	106	0	720	135
	NH	262	57	583	30
Yield per unit harvested area (kg/*rai*)	DD *	326	43	867	56
	NH	269	57	583	31

Note: The number of sample households was 178 in Don Daeng (DD) and 151 in Na Hom (NH).
* 108 households

Table 5 Yield Distribution in Don Daeng and Na Hom

Yield per Household			Yield per Unit Harvested Area		
	Don Daeng	Na Hom		Don Daeng	Na Hom
0 t	39.3%	0.0%	0-100 kg/*rai*	5.6%	0.7%
0-1	20.8	1.3	100-200	20.4	23.8
1-2	17.4	12.6	200-300	25.9	45.7
2-3	9.0	27.2	300-400	22.2	24.5
3-4	4.5	23.8	400-500	10.2	4.6
4-5	4.5	19.2	500-600	7.4	0.7
5-6	2.8	8.6	600-	8.4	0.0
6-7	0.0	4.0			
7-8	1.1	1.3			
8-9	0.6	1.3			
9-10	0.0	0.7			

The cutting yield survey in both villages supported this conclusion (Table 6). Grain weight, straw weight and panicle number per unit area, and culm length in Na Hom were less than those in Don Daeng. These results mean less vegetative growth in Na Hom. Although the number of hills per unit area was lower in Don Daeng, the yield was higher because of higher number of spikelets per unit area, owing to higher number of panicles per unit area than in Na Hom. Because the variation in the number of panicles per unit area in Don Daeng was smaller than that in Na Hom, the difference in the number of spikelets per unit area among paddy fields in Don Daeng was thought to be as the result

Table 6 Rice Yield and Yield Components in Don Daeng (DD) and Na Hom (NH)

	Village	Mean	Max.	Min.	CV(%)
Grain weight	DD	356a	621	169	34
(g/㎡)	NH	265b	434	160	25
Straw weight	DD	447a	769	217	38
(g/㎡)	NH	333b	468	228	22
Grain-straw	DD	81a	108	66	15
ratio	NH	81a	99	60	18
Hill number	DD	17.4b	26.0	10.5	17
/㎡	NH	23.1a	28.8	12.9	16
Panicle number	DD	9.2a	15.7	6.2	32
/hill	NH	4.5b	5.5	3.8	13
Panicle number	DD	170a	209	125	16
/㎡	NH	112b	156	73	23
Spikelet number	DD	92b	136	51	29
/panicle	NH	111a	138	85	13
Spikelet number	DD	15,203a	25,498	9,842	26
/㎡	NH	12,310b	19,079	7,880	25
Percentage of	DD	80a	93	40	23
ripened grain	NH	76a	83	60	8
1,000-grain	DD	26.1a	27.8	23.9	5
weight (g)	NH	25.5a	27.7	24.2	4
Culm length	DD	120a	163	76	24
(cm)	HN	112a	136	94	14

Note: 1) The number of paddy fields in Don Daeng and Na Hom surveyed are respectively 17 and 11, except for the number of hills/㎡, 95 and 30.
2) Values followed by the same letter are not significantly different at the 5% probability level.

of the variation in the number of spikelets per panicle. In Na Hom, however, the variation in the number of panicles per unit area resulted in differences in the number of spikelets per unit area.

This difference in the yield formation between the two villages was caused by the difference in soil fertility of paddy fields in the villages, as described in II-2. According to the correlation analysis in Table 7, correlation coefficients among grain weight per unit area, the number of hills per unit area, the number of panicles per hill and that per unit area show significantly large positive values in Na Hom. At the same time, the correlation coefficient between ripened grain percentage and the number of spikelets per

Table 7 Correlation Coefficients among Rice Yield and Yield Components in Don Daeng (upper row) and Na Hom (lower row)

	Grain weight	Hill number	Panicle number/hill	Panicle number/m²	Spikelet number/panicle	Spikelet number/m²
Hill number	-0.16 0.69 **					
Panicle number/hill	-0.06 0.78 **	-0.83 *** 0.69 **				
Panicle number/m²	-0.36 0.82 ***	0.00 0.89 ***	0.53 * 0.94 ***			
Spikelet number/p.	0.93 *** 0.30	-0.11 -0.29	-0.26 -0.16	-0.64 ** -0.22		
Spikelet number/m²	0.96 *** 0.97 ***	-0.18 0.70 **	0.06 0.83 ***	-0.15 0.85 ***	0.85 *** 0.32	
ripened grain %	0.73 *** -0.15	-0.34 -0.04	-0.04 -0.52	-0.67 ** -0.33	0.75 *** -0.10	0.56 * -0.37
1,000-grain weight	0.73 *** 0.53	0.18 0.35	-0.58 ** 0.64 *	-0.75 *** 0.54	0.86 *** -0.15	0.59 ** 0.46
Straw weight	0.92 *** 0.67 **	-0.01 0.27	-0.21 0.12	-0.38 0.21	0.91 *** 0.70 **	0.90 *** 0.58 *

	Percentage of Ripened Grain	1,000-grain weight
1,000-grain weight	0.66 ** -0.24	
Straw weight	0.58 ** 0.30	0.81 *** 0.00

Note: *, ** and *** show significance at the 0.05, 0.01 and 0.001 probability level, respectively.

unit area was not significant. These results mean that grain yield in Na Hom depends considerably on vegetative growth. On the other hand, the higher correlation coefficients among grain weight, spikelet number per panicle and per unit area, percentage of ripened grains, 1,000-grain weight and straw weight in Don Daeng show the influence of drought damage after the panicle formation stage in the upper paddy fields, where rice was planted in Mid-September. Hence the major problems in rice growing were drought in Don Daeng and poor soil fertility in Na Hom.

Comparing the values of yield and yield components with those in 1981 and 1983 in Don Daeng, the number of spikelets doubled due to denser planting and the larger number of panicles per hill. The correlation coefficient between the number of panicles per unit area and grain weight fell to a negative value from 0.638 in 1983 [Miyagawa and Kuroda

Table 8 Amount of Organic and Inorganic Fertilizers Applied to Nursery Beds in Don Daeng (DD) and Na Hom (NH)

	Organic Manure (t/*rai*)		Chemical Fertilizer					
			N(kg/*rai*)		P_2O_5(kg/*rai*)		K_2O(kg/*rai*)	
	DD	NH	DD	NH	DD	NH	DD	NH
Mean	0.3	2.0	3.4	9.9	0.2	7.3	0.2	4.6
Minimum	0.0	0.0	0.2	1.4	0.0	0.0	0.0	0.0
Maximum	1.0	6.9	30.7	64.0	3.3	64.0	3.3	32.0

Table 9 Amount of Organic and Inorganic Fertilizers Applied to Planted Fields in Don Daeng and Na Hom

	Organic Manure (t/*rai*) *		Chemical Fertilizer							
			Total(kg) **		N(kg/*rai*) *		P_2O_5(kg/*rai*) *		K_2O(kg/*rai*) *	
	DD	NH	DD	NH	DD	NH	DD	NH	DD	NH
Mean	1.1	4.3	117	325	2.7	3.6	1.4	3.2	0.6	2.2
Minimum	0.1	1.0	10	50	0.4	0.9	0.0	0.0	0.0	0.0
Maximum	8.0	16.0	450	700	11.5	8.9	10.0	8.9	7.5	8.9

*Amount per unit planted area

**Amount per household

1988]. KDML105 and RD6 are so-called panicle-number types, which respond to fertilizer by producing more panicles. Supplying these varieties with chemical fertilizer gave rise to high productivity in Na Hom. In Don Daeng, in spite of efforts to boost the potential productivity, natural disaster was still a threat to rice production.

IV Investment in Rice Growing

IV-1 *Investments and Their Effects*

There was remarkable difference in fertilizer use between the two villages. In nursery beds, 87.1% of households applied organic manure and 98.8% applied chemical fertilizers in Na Hom, but only 28.1% and 62.5%, respectively, did so in Don Daeng. Furthermore, the application per unit area was higher in Na Hom than in Don Daeng (Table 8).

Table 9 summarizes the manuring practice in planted paddy fields. Organic manure is usually spread over the fields before plowing. The rate of application per unit area was less in Don Daeng than in Na Hom. Only barnyard manure from water buffaloes or cattle was used in Don Daeng, while, in Na Hom, forest litter, domestic waste, rice chaff, etc. were also used. In this village, a little barnyard manure was available because of the small number of cattle. The proportion of households rearing water buffaloes was 55.3%

in Don Daeng and as much as 81.6% in Na Hom. However, the number of animals kept per rearing household in Na Hom was 1.1 (range 1-2), which was fewer than the 3.0 (range 1-10) in Don Daeng. The percentage of households rearing water buffaloes has decreased in the past ten years as power-tillers have spread. Land for forage grasses was very scarce and growth of grasses was very poor in Na Hom owing to the land conditions. Elsewhere in the Northeast where cattle-rearing is difficult, farmers usually buy or hire water buffaloes only in the transplanting season and do not breed them.

Until the 1980s, few farmers in Don Daeng used barnyard manure or even chemical fertilizers in their paddy fields. But barnyard manure was used frequently on vegetable gardens and mulberry fields. This reflects the importance of fruit and vegetables, especially chili, as cash crops for sale at markets in Khon Kaen [Funahashi 1990 : 179]. In Na Hom, old farmers answered that organic manure has been applied to paddy fields since they can remember.

Chemical fertilizers were applied before or just after transplanting. The proportions of households which applied organic manure and chemical fertilizers were 70.2% and 100% in Na Hom, but 22.6% and 91.5% in Don Daeng. Of all the organic manure users, 35.7% in Don Daeng and 9.9% in Na Hom applied it to every paddy plot they cultivated. The rest of them used it only on part of their fields, because of a shortage of total amount of organic manure. As for the chemical fertilizers, 72.9% in Don Daeng and 97.9% in Na Hom of all users applied them to every paddy field they worked.

This means that 72.3% of planted paddy fields in Don Daeng and 99.4% in Na Hom were dressed with chemical fertilizers. The expenditure on chemical fertilizer per household was 650 baht (range 140-2,680 baht) in Don Daeng and 1,899 baht (range 300-4,110 baht) in Na Hom. The dressing rates in terms of nitrogen, phosphorus and potassium are shown in Table 9. Farmers in Na Hom used three times more chemical fertilizers than those in Don Daeng in terms of both expenditure and amount. And this is also true in terms of nutrient elements per unit area. Nevertheless, vegetative growth of rice was poorer in Na Hom than in Don Daeng. According to Table 6, the maximum straw weight observed among the samples in Na Hom amounted to only about 60% of that in Don Daeng, though all sample fields in Na Hom were manured. In Na Hom, the minimum number of panicles per hill was only 3.8, which indicates that no effective tillering occurred after transplanting. Na Hom seems to be very disadvantageous in terms of the fertilizer economy, at least in 1991. This disadvantage is compensated for by the large paddy area per household.

There was a significant correlation between the nitrogen dressing rate and rice yield per unit harvested area in Na Hom (Fig. 6). In Don Daeng, however, this correlation coefficient was very small. It is a notable contrast that very low fertilizer application brought high yields in several fields in Don Daeng, but only low yields in Na Hom. The respective correlation coefficients of yield with phosphorus and potassium dressing rates were 0.30^{*} and 0.21^{*} in Don Daeng but 0.50^{**} and 0.40^{**} in Na Hom. Drought in late-

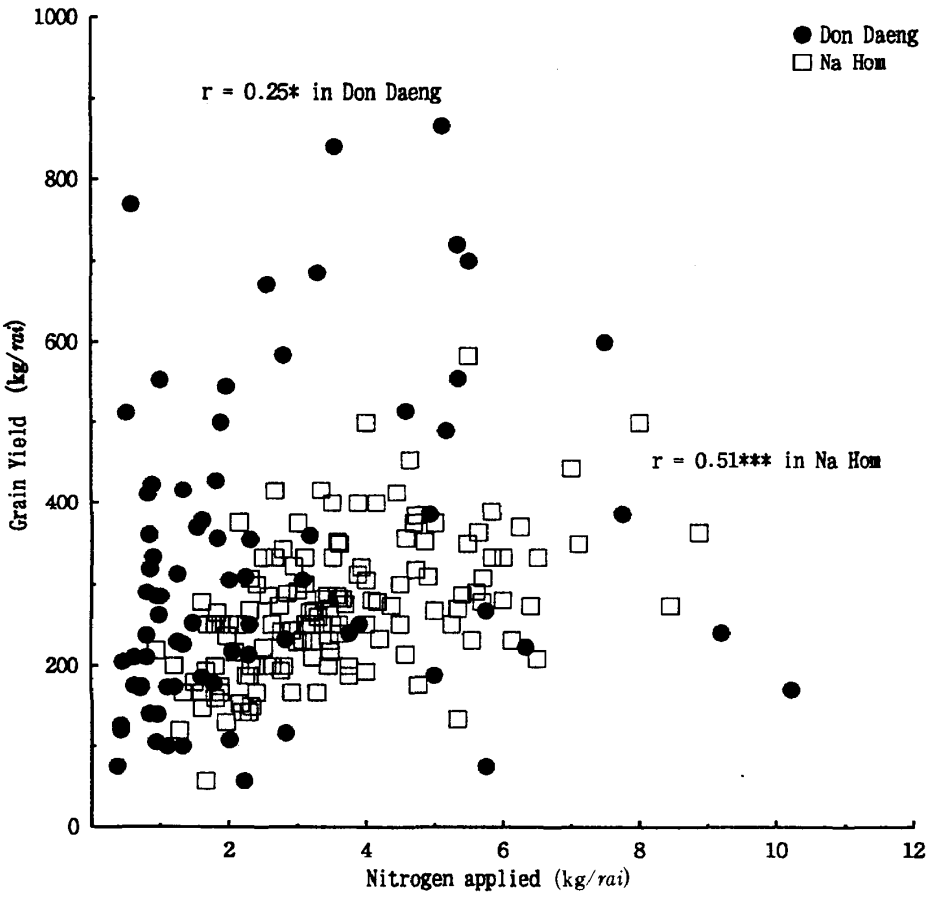

Fig. 6 Relationships between Grain Yield and Nitrogen Applied at Don Daeng and Na Hom

planted paddy plots might have inhibited the fertilizer effect in Don Daeng in this year. The effectiveness of fertilizer use was recognized by 86.4% of users in Na Hom but only 62.3% in Don Daeng.

The proportion of households using pesticides against crabs was 72% in Don Daeng and 63% in Na Hom. Among users, they were applied to 68.9% (range 3.2-100%) of the planted area in Don Daeng and 74.3% (range 4.3-100%) in Na Hom. The expenditure per household averaged in 36 baht the both villages (range 18-142 baht in Don Daeng and 20-100 baht in Na Hom). Other fungicides and herbicides were not used after transplanting in both villages. Insecticide was used in seed nurseries by 26% of households in Don Daeng and 20% in Na Hom. There was little difference in use of chemicals other than chemical fertilizers between the two villages.

Irrigation was practiced by 83% of households in Don Daeng, at a cost of 528 baht (range 0-4,500 baht) per user. Water was raised by pumps powered with gasoline or diesel engines or a electric motor. One third of the total paddy area was irrigated in 1991. There was no irrigation in Na Hom.

Weeding by hand was more common in Na Hom than Don Daeng, being practiced by 70% and 18% of households respectively. In the 1980s, it was practiced seldom in lowland

rice fields but often in upland rice fields in Don Daeng. Increased fertilizer use might have stimulated weed growth. Direct dry-seeding might have had the same effect. It is clear that the all-year-round cultivation in irrigated areas such as Nam Phon in Khon Kaen Province also stimulated vigorous growth of *Cyperus spp.*

Power-tillers or farm tractors were used by 81.5% of households in Don Daeng and 81.8% in Na Hom. Although the rate of usage was similar in the two villages, more farmers owned their machines in Don Daeng (19.4%) than in Na Hom (5.1%). In Don Daeng, planting must be completed within a shorter period under unreliable rainfall conditions in order to secure a large planted area. The short planting season may cause competition for machines among farmers, which might explain the higher ownership rate in Don Daeng. The expenditure for hiring machines per employer was 1,470 baht (range 0-6,400 baht) in Don Daeng and 979 baht (range 140-2,700 baht) in Na Hom. The average rental of 175 baht/*rai* in Don Daeng was much higher than that of 82 baht/*rai* in Na Hom. The difference in unit price might be caused by the competition among farmers as well as by the urbanization around Khon Kaen City.

For threshing, a threshing pan or ground which is square in shape is coated with buffalo dung, and bundles of harvested rice are piled up in the shape of a house. After a ritual of thanks to the rice goddess (*mee phoosop*), threshing starts. They hold a bundle with a string tied between the ends of a pair of sticks and beat it against the ground or a small stand. About nine strokes are enough to thresh a bundle. This traditional threshing method was common in the Northeast until the 1980s.[5] In 1991, almost half of household

Table 10 Expenditure of Rice Growing per Household (baht)

	Don Daeng		Na Hom	
	Total	%	Total	%
Chemical fertilizer	432	10.6	1,899	46.2
Pesticide	26	0.6	23	0.6
Irrigation	439	10.8	0	0.0
Land consolidation	1,624	39.8	257	6.3
Hiring				
Power tiller	913	22.4	742	18.1
Transplanting	508	12.5	719	17.5
Harvesting	129	3.2	280	6.8
Threshing	6	0.1	189	4.6
Total	4,077	100	4,109	100
Total per unit planted area(*rai*)	340		254	

5) In some villages, rice is threshed by having water buffaloes trample it.

used nylon fishing net instead of buffalo dung. Furthermore 1% of households in Don Daeng and 40% in Na Hom hired threshing machine.

It was observed in the villages that many small paddy plots on slopes have been consolidated into a small number of large plots by use of hired bulldozers for convenience in use of power-tillers and in transplanting. Land consolidation was carried out by 31% and 12% of households in Don Daeng and Na Hom, respectively. Of those households that consolidated their fields, the consolidated area per household was 4.5 *rai* (range 2.5–28 *rai*) in Don Daeng and 2.5 *rai* (range 0.5–8 *rai*) in Na Hom. The expenditure per household for it was 5,203 baht (range 0–23,500 baht) in Don Daeng, much more than the 2,719 baht (range 300–10,000 baht) in Na Hom.

The total cost of rice growing per household is shown in Table 10. It was found to be almost the same in the two villages. But the cost per unit planted area was much

Table 11 Sources of Income in Don Daeng and Na Hom

	Don Daeng		Na Hom	
	N	%	N	%
Employment				
Village	24	13.5	20	13.2
Agricultural center (Thapra)	19	10.7	-	-
Khon Kaen City	78	43.8	-	-
Yasothon Province	-	-	5	3.3
Bangkok	19	10.7	98	64.9
Other provinces	6	3.4	4	2.6
Foreign countries	1	0.6	1	0.7
Unknown	7	3.9	0	0
Selling products				
Rice	34	19.1	112	74.2
Vegetables	32	18.0	0	0
Cassava	10	5.6	0	0
Cattle and/or buffalo	8	4.5	4	2.6
Pig	3	1.7	0	0
Horse	1	0.6	0	0
Fish	3	1.7	0	0
Variety store, merchant	11	6.2	4	2.6
Selling fuel	1	0.6	0	0
Selling lottery tickets	1	0.6	0	0
Loan	4	2.2	5	3.3
Others	0	0	4	2.6

higher in Don Daeng than in Na Hom. Land consolidation was the biggest item of expenditure in Don Daeng, while chemical fertilizer was the biggest in Na Hom. This reflects the difference in priority between the two villages: securing of planted area in Don Daeng, and better growth after planting in Na Hom.

IV-2 *Sources of Income*

In Na Hom the most important sources of cash income are sale of rice, followed by remittances from family members working in Bangkok (Table 11). Workers in Bangkok are being engaged in transportation, being hired as taxi drivers at present or drivers of three-wheeled vehicles (*sam roh*) in earlier days. This is common among villagers from Yasothon province. One old farmer is said to have purchased 43 *rai* of paddy fields for 1,200 baht with his earnings as a *sam-roh* driver in Bangkok.[6] Others go to provinces in the Central Plain as hired laborers for transplanting and harvesting of rice. Yasothon city does not offer enough off-farm jobs to villagers. On the contrary, 68% of farmers in Don Daeng can find jobs in or near the village.

Na Hom has few agricultural products for sale other than rice, while Don Daeng has many. Soil is too poor to grow cassava in Na Hom. It is said that farmers tried to plant cassava but failed [Nakada 1995]. Irrigation is indispensable for vegetable-growing, which is possible only a small area around houses and small gardens (about 2 m × 2 m) near tube wells in paddy fields. These difficulties of crop diversification in Na Hom prompted investment in and commercialization of rice growing. Rice was the source of cash income for 19% of households in Don Daeng. Even this low percentage should not be taken as the average, however, because the harvest was good in the preceding year (1991).

Table 12 Allocation of Products of 1991 per Household (kg(%))

Varieties	Total Yield	Seed for Next Season	Rice Sold after Threshing	Offered Rice	Residuals (Storage)	Percentage of Households Selling Rice
Don Daeng						
Total	1,214 (100)	58 (4.7)	103 (8.5)	104 (8.6)	949 (78.2)	17.4
Glutinous	948 (100)	46 (4.9)	13 (1.4)	89 (9.4)	801 (84.5)	3.4
Nonglutinous	266 (100)	12 (4.5)	90 (33.8)	15 (5.6)	148 (55.6)	14.6
Na Hom						
Total	3,899 (100)	82 (2.1)	143 (3.7)	62 (1.6)	3,612 (92.6)	39.1
Glutinous	2,025 (100)	39 (1.9)	5 (0.2)	35 (1.7)	1,945 (96.0)	2.0
Nonglutinous	1,874 (100)	43 (2.3)	138 (7.4)	27 (1.4)	1,667 (89.0)	37.7

6) I owe this information to Nakada Yoshiaki.

V Commercialization of Rice

V-1 *Selling Rice*

Table 12 shows the allocation of the harvest in 1991, which was investigated one month after threshing. It includes households whose crop was damaged by flooding. The amount of rice sold in Na Hom was more than that in Don Daeng at that time. The number of households who sold rice in Don Daeng was smaller than in Na Hom. The amount of rice sold per seller and the price per kilogram were 592 kg (range 60–1,860 kg) and 2,301 baht (range 274–7,500 baht) in Don Daeng, and 361 kg (range 25–1,000 kg) and 2,162 baht (range 470–5,500 baht) in Na Hom. At that time, however, this figure had not reached 10% of total production in Na Hom. According to Nakada, 48% of the total production of 1991 had been sold by August 1992 [*ibid.*].

On the other hand, it was estimated that no more rice would be sold in Don Daeng because of the small surplus there. Flooding damaged the paddy lands of 79% of the households to some extent. Farmers had to supplement the loss with purchased rice (29.5%), borrowed rice (3.2%), shared rice (1.6%), dry-season rice (5.8%), cassava (5.4%), vegetables (20.8%), new jobs outside the village (30.1%) and others (3.2%). One hundred and thirteen households obtained 1,447 kg rice on the average to supplement the deficiency. This consisted of 79 kg for seed (83 households) and 1,481 kg for consumption (103 households) in the case of glutinous rice, and 30 kg for seed (20 households) and 252 kg for consumption (15 households) in the case of nonglutinous rice. Old villagers claimed that in their youth they had visited relatives in other villages to exchange fish from Don Daeng for rice when flood damaged most of their paddy fields.

The rice trade throughout of a year (from harvesting time in 1990 to that in 1991) is presented in Table 13. Twice as many people sold rice in Na Hom as in Don Daeng, and the average income from sale of rice in Na Hom was double that in Don Daeng. Glutinous rice was sold by 20.2% of households in Don Daeng and 41.1% in Na Hom. Nonglutinous

Table 13 Amount of Rice Traded per Household from Harvesting Time in 1990 to That in 1991

	Sold Rice (kg)		Sold Rice (baht)		Purchased Rice (kg)		Purchased Rice (baht)	
	DD	NH	DD	NH	DD	NH	DD	NH
N *	66	134	67	135	6	2	6	2
Mean	1,089	1,392	4,258	7,480	446	1,200	3,398	3,250
Minimum	120	120	400	500	60	1,200	780	500
Maximum	6,000	4,200	20,000	25,000	1,500	1,200	5,600	6,000

Note: Percentages of surveyed households that sold rice were 37.6 in Don Daeng and 88.7 in Na Hom.
* Number of households.

Table 14 Rice Sale from Harvesting Time in 1990 to That in 1991

	% of Households		Amount Sold per Seller			
	DD	NH	DD	NH	DD	NH
Glutinous rice	13.5	6.0	810 kg	860 kg	3,632 baht	3,856 baht
Nonglutinous rice	17.4	49.0	985	1,285	3,876	7,223
Both	6.7	35.1	1,890	1,658	6,500	8,578

rice was sold by 24.1% of households in Don Daeng while 84.1% in Na Hom (Table 14). This year was a bumper year for Don Daeng as shown in Fig. 5, but the amount of rice, even glutinous rice, sold in Don Daeng was less than in Na Hom. In Na Hom, the selling price at the farm gate was 5.6 baht/kg of paddy for nonglutinous rice and 4.5 baht/kg for glutinous rice. The number of households who purchased rice during this period was few in both villages. By tradition, the glutinous rice that is the staple food produced by people in the Northeast was mainly stored. According to the rice granary survey by Funahashi in 1983, the average storage capacity was 6.85 t, corresponding to three years' consumption per household in Don Daeng [Fukui 1993]. Here, farmers occasionally sold rice when the yield was so good as to exceed the storage capacity. It is apparent that farming in Na Hom has already become commercialized. But in Don Daeng, farming is still in a transitional phase from subsistence to commercialized production.

V-2 *Necessary Conditions for Commercialization*

Productivity growth has allowed population increase, which has resulted in a decrease in per capita holdings of rice land. According to Somkiat *et al.* [1990], in Na Hom at the end of the 1970s, before the onset of commercialization, 460 kg of paddy per capita of mainly glutinous rice for domestic consumption was produced from 4 *rai* per capita. Introduction of an improved variety, RD6, together with chemical fertilizers in the 1980s brought about higher yield. The resulting surplus was not stored but sold [Nakada 1995]. This apparently differs from Don Daeng, where farmers stored the harvest to the maximum capacity of the granaries. The sale of rice in Na Hom was due to the stability of rice production caused by the favorable rainfall distribution.

At the end of the 1980s, 300 kg per capita of glutinous rice and 200 kg of nonglutinous rice from 1.4 *rai* each was produced in Na Hom. Less glutinous rice was produced in the 1980s than the 1970s, the deficit being supplemented by purchased rice. This is because the selling price of nonglutinous rice was almost 1 baht/kg higher than that of glutinous rice in 1991. The difference in price promoted the commercialization of nonglutinous rice. In some villages near Na Hom, however, production of glutinous rice was not sacrificed for that of nonglutinous rice.

I have estimated the per capita in Don Daeng to be 352 kg of unhusked paddy per year. Adding 2.4 kg/*rai* of seed to that gives an annual per capita requirement of about

400 kg [Miyagawa 1990]. Recently, Nakada concluded that 319 kg of paddy was consumed as meals and an additional 142 kg for other purposes per person per year in Na Hom [Nakada 1995]. From these facts, commercialization of rice should become possible when annual production can be guaranteed to exceed the level of domestic consumption (about 400 kg).

Two kinds of factors, promotive and permissive, can be recognized in the commercialization of rice. Cash demand growth is the principal promotive factor. In Don Daeng, for example, radios, bicycles, electric fans, motorcycles, TVs and ready-made clothes rapidly spread among villagers, and block-wall houses took the place of old wooden houses with walls of bamboo or leaves [Funahashi 1990]. Hence, it can be said that there was motive for commercialization in both villages, as in most villages in the Northeast. There are two ways to satisfy this demand among villagers. Don Daeng is typical of the non-commercialization of rice. In Don Daeng, where soil is fertile, and there is a convenient river source for irrigation and a big market near the village, growing cash crops in upland fields and vegetable gardens became a more reliable and easier way to secure income than unreliable rice production. On the other hand, the natural surroundings of Na Hom are unsuitable for crops other than rice. Therefore, villagers were obliged to depend on rice as a cash crop. A paucity of agricultural products other than rice is recognized as the second promotive factor.

Once the per capita annual yield, not year-to-year average yield, exceeds the level of 400 kg, commercialization of rice becomes possible in a village. Such is the annual average yield in Na Hom. The factors necessary in order to realize such a yield include low natural hazard, low fluctuation yield among years and among paddy fields, high potential average yield and enough money for investment. A considerably high yield potential of paddy fields is also necessary to maintain rice commercialization even the paddy fields are divided for inheritance. If the potential yield is not high enough the land is divided for inheritance, it will not be able to produce enough rice for sale.

When the fluctuation of yield is small, it is possible to raise yield easily by application of fertilizers. Differences in the range of yield fluctuation between Don Daeng and Na Hom were pointed out shown in III-3. The ratios of planted area and harvestable area to total paddy area in Na Hom were higher and more stable than those in Don Daeng. When the variation in yield among paddy fields is small, farmers can apply fertilizers to every field. Such variation is mostly caused by differences in water regime among paddy fields. As shown in Table 5, some farmers obtained extremely high production, while many farmers had no harvest in 1991 in Don Daeng. But in years of less rainfall, rice was damaged most severely in the higher paddy fields, where a good harvest was realized in rainy years. At the onset of the rainy season, nobody can predict the duration or the degree of the dry spell and flooding during the season. This situation makes farmers hesitate to use fertilizers in all their paddy fields.

A minimum amount of funds is necessary to raise the yield potential by purchasing

fertilizer in the first stage of rice cultivation for sale. After the yield has increased and enough rice can be sold, farmers can continue to obtain the money for chemical fertilizers to use in next season. In the case of Na Hom, income from Bangkok was used for this investment.

V-3 *Outlook for the Future*

Will farmers in Don Daeng plant a large area of nonglutinous varieties for sale in the future? Almost every farmer interviewed took a negative stand at present. They are not familiar with planting and sale of nonglutinous rice in order to purchase glutinous rice for consumption, as villagers in Na Hom do. If irrigation canals should be extended to every paddy field, they expect to plant more glutinous rice than at present.

In Don Daeng, three villagers planted only nonglutinous rice in their paddy fields in 1991. Two of them planted glutinous and nonglutinous rice in 1990 and sold both, and it is not clear what the third did. It is still far from certain that they were pioneers of commercial rice growing. Their rice yield and the paddy area damaged by flooding were not significantly different from those of the households who grew only glutinous rice in 1991. The first farmer planted rice in 8 *rai*, and harvested 600 kg from 3 *rai*. The second one planted rice in 23 *rai*, but his entire crop failed. The third one planted nonglutinous rice for the purpose of sale and harvested 540 kg from 3 *rai* of 5 *rai* planted, of which he sold 180 kg (750 baht) for purchase of glutinous rice. At seeding time, he had little seed of glutinous varieties in the storage. He thought the selling price of nonglutinous rice would be higher than that of glutinous one. He needed money to hire a power tiller. Although nonglutinous rice sometimes realizes a better price than glutinous rice, the average farm price of glutinous rice, 4.9 baht/kg, was higher than that of nonglutinous rice, 3.9 baht/kg in 1990-1991 in Don Daeng. There are promotive factors for the rice commercialization, but no permissive factor.

Recently, urban residents of provincial capitals even in the Northeast are tending to eat more nonglutinous rice. Electric cookers for nonglutinous rice are also not uncommon in many villages. Villagers have also begun to eat more nonglutinous rice than in the past. The demand for nonglutinous rice seems to be increasing. Therefore, there is an incentive to plant more nonglutinous rice in this area at present. Villages in the eastern and northern parts of the Northeast have the potential to expand the nonglutinous rice cultivation through a similar process to that in Na Hom village, because these areas have more abundant and stable of rainfall than other areas. At present, no expansion has yet occurred in Nakhon Phanom and Sakon Nakhon Provinces where much rainfall is expected every year. Transportation problems may still remain unsolved.

On the other hand, irrigable paddy fields in the central and western parts also have the potential to grow more nonglutinous rice. But such areas cannot be expected to contribute as much to the expansion of nonglutinous rice cultivation as the high rainfall area, because irrigable areas near the floodplains of Chi and Mun Rivers will be

restricted in the future.

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