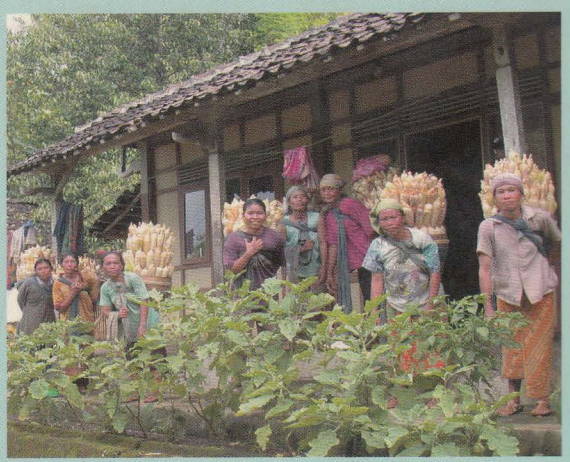
JSPS-DGHE
Core University Program in Applied Biosciences

Proceedings of the 2nd Seminar

Toward Harmonization between Development and Environmental Conservation in Biological Production



February 15-16, 2003

Sanjo Conference Hall
The University of Tokyo

Sponsored by Japan Society for the Promotion of Science

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Contents

Preface

Nearly five years has passed since the JSPS-DGHE Core University Project was started in a densely populated rural area of Indonesia under the title "Toward Harmonization between Development and Environmental Conservation in Biological Production." Establishing a system of sustainable agricultural production is one of the most important issues in the 21st century, particularly for developing countries including Indonesia. The Graduate School of Agricultural and Life Sciences, the University of Tokyo, and Bogor Agricultural University (IPB) have actively carried out this research project in cooperation with other universities in both countries.

The main purpose of the Second Seminar is to trace back the progress of our research activities at the turn of this ten-year project. The academic results of this project are well reflected by the papers submitted to this seminar, amounting to 57 papers including eight for the plenary session, 35 for the group meeting and fourteen for posters. In addition, a book of collected papers will be published in order to disseminate our academic results.

Moreover, six eminent experts will participate in this seminar to objectively evaluate overall performance of the first half of this project. We deeply appreciate that they kindly arranged to undertake this task given their busy schedules. Their esteemed comments will provide valuable guidance for the next stage of this project.

We would like to express our thanks to all researchers who participate in the seminar in spite of the sudden rescheduling. We hope that discussion throughout the seminar will be fruitful and shall create an impetus for further research. It is not only desired that our project will produce still more academic achievement in the future, but will also harmonize agricultural development and environmental conservation in rural Indonesia. Our seminar is a start in this new direction.

January 27, 2003

Dr. Yoshihiro Hayashi and Dr. Kazuhiko Takeuchi
Coordinator and Sub-coordinator of the Japanese Team

Agricultural Sustainability and Economic Activities in a Highland Village in West Java, -Duration of Land Use Cycles in the Highlands-

Kosuke Mizuno and Sugiah Machfud Mugniesyah, Ageng Herianto, Hiroshi Tsujii *,

1. Introduction

Agricultural sustainability is supported by both the factors directly related to the agriculture itself and external factors. Factors that are directly related agriculture, such as irrigation, selection of plants and planting times, are closely related to agricultural sustainability. External factors such as employment and income can also influence the sustainability. Economic activities outsides the agriculture can be called no-agricultural sector.

The village that was surveyed is located in a mountainous area in West Java, Highland farming is the dominant type of agriculture there. Highland farming has complex characteristics. A large number of plants are grown, and many land use cycle are found on the land plots. The complexity of farming itself is closely related to the sustainability of agriculture.

Among the many factors of sustainability of highland agriculture, ensuring that the duration of the cycles of highland farming is appropriate is an important factor[i]. Dry rice farming is important for highlands. When the season for dry rice farming ends, the next stages will start, and after several stages farmers will burn the field and plant dry rice again. As long as the technology is not much innovated, the duration of a cycle can become the indicator of the fertility and sustainability of highland firming. If the duration of a cycle is too short, the fertility of land can decrease. This is the second best way to measure the sustainability of highland firming. Comparing the productivity and fertility of stage cycles is quite difficult, because a cycle lasts for many years, sometime 30 years, and it is quite difficult to collect thirty-year old data.

Many factors can influence the duration, such as the area of the agricultural land, the status of land ownership, and availability of wet rice farming, social factor including gender perspectives[ii]. Off-farming activities can influence the interval, for example, availability of agricultural wage labor, or non-agricultural business

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activities may mitigate the pressure of farmers to cultivate the highland within cycle that are too short.

This paper will describe the highland agriculture in the village under the survey. Chapter 2 shows the general picture of the surveyed village. Chapter 3 proposes an analysis of the factors that influence the intervals in the highland farming. Chapter 4 describes economic activities and their income including the non-firm or non-agricultural factors that sector to influence the interval. Chapter 5 will offer the conclusion of this paper.

This paper is based on the field survey conducted by West Java team of Social and Economic Group of Core University Program Between Bogor Agricultural University and University of Tokyo. Field survey were conducted for five years. Around 60 – 63 households were surveyed, using household survey questionnaires.

2. General picture and Highland Farming at Kemang Village.

2.1 General picture and Agriculture at Kemang Village

The topographic character of Kemang Village, which is located in the District of Cianjur, Bojongpicung Sub-district, is that of a hilly and mountainous area. It is part of the Priangan Highlands. The distance that separates it from the center of the Sub-district is about 7 km, and village people must cross over a mountainous pass to get there.

This mountain constitutes a natural barrier for the people outside the village, so migration inflows into the village are small. The population density of 174 persons/km^2 in the village (including the land controlled by the National Forestry Corporation - Perum Perhutani) or 297 persons/km^2 (excluding the area controlled by the National Forestry Corporation) in 2001 is relatively small compared to the average population density of 1009 persons/km^2 in West Java in 2000 (BPS, 2001). The population was 4,384 persons in 2001, whereas the area of the village is 2518.63 hectares. Of that area, 1040.6 ha are covered by forests controlled by the National Forestry Corporation, 878.6 ha are earmarked for highland agriculture and forestry. Rice fields are relatively small, with just 83 ha [Desa Kemang 2001]. In the area controlled by the National Forestry Corporation, social forestry programs are being implemented, so that the local people have been able to take part in maintenance and cultivation. In 1998, the National Forestry Corporation integrated the "Forest Village Society Program" (Program Masyarakat Desa Hutan PMDH) and the "Social Forestry Program" (Perhutanan Sosial) into the '"Integrated Forest Village Society Program" (Program Masyarakat Desa Hutan Terpadu: PMDHT). Kemang village was made a model village of PMDHT [Inoue et al. 2000]. The area of the National Forestry Corporation is not maintained and cultivated by the local people of Kemang Village only. Naturally, it is controlled by the company. Therefore, private highland areas are more important for the villagers' economy.

In any event, the private highland fields, the forest area and the National Forestry Corporation's area that shape the slopes of the mountains and hills, and wet rice fields that cover the lowlands are the major agricultural areas of the people in the village under survey. Many of the plants in the highlands and the National Forestry Corporation area are subsistence-oriented, but some plants there are highly commercialized. The most important plant in the National Forestry Corporation's area is teak; in the private highland areas, it is banana trees, which have been spreading since the second half of the nineties, palm sugar (*Arenna pinnata sp.*),, and chilly plants.

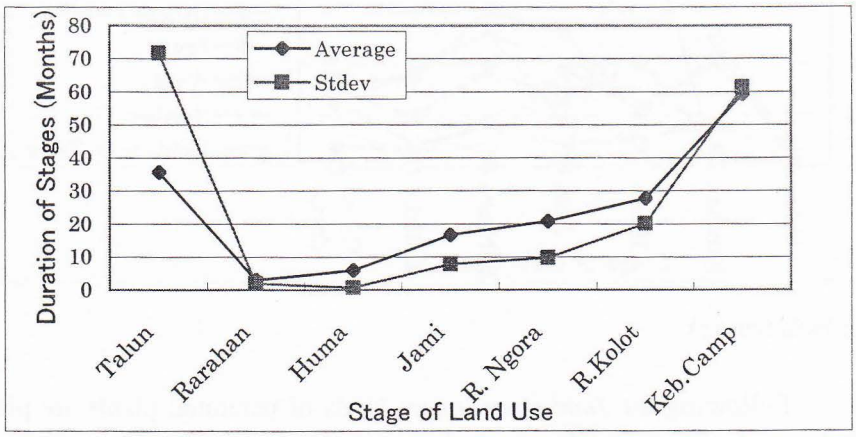
Apart from these agricultural and forestry activities, there are other non-agricultural activities including furniture manufacturing, rice milling, timber trading, grocery stores, the trade of banana leaves, and – also important – is the supply of migrant workers, especially international migrants who work in Saudi Arabia.

The village consists of 22 hamlets that form part of three sub-villages *(Dusun).* Dusun I, Dusun II and Dusun III have seven, five and ten hamlets respectively. The village lies at an altitude of between 400-800 meters above sea level, and the topography ranges from gently sloping to steep hilly terrain. (Sugiah et al, 2002). Access to the nearest town is not easy. The road providing access to the nearest town was build in 1990s. Before that time, people had to walk to get there

2.2 Up-land agriculture in Kemang Village.

People use the slop of mountain and hill as up-land agriculture and forestry. The land use system is quite complicated, however we can find a typical type of land use.

Chart 1. Average duration of up-land farming stage and its stand. deviation



(Source: Field Survey)

Typically people plant dry rice (*pare huma*) during October and December

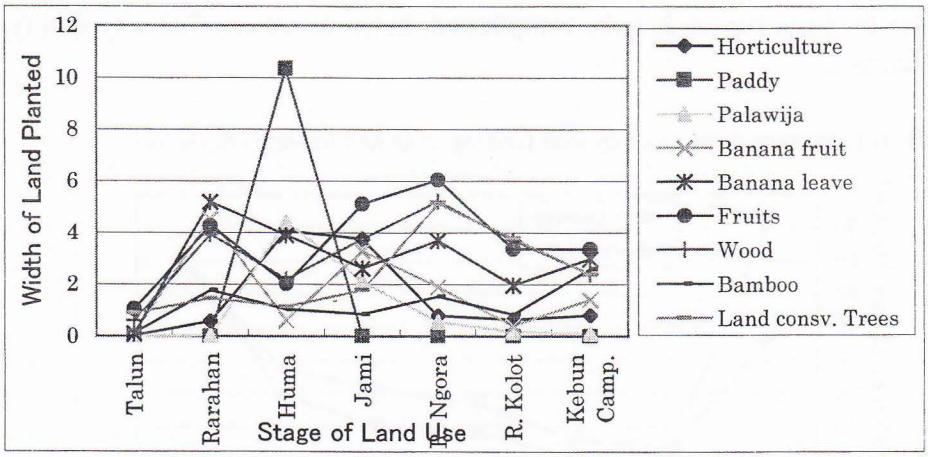
and will harvest after 6 months. This stage is called *Huma*. Before they plant dry rice, they slash and burn the land. Land that is not cultivated although there are a lot of productive permanent tree is called *Talun*.[iii] This land called *Talun* is slashed and burned so that dry rice can be planted. After slash and burn, the land is prepared for planting dry-rice, for example making pillows in order to avoid soil erosion. Trees for avoiding erosion such as *Caliandra* are planted in this stage. This stage is called *Rarahan.* We can think that once there is huma stage, Rarahan stage is necessary to be passed, and last about 2 – 5 months.

Chart 1 shows the average length of period for each stage of land use, and its standard deviation. This chart is based on the personal interviews with respondents. Respondents answered on the land use system for each plots they used. According Chart 1, average period of land use for Rarahan is 3.04 months and standard deviation is 1.9 months.

After the harvest of dry rice, people tend to plant secondary crop (*Palawija*, and recently banana trees for leaf harvesting are planted. This stage after the harvest of dry rice is called *Jami.* Periods of *Jami* stage vary a lot from 3 months to 2 –3 years. Its average id 16.6 months and standard deviation is 7.7 months.

Chart 2 shows that kinds of plants used for each stages of land use and its area planted for each kinds of trees per stage of land use (total up-land used by 60 surveyed households is 30.65ha).

Chart 2. Area of trees planted according to the stage of up-land farming



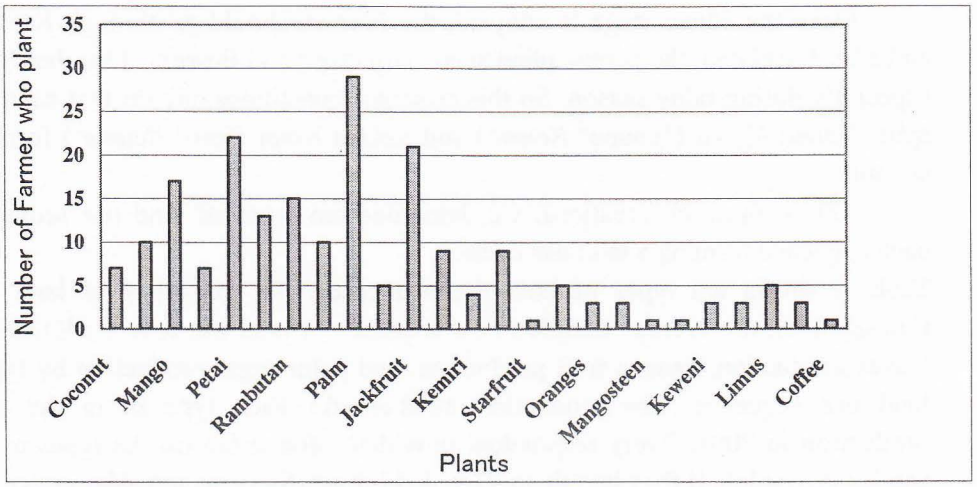
(Source: Field Survey)

Following the *Jami* stage, many kinds of perennial plants are planted and will be productive (including perennial plants that have existed for many years), but maintenance needs not be as intensive as it is at the *Huma* or *Jami* stages. This stage is referred to as *Reuma Ngora*.[iv] Many kinds of perennial trees, such as sugar palm (*Arenna pinnata*), durians (*Durio zibethinus*), *petai*, mango, *rambutan*,

jengkol, coconut and jackfruit (*Artocarpus heterophylla*) trees are planted and produce. Large numbers of banana trees are planted for their leaves. The *Reuma Ngora* period vary a lot, from 10 months to 3 years. Chart 3 shows the area of trees planted during the *Reuma Ngora* periods. This Chart demonstrates the of wide variation of plants in those stages.

After the *Reuma Ngora*, land use will move to the *Reuma Kolot* stage, in which maintenance is more basic. For example, the land may not touched for several months. However, the land is still being used productively, and perennial trees are productive. The periods of this stage vary more variable. They can vary from 1 to 5 years.

Chart 3, Number of Farmers who Plant during the Stage of *Ruema Ngora* according to Kinds of Plants



(Source: Field Survey)

After such productive use, the land is fallowed for a few years, sometimes for ten years or more. This period is called *Talun*. Production of trees and plants is low during this period.

People sometimes prefer to use land as *Kebun Campuran* after it being used as *Jami.* In this kind of land use type, perennial trees, tall annual plants, short annual trees and root plants are mixed. Horticulture, fruits, trees for building materials including bamboo, are planted. *Kebun Campuran* can be translated into "mixed plantations or gardens". This is a productive use of the land, and it lasts for quite a long time, sometimes ten years or more (the average is 59.1 months and the standard deviation is 61.3 months). Banana trees are often planted for both their fruits and their leaves during this period. After the long *Kebun Campuran* period, the *Talun* period starts.

Chart 2 helps us understand that trees for land conservation are planted at

every stage of land use. From this chart, we can understand that more land is being used in the *Huma*, *Jami*, *Reuma Ngora* and *Rarahan* periods.

2.3 Variation of land use stages cycle.

The above-described sequential pattern of stages is a typical case. In reality, many variations of stage cycles are found because there are many options for the farmers.

One option is the *Reuma Ngora/Reuma Kolot* and *Kebun Campuran* alternative, although some people take both *Reuma Ngora/Reuma Kolot* and *Kebun Campuran*. *Talun* is a long period with a low productivity, thus some people are not keen to use this cycle. *Huma* is an important period for producing dry rice. However some people are not interested to use the land as *Huma.* Perhaps, they would rather plant many banana trees, or have a lot of wet rice. Some people do not prefer to use the land as *Reuma Ngora/Reuma Kolot* or *Kebun Campuran*.

Once the *Huma* stage is adopted, the farmers should go through *Rarahan*, and after the *Huma*, the people plant secondary crops and flowers at the *Jami* stage especially during rainy season. So this sequence constitutes one set that cannot be split. *Reuma Ngora* ("young" *Reuma*) and *Reuma Kolot* ("old" *Reuma*) form one set, too.

From these observations, we determine ten types of land use sequences, each sequence forming a land use cycle.

Table 1 shows ten types of land use sequences, the frequency of land plots (households), the average duration of a sequence of land use (one cycle), banana leaves production, banana fruit production, and palm sugar production by type of land use sequence. The production numbers for each type mean the year's production in 2001. Every respondent provided information on the types of land use for three plots if they had them. Detailed information was provided concerning the largest plot only for each respondent. This explains why the number of plots varies in each column of Table 1.

The duration of each cycle varies a lot. The typical type mentioned above consists of 65 months per cycle. If *Kebun Campuran* is added to the typical use of the land, the cycles become longer, that is 192 months. The types of land use without *Talun* have relatively short periods of one cycle. Almost every type produces banana leaves, banana fruits, and palm sugar.

There are various reasons underlying the selection of these types. However, there may be proper periods of one cycle to maintain fertility levels, assuming that the technology to maintain fertility, such as the selection and planting of land conservation trees, does not change drastically.

Table 1. Types of land use stage cycle, period of cycle, average yearly production of Banana Leaves, Banana Fruit and Palm Sugar (in 2001)

Code of Cycle	The Cycle	Tot. plot of Land	Period of Cycle		Banana Leave Prod.		Banana Fruit Prod.		Palm Sugar Prod.	
			Average (months)	Number of plot	Average (Kg)	Number of Plot	Average (Kg)	Number of plot	Average (Kg)	Number of plot
A	T-R-H-J-RN/RK-KC	18	192	18	156.9	8	42.5	8	7.5	8
B	T-R-H-J-RN/RK	32	65	32	118.3	15	68.9	15	1.6	15
C	R-H-J-RN/RK-KC	29	92	22	148.4	13	34.6	13	3.7	13
D	T-KC	5	375	4	300	1	100	1	36	1
E	R-H-J-RN/RK	41	66	36	96,2	18	73.2	18	1.5	18
F	R-H-J-KC	4	51	4	1700	1	90	1	15	1
G	T	9	104	2	-	0	-	0	-	0
H	RN/RK	16	87	6	341.9	4	42.1	4	8.7	4
I	KC	6	120	1	-	0	-	0	-	0
J	R-H-J	19	20	16	1380	1	275	1	3050	1
N=		179	141	141	1	61	1	61	1	61
Average		-	90.9	-	187.5	-	61.9	-	54	-

(Source: Field work)

2.4 Gender and Variation in Land Ownership in Relation to Succession

It was reported that women in Kemang Village had access to rice fields as well as dry land (slopping land), as parent – mother and father – tend to bequeath their land to their children (sons and daughters) based on gender-equitable values called *sanak* (Mugniesyah and Mizuno, 2002). Women's access to land might significantly determines highland agricultural sustainability..

Table 2. The Type of Succession Cycle By Land Ownership in 2001

Type of Cycle	Land Owner				Total (%)
	M	W	GG	O	
T-R-H-J-RN/RK-KC (A)	2.1	9,2	1,4	0,0	12,8
T-R-H-J-RN/RK (B)	2.1	5,7	4,3	10,6	22,7
R-H-J-RN/RK-KC (C)	5.0	4,3	5,7	0,7	15,6
T-KC (D)	1.4	0,7	0,7	0,0	2,8
R-H-J-RN/RK (E)	6.4	7,8	6,4	5,0	25,5
R-H-J-KC (F)	0.0	2,1	0,7	0,0	2,8
T (G)	0.0	0,0	0,7	0,7	1,4
RN/RK (H)	1.4	1,4	0,7	0,7	4,3
KC (I)	0.0	0,0	0,7	0,0	0,7
R-H-J (J)	0.0	0,0	0,7	10,6	11,3
Total (%)	18.4	31,2	22,0	28,4	100,0
Total (N)	26	44	31	40	141

(in Percent)

Note: M= Men (Husband &his family); W=Women (Wife and her Family)
GG= *Gono-gini* (Husband and Wife);
O = Others (National Forest Company Land and non relatives)

As seen at Table 2, the bigger percentage of land was controlled by women (31.2 percent). Furthermore, the percentage of land controlled by women and cultivated by implementing Type A and B --the two longest periods of land-based successions -- was higher than that of men. Of the total, 9.2 percent of Type A and 5.7 per cent of Type B were implemented by farmer households who cultivated highlands belonging to their wives and her families; meanwhile those of men were around 2 per cent, for Type A and B. The next chapter discusses the variables that influence the duration of the cycle.

3. Analysis on the duration of stage sequence cycle-factors related to up-land farming.

Many factors may have an influence on the duration of the cycles. In this chapter, we examine the factors that are related directly to highland farming. These factors are the area of highland farms managed by household, the distance between the farmhouse and the plot of highland, the area of the plot surveyed, the number of family members, the income derived from the production of banana leaves and fruits, the income from the production of palm sugar by household, farmer perception in relation to the fertility of the plot, the ownership status, and the type of land use cycle.

Duration of cycle = F(WUH, DIT, WPS, NFM, PBL,IPS, IFT, OWN, TPC1, TPC2, TPC3) (3-1)

In order to examine the influence of these factors on the duration of cycle, we assume the following linear equation parameters:

Duration of cycle: duration of a sequence of land use cycle for the major plot per household (in months).

WUH: Area of highland farm managed by one household (in hectares)

DIT: Distance from the farmhouse surveyed to a plot of highland farm (in minutes, being the time taken by farmers to walk to the plot)

WPS: Area of the plot being surveyed

NFM: Number of family members in the household being surveyed

IBL: Income from banana leaves production by household surveyed during 2001 (in Rupiah)

IPS: Income from palm sugar production by household surveyed during 2001 (in Rupiah)

PFT: Perception of farmers in relation to the fertility of the plot (1: quite fertile, 2: fertile, 3: not fertile)

DMN: Duration of land management after acquisition by respondent (in years)

OWN: Ownership of plots using dummy variables (1: owned by household member, 0: not owned by household member, such as leasehold)

TPC1: Type of stage sequence using dummy variables (1: Both *Talun* and *Huma*, 0: other combination)

TPS2: Type of stage sequence using dummy variables (1: *Huma* in, *Talun* out; 0: other combination)

TPS3: Type of stage sequence using dummy variables (1: *Talun* in, *Huma* out; 0: other combination).

Here we see the correlation coefficient between duration of a cycle of land use with the variants mentioned above. In order to eliminate the effects of common factors, we have calculated the partial correlation coefficients.

The Table 3 shows the results of multiple-regression analysis. We can derive from Table 2 that the factors of distance and income from banana production are significant in order to shorten the cycle. On the other hand, the factors of duration of management after start-up, the area of land managed by one household and fertility have a positive correlation with the duration of one cycle of land use. The longer the duration of management after cultivation has started, the longer the duration of each cycle of land use. The larger the area of the highland farm controlled by one household and the greater the fertility of the land, the longer the duration of the land use cycle.

Table 3, Estimations result of up-land cycle duration measured by up-land faming related variable.

Variable	Regression Coefficient	Significance level with t-values	Partial Correlation coefficient with dependent
Constant	123.4		
area of plot	-8.300	0.640	-0.040
Distance	-0.594	0.001***	-0.273
area of highland plot managed by household	0.149	0.020**	0.199
Number of family Members	-3.349	0.221	-0.105
Banana leaves income	-8.921E-06	0.008*	-0.225
Palm sugar income	1.430 E-6	0.512	0.057
Fertility	-22.253	0.037**	0.199
Term after acquisition	2.465	0.000***	0.397
Ownership	4.302	0.766	0.026
Type of cycle1	31.165	0.025**	0.191
Type of cycle 2	6.703	0.619	0.043
Type of cycle 3	95.339	0.000***	0.329

Adjusted R^2 =0.471

Note:*** significance level=1%, ** significance level=5%, * significance level=10%

Based on those data, we can say that the spread of banana trees for their leaves will shorten the duration of the cycle, because banana leave production has increased drastically over these years [Mizuno et al. 2000].

People tend to lengthen the duration of land use cycles when they hold the land for longer periods. This tendency may be related to the factor of land use type. With dummy variables of land use type, we can say that land use including the *Talun* stage, but excluding the *Huma* stage has a significant effect on the duration of land use. Land use type including both *Talun* and *Huma* also has a positive effect on the duration of a cycle.

The results of the distance and fertility factors indicate that the shorter the distance, the longer the duration of one cycle, and the more fertile the land, the shorter the duration of the cycle.

Factor of land ownership has no significant relation with the duration of one cycle in this calculation. However, considering the importance of gender access to land, that is access to land is different between women and men as we discussed above, we examine the influence of ownership on the duration of cycle with women's access to land. With the same equation with (3-1), we displace variable of women's ownership on land with household ownership on land. Dummy variable was used, 1: wife ownership, or wife kinship ownership, 0: other than 1. Results of

estimation said that variable of women's ownership had regression coefficient of 13.638, significant coefficient of t-value of 0.283, and partial correlation coefficient of 0.092[v]. This variable is not statistically significant enough, but somewhat more significant than the variable of household ownership. This variable says women's access to land have somewhat influenced on prolonging the duration of the cycle, means positive effect on sustainability of up-land agriculture.

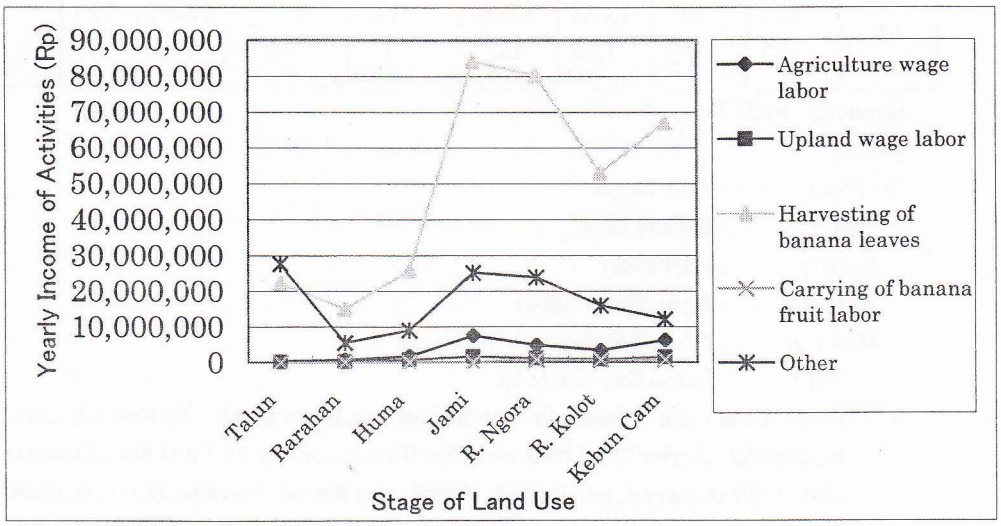
4. Economic activities at Kamang Village and factors influencing duration of cycle.

4.1 Agricultural sector

Economic activities and employment opportunities in the agricultural sector are closely related to highland farming. The highland farming stages give rise to give variations in those activities.

Chart 4 shows the income earned by farm labourers in relation to highland farming stages. At the time of *Jami* and *Reuma Ngora*-stages, farm labourers are in peak demand both for highland farming and wet rice farming.

Chart 4. Various agricultural wage labor according to the up-land farming stage



(Source: Field Survey)

Income from various activities in the agricultural sector varies according to the strata.

Table 4 shows the income composition of surveyed households according to the strata. Incomes from wet rice farming, agricultural labour, palm sugar and banana leaf production have a close relationship with the household strata. The upper strata have a higher proportion of income towards total household income generated by rice farming and banana leaf production. On the contrary, agricultural labour and palm sugar production generate a higher percentage towards total

household income.

Table 4, Household Income per economic Activities according to Strata (2001)

Strata	Rice Farm	Upland Farm			Hsbdry.	Agr.Lab.	Non.Agr	L.O/S.I	Total
			PlmS	BnnLf					
A 13	1,757 9.2	4,379 23.0	879 4.6	2,757 14.5	75 0,4	23 0.1	12,642 66.4	152 0.8	19,028 100
B 19	622 4.9	3,083 24.4	1,324 10.5	1,267 10.0	515 4.1	321 2.5	7,611 60.2	486 3.8	12,638 100
C 18	117 2.6	3,618 79.1	1,683 36.8	1,070 23.4	-3 -0.1	172 3.8	629 13.7	43 0.9	4,576 100
D 11	53 1.4	1,074 29.2	1,038 28.2	-361 -9.8	-5 -0.1	2,273 61.8	283 7.7	0 0	3,678 100
Total 61	612 5.9	3,155 30.6	1,288 12.5	1,260 12.2	175 1.7	566 5.5	5,610 54.4	196 1.9	10,314 100

(Source; Field Survey)

(Note)

(1) PlmS : Palm Sugar
BnnLf : Banana Leaf
Hsbdry : Husbandry
Agr.Lab : Agricultural Labor
Non.Agr : Non Agriculture
L.O/S.I : Lease Out/ Share In

(2) Strata codes are based on scoring of socio-economic factors of surveyed households. Agricultural land was classified according to the status of ownership, that is either owned, mortgaged, shared, and leased. Farmhouses were classified into 4 groups according to the types of roof, walls, and floors. Occupations were classified into 4 groups. According to these classifications, scores were given to each status, type, and group. Strata of households were decided according to the scores given to each household. For further explanations, refer to (Mugniesyah et al, 2001)

. There is a social production relationship between land owners and the lower stratum (often landless people) who harvest the palm tree liqueur – tapping of *aren* liqueur—as well as the banana leafs, depending on the location of the land; and, in the case of palm sugar, it depends on whether the owner produces palm sugar or not. In terms of income share, in case the land is located close to the settlement, the

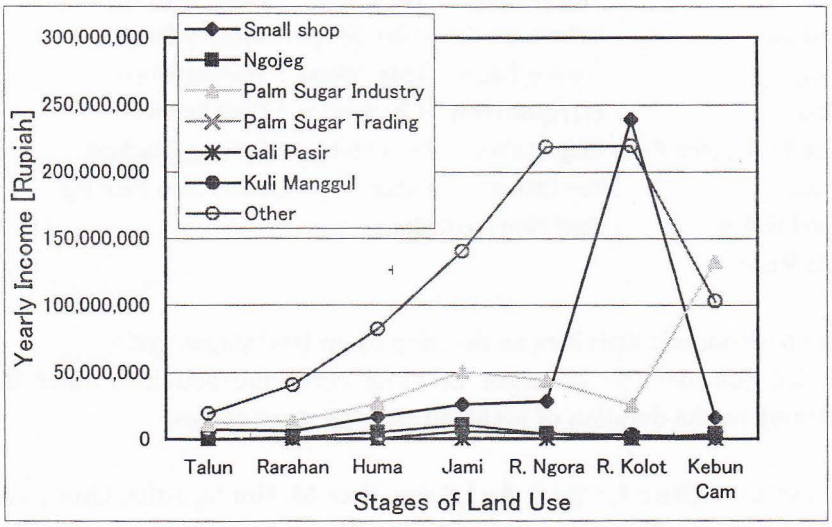
income share is equal (each is 50 percent), and, in the case of land that is more remote, it is split one third for the owner and two thirds for the harvester, both for the palm sugar and banana leaves (Mugniesyah et al, 1999). This means that this social production relationship also contributes to the cultivation of remote agricultural lands so that wider area of land will be more evenly made use of.

4.2 Non -agricultural sector

The non-agricultural sector plays an important role in the economy. 54.4% of total income amongst the surveyed households came from the non-agricultural sector. Table 3 clearly shows that the higher the household strata, the larger the percentage of non-agricultural sector income towards total household income.

Chart 5 shows the variations of non-agricultural economic activities in relation to the stages of highland farming. The unit used is the income earned by each activities in the non-agricultural sector. At the stage of *Reuma Ngora*, *Reuma Kolot* and *Kebun Campuran*, the economic activities of surveyed households are quite important amongst the various economic activities of the non-agricultural sector.

Chart. 5 Income of various kinds of non-agricultural activities according to the stages of up-land farming



(Source: Field Survey)

Table 5 shows the composition of the income derived from the non-agricultural sector by the surveyed households. Rice milling, grocery stores, civil service, timber trading and the renting out of machinery have a clear relationship with the strata, and the higher strata derive a greater percentage of

income from these activities towards total household income

Table 5, Composition of Household Non Agricultural Income,

(Unit: Rp. 1000, %)

Strata	Rc Mill	Ho. Indstr	Artsn	Grsr. Shop	Trde Sgr	Trdg. Wood	Trans	Pub. Wkng	Non FWG	Own Mchn	Rmtnc	Other	Total N.Agr
A	554	0	25	2,945	0	462	0	5,086	0	3,085	323	162	12,642
13	2.9	0	0.1	15.5	0	2.4	0	26.7	0	16.2	1.7	0.9	66.4
B	164	27	53	2,021	1,074	505	707	706	5	1,471	611	267	7,611
19	1.3	0.2	0.4	16.0	8.5	4.0	5.6	5.6	0.0	11.6	4.8	2.1	60.2
C	0	0	43	187	0	23	0	0	0	0	54	322	629
18	0	0	0.9	4.1	0	0.5	0	0	0	0	1.2	7.0	13.7
D	0	64	0	0	0	0	0	218	0	0	0	1	283
11	0	1.7	0	0	0	0	0	5.9	0	0	0	0.0	7.7
Total	169	20	34	1,312	334	263	220	1,343	2	1,115	275	523	5,610
61	1.6	0.2	0.3	12.7	3.2	2.5	2.1	13.0	0.0	10.8	2.7	5.1	54.4

Note: Rc Mill : Rice Milling, Ho. Indstr : Home Industry
Artisan : Artisan Grsr. Shop : Grosary Shop
Trdg Sgr : Trading Sugar Trdg. Wood : Trading Wood
Trans : Transportation Civ Service : Civil Service
Non FWG: Non Farm Wage Labor Own Mchn : Owning Machine
Rmtnc : Remittance Other : Other Non Farming
Total N.Agr : Total Non Agriculture

(Source) Field Work

4.3 Influence of economic activities on duration of up-land stages cycle.

Here, we consider the influence of those economic activities other than highland farming on the duration of highland farming stage cycles.

Duration of cycle = G(Rice f, Up-l f, Ag l, Leso, Rice M, Hm In, Artis, Gros., Trad. T, Trsnsp., Cvl s, Ren M, Rmt, Othr)

Here *Rice f.* means wet rice farming, *Up-f* means highland farming, *Ag l* means agricultural labour, *Leso* means income from the leasing out/sharing out of agricultural land, *Rice M* means rice milling, *Hm In* means home industry, *Artis* means artifacts production, *Gros* means grocery store management, *Trad T* means timber trading, *Trnsp* means transportation, *Cvl s* means civil service, *Ren M* means

income from remittances, and *Othr* means income other than income from agriculture. Each type of income was estimated for each household. Partial correlation coefficients to dependents were also measured.

Multiple regression results show that only wet rice farming and rice milling activities have statistically significant coefficients Wet rice farming leads to a regression coefficient of 1.385 E-5, and is 5% significant with the t-result. Rice milling management has a regression coefficient of 4.539 E-5, and is 1% significant. Wet rice farming has a partial correlation coefficient of 0.255. Rice milling has a partial correlation coefficient of 0.401. Adjusted R^2 was 0.366.

Based on these results, we can conclude that the greater the income from wet rice farming, the longer the duration of the highland farming cycle. In the field, we got the information that people make use of the income from wet-rice farming to buy inputs for dry up-land farming. These practices may have shortened the duration of a cycle, however wet-rice farming has a positive effect on lengthening the duration of the highland stage cycle..

5. Conclusions

We have studied the sustainability of highland agriculture by examining the duration of the cycles of highland land use stages. Excessively intense exploitation will lead to a shortening of the duration, in such a way that land fertility will decrease.

Firstly, we have estimated the regression coefficients and the partial correlation coefficients of many factors in relation to the production of highland farms.

We have examined the factors that are directly related to highland farming. From the estimations based on the data compiled by our field team, the length of time following the acquisition of land has a positive effect on lengthening the duration. The area of highland farms managed or controlled by the surveyed households also is positively correlated to a lengthening of the duration. On the other hand, income form banana leaf production was correlated to a shortening of the duration of the cycle.

The selection of the stages of highland farming is also closely correlated to the duration of the cycle. When *Talun* was applied, whereas *Huma* was not, the duration was increased. When both *Talun* and *Huma* were applied, there was also a correlation with to a lengthening of the duration. The longer people controlled the land, the more sustainable the use of it.

Women's access to land may have positive effect to lengthen the duration of a cycle. Estimated data shows some correlation between the lengthening the duration and women's access to land, however the correlation was not so clear.

Secondly, we examined the factors of the various economic activities, both in the agricultural sector and the non-agricultural sectors. Estimates indicated that wet

rice farming was positively correlated to prolonged cycles. On the other hand, most economic activities have a weak correlation or no relation with the duration of the cycle. We can say that the selection of the stages and the duration of each stage do not easily change according to the income and employment opportunities in many sectors or economic activities, or according to the level of income. This phenomenon could have a positive effect on sustainability, because we can assume that the traditionally established system of highland farming is not drastically changing at present, except the factor of banana leaf planting, which is spreading rapidly.

Note

[i] Stevenson and Lee (2001) discussed many definition of sustainable agriculture. For example, sustainable agriculture is defined as the use of farming practices which maintain or improve economic viability of agricultural production, natural resource base, and environment, which is influenced by agriculture activities. In addition to these definition, they refer to the ability of an agricultural system to maintain production through time, in the face of long-term ecological constraints and socio-economic pressures. Sajise (1997) emphasized continuing productivity of agriculture while maintaining the resource base and minimizing adverse impact on the resource base

[ii] On gender perspectives to the agricultural sustainability, see for example (Meetje et al. 1996)

[iii] For explanation on *Talun* in West Java, see (Tony et al. 1996)

[iv] For explanation on Reuma in West Java, see (Johan 1992)

[v] In this case, adjusted R2=0.475, means somewhat more than the case of estimation using the variable of household ownership.

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