

## CHAPTER IV

### SUPPORTING DATA FOR THE MODEL

#### IV.1. DATA COLLECTION

The data which are used in creating and analyzing the Baduy shifting cultivation model is derived from the data that has been collected during an intensive case study in 1985/1986 (Iskandar, 1985). Secondary data are also obtained from statistical data and literature. Data available are for population, production and consumption, farming systems, and land use systems. Farming system data consist of crop species, crop production, cropping calendar and land rental. These data have been compiled and use to construct the model. Any missing data have also be estimated using sources of data from other countries and using expert-opinion. These data can also be verified by further research and experiments.

The following section outlines in more details the information on the Baduy society as the basis for data used in the model.

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## IV.2. THE BADUY SOCIETY

### IV.2.1. GEOGRAPHY

The study area is located in Baduy area province of West Java. It is situated in latitude  $6^{\circ}27'27'' - 6^{\circ}30' N$  and longitude  $106^{\circ}3'9'' - 106^{\circ}4'55'' E$ . The area is in a remote place about 37 km from the capital of regency, Rangkasbitung. Because of the area's isolation and since the Baduy people try to maintain their culture, until the present, cultural and agricultural systems are still highly traditional.

The most important river of this area is the Ciujung. It runs from the hilly forest area of inner Baduy, downstream to the regency, and eventually flows out into the North Java Sea.

The river has many functions, such as for irrigation, fishing, bathing, washing, and traditional transportation in the downstream areas.

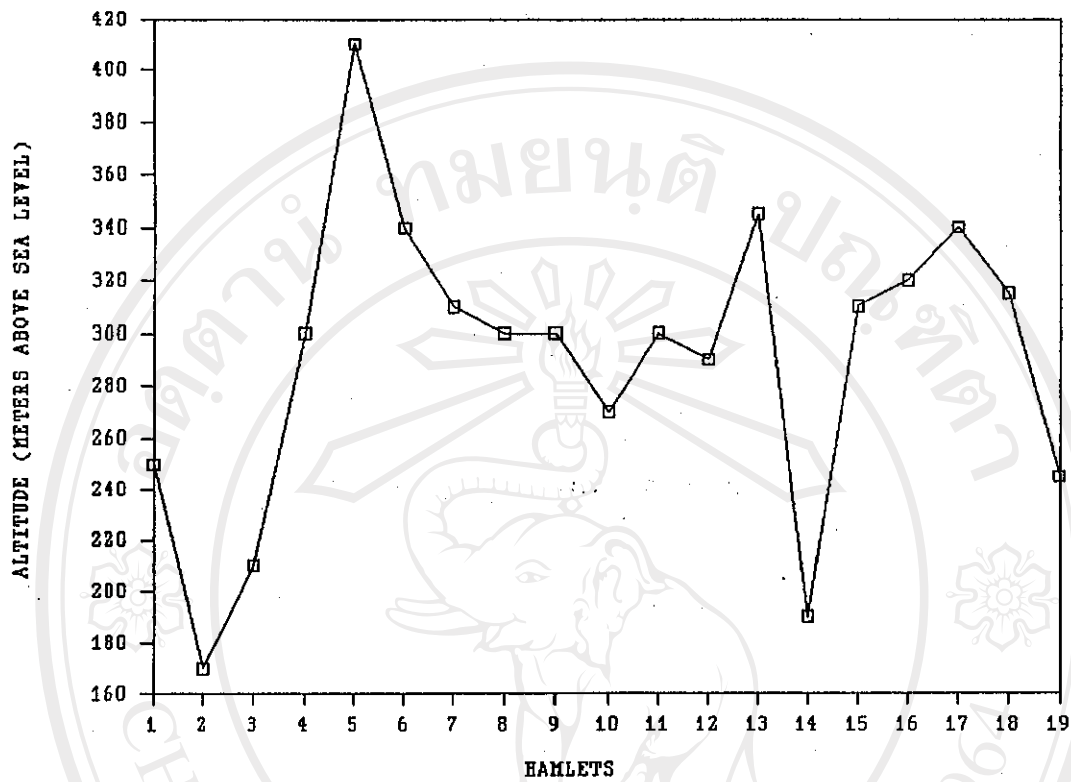
Most hamlets in Baduy are located along the river, and houses are of traditional style. The houses are built of bamboo and wood, with their roofs made of sago palm leaves (Metroxylon sagu) mixed with sugar palm fiber (Arenga pinnata). Houses are grouped in hamlets, usually located in flat areas near water resources or the river. Agricultural field are situated out side of settlement area.

#### IV.2.2. ALTITUDE

The Baduy area consists of moderately steep to very steep low hills and mountains, and forms a ridge-and valley complex. Based on direct measurement in the field on 19 locations or hamlets, the elevation ranges from 170 m to 410 m above sea level, with hill summits typically more than 50 m above the associated valley floors (Figure 6) (Purnomohadi, 1985).



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- |              |                 |
|--------------|-----------------|
| 1 Kaduketug  | 11 Cikartawarna |
| 2 Gajeboh    | 12 Cibeo        |
| 3 Ckl Hilir  | 13 Cisaban      |
| 4 Cipaler    | 14 Cinangseuri  |
| 5 Ckl Girang | 15 Sorokokod    |
| 6 Cipiit     | 16 Kaduketer    |
| 7 Ciranji    | 17 Karahkal     |
| 8 Cijahe     | 18 Kd.jangkung  |
| 9 Cikeusik   | 19 Bbk.Cipondok |
| 10 Cisadane  |                 |

Figure 6 Average altitude of Baduy area.

#### IV.2.3. SOIL TYPE

The soil type of the Baduy area is mainly brown latosol. Top soil is sandy loam or sandy clay, of high erodibility. Top soil in some places has been badly eroded (Purnomohadi, 1985).

#### IV.2.4. RAINFALL

The area has a tropical climate of two main seasons, the dry season during April-October, and the wet season, during October-April. The average annual rainfall is 3440 mm, ranging from 1848 mm to 4590 mm (The Institute Of Meteorology and Geophysics, 1968-1980). On average the wettest month is January (523 mm) and the driest month is July (102 mm) (Figure 7).

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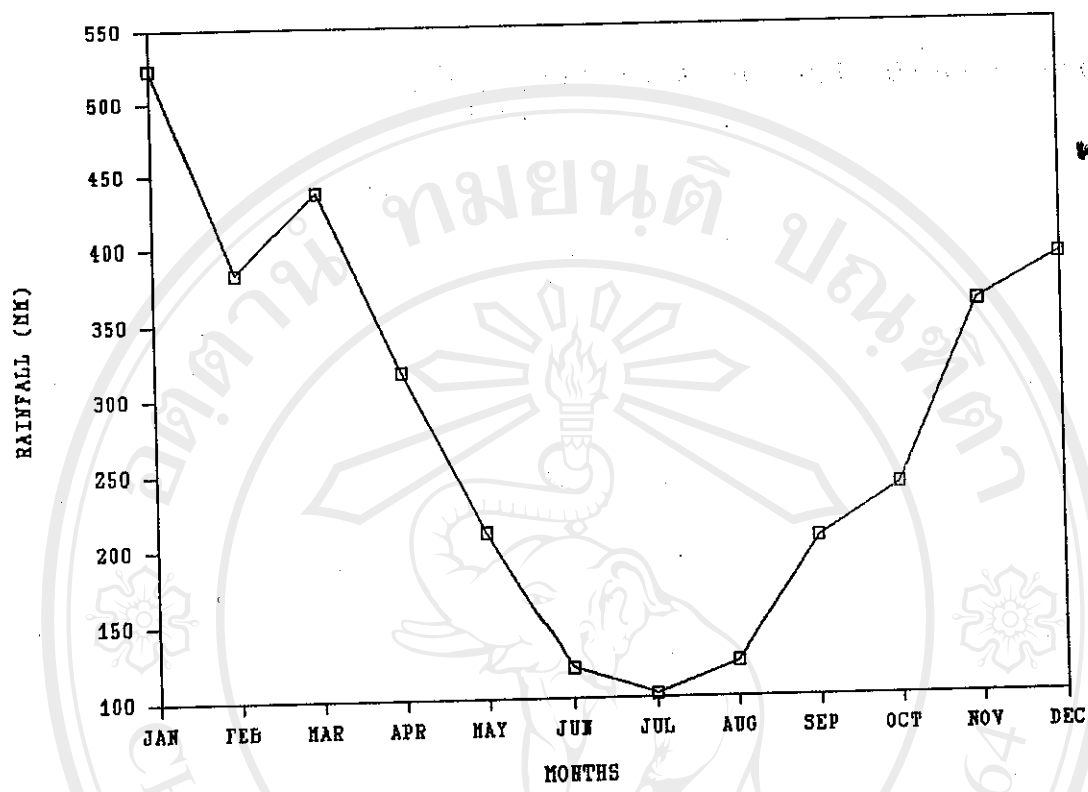


Figure 7 Average rainfall in Baduy and adjacent area in 1960-1980.

#### IV.2.5. ADMINISTRATION

The settlement of Baduy has been increased over time. In the eighteenth century the border areas were declared by the King Jusuf of Islam Kingdom at Banten (Garna, 1987).

According to the declaration, the Baduy area was divided into three regions, the area inside Baduy itself which is called "conservation area" (tanah titipan) or inner Baduy (Baduy dalam) and outer Baduy surrounding inner Baduy. The "dangka area" is located both in non-Baduy area and in outer-Baduy. According to Van Trich (Garna, 1987) in the beginning of the twentieth century Baduy area consisted in inner Baduy of 3, outer Baduy of 23, and dangka area of 9 hamlets, with 2 and 7 hamlets in Baduy area and non Baduy area, respectively. Meanwhile, between 1938-1941 and 1972 the Baduy area was recorded to have 34 and 39 hamlets, respectively. In 1985 the Baduy area had 40 hamlets, mainly consisting of inner and outer Baduy, while dangka area in non Baduy had been abandoned because of population pressure of non-Baduy people. The borders between inner Baduy and outer Baduy are not clearly marked. Borders are marked only by natural features, such as rivers. However, the border between the Baduy and non Baduy areas are clearly marked, with permanent border markers built in 1986 by government. The main purpose of making permanent borders is to prevent conflict between Baduy people and non Baduy people, which usually occurs.

Administratively, the Baduy area belongs to the village (desa) of Kanekes, district (kecamatan) of Leuwidamar, regency (kabupaten) of Lebak, residency (kresidenan) of

Banten, province (province) of West Java, Indonesia (Figure 1).

The formal administration is organized by a formal leader or head of village (jaro) and his staff (pangiwa), who reside in outer Baduy. While non-formal organization in the community is organized by an informal leader (puun) and his staff (barisan kolot), who reside in inner Baduy.

#### IV.2.6. PEOPLE AND POPULATION

According to Pleyte (1905) Baduy society is composed of a group originally people of Hindu Padjadjaran, in West Java. In the sixteenth century, the Kingdom of Hindu Padjadjaran was shattered by King of Jusuf, Islam Kingdom of Banten, West Java. Accordingly, some people of Padjadjaran Kingdom move into the mountains and settled in isolated forests of Banten, West Java. They continued to practice their livelihood and tried to keep harmony with nature.

The Baduy society can divided into two groups, the inner Baduy (Baduy dalam) and outer Baduy (Baduy luar). Characteristically, the inner Baduy people are more traditional than outer Baduy people.

The population of Baduy has been noted since long time ago. According to Penning (Garna, 1987), the Baduy population in 1888 was 1,476 people settled in 27 hamlets. Thereafter, in 1908, 1928, 1966, 1969, 1980, 1983, 1984 and



1986 the population of Baduy was recorded to be 1,547, 1,521, 3,935, 4,063, 4,057, 4,574, 4,587 and 4,850, respectively (Table 8). The population is dominated by outer Baduy people who comprise 80 per cent of the total, with only 20 per cent of the total population from inner Baduy.

Annual population growth increased from 0.23 % in 1888-1908 to 2.50 per cent, 4.00 per cent and 2.75 per cent in 1928-1966, 1980-1983 and 1984-1986, respectively. The population growth, however, decreased to -0.08 per cent and -0.01 per cent in 1908-1928 and 1969-1980, respectively. This phenomena was interesting and has been discussed by Van Trich. However, appropriate answers could not be found. Van Trich has assumed that decrease in population growth in Baduy may be caused by close intermarriage among the people (Garna, 1987).

Table 8 Population of Baduy in 1888 to 1986

Year (year)	Time (year)	Population (people)	Change of number (people)	Growth (r)
1888-1908	20	1476-1547	71	0.23
1908-1928	20	1547-1521	-26	-0.08
1928-1966	38	1521-3935	2414	2.50
1966-1969	3	3935-4063	128	1.07
1969-1980	11	4063-4057	524	-0.01
1980-1983	3	4057-4574	517	4.00
1983-1984	1	4574-4587	13	0.28
1984-1986	2	4587-4850	263	2.79
1888-1986	98	1476-4850	3374	1.21

Source: Garna, J. 1987. Baduy People (Indonesian).  
Selangor: University Kebangsaan Malaysia Press.

#### IV.2.7. RELIGION

The Baduy society has a special religion, which is called "Sunda Wiwitan" or "Sunda Asli" (original Sundanese). According to Kruseman (Garna, 1987) Sunda Wiwitan is principally Buddhism influenced by Hinduism and Islam. According to their religion, Baduy people believe that their god is mono supernatural (batara tunggal). They believe that their god is the only true god (Lee, 1976). Based on their religion and their culture, they have traditional law (adat) and taboo. In their livelihood, they try to keep harmony with nature. Therefore, the Baduy society is one of the most puritanical in terms of its ethnic of making peace with nature.

#### IV.2.8. SUBSISTENCE OF THE PEOPLE

Shifting cultivation is the main source for subsistence of Baduy society. Other activities, such as making handicraft, patronage and labor serve supplementary sources. The practice of shifting cultivation is considered one of their religious obligations. Accordingly, the practice of shifting cultivation has been integrated in the socio-economic aspect and culture of their society.

The Baduy area has known three known kinds of shifting cultivation, namely upland rice field or ladang owned by

informal leader (huma or ladang puun), upland rice field owned by communally (huma serang), and upland rice field owned by each household both of inner and outer Baduy people (huma masyarakat umum). Ladang puun and ladang serang are only found in inner Baduy. However, the ladang masyarakat umum are found both in inner and outer Baduy. Even outer Baduy people have practiced shifting cultivation in non-Baduy or neighboring areas.

#### IV.2.9. LAND USE AND CROPPING SYSTEMS

In general, land use systems in Baduy can be divided into three zonations (Figure 8).

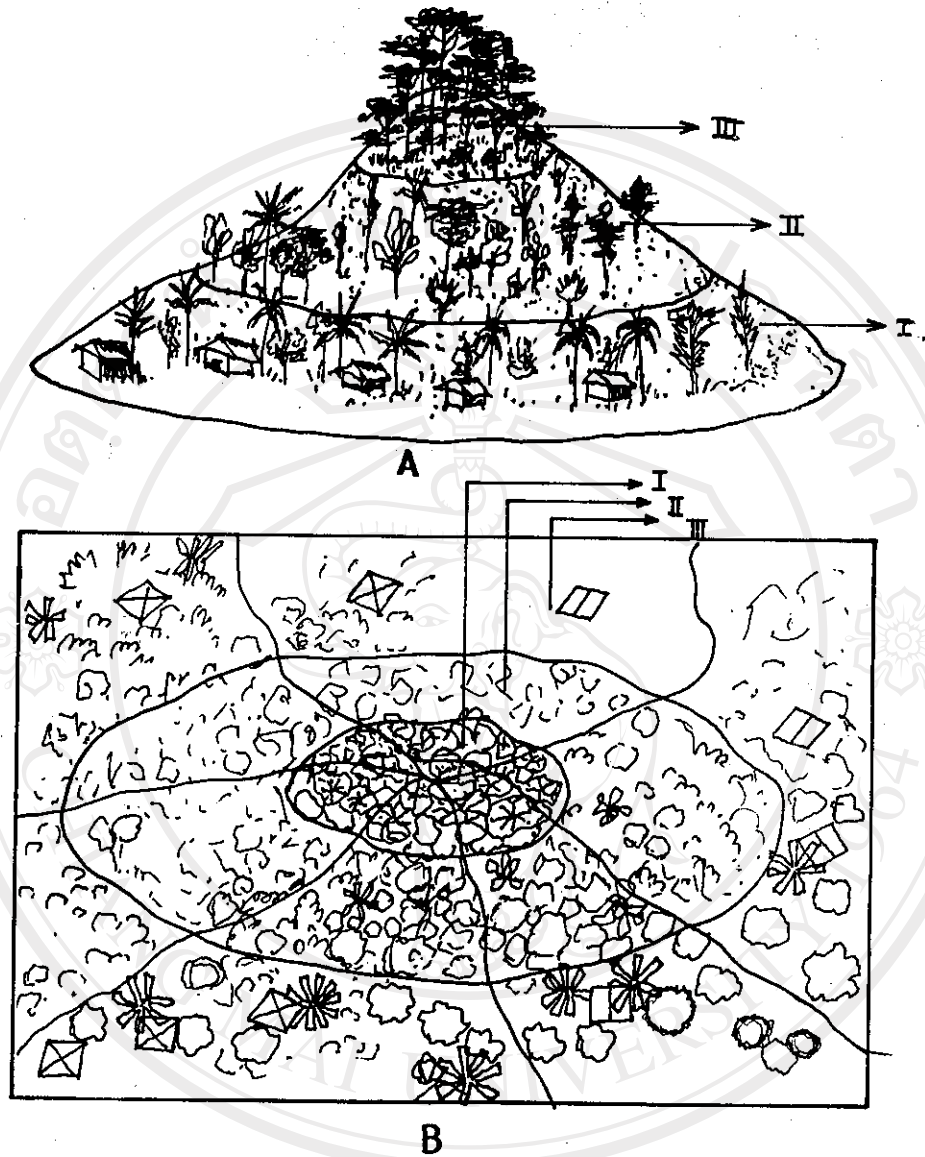
The first zonation is flat area, near water resources, mainly used for settlement. It is surrounded by man-made forest which is usually called village forest (hutan kampung). In the settlement area, traditional houses of Baduy area are usually found. In the village forest many species of plants are found. About 70 species of plants have been recorded in the village forest, which is dominated by fruits, building materials, fire woods and cash crops, such as durian (Durio zibethinus), sugar palm (Arenga pinnata), coconut (Cocos nucifera) and bamboo (Bambusa sp).

The second zonation is located in the upper part of the settlement area on hill sides. These have as the main purpose intensive rice cultivation or cultivation of other

annual crops. This land is usually called upland rice field (ladang). In ladang, piece of land can be developed into monoculture garden (kebun) or mixed-garden (kebun campuran). After harvesting rice, the field will be planted with non rice crops in monoculture or mixed annual and perennial crops.

Ladang has been recorded to have about 44 species of plants, dominated by annual plants such as rice (Oriza sativa), pigeon pea (Cajanus cajan) and cucumber (Cucumis sativus).

In the second zonation, overlapping with ladang, are found monoculture gardens (kebun), mixed gardens (kebun campuran) and secondary forest (reuma). The garden is usually dominated by annual plants such as cassava (Manihot esculenta) and sweet potato (Ipomoea batatas). While mixed garden it is usually planted with mixed annual and perennial plants, such as banana (Musa paradisiaca), coffee (Coffea canephora) and mango (Mangifera indica). The secondary forest (reuma) is a fallow land area abandoned after harvesting rice. In secondary forest, about 57 species of plants have been recorded consisting of mixtures of wild, semi wild and domesticated plants. Fruits, building materials and fire wood are usually found in this land use, which is dominated by mango (Mangifera indica), house mango (Mangifera foetida), albasiah (Albizia falcataria), petai (Parkia speciosa) and ki seureuh (Piper aduncum).



A=vertical; B=horizontal ; III=third zonation: protected forest area; II=second zonation: ladang, reuma, mono culture garden, and mixed garden area; I=first zonation: man-made forest and settlement area.

Figure 8 Zonation system in Baduy area, West Java, Indonesia.

Accordingly, in secondary forest, although the land is abandoned after harvesting rice and other annual crops, it still provides benefits to the owner. For example, it has provides income to the people.

The third zonation is located on top of the hills. The main purpose is for natural reserves. This land use type is usually called forest protection (hutan titipan) or mature forest (hutan tua).

Shifting cultivation is usually intensively practiced in the second zonation, however, the first and the third zonation are never opened for planting rice. Hence, vegetative complexity including mostly perennial plants which is very important in conserving land and water resources is usually found in this area. Even, the first zonation, man-made forest, serves an economic function, cropped with fruits and industrial plants.

The dynamic changes in land use are determined by changing cropping systems. For example, with the increasing introduction of more economic perennial crops such as clove in outer Baduy, the shifting cultivation area and fallow forest area are reduced.

The practice of shifting cultivation varies from place to place, but the general pattern is basically the same, i.e, site selection, clearing and burning, cropping and fallowing.

Site selection (narawas) marks the beginning of the cultivation cycle. Several considerations determine whether the area is chosen as the same piece of land after harvesting rice, secondary forest (reuma) or area in non-Baduy. Predicted soil fertility is the primary concern. Land productivity is a function of both amount of biomass and inherent soil properties. Generally, Baduy people have several ways of recognizing soil fertility, using various indicators of soil fertility, vegetation and topography i.e. location in flat area. A piece of land is considered good for shifting cultivation, if the soil has black color with high content of humus. Some plants are considered indicators of fertile soil, such as ki seureuh (Fiper aduncum) and marselan (Macaranga sp).

In preparing upland rice fields (ladang), a piece of land is cleared. The shrubs are cut totally, however, woody plants and economic plants, such as fruits, are only pruned. Branch and stem of wood are collected for fire wood. Other biomass is burned to supplement nutrients to crops. The piece of land then prepared for planting rice and other annual crops. Cultivating rice mixed with annual crops on a piece of land is usually done for only one or two years before being fallowed. This depends on soil fertility. After harvesting rice and other annual crops, the land is abandoned and developed into secondary forest (reuma) by natural succession. The fallow secondary forest can be

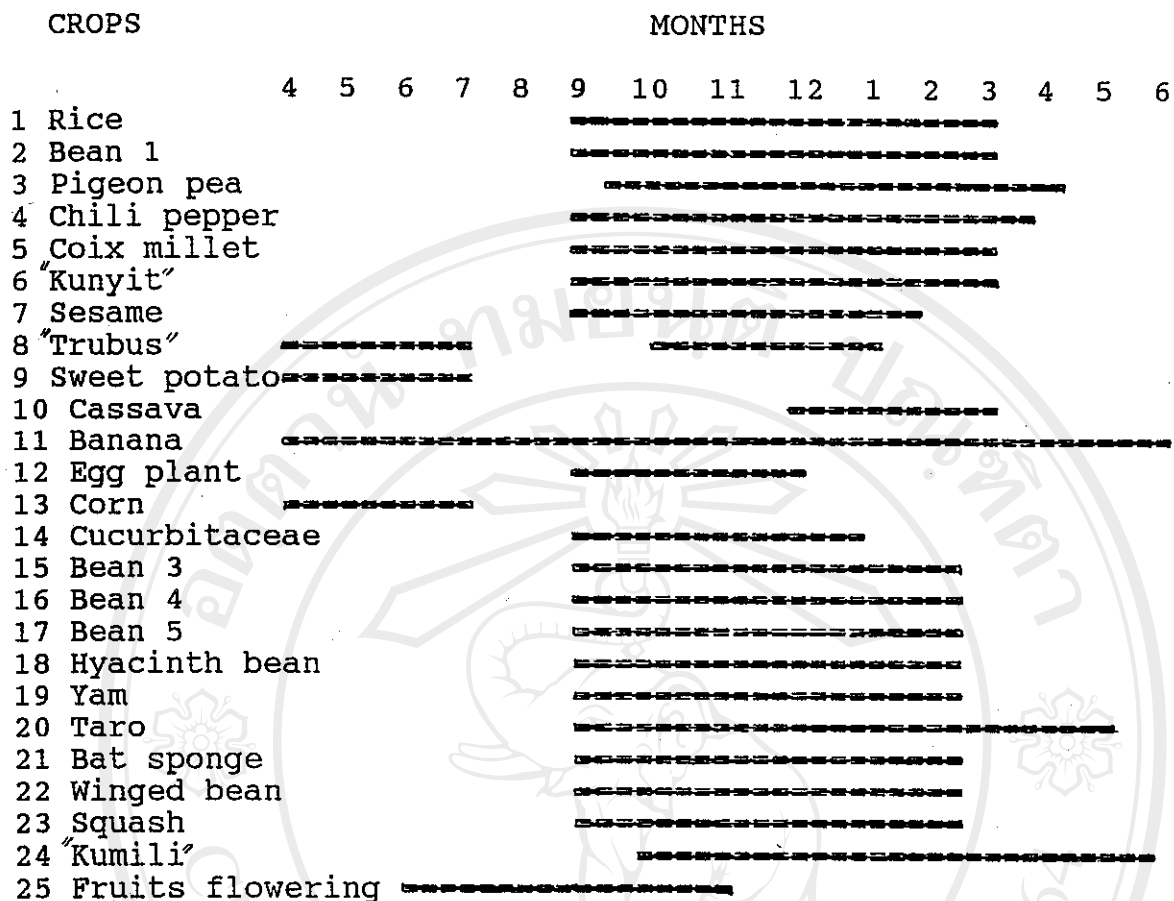
opened for planting rice in the next year or abandoned for more than two years. The people will then shift to another piece of forest land and do the same procedures, cutting and pruning, burning, weeding and harvesting. The site selection, clearing and burning, of forest for a plot of upland rice in Baduy is usually done during the dry season, March/April to July/August. Rice planting is done early in the rainy season in September/October with harvesting in the late rainy season in February/ March (Iskandar, 1985). Figure 7 shows the pattern of rainfall. The critical periods are the relatively dry spell around June-August, which enable the cut vegetation to dry out, and wetter period about September, which facilitates crop establishment. The aim of the farmer is to fire the farm and begin planting just before the onset of the rains. If he fires and plants too early, germination and seedling establishment will be poor. If he fires too late there will be poor burn and hence a reduction in the availability of nutrients for crop growth (Cramb, 1985). Meanwhile, according to Terry Rambo (1984) at least six major beneficial effect of burning: 1) clearance of unwanted vegetation from the field, 2) alteration of soil structure making planting easier, 3) enhancement of soil fertility by plant ashes, 4) decrease in soil acidity, 5) increase in availability of soil nutrient, and 6) sterilization of soil and reduction of microbial, insect, and weed populations.



Upland fields have more than 25 main species of crops. A cropping calendar is presented in Figure 9. Based on the cropping calendar, the farmer can harvest from wide variety of crops almost every month. He gets products throughout the year. Additionally, having high diversity of crops in agricultural land has an important role in reducing pest damage as well as protecting the land against erosion.

The development of land use systems in Baduy area is from upland rice field or ladang into monoculture garden or kebun, and mixed garden or kebun campuran, if the other annual or perennial plant crops are cultivated after harvesting rice. Eventually the land can be developed into a settlement or hamlet (kampung) and village forest (hutan kampung), if home constructed (Figure 10).

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Source: Case Study (1985/1986)

Figure 9 Cropping calendar of Baduy's shifting cultivation of West Java, Indonesia

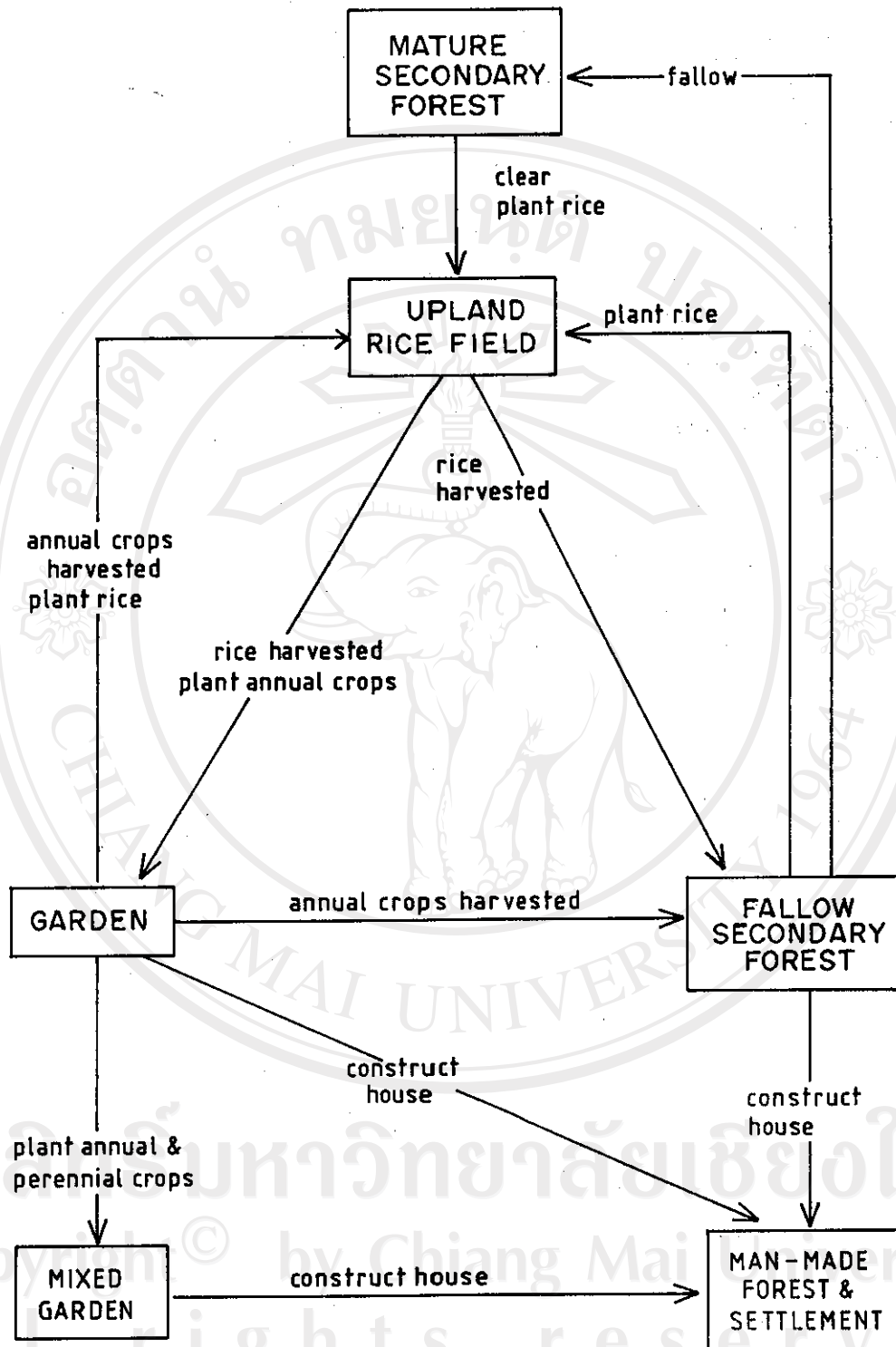


Figure 10 Development land use system in Baduy, West Java.

### **IV.3. DATA USED IN THE MODEL**

The main data used in Baduy's shifting cultivation model are demography, land use system, agricultural production and consumption.

#### **IV.3.1. DEMOGRAPHY**

Demography data mainly consists of the number of Baduy population in 1888-1986, the crude death rate and the crude birth rate which is based on the ratio of the total registered death and birth rate in 1984/1985, to total population. A more detailed demography data of Baduy is presented in Table 8 and Table 12.

#### **IV.3.2. LAND USE SYSTEM**

Based on the analysis of LANDSAT imagery (remote sensing) in 1984, the total area of Baduy is about 5,102 hectares (0.5 per cent), permanent forest land of 2,420 hectares (49 per cent), agricultural land of 709 hectares (14 per cent), and fallowed agricultural land of 1,0876 hectares (37 per cent) (Purnomohadi, 1985). However, in this analysis mixed garden and monogarden can not be separated. Based on my field survey in 1985/1986, the LANDSAT imaginary data can be modified into 6 land use types, i.e, mature

forest, secondary forest (reuma), upland field rice (ladang), monoculture garden (kebun), mixed-garden (kebun campuran) and man-made forest (hutan kampung) (Table 9).

Table 9 Land use type in Baduy, West Java

Land use type	Acreege (ha)	Percent to total (%)
1 Settlement area & man-made forest	78	1.5
2 Upland rice field ( <u>ladang</u> )	669	13.1
3 Monoculture garden ( <u>kebun</u> )	669	13.1
4 Mixed-garden ( <u>kebun campuran</u> )	50	0.9
5 Fallow land ( <u>reuma</u> )	1154	14.0
6 Mature forest ( <u>hutan tua</u> )	2482	22.6
TOTAL AREA	5102	100.0

Source: Field Survey (1985/1986)

#### IV.3.3. AGRICULTURAL PRODUCTION

The main production data are outputs from each type of agricultural land i.e, upland rice field (ladang), secondary forest (reuma), monogarden (kebun), mixed-garden (kebun campuran), and man-made forest (hutan kampung). Production is interms of monetary unit (rupiah).

Based upon case study 1985/1986, the production of each land use system which is used in as coefficient in the model is Rp 347,000; Rp 412,000; Rp 319,000; Rp 320,000; and

Rp 955,000 for upland rice field (ladang), secondary forest (reuma), monogarden (kebun), mixed-garden (kebun campuran), and man-made forest (hutan kampung), respectively (Table 10)

Table 10 Agricultural production in Baduy

Agroecosystem Type	Area/household (ha)	Production	
		Rp/hh/year	Rp/ha/year
1 Upland rice field ( <u>ladang</u> )	0.8	277,986	347,483
2 Secondary forest ( <u>reuma</u> )	0.8	329,620	412,025
3 Monogarden ( <u>kebun</u> )	0.5	159,363	318,726
4 Mixed-garden( <u>kebun campuran</u> )	0.7	223,924	319,891
5 Man-made forest( <u>hutan kampung</u> )	0.03	47,731	954,620

Source: Case Study (1985/1986)

#### IV.3.4. FOOD CONSUMPTION

Consumption data mainly consists of average quantity of food unit in grams consumed by people in the household. This can also be converted to monetary unit (rupiah).

Based upon case study in 1985/1986, the average food consumption of the household is presented in Table 11.

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Table 11 Average food consumption of Baduy people in a day/household

Nutrient (unit)	Average of food consumption & resources		Total
	Agric.Prod.	Market	
1 Calories (K.Cal)	4,704	357	5,061
Percent to total (%)	93	7	100
2 Protein (Gram)	78	34	112
Percent to total (%)	70	30	100
3 Vitamin A (I.V)	563	271	834
Percent to total (%)	68	32	100
4 Vitamin C (Mgr)	128	3	131
Percent to total (%)	98	2	100
-----			
Total equivalent to money	Rp 636	Rp 143	Rp 799
Total equivalent to rice	3 liters	1 liters	4 liters
Total equivalent to money/yr	Rp 288,000		
Total equivalent to rice/yr	1,440 liters		
=====			

From interviews of the case study, average quantity of consumption converted to money was about Rp 800 per day per household or Rp 288,000 per household per year. Meanwhile, the average quantity of consumption converted to unhusked rice was about 4 liters per day per household or 1,440 liters rice per household per year. The average number of persons in the households of respondents was 3 persons. However, based on survey data of total population, the average number of persons per household in the total population was 5 persons. Accordingly, the average quantity of consumption of the total population was Rp 1,333 per day per household or Rp 479,999 per year or equal to 2,400 liters rice per year. Furthermore, the food consumption is used in the model is Rp 56,000/person/year.

#### IV.4. MODEL INITIALS

The initial values of variables used both in the base runs and alternative runs which are applied in the analysis Baduy's shifting cultivation is presented in Table 12 and Table 13.

Table 12 Initial parameter values used in base run of Baduy's shifting cultivation

SYMBOL	DESCRIPTION	UNIT	VALUE
<b><u>LEVEL</u></b>			
FOD	food	rupiah/year	442,000,000
LDA	ladang area	hectare/year	736
MMFA	man-made forest area	hectare/year	25
MNGDA	monogarden area	hectare/year	107
MXGDA	mixed garden area	hectare/year	50
POP	population	people/year	4,600
RMA1	reuma, fallow time 1 year	hectare/year	76
RMA2	reuma, fallow time 2 years	hectare/year	76
RMA3	reuma, fallow time 3 years	hectare/year	76
RMA4	reuma, fallow time 4 years	hectare/year	1,536
SFRT0	soil fertility after fallow zero years	kg rice/year	950
SFRT1	soil fertility after fallow one year	kg rice/year	1,194
SFRT2	soil fertility after fallow two years	kg rice/year	1,330
SFRT3	soil fertility after fallow three years	kg rice/year	1,520
SFRT4	soil fertility after fallow four years	kg rice/year	1,900
<b><u>AUXILIARY</u></b>			
BRF	birth rate fraction	per cent of population/yr	3.7
DRF	death rate fraction	per cent of population/yr	1.3
MIF	in-migration rate	per cent of population/yr	5
MOF	out-migration	per cent of population/yr	5



## COEFFICIENT

A1	ladang output	rupiah/ha/yr	347,000
A2	reuma1 output	rupiah/ha/yr	412,000
A3	monogarden output	rupiah/ha/yr	319,000
A4	mixed-garden output	rupiah/ha/yr	320,000
A5	man-made forest output	rupiah/ha/yr	955,000
A6	land rent in non Baduy	% of total rice product.	20
A7	ladang area non Baduy	ha/family	0.16
A8	food buying	% of cash come	5
A9	food requirement per person	rupiah/person	56,000
A10	food export	% of total agric.prod.	5
A11	food loss	% of total agric.prod	5
B2	input into reuma1 from ladang area	% of ladang area	50
B3	input into monogarden from ladang area	% of ladang area	49
B4	input into man-made forest from ladang area	% of ladang area	1
B5	input into reuma1 from monogarden area	% of monogarden area	69
B6	input into mixed-garden from monogarden area	% of monogarden area	30
B7	input into man-made forest from monogarden area	% of monogarden area	1
B8	input into man-made forest from mixed-garden area	% of mixed-garden area	1
B9	abandoned settlement area due to transmigration	% of man-made area	0
E1	reduction of reuma3 output due to natural vegetation competition	% of reuma3 output	30
E2	reduction of reuma4 output due to natural vegetation competition	% of reuma4 output	20

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Table 13 Initial parameter value used in alternative runs of Baduy's shifting cultivation

<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>UNIT</u>	<u>VALUE</u>
BRF	birth rate fraction	% of population per year	2
IMXGDA	initial of mixed-garden area	hectare per year	1,586
IMXGDA	initial of mixed-garden area	hectare per year	1,662
MIF	in-migration rate	% of population per year	0
MOF	out-migration rate	% of population per year	0
RMA3	reuma, fallow three years	hectare per year	0
RMA4	reuma, fallow four years	hectare per year	0
SFRT1	increment of soil fertility 1 year	kg rice	1.31*SFRTO
SFRT2	increment of soil fertility 2 years	kg rice	1.25*SFRTO
X1	response in birth rate due to food surplus	per cent of food surplus	0.1
X2	response in in-migration due to food surplus	per cent of food surplus	0.1
X3	response in death rate due to food deficit	per cent of food surplus	0.1
X4	response in out-migration rate	per cent of food surplus	0.1

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