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A SYSTEMS MODEL ANALYSIS OF THE TRANSMIGRANT FAMILY PRODUCTIVITY AND RETURNS

BY

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ABSTRACT

A SYSTEMS MODEL ANALYSIS OF THE TRANSMIGRANT FAMILY PRODUCTIVITY AND RETURNS

By

Kartiko Hari Respati

The capability of a transmigrant family in cultivating their land with different assumed labor, animal , and tractor inputs was studied in this research. A system approach was used for the analysis methodology. A computer model was formulated to simulate different labor and resource inputs to evaluate the working capability of a transmigrant family.

The general objective of this study was to develop a framework for the analysis and evaluation of the optimum area of land that a transmigrant family could effectively cultivate under various conditions and with different inputs. The specific objectives are :

1. Establish a database from available secondary sources of information on manhours required for the cultivation of various crops under various new land conditions.
2. Consider family labor and resources available.
3. Develop a systems model for evaluation of the critical parameters pertaining to optimum land utilization capability of transmigrant families.
4. Evaluate the cost and return data for land preparation with a hand tractor, a bullock, and manual labor.

Conclusions of this study are as follows :

A systems model was developed and tested for the productivity of a transmigrant family which provides the means to study productivity and land utilization under a variety of conditions and with different input resources.

The simulation studies made provide examples of how the systems model might be utilized in the planning of land and resource allocation for transmigrant families.

Based on assumptions made, a transmigrant family of four with no outside laborers could utilize 1.9 ha of land with a crop mix of paddy, beans, and cassava; or a crop mix of corn, beans, and cassava.

Based on assumptions made, a transmigrant family's farm income was Rp 218,914 for a custom-hired bullock, Rp 230,951 for a custom-hired tractor, and Rp 306,831 for a transmigrant family owned a tractor.

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I. INTRODUCTION

1.1. The country

Indonesia is the world's largest archipelago. The Republic of Indonesia is composed of 13,667 islands. More than half of the islands are still unnamed and only seven percent are inhabitated. The archipelago stretches along the Equator between 94°45' and 141°05' East longitude and from 6°08' North to 11°15' South latitude. The land area of Indonesia is about 1.9 million km^2 and the sea area is about 9.9 million km^2. Administratively, Indonesia is divided into 27 provinces with Jakarta as the Capital city (CBS, 1985).

Based on the 1980 Population Census, the projected total population of Indonesia in 1985 was 165 million people. This makes it the fifth most populous country in the world after China, India, USSR, and USA. Sixty-one percent of Indonesia population (100 million) live on the island of Java (table 1.1.) which comprises only 6.9 percent of the total area of Indonesia. The population of density on Java was tabulated at 759 people per km^2 in 1985 (table 1.2.), thus giving evidence to an uneven distribution among islands as well as among provinces. Nearly two thirds of Java's farm families have less than one-half hectare of agricultural land. This is a subsistence size plot and it generates a low income for the farmers. This unevenly distributed population and the fact that most consists small-farm-households obstruct the development in both the inner islands (Java, Bali, and Lombok

MAP OF THE REPUBLIC OF INDONESIA

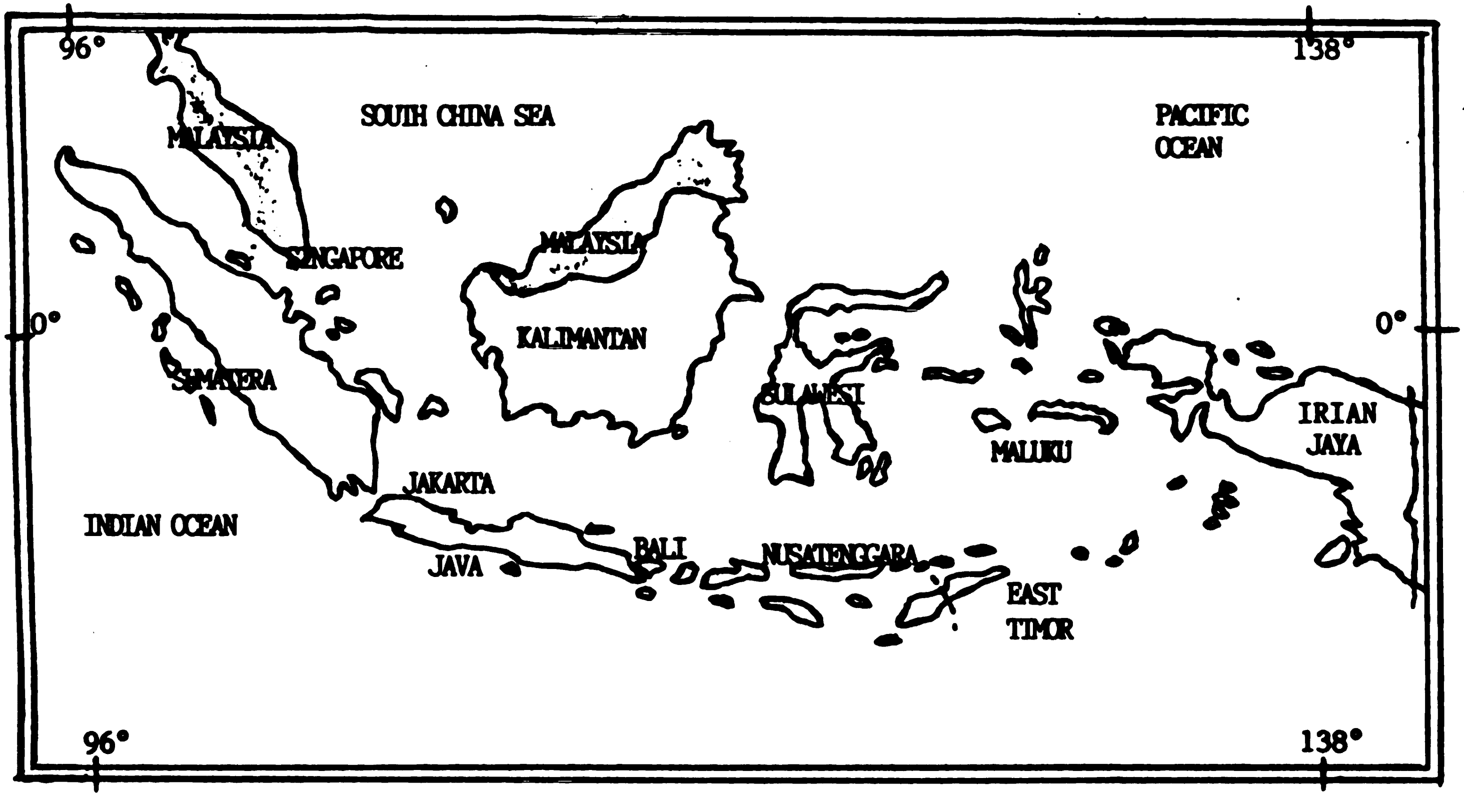

Table 1.1. The Population of Indonesia by Province and Island Based on Data from The Central Bureau of Statistics[a] (Thousands of People)

Province / island	1980	1985[b]	Population %
Aceh	2,611	3,604	1.82
North Sumatera	8,361	9,518	5.76
West Sumatera	3,407	3,695	2.24
Riau	2,169	2,534	1.54
Jambi	1,446	1,741	1.05
South Sumatera	4,630	5,543	3.30
Bengkulu	768	943	0.57
Lampung	4,625	6,033	3.65
Sumatera[c]	28,016	32,992	19.93
Jakarta	6,503	7,890	4.78
West Java	27,454	30,973	18.75
Central Java	25,373	27,145	16.44
Yogyakarta	2,574	2,290	1.81
East Java	29,189	31,281	18.94
Java[c]	97,270	100,279	60.72
Bali	2,470	2,659	1.61
West Nusatenggara	2,725	3,071	1.86
East Nusatenggara	2,737	3,053	1.85
East Timor	555	629	0.38
Nusatenggara[c]	8,457	9,411	5.70
West Kalimantan	2,489	2,837	1,72
Central Kalimantan	954	1,149	0.70
South Kalimantan	2,065	2,306	1.40
East Kalimantan	1,218	1,550	0.93
Kalimantan[c]	6,723	7,842	4.75
North Sulawesi	2,115	2,394	1.45
Central Sulawesi	1,289	1,551	0.94
South Sulawesi	6,062	6,651	4.03
Southeast Sulawesi	942	1,092	0.66
Sulawesi[c]	10,410	11,688	7.08
Maluku	1,411	1,646	0.99
Irian Jaya	1,174	1,368	0.83
Indonesia	147,490	165,155	100.00

a: CBS,1985 b: projected c: island

Table 1.2. Percentage of Area and Population Density in Indonesia by Province / Island[a] (1985[b])

Province / island	Area km²	Area %	Population %	Density people/Km²
Aceh	55,392	2.88	1.82	54
North Sumatera	70,787	3.69	5.76	134
West Sumatera	49,778	2.59	2.24	74
Riau	94,562	4.93	1.54	27
Jambi	44,924	2.34	1.05	39
South Sumatera	103,688	5.4	3.3	53
Bengkulu	21,168	1.1	0.57	45
Lampung	33,307	1.74	3.65	181
Sumatera[c]	473,606	24.67	19.93	70
Jakarta	590	0.03	4.78	1,337
West Java	46,300	0.41	18.75	669
Central Java	34,206	1.78	16.44	794
Yogyakarta	3,169	0.17	1.81	943
East Java	47,922	2.5	18.94	653
Java[c]	132,187	6.89	60.72	759
Bali	5,561	0.29	1.61	478
West Nusatenggara	20,177	1.05	1.86	152
East Nusatenggara	47,876	2.49	1.85	64
East Timor	14,874	0.78	0.38	42
Nusatenggara[c]	88,488	4.61	5.70	106
West Kalimantan	146,760	7.65	1.72	19
Central Kalimantan	152,600	7.95	0.70	8
South Kalimantan	37,660	1.96	1.40	61
East Kalimantan	202,440	10.55	0.93	8
Kalimantan[c]	539,460	28.11	4.75	15
North Sulawesi	19,023	0.99	1.45	126
Central sulawesi	69,726	3.63	0.94	22
South Sulawesi	72,781	3.79	4.03	91
Southeast Sulawesi	27,686	1.44	0.66	39
Sulawesi[c]	189,216	9.85	7.08	62
Maluku	74,505	3.88	0.99	22
Irian Jaya	421,981	21.99	0.83	3
Indonesia	919,443	100.00	100.00	180

a: CBS, 1985
b: Projected
c: Island

of West Nusatenggara province) and the outer islands (islands other than Java, Bali, and Lombok), therefore making transmigration; i.e., the resettlement of people in less densely populated areas, an important program for the Indonesian government in its quest for a more equitable distribution of land.

1.2. Transmigration

Transmigration is one of the major programs of the Indonesian government along with family planning and increasing food production.

The term "Transmigration" is defined by the Government of Indonesia as :

> ... the removal and transfer of population from one area to settle in another area determined within the territory of the Republic of Indonesia, in the interest of the country's development, or for other reasons considered necessary by the government. (Statute no. 3 of 1973 : The Basic Stipulations for Transmigration).

From the definition above, transmigration is a national effort to carry out regional development; especially for the development of the provinces outside of Java, Bali, and Lombok (an island of West Nusatenggara province). It is also a process of allocating and reallocating human resources for regional development.

1.2.1. History of Transmigration

The transmigration program was started in 1905 during the period of Dutch colonization. The original idea behind the transmigration program was a concern of the colonial government on the possibility of overpopulation in Java island (Swasono 1985). Raffles (1814) and Du Bus de Gisignies (1827) saw overpopulation as jeopardizing future colonization in Java. The limited land available along with overpopulation in Java drove the colonial government to implement the transmigration program.

The purpose of the transmigration program at that time was to create the farming system for a rice-growing pattern utilizing irrigation and to send workers to government estates. The first group of transmigrants in 1905 consisted of 115 families from the province of Central Java who were sent out to Lampung province. From 1905 up to 1941 there were 257,313 people or 144,000 families who had been moved to the outer islands (Swasono 1985). The transmigration program was stopped from 1941 until 1949 when the second world war and the Indonesian independence war took place.

The transmigration program was resumed in 1950 under the Indonesian government. By 1968, 101,240 families or about 424,000 people had been moved to the outer islands.

In 1969 the government started its first five year national development plan. Since then, transmigration programs have been improved and by the third five year national plan in 1985 457,572 families had been moved.

1.2.2. Transmigration program

Transmigration has been coupled with another government program of increasing food production through the implementation of extensive rice production. The transmigration program has opened new areas for paddy rice cultivation outside Java, Bali and Lombok. The program has also provided the opportunity of increasing food production through the use of high yield varieties, fertilizer, and application of appropriate mechanization.

Resettlement under the official transmigration program has been based almost entirely on small-holder agriculture. There are six different farming systems in the Transmigration programs (Martono 1985):

a. Farming systems with rainfed scheme
b. Farming systems with irrigation scheme
c. Farming systems for tidal areas
d. Farming system with cash crops scheme
e. Farming systems for fishermen and fish-breeding in coastal ponds
f. Farming system based on animal husbandary

Transmigrants are recruited in rural areas of Java, Bali, and Lombok. They must be married, of good character, and have previous farming experience. On arrival in the new area the transmigrants receive a small house on 0.25 ha of village land, 1 ha of cleared farmland for foodcrop cultivation, and 0.75-1 ha of additional land for future development. The 0.25 ha of village land consists of a small house and garden for planting of vegetables, soybeans, groundnuts, and paddy. The one hectare of farmland is located next to the house and is for planting paddy, while 0.75-1 ha of additional land is situated outside of the village. Public facilities including schools and clinics are located in the village center. The transmigrants are also provided with selected agricultural equipment and supplies such as hoes, chopping knives, and seeds.

Plans are that during the first year in the new area, the transmigrants should be able to cultivate their 0.25 ha of village land and the 1.00 ha of farmland. They are supplied with fertilizer and the basic needs (subsistence supplies) for survival. The land is supposed to be in a "cultivable condition". However, the transmigrants have to do additional land clearing from woods and covercrops before they can cultivate their land.

II. OBJECTIVES

Sumangat and Purwadi (1978) found that most of the transmigrant families can work only 0.7 hectare and thus leave the rest of their allocated land uncultivated. This results in an inefficient use of land and resources.

An analysis is needed to establish the optimum amount of land under various conditions for the transmigrants and whether the transmigrants should be supplied with additional inputs (animal or tractor) for more effective utilization of the land and the welfare of the transmigrants.

The general objective of this study is to develop a framework for the analysis and evaluation of the optimum amount of land that a transmigrant family can effectively cultivate under various conditions and with different inputs. The specific objectives are :

1. Formulate a database from available secondary sources on manhours required for the cultivation of various crops under specific new-land conditions.
2. Consider family labor and resources available.
3. Develop a systems model for evaluation of the critical parameters pertaining to the optimum land utilization capability of transmigrant families.
4. Evaluate the cost and return data for land preparation with a hand tractor, a bullock, and manual operation.

III. REVIEW OF LITERATURE

3.1. Agricultural hand-tools

Indonesian agriculture, which mainly consists of small farms, is carried out with human and animal power. The predominant source of power is human.

Commonly used hand tools for farming in many areas of Indonesia are as follows (A.C. Pandya.1978) :

a. Cangkul / pacul (hoe),

b. Parang (chopping knife),

c. Sabit (sickle),

d. Ani-ani (rice harvesting knife),

e. Garpu tarik (forked hoe),

f. Garpu alang-alang (forked hoe used for eradicating pernicious weeds called alang-alang or Imperata cylindrica),

g. Linggis (crowbar),

h. Kampak (axe),

i. Sekop (shovel),

j. Tajak (weeding hook),

k. Ganco (mattock),

l. Slundak (tool for making water channels in the field),

m. Tugal (sowing stick).

Plowing and harrowing are done by 'Pacul' (hoe), seeds are broadcast or sown by hand or 'Tugal' (sowing stick), and weed control is by 'Garpu alang-alang' (forked hoe), or 'Tajak' (weeding hoe). Rice harvesting is carried out by 'Ani-ani' (harvesting knife) or by 'sabit' (sickle). 'Parang' (chopping knife) is used for chopping bush and grass, and 'Kampak' (axe) for cutting tree stubs and branches. 'Sekop' (shovel) is used for removing soil.

The government give transmigrants some of these hand tools which consist of the following :

a. 'Cangkul' / 'pacul' (hoe),
b. 'Parang' (chopping knife),
c. 'Tajak' (weeding hook),
d. 'Slundak' (tool for making water channel in the field),
e. 'Ganco' (mattok),
f. 'Garpu alang-alang' (forked hoe),
g. 'Linggis' (crowbar).

3.2. Land Clearing Operation for Forest Land

The objective of land clearing is to prepare the land for cultivation just prior to the rainy season. Clearing should be performed in a way which minimizes the disturbance of top soil.

Mailangkay (1978) stated that land clearing chronological activities consist of :

1. Underbrushing,
2. Cutting and felling,

3. Stockpiling the usable timber,
4. Windrowing and burning the jungle debris,
5. Harrowing on the contour and spreading rock phosphate on the harrowed area.

3.2.1. Underbrushing

Underbrushing is a process of cutting brush, vines, and small trees. This activity is done either by manual operation using "parangs" or chopping knives and axes; or by a small crawler tractor of 100 bhp.

During underbrushing, inspection and evaluation of the standing timber is carried out to determine the forest class for each area. An estimate of the number of trees is made by taking three random samples for each different kind of vegetation. The estimates are made by randomly locating two points 100 meters apart. The vegetative growth is measured and counted along a straight line between these points for a width of five meters on either side. This provides the population measure for 1/10 hectare. Caterpillar Co. classified the forest class based on diameter as follows (Caterpillar Performance Handbook):

less than 30 cm

31 cm - 60 cm

61 cm - 90 cm

91 cm - 120 cm

121 cm - 180 cm

3.2.2. Cutting and Felling

Cutting and felling is a process of selecting and cutting trees of 30 cm or greater diameter which are suitable for sawing into timber or for commercial uses. Trees with diameters larger than 30 cm are cut at breast height and the stumps are left, and trees smaller than 30 cm in diameter are sheared at ground level.

The trees will be cut by chain saw or by other approved means. The timber will be stripped of branches and assembled into stockpiles at one kilometer distance apart.

3.2.3. Stockpiling

The usable wood stockpiles are placed near to the main roads for transportation and sawing into lumber. The non-usable timber is placed in windrows and burned.

3.2.4. Windrowing and Burning

After removal of the usable timber, the land clearing operation is continued with the clearing of all trees, brush, vines, stumps, and other debris. Special tools and equipment are used and the debris is placed in windrows 30 meters apart along the contour.

Clearing and windrowing is done with crawler tractors equipped with multipurpose tooth-jungle rakes which allow soil to pass through. The windrows are burned after sufficient drying to ensure a hot, continuous burn of at least 80 percent of the material.

3.2.5. Harrowing and Spreading rock phosphate

After all debris has been burned, the final clearing of the areas is achieved by disc harrowing using heavy-duty harrows to a depth of approximately 30 or 40 cms, to cut out roots, subsurface stumps, and vegetation. All harrowing is carried out on the contour and is done in such a manner that the top soil is not burried and the subsoil is not to be exposed.

After harrowing , the rock phosphate is spread on the harrowed areas at the rate of 500 kilograms per hectare. The rock phosphate should be crushed so that ninety percent will pass a 100 mesh sieve, and have a maximum moisture content of 1.5 % .

3.3. Land Clearing Operation for Alang-alang grass (Imperata cylindrica)

Some of the transmigration sites have been developed from reclamation of large areas of alang-alang grass (Imperata cylindrica). Tajau Pecah, for instance, had alang-alang grass growing before it was chosen as a transmigration site.

Sorjani (1970 in Soewardjo 1986) stated that in Indonesia it is estimated there are about 16 million hectares of alang-alang grass, and it is estimated that the area is increasing by 150,000 to 200,000 hectares yearly. Shifting cultivation, especially in Sumatera and Kalimantan, plays a major role for increasing its population.

Land clearing for alang-alang grass has been fully mechanized using crawler tractors and wheel tractors. Equipment used in land clearing operations were disk plow and disk harrow. Land clearing operations consist of a first plowing, first harrowing, and a second plowing and harrowing.

3.3.1. First plowing

First plowing is carried out to cut out and destroy the roots of the alang-alang. Roots of alang-alang are left in the sun for four weeks.

3.3.2. First harrowing

First harrowing is done to expose and destroy the rest of the alang-alang rhizomes that were mixed with soil.

3.3.3. Second plowing and harrowing

Second plowing and harrowing are the last operations and are intended to put the land into a condition that is free from alang-alang and ready for cultivating.

3.4. Climate

Two topics are discussed in this sub-chapter, i.e. agroclimatic zones and distribution of rainfall.

3.4.1. Agroclimatic zones

Oldeman (1980) classified the various rainfall distribution into five main agroclimatic zones for rice-based cropping pattern. He defined wet months as having 200 mm of monthly precipitation or more and dry months as having 100 mm of monthly precipitation or less. The main agroclimatic zones are as follows :

Zone A : More than 9 consecutive wet months;

Zone B : 7-9 consecutive wet months;

Zone C : 5-6 consecutive wet months;

Zone D : 3-4 consecutive wet months;

Zone E : less than 3 consecutive wet months.

The agroclimatic zones are sub-divided according to the length of the dry period, i.e. the number of consecutive dry months. If a dry period is less than two months, year-round cultivation of food crops is possible, and the growing period is 11 to 12 months. A dry period of 2 to 3 month requires careful planning for year-round cultivation. If the dry period lasts four to six months a fallow period is unavoidable, but two selective crops in sequence are possible. A dry period of 7 to 9 months, or a growing period of 3 to 5 months, allows the cultivation of only one food crop. If the dry period is more than nine months, the area is not suitable for food crop production without an additional source of water. This classification system, which is applied in Indonesia, leads to a total of 18 agroclimatic zones (Figure 3.1.).

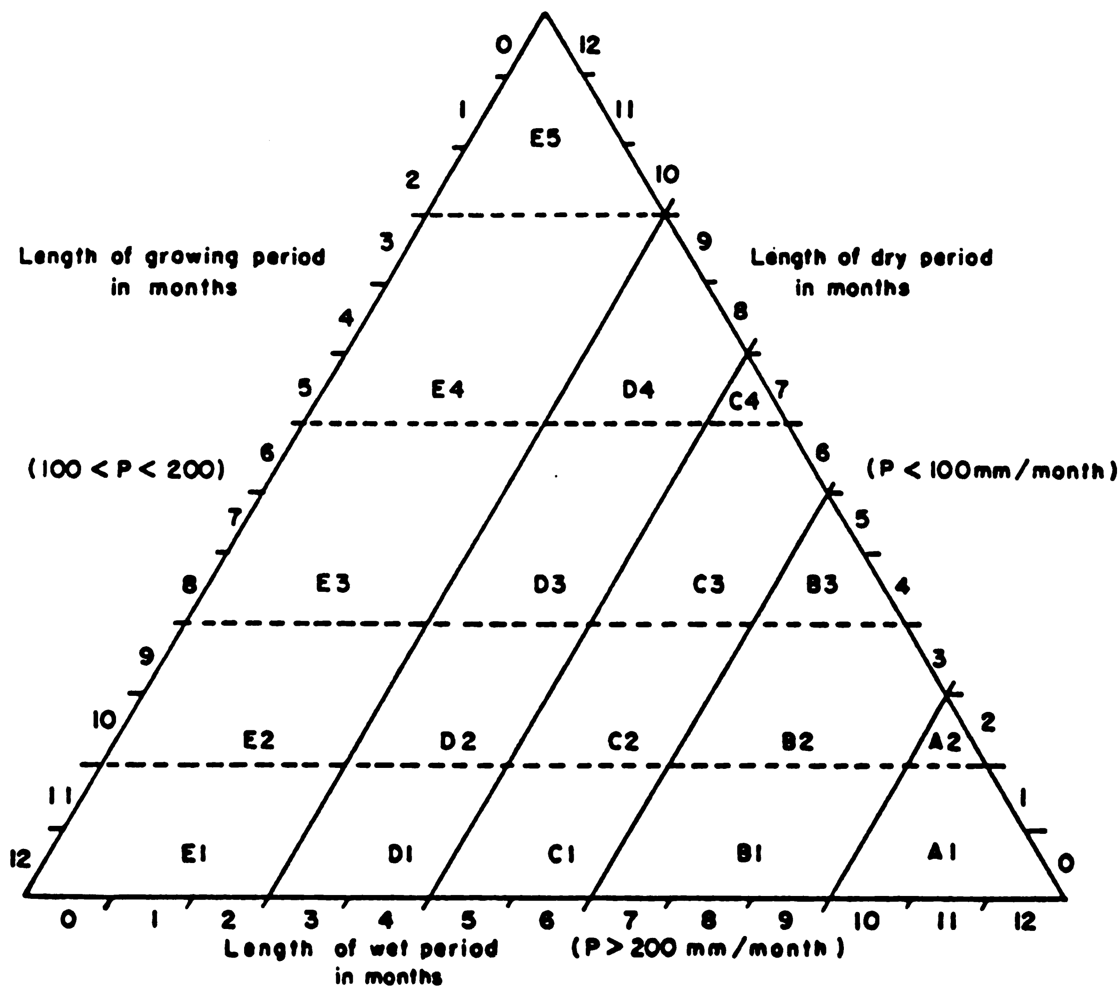

Figure 3.1. System of Agroclimatic Classification for Rice-based Cropping Pattern (FAO 1982)

The following is an illustration of the agroclimatic classification. Rainfall data of Tajau Pecah shows that there are six consecutive wet months and two dry months. The wet months of Tajau pecah are in C section of the agroclimatic system and can be found along the bottom line of the triangle. The dry months are located on the right line of the triangle. The cross section between the wet months and dry months is on C-2 section. Therefore, Tajau Pecah is classified in the C-2 zone using this system.

3.4.2. Distribution of rainfall

Mean monthly rainfall data indicate only a trend of certain climate patterns. They can be useful in the indentification of agroclimatic zones, but do not provide any information on the rainfall variability (Oldeman, 1982).

Yevjevich (1972) and Doorenbos & Pruitt (1977) used a probability method to calculate the distribution of rainfall. This method assumed that rainfall is normally distributed. To compute rainfall probability, rainfall records are arranged in decreasing order. Each record is assigned a ranking number (m). The highest rainfall of a particular year is then ranked as number one. The second highest rainfall of a certain year is ranked as number two and so on. The ranking numbers are then given probability levels Fa(m), which are calculated as follows :

$$Fa(m) = 100 * m / (n + 1) \qquad (3.1.)$$

where : $Fa(m)$ = probability level in percent

m = ranking number

n = number of recorded years

To illustrate this method, an example from Oldeman (1982) will be shown. A 63-year monthly rainfall chart for October in Tanggerang, Indonesia, was arranged in decreasing order and each record was given a ranking number (m). To calculate the rainfall probability for rank number 20 (Figure 3.2.) is :

$$Fa(m) = 100 * m / (n+1)$$

$$Fa(20) = 100 * 20 / (63+1) = 31.25 \%.$$

This means that ranking number 20 has a rainfall probability of 31.25 % .The probability of at least 150 mm of rainfall during October is 31.25 % .

To know which rank number has a probability level of 80%, a calculation can easily find this by substituting 80 % for Fa(m).

$$Fa(m) = 100 * m / (n+1)$$

$$80\% = 100 * m / 64$$

$$m = 51$$

This means that the 80% probability of rainfall is 40 mm or in 8 out of 10 years rainfall for October in Tanggerang is

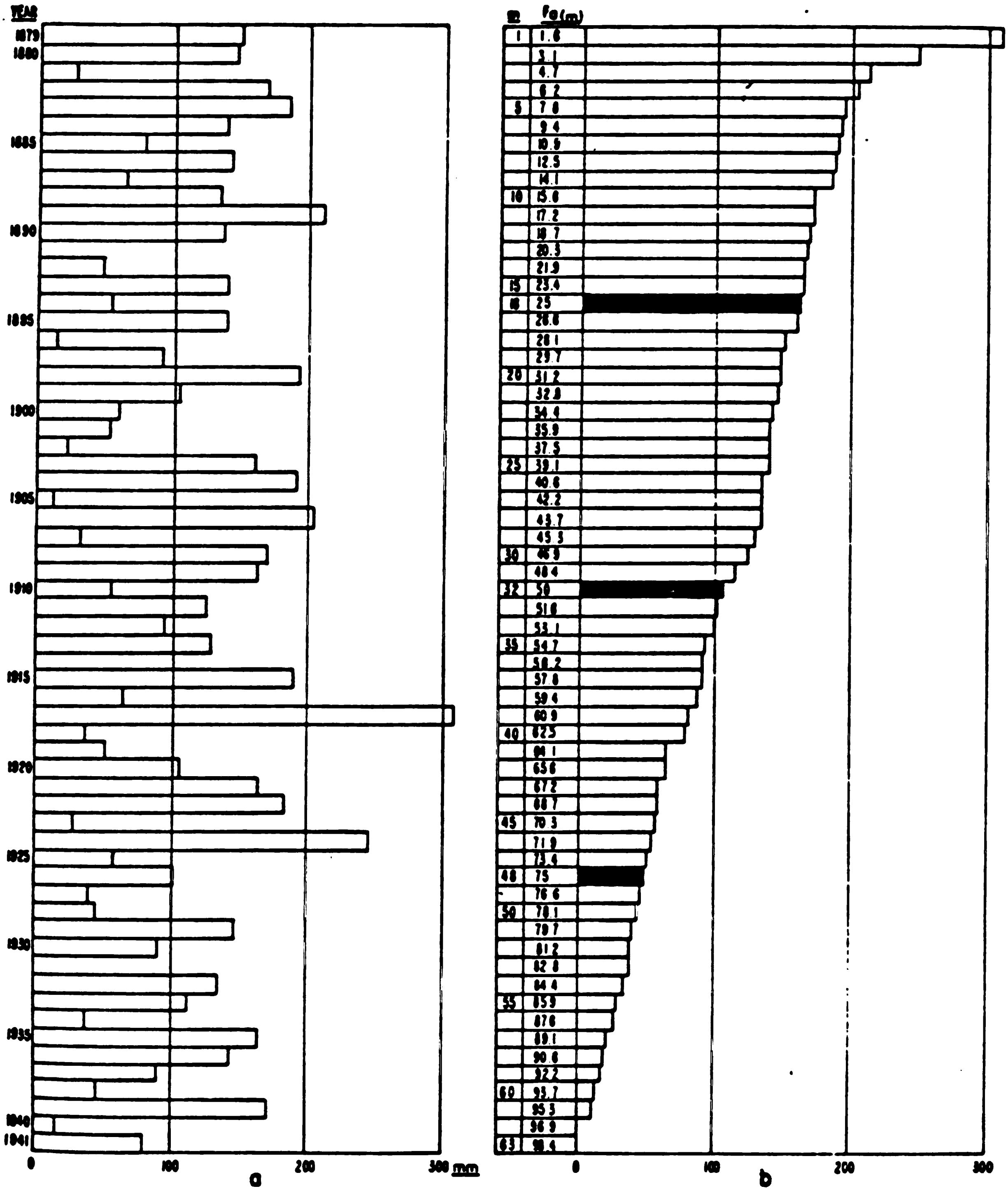

Figure 3.2. October rainfall during a period of 63 years for Tanggerang, Indonesia, arranged in chronological order (a) and in ranking order (b).

at least 40 mm. This can be found by drawing a line from m = 51 to 40 mm at the bottom of the graph in figure 3.2.

3.5. Crop Water Requirement

Crop water requirements are defined as the depth of water needed to meet the evapotranspiration water loss (ETcrop) under the following conditions (Doorenbos & Pruitt, 1977):

1. The planted crop is assumed free of disease,
2. Crop is growing in large fields,
3. Crop is planted under non-restricting soil, water and fertility conditions,
4. Crop is assumed to be achieving full production potential under the given growing environment.

To calculate the crop water requirement, two topics are discussed : crop coefficient (Kc) and crop evapotranspiration (ETcrop).

3.5.1. Crop coefficient (Kc)

Crop coefficient (Kc) is a ratio between crop evapotranspiration (ET crop) and the reference crop evapotranspiration (ETo) when the crop is grown in a large field under optimum growing conditions.

The value of the crop coefficient (Kc) varies with the development stage of the crops. Coefficient values for different crops can be found in Doorenbos & Pruitt (1984) and Doorenbos & Kassam (1979). The values of Kc for the traditional crop used in this thesis can be found in the next chapter.

3.5.2. Crop evapotranspiration

Crop evapotranspiration can be calculated with the following formula :

$$ET\ crop = Kc * ETo \qquad (3.2.)$$

where :

ET crop = crop evapotranspiration in mm / day or mm / month

Kc = crop coefficient

ETo = the rate of evapotranspiration from an extensive surface of 8 to 15 cm tall, green grass cover of uniform height, actively growing, completely shading the ground and not short of water (Doorenbos & Pruitt 1984), mm / day or mm / month.

There are four methods to calculate ETo :

1. Blaney-Criddle method,
2. Radiation method,
3. Penman method,
4. Pan Evaporation method.

A complete calculation of these methods can be found in Doorenbos and Pruitt (1984, pp.3-34). Pan evaporation method was used in GMU research (1978).

3.6. Water balance

In the calculation of the water balance, three assumptions were made (UGM,1979) :

1. Depth of root zone

   Depth of root zone was assumed for paddy rice, corn, and beans as 40 cm.

2. Coefficient of run-off (Kr)

   The value of Kr was assumed to be 0.2. This value can be applied for areas which have relative humidity more than 70% and high rainfall distribution (Doorenbos & Pruitt 1975, in GMU 1979).

   Kr = 0.2 means that rainfall infiltration into the ground is 80% from total rainfall (Pt) in millimeters.

3. Water readily available for crops (Sa)

   Moisture content for clay soil for every 30 cm of depth of root was assumed as 4.5-6.0 cm of water (FAO, 1971 in UGM 1979). For further evaluation, moisture content for crops was assumed to be 5 cm of water for every 30 cm of depth of root. (GMU 1979).

Availability of water is calculated as follows :

$$Sa = D * 5 \text{ cm}/30 \text{ cm} \qquad (3.3.)$$

where :

Sa = availability of water, cm of soil water content

D = depth of root in cm

Surplus of water is calculated as follows :

$$SR = \frac{(Pt - ET \text{ crop})}{10} + Sa \qquad (3.4.)$$

where :

SR = surplus of water, cm of soil water content

Pt = total rainfall, millimeter

ET crop = crop evapotranspiration, milimeter

Sa = availability of water, cm of soil water content

10 = conversion factor from milimeter to centimeter

If SR is negative the ET crop > (Pt + Sa), and the crop is short of water. If SR is positive the ET crop < (Pt + Sa), and the crop has more than enough water available. If SR is equal to zero, ET crop = (Pt + Sa).

3.7. Power input requirements

For determining labor requirements or other power inputs, a description of field operations, applied equipment, and the capacity of work for paddy rice, corn, beans, and cassava cultivation are presented on the following tables.

The labor requirement values in the following tables will be used in analysis of labor surplus of the transmigration farmland model in chapter IV.

Table 3.1. Various Operations, Power Inputs, and Equipment used for rice cultivation for One Hectare of Land (Hours).

No.	Field Operation	Inputs	Equipment	Capacity (hours/ha)
1.	First plowing	animal	moldboard plow	50 - 60
		hand - tractor	rotary tiller	20 - 30
2.	Second plowing	animal	moldboard plow	50 - 60
		hand - tractor	rotary tiller	20 - 30
3.	Harrowing	animal	comb harrow	20 - 40
		hand - tractor	rotary tiller	10 - 20
4.	Basic Manuring	man		60 - 80
5.	Planting	man		150 - 170
6.	Top dressing	man		60 - 80
7.	Weeding (3 X)	man	hoe, weeding hook	350 - 360
8.	Applying herbicides	man	sprayer	70 - 80
9.	Harvesting	man	sickle	370 - 380

Source : GMU 1978

Table 3.2. Various field Operations, Power Inputs, and Equipment Used for Corn Cultivation for One Hectare of Land (hours)

	Field Operations	Inputs	Equipment	Capacity (hours/ha)
1.	First Plowing	animal	moldboard plow	50 - 60
		hand - tractor	rotary tiller	20 - 30
2.	Second Plowing	animal	moldboard plow	50 - 60
		hand - tractor	rotary tiller	20 - 30
3.	Harrowing	animal	comb harrow	20 - 40
		hand - tractor	rotary tiller	10 - 20
4.	Manuring	man		40 - 50
5.	Planting	man	hoe	25 - 36
6.	Weeding	man	hoe, sickle	200 - 280
7.	Harvesting	man	sickle	18 - 24

Source : GMU 1978

Table 3.3. Various Field Operations, Power Inputs, and Equipment Used for Beans Cultivation for One Hectare of Land (Hours).

No.	Field Operations	Inputs	Equipment	Capacity (hours/ha)
1.	First Plowing	animal	moldboard plow	50 - 60
		hand - tractor	rotary tiller	20 - 30
2.	Second Plowing	animal	moldboard plow	50 - 60
		hand - tractor	rotary tiller	20 - 30
3.	Harrowing	animal	comb harrow	20 - 40
		hand - tractor	rotary tiller	10 - 20
4.	Manuring	man		40 - 44
5.	Planting	man	hoe	25 - 36
6.	Weeding	man	hoe, sickle	200 - 280
7.	Applying Herbicide	man	sprayer	70 - 75
8.	Harvesting	man	sickle	64 - 79

Source : GMU 1978

Table 3.4. Various Field Operations, Power Inputs, and Equipment used for Cassava Cultivation for One Hectare of Land (Hours)[1].

No.	Field Operations	Inputs	Equipment	Capacity (hours/ha)
1.	Planting	man		22 - 30
2.	Harvesting	man	chopping knives	55 - 60

Source : GMU 1978

[1] Cassava is planted simultaneously with corn or beans; therefore, the field operations of its cultivation are planting and harvesting.

3.8. Crops management

Production inputs and projected production for different crops for one hectare of land can be seen on tables 3.5. and 3.6. Table 3.7. shows the monthly activities for each crop during a year.

Table 3.5. Production Inputs Required for Different Crops for One Hectare of Land (Kilogram)

No.	Crops	Seeds	Fertilizer
1.	Paddy rice	40	100 NPK + 50 TSP
2.	Corn	30	30 NPK
3.	Beans	50	50 NPK + 100 TSP

Source : GMU 1978

Table 3.6. Projected Production for Different Crops Based on One Hectare of Land

No.	Crops	Projected production (100 kg)
1.	Paddy rice	15
2.	Corn	8
3.	Beans	7
4.	Cassava	100

Source : GMU 1978

Table 3.7. Various Field Operations for Different Crops During a One Year Period

Months	Paddy rice	Corn	Beans	Cassava
January	Weeding II	Land prep.		
February	Weeding III	Basic mng.	Land prep.	
March	Harvesting	Planting	Basic mng.	Plant.
April		Weeding	Planting	
May			Weeding	
June		Harvesting	Spraying	
July			Harvesting	
August				
September	Land prep.			
October	Basic manuring			
November	Planting			Harvt.
December	Top Dressing & Weeding I			

Source : GMU 1978

Rainfall data and analysis of crop water requirements will be used for determining the planting time of traditional crops on the simulation of the transmigrant family model.

Based on the methods discussed above in regard to rainfall, water requirements and labor requirements, the data on the following chapter is collected.

IV. DATA COLLECTION

Secondary data for this study have been obtained mainly from research carried out at Gadjah Mada University (GMU) from 1977 to 1982 in Tajau Pecah, South Kalimantan. Other data sources has been the Central Bureau of Statistics (CBS) and the Ministry of Transmigration (MOT).

4.1. Characteristics of the Area Studied

The GMU research was location specific at the transmigration project of Tajau Pecah village in South Kalimantan. The village is located in the district of Jorong, and the county of Tanah Laut. The distance between the village and Pleihari, the capital of Tanah Laut county, is 12 km. The distance between the village and Banjarmasin, the capital of South Kalimantan province, is about 77 km.

Total area provided for the transmigration project in Tajau Pecah was 15,000 ha, out of which 2,000 ha had been used. Each family received 2.0 ha of land consisting of 0.25 ha for houselot and 1.75 ha for foodcrop cultivation. The transmigrants also received agricultural equipment consisting of : chopping knives, hoes, and crowbars. Most of the transmigrants provided themselves with other needed agricultural tools.

The original vegetation of Tajau Pecah was Alang-alang grass (Imperata cylindrica). Most of the topography of Tajau Pecah was flat with a 4-6% of slope and some hills. Soil type in Tajau Pecah was clay and was classified as red-yellow podzolik with 5-15 cm of top soil.

The Tajau Pecah area is drained by the Swarangan River and several small tributaries, such as : Gunung Mangerang, Batu Bananjang, Munggu Rumbi, Langset Besar and Kuranji Bahalang. Water in these tributaries includes soil run-off resulting from local rains.

4.2. Crop Water Requirement

Based upon classification of agroclimatic zones by Oldeman (1982), Tajau Pecah is classified in the C-2 zone which is characterized by a 5-6 month wet period and a 2-3 month dry period (Figure 4.1.)

The distribution of rainfall for Tajau Pecah was taken during the year 1952-1976 (25 years) from the weather station at PT Gunung Mukti, 10-15 Km from Tajau Pecah. Monthly rainfall probability used in the analysis was assumed 75% and the possibility of failure of harvest was one out of every four years. The average values of monthly rainfall distribution and its probability are presented in table 4.1. Appendix A shows the data of monthly rainfall during 1952-1976 for the transmigration project of Tajau Pecah.

Rainfall data will be used for determining the planting time of each traditional crop used in the transmigrant family model.

Table 4.1. Average Monthly Rainfall in Tajau Pecah During 1952 - 1976, Rainfall which Has Probability 75%, and Monthly Rainfall in 1977

Months	Average monthly rainfall[1] (mm)	P = 75% (mm)	Rainfall 1977 (mm)
January	378	272	290
February	279	206	346
March	308	185	372
April	218	141	354
May	169	84	121
June	138	48	138
July	131	47	1
August	74	28	25
September	95	14	0
October	139	55	67
November	275	199	125
December	397	256	396

1. 1952 - 1976

Source : Weather station of PT Gunung Mukti, in GMU Report on the Transmigration Projects in Tajau Pecah, 1978.

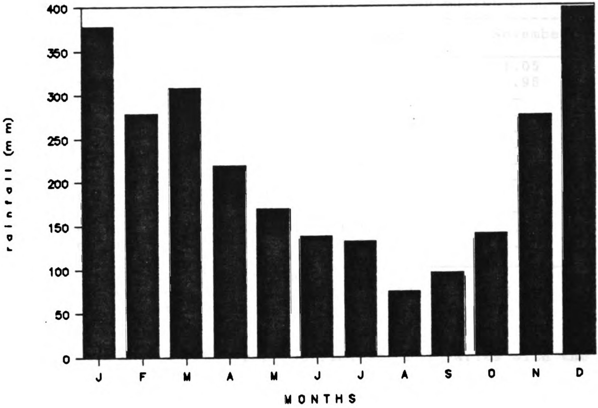

Figure 4.1. Distribution of Rainfall in Tajau Pecah, 1952 - 1976

Tables 4.2 to 4.4. present crop coefficient (Kc) for paddy rice, corn, and beans. The values of Kc were taken from Doorenbos and Pruitt (1977).

Kc will be used for determining crop evapotranspiration (ET crop) of traditional crop used in the simulations of transmigrant family model.

Table 4.2. Values of Crop Coefficient (Kc) for paddy rice planted in different months

Months	Paddy rice planted in		
	September	October	November
January	-	.95	1.05
February	-	-	.95
March	-	-	-
April	-	-	-
May	-	-	-
June	-	-	-
July	-	-	-
August	-	-	-
September	.88	-	-
October	1.10	.88	-
November	1.05	1.10	.88
December	.95	1.05	1.10

Source : Doorenbos & Pruitt (1977)
Growing period : 30 / 30 / 30 - 35 / 20 - 25
RH :> 70%

The values of the crop coefficient (Kc) varies with the development stage (growing period) of the crops. From the above table 4.2., development stages of paddy crops which is planted on September are 30 days for initial period with Kc = 0.88, 30 days for crop development period with Kc = 1.10, 30 - 35 days mid-season with Kc = 1.05, and 20 - 25 days late season with Kc = 0.95. Values of the crop coefficient is taken for area with relative humidity at least 70 % .

Table 4.3. Values of Crop Coefficient (Kc) for corn planted in different months

Months	Corn planted in			
	September	October	March	April
January	-	0.55	-	-
February	-	-	-	-
March	-	-	0.75	-
April	-	-	0.80	0.75
May	-	-	1.05	0.80
June	-	-	0.55	1.05
July	-	-	-	0.55
August	-	-	-	-
September	0.75	-	-	-
October	0.80	0.75	-	-
November	1.05	0.80	-	-
December	0.55	1.05	-	-

Source : Doorenbos & Pruitt (1977)
Growing period : 20 / 30 / 30 / 20 or
20 / 30 / 40 / 30
RH : > 70%

Table 4.4. Values of Crop Coefficient (Kc) for Beans planted in different months

Months	Beans planted in			
	September	October	March	April
January	-	0.55	-	-
February	-	-	-	-
March	-	-	0.75	-
April	-	-	0.80	0.75
May	-	-	1.00	0.80
June	-	-	0.55	1.00
July	-	-	-	0.55
August	-	-	-	-
September	0.75	-	-	-
October	0.80	0.75	-	-
November	1.00	0.80	-	-
December	0.55	1.00	-	-

Source : Doorenbos & Pluitt (1977)
Growing period : 20 / 20 / 40 / 20 - 25
Rh : > 70%

Tables 4.5. to 4.7. show the values of water consumption requirement for paddy rice, corn, and beans. The values were taken from GMU research done in 1978.

Table 4.5. Crop Evapotranspiration (ET crop) per Month for Paddy Rice Planted in Different Months (mm of soil water content)

Months	Crop Evapotranspiration		
	September	October	November
January	-	94	104
February	-	-	102
March	-	-	-
April	-	-	-
May	-	-	-
June	-	-	-
July	-	-	-
August	-	-	-
September	124	-	-
October	157	121	-
November	110	106	92
December	109	120	126
Total annual ET	500	441	424

Source : GMU 1978

Table 4.6. Crop Evapotranspiration (ET crop) per Month for Corn Planted in Different Month (mm of soil water content)

Months	Crop Evapotranspiration (ET crop)			
	Sept	October	March	April
January	-	55	-	-
February	-	-	-	-
March	-	-	100	-
April	-	-	110	104
May	-	-	124	94
June	-	-	59	113
July	-	-	-	63
August	-	-	-	-
September	78	-	-	-
October	114	78	-	-
November	110	84	-	-
December	63	120	-	-
Total Annual ET	365	337	393	374

Source : GMU 1978

Table 4.7. Crop Evapotranspiration (ET crop) per Month for Beans Planted in Different Months (mm of soil water content)

Months	Crop Evapotranspiration (ET crop)			
	Sept	October	March	April
January	-	54	-	-
February	-	-	-	-
March	-	-	93	-
April	-	-	111	97
May	-	-	114	94
June	-	-	59	108
July	-	-	-	63
August	-	-	-	-
September	78	-	-	-
October	114	78	-	-
November	105	84	-	-
December	63	114	-	-
Total Annual ET	360	330	377	362

Source : GMU 1978

4.3. Water Balance

Calculation for water balance was based on distribution of rainfall and probability of occurence (75%). The surplus water values are presented in table 4.8. for paddy rice and table 4.9. for corn and beans.

Table 4.8. Surplus of Water per Year for Paddy Rice Planted in Different Months in Transmigration Project of Tajau Pecah

Months	Paddy Rice Planted in		
	September	October	November
January	n	positive	positive
February	n	n	positive
March	n	n	n
April	n	n	n
May	n	n	n
June	n	n	n
July	n	n	n
August	n	n	n
September	negative	n	n
October	negative	negative	n
November	positive	positive	positive
December	positive	positive	positive

Source : GMU 1978
n : not considered

Table 4.9. Surplus of Water per Year for Corn and Beans Cultivation Planted in Different Months in Transmigration Project of Tajau Pecah

Months	Corn and Beans Planted in			
	Sep	Oct	March	April
January	n	pos	n	n
February	n	n	n	n
March	n	n	pos	n
April	n	n	pos	pos
May	n	n	pos	pos
June	n	n	pos	pos
July	n	n	n	pos
August	n	n	n	n
September	neg	n	n	n
October	neg	pos	n	n
November	pos	pos	n	n
December	pos	pos	n	n

Source : GMU 1978
n : not considered

4.4. Power inputs availability

In the transmigration project of Tajau Pecah, there were three different power inputs used in land preparation (man, animal, and tractor).

4.4.1. Human resource

There were 1000 transmigrant families in Tajau Pecah with a total of 4341 people distributed among six village blocks. The block distribution of transmigrant families were as follows :

block A : 128 families,
block B : 105 families,
block C : 192 families,
block D : 150 families,
block E : 150 families,
block F : 175 families.

The average for a family was four people, and of a family only 2-3 people were available to work their land (GMU,1978). The field work requirement with hoe and crowbar as tools was measured by local standard, that is 0.25 "borong per kenjing"[1] or 692 man hours per hectare (GMU,1978).

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[1]. 1 borong = 17 * 17 sq. m
= 289 sq. meter

1 kejing = 5 hours

0.25 borong / kejing = (10000 / (0.25 * 289)) * 5
= 692 manhour / ha.

To calculate manhours needed for cultivating different crops in Tajau Pecah, a list of manhour requirements for each activity in every month must be made, and followed by analysis of labor surplus by subtracting the manhour requirements from the availability of manhours. Table 4.10 shows the manhours requirements for one hectare of traditional crops.

The availability of manhours is calculated as follows :

$$CAP = L * H * D * PWD \qquad (4.1.)$$

where : CAP = available working capacity, manhours / month

L = available labor unit, man

H = available working hours, hours / day

D = available working days, days / month

pwd = probability of a working day, decimal

Table 4.10. will be used in the simulations of labor surplus during growing the traditional crops. Labor surplus of each activity during growing the crops will be obtained by subtracting the labor requirement for each planted crop from the available working capacity of family labor for each month during one year period. The availability of working capacity of a transmigrant family for each month is calculated with equation 4.1.

Table 4.10. Distribution of Manhour Requirements per Hectare for Traditional Crops.

Months	Paddy Rice (h/ha)	Corn (h/ha)	Beans (h/ha)	Cassava (h/ha)	Total
January	180	-	-	-	180
February	180	398	-	-	578
March	380	40	398	25	843
April	-	30	40	-	70
May	-	240	30	-	270
June	-	-	210	-	210
July	-	20	70	-	90
August	-	-	70	-	70
September	398	-	-	-	398
October	70	-	-	-	70
November	160	-	-	60	220
December	180	-	-	-	180
Total	1548	728	818	85	3,179

Source:GMU 1978

4.4.2. Animal-drawn power

Animal-drawn power in Tajau Pecah was derived from Bali cattle (Bos banteng or Bos sondaicus), which were used as a part of the government's "Credit livestock distribution system". The animal-drawn equipment consisted of a locally manufactured plow. Every four transmigrant families received a pair of animals, and the capacity of work of a pair of animals was 140 hour per ha (GMU,1977).

4.4.3. Tractor power

Tractors are used to help the transmigrants with the preparation (plowing and harrowing) of their 0.75 ha of crop land. The 0.25 ha of houselot was worked by the transmigrants themselves. The tractor can be rented for Rp.50,000 per ha (Rp is rupiah, Indonesian currency)[2]. The tractors are used for first and second plowing and harrowing operations.

4.5. Cropping Rotation and The Transmigrants' Return

Present cropping rotation and amount of cultivated areas for Tajau Pecah and the financial analysis of a transmigrant family are shown on tables 4.12. and 4.13.

Table 4.11. Present Cropping Rotation and Planted Areas for Different Crops in Transmigration Project of Tajau Pecah

No.	Crops	Months	Planted Areas (Ha)
1.	Paddy Rice	September - January	0.70
2.	Corn	May - August	0.18
3.	Beans	January - April	0.18
4.	Cassava	February - September	0.35

Source : GMU 1978

[2] Exchange rate : US$ 1.00 = Rp. 450 (1977)
Since 1986 US $ 1.00 = Rp. 1,650

Table 4.12. Financial Analysis of a Transmigrant Family Production at the Present Time

Items	Paddy rice	Corn	Beans	Cassava
Planted Area (ha)	0.7	0.18	0.18	0.35
Income :				
Production (Kg)	1050	144	126	3500
Value (Rp. / Kg)	70	50	100	10
Gross Income (Rp)	73500	7200	12600	35000
Production cost:				
Fertilizer (Rp)	7000	1800	1800	3500
Seeds (Rp)	1050	2700	1620	-
Others (Rp)	32550	672	1143	14700
Total	40600	5172	4563	18200
Net Income (Rp)	22400	2028	8037	16800

Source :GMU 1978

Farmgate price of each traditional crop will be used in the simulation of the financial analysis of the transmigrant family model. Farmgate price of the traditional crop can be found on appendix B. Market price of rice, Rp. 90 per kg milled rice, is used to analyze the rice equivalent for transmigrant family income.

Data on this chapter will be used in the analysis of the transmigrant family model on the following chapter.

V. MODEL DEVELOPMENT AND SIMULATION INPUTS FOR THE TRANSMIGRANTION FAMILY MODEL

5.1. System Approach for the Transmigration Family Model

5.1.1. Background Information

The subsistence level of a transmigrant is used to analyze the total area needed for the farmland of a transmigrant family. The subsistence level is defined as a level at which the basic supply needs of a transmigrant are fulfilled, and it is measured by the equivalent amount of rice production needed for a transmigrant's food and other needs by selling his farm products.

The equivalent subsistence level in milled rice was defined to be 240 Kg per person per year[1]. If the average size of a transmigrant family is assumed to be five people (MOT, 1978)[2], then the equivalent of 1200 kg of milled rice must be obtained by each transmigrant family from their farm during a year.

5.1.2. Problem Definition

Research carried out by GMU (1978) showed that the average land area cultivated by a transmigrant family was 1.00 "bau" (local term for 0.7 hectare). This was the area

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[1] Sajogjo, et al., 1978 in Penny 1982

[2] Ministry of Transmigration

developed from alang - alang grass. The rest of the area of the allocated two hectares was left uncultivated. The families for which these data were collected did not have power inputs such as animal traction or a tractor to assist with the work. The question arose as to what are the limitations on the productivity of the transmigrant families, and how can they be overcome. A systems model was formulated in this study to analyze the productivity of transmigrant families with various assumed inputs and conditions.

A systems approach as a problem analysis methodology is used to analyze and to compare :

1. Various areas cultivatable with different power inputs used in land preparation.
2. The transmigrant productivity and return with different crop mixes.

5.1.3. System Identification

The principal features for analysis of the transmigration family model are identified and illustrated in figures 5.1. and 5.2. The controllable inputs for this model are the availability of human resources, animals and tractors at the transmigration sites, and the production inputs such as crops, herbicides, and fertilizer. The number of human laborers and power inputs in these controllable inputs may be varied during the simulation process to compare several combinations of inputs.

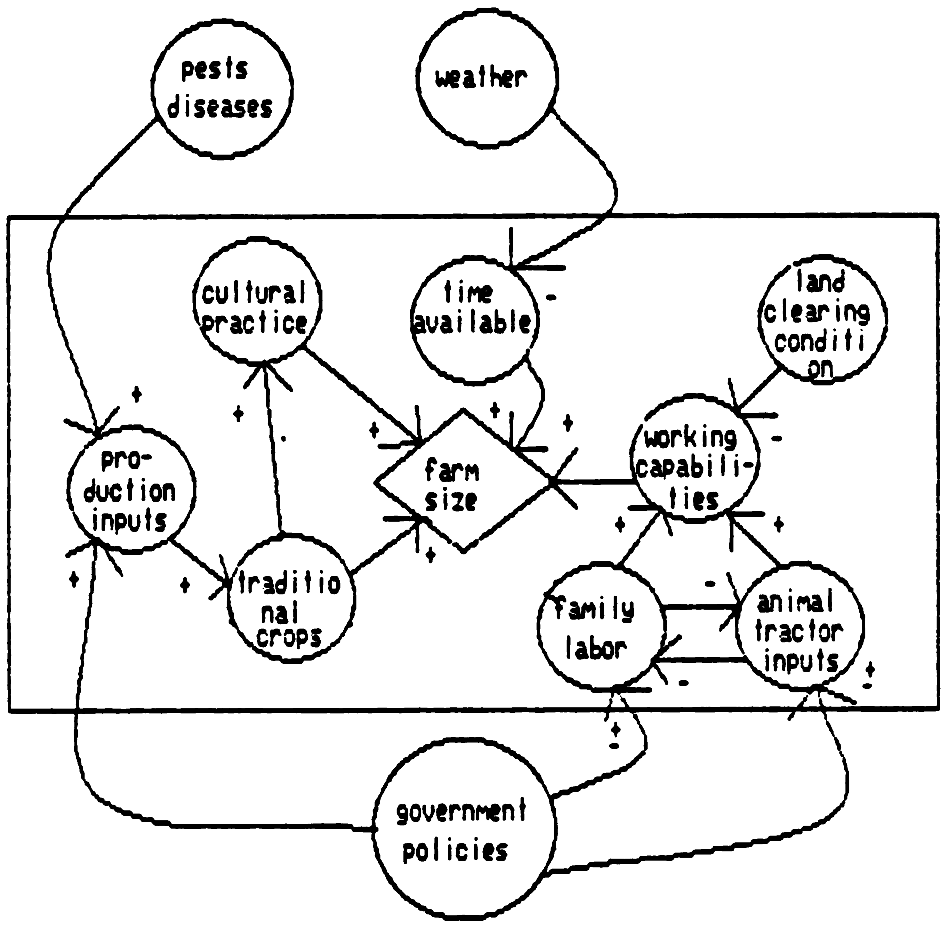


figure 5.1. Causal loop for the transmigrant family model

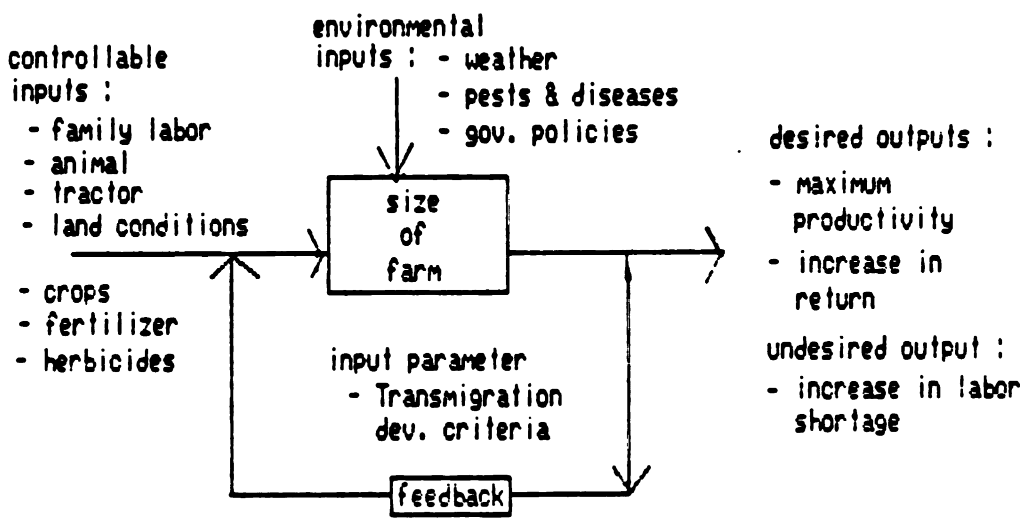


figure 5.2. Blackbox diagram for transmigrant family model

The exogeneous or environmental inputs are variables which affect the system but are not influenced by the system (Manetsch and Park, 1987). In the transmigration family model, environmental inputs were weather conditions, pests and diseases, and established government policies.

The input parameters, which are to be fixed during the simulation process, are variables which serve to specify the structure of the system (Manetsch and Park, 1987). At the present time, transmigration development criteria such as an allocation of two hectares of land, selected agricultural equipment for the transmigrants are classified as input parameters.

The desirable results from using the transmigration family model were a higher productivity and low cost-return ratios. An decrease of labor capacity would be an undesirable result which would force transmigrants to readjust their management practice.

5.1.4. System Linkage

The linkages between identified components in the transmigration family model were illustrated in the causal loop model presented in figure 5.1. The following discussion describes the relationships between the critical components in the system.

The problem of labor shortage during land preparation was analyzed by replacing human labor with animal-draft traction or a tractor. Application of a power input reduces the number of laborers needed for land preparation.

The land condition, along with the availability of human labor or other power inputs, directly affects the productivity of labor or other power inputs. The land condition after the land clearing operation affects the field efficiency of animals or tractors during land preparation for growing the crops.

Cultivated areas were planted with traditonal crops such as paddy, corn, beans, and cassava by the transmigrants. The size of the cultivated area for each crop was determined by the availability of labor from each transmigrant family in the preparation of the land for growing crops and the number of non rainy days during the month of land-preparation operations.

Crop selection is based on local soil conditions, weather, and capability of obtaining production inputs. The traditional crops were manipulated in simulation studies to analyze the labor capacity during growing the crops, the productivity of a labor unit, and transmigrant family's return with various crop mixes. The production inputs remained fixed during the simulation process.

5.2. Transmigration family model

The working capability of a transmigrant family and the availability of non-rany days are two critical factors in determining total area cultivatable by the transmigrant families during land preparation. The working capability of a transmigrant family was influenced by the availability of family laborers and other power inputs, and the workability of the soil for land preparation. The availability of non-rainy days are affected by the probability of a working day.

To avoid the failure of harvest because of pests and diseases, the transmigrant generally must plant their crops simultaneously with those of other farmers in the surounding area. This situation creates a labor shortage during the land preparation period.

Assumed production inputs (crops, herbicides, and fertilizer), which are adapted to the local conditions of soil, pests and diseases, were purchased from a local market. The crops were to be planted on the area cultivated by the transmigrants.

The area planted for each crop was adjusted to transmigrant capabilities. Shortages of labor during crop growth is eliminated by rearranging the cropping pattern and reducing the planted area for each crop. Evaluation of the planted area for each crop provided a feedback mechanism for the system.

5.2.1. Farm size analysis.

Working capabilities assumed for humans using a hoe and crowbar as tools were taken from measurements GMU (1978). The measured capacity for a person was 0.25 'borong per kejing' and it was equal to 692 manhours per hectare (see section 4.4.1.).

In the evaluation of labor utilization, an assumption was applied to differentiate between men, women, and children. An adult male devoting one hundred percent of his time working in an agricultural field was assumed equal to one unit of labor. This assumption is a modification of data taken by GMU (1978) and TAD (1981). The following table 5.1. shows the composition of a labor unit.

Table 5.1. The composition of a unit of labor

Types	Labor unit	Explanatory
Adult man	1.0	working 100% of his time in agricultural field
Adult woman	0.5	if she has children under seven years old
	0.75	if all children are at least seven years old
Children (seven years and older)	0.30	if in school
	0.50	if not in school
Other Adults	1.0	

The working capacity available in term of manhours per month was calculated as follows :

$$CAP = L * D * H * pwd \quad (4.1.)$$

where :

CAP	=	available working capacity, manhours / month
L	=	available unit labor, man
D	=	available working days, days / month
H	=	available working hours, hours / day
pwd	=	probability of a working day, decimal

The cultivated area was then calculated by dividing the working capacity available to actual capacity as follows :

$$A = CAP / CM \quad (5.1.)$$

where :

A	=	cultivable area, hectares
CM	=	measured working capacity
	=	692 manhours / ha, (GMU,1977).

Effective field capacity of power input derived from Hunt (1977) was used to calculate the capability of machine operation and animal traction. Effective field capacity was defined as actual rate of performance of land or crop processed in given time based upon total field time (ASAE Standards, 1984). Field operation capacity was calculated as follow :

$$EFC = \frac{S * W * E}{10} \quad (5.2.)$$

Where :

EFC = effective field capacity, Hectares / hour

S = speed, Kilometers / hour

W = effective width of equipment, meters

E = field efficiency, decimal

10 = conversion factor to a unit of Hectares per hour

GMU (1978) stated that field efficiency for animal and tractor in the transmigration area was low as the result of land conditions after the land clearing operation. Some stumps were left and pieces of wood could be found in the soil as a result of land clearing operations, makeing power inputs such as animal and tractor difficult to operate in the new area. For the purpose of simulations, field efficiency of power inputs is assumed to be 0.51 - 0.59 (GMU 1978).

Area cultivated by animal-drawn traction or tractor were calculated by an equation derived from ASAE Standards (1984) as follows :

$$A = EFC * D * H * pwd \qquad (5.3.)$$

where : A = cultivable area, hectares

D = the estimated working days available, days

H = the expected hours available for field work each day, hours

pwd = the probability of a working day, decimal

Several assumptions were made in evaluation of working days and expected working hours available as follows:

1. Working days available for each month were obtained through the evaluation of the average monthly non-rainy days for 25 years (1952 - 1976) in the location (Appendix A). The working days were calculated by multiplying total days in a month to the probability of a working day.
2. A rainy day was defined as a day with rainfall at least equal to 10 mm, thus there would be no work during the rainy days (Djojomartono 1979). The field work would be resumed on the following day if there was no more rain.
3. The probability of a working day (pwd) was obtained from the ratio of total non-rainy days in a month to total days for that month. In this model, soil conditions were not assumed as a constraint since soil can be used to plant the crop for a whole year.

   An example of a pwd calculation is as follows :

   Month : September

   Number of non rainy days : 25

   pwd = 25 / 30 = 0.83

4. The effective working hours in a field were assumed to be 5 - 10 hours per day (Soedjatmiko, 1981), and the transmigrants work longer in the fields during the busy field operation. For instance, during the land preparation operation the working hours were assumed to be ten hours per day, while the manuring operation was assumed at six hours per day. The transmigrants work longer in the field during the wet months to compensate for the rainy days when work could not be accomplished (Appendix B).

5.2.2. Productivity analysis

The size of the planted area for each crop was determined by the ability of a transmigrant family to prepare the land for growing each traditional crop. In this model land preparation was carried out during September for rice, February for corn and cassava, and March for beans.

Two assumptions were made in the cropping system as follows :

1. The applied cropping system was a multiple cropping system defined as growing two or more crops on the same field at different time during a year (FAO 1983). The transmigrant will divide his farm land into several plots depending upon the number of crops he wants to plant and the decision to plant each crop on a different plot.

2. Multiple cropping would be specified as relay inter-cropping; that is, growing two or more crops simultaneously during part of each one's cycle (FAO 1983). A second crop was inter-planted before the first crop is ready to harvest.

The planting time used for each crop was taken from the evaluation of crop water requirements and water balance made by GMU (1978). In the transmigrant family model, crops would be planted in the particular month that the availability of water for crops meets or exceeds the water requirement for growing the crops (see tables 4.8. and 4.9.). The following is the timetable used for planting, growing, and harvesting :

Table 5.2. Timetable for planting, growing, and harvesting traditional crops.

No.	Crops	Months
1.	Paddy	November - March
2.	Corn	March - June
3.	Beans	April - July
4.	Cassava	March - November

The projected yield (see table 3.6.) was used to establish the analysis of the expected production in this model. The expected production was calculated as follows :

$$EXPROD_i = A_i * PROCROP_i, \qquad (6.4.)$$

where : $EXPROD_i$ = Expected production of planted crop, Kg

A_i = Planted area, hectare

$PROCROP_i$ = Projected crop yield, Kg / hectare

i = Tradional crop, i= 1,2,...,n

1 = paddy rice 2 = corn

3 = beans 4 = cassava

The productivity of the transmigrant is defined as the ability of a unit laborer to generate a number of products, and it is analyzed as follows :

$$PROVI_i = \frac{EXPROD_i}{\text{unit labor}} \qquad (5.5)$$

where : $PROVI_i$ = productivity, Kg / unit labor

The evaluation of cost and return was done by subtracting the costs of producing each traditional crop from the gross income obtained from selling the crop. The result of the return was analyzed by converting to the milled rice equivalent (EQRICE).

The following flowchart is a logical computer program for the transmigration farmland model.

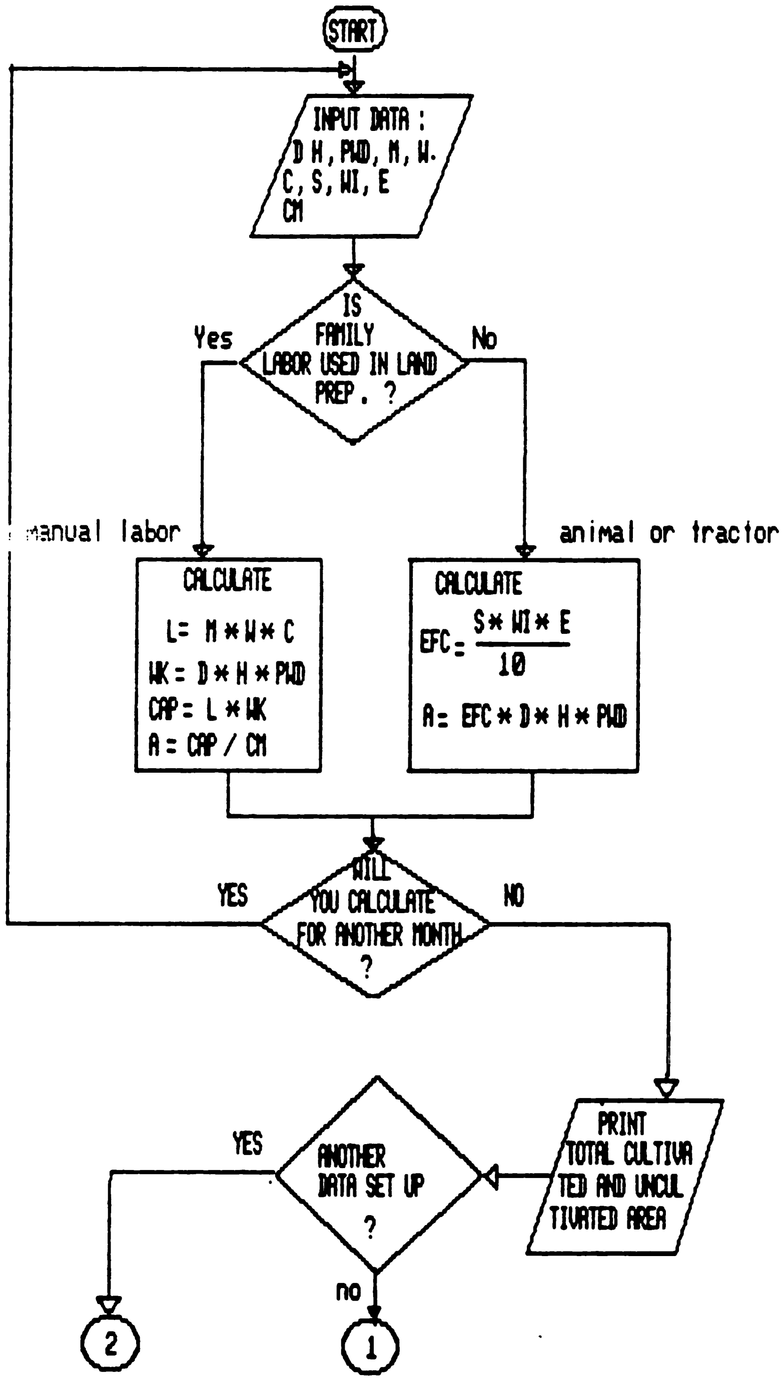
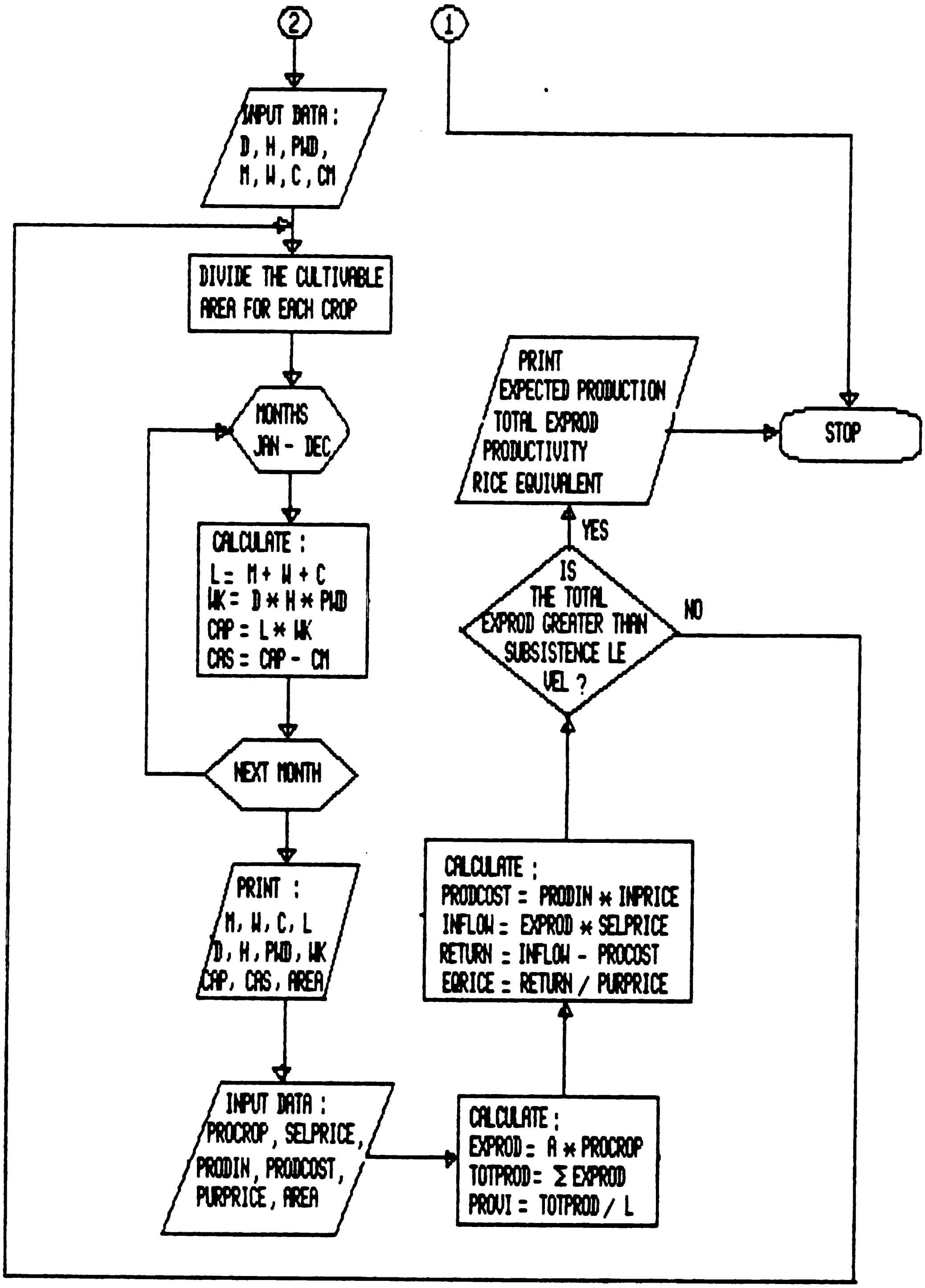


figure 5.3. Transmigration family model flowchart

figure 5.3. (cont'd)



Note on flowchart :

H	:	availability of working hours, hours / day
D	:	availability of working days, days / month
pwd	:	probability of a working day, decimal
WK	:	availability of working time
		= H * D * PWD, hours
M	:	man laborer, man
W	:	woman laborer, man
C	:	child laborer, man
L	:	availability of unit laborer
		= M + W + C, man
CAP	:	availability of working capacity
		= L * Wk, manhours
CM	:	measured capacity
		= 690 manhours / hectare
S	:	working speed of a power input, Km / hour
W	:	effective width of a piece of equipment, meter
E	:	efficiency, decimal
10	:	conversion factor to a unit of hectare
EFC	:	effective field capacity, hectare / hour
A	:	number of cultivable areas
		= CAP / CM or EFC * H * D * PWD
CAS	:	surplus of working capacity, manhours
EXPROD	:	expected production of a crop, Kg / ha
PROCROP	:	projected production of a crop, Kg / ha
TOTPROD	:	total production of crops, Kg

PROVI : productivity of a laborer, Kg / unit laborer

PRODIN : production input of each crop, Kg

INPRICE : price of input, Rp.

PRODCOST : cost of production, Rp.

SELPRICE : selling price of a product, Rp.

INFLOW : total of production sale. Rp.

RETURN : profit of total production, Rp.

EQRICE : equivalent of value of rice. Kg

5.3. System Simulation Inputs

Simulation usually refers to a computer program or other functioning models that represent a system of different design and management strategies (Manetch & Park 1987). Simulation models are best at providing a range of information rather than a single optimal point (Soedjatmiko 1981).

The transmigration family model was formulated to represent the productivity of a transmigrant family. Various assumptions of labor input for the transmigration family model can be made to represent the availability of family labor and outside labor. The model may also be used to consider the use of animals and / or hand tractors.

Plans call for the transmigrants to arrive at the new area during the month of August which allows them approximately two months to prepare their land for planting in November.

Several simulations were used to analyze the area that the transmigrants could prepare and cultivate. Those simulations were as follows:

1. Simulation 1 assumed that the land preparation was done entirely by the transmigrant family, and the family consisting of parents with two children under seven years old who were not in school.
2. Simulation 2 assumed a family with one child under seven years old, and one child more than seven years old, but in school.
3. Simulation 3 assumed a family with two children older than seven years old and in school.
4. Simulation 4 assumed that the labor input was the family from simulation 3 plus one hired laborer for land preparation.

It was assumed that only manual labor was used for growing the crops on all simulations. The rationale for this is that planter and other agricultural machines are generally not available in transmigration areas; and planting, weeding, and harvesting are done manually.

Simulations using additional power inputs such as animals or hand tractors for land preparation operations would be analyzed to find out the affect of using power inputs to the transmigrant family income.

Transmigrant family working hours and days were taken from the file WORKDATA. These assumptions provide the availability of working hours and days based on the probability of each working day in the course of a year.

The following table 5.3. shows the simulated availability of labor unit for the land preparation.

Table 5.3. Simulated Labor Input Units for Land Preparation (man).

Simulations	M[1]	W[2]	Cu[3]	Ca[4]	Labor unit
1	1	1	0	0	1.5
2	1	1	0	1	1.8
3	1	1	0	2	2.35
4	2	1	0	2	3.35

1. M = man
2. W = woman
3. Cu = children under seven years old
4. Ca = children at least seven years old

Labor surplus was obtained by subtracting the labor requirement per hectare for growing traditional crops from the monthly availability of labor input beyond the land preparation operation. The labor requirement data are included in file LABDATA.

Projected yield per hectare of each traditional crop was used to summarize the expected production from a mixed crop; that is, the traditional crops were assumed to be planted in the same field that consists of several plots. Each plot would be planted with one traditional crop. Projected yield data were taken from the research findings of Gadjah Mada University (1978) and are listed under file PROJCROP. The projected yield per hectare might be higher if land preparation is done using animals or hand tractors (Soedjatmiko 1981).

Production costs and the selling prices of products were assumed for a financial analysis of a transmigrant family. The production costs are listed under file PRODCOST and selling prices at farm level (farmgate price) are listed under file PRICEDAT. All these data files are included in appendix B.

Each land productivity simulation was run to evaluate the different assumed inputs of manual labor, animals, and hand tractors. A custom hired animal or tractor was assumed along with owning a hand tractor, to examine how they affected a transmigrant's farm income.

VI. SYSTEM SIMULATION OUTPUTS AND DISCUSSION

The system simulation outputs of the transmigration family model were; cultivable area of farmland, surplus labor evaluation, transmigrant productivity, and financial analysis.

6.1. Cultivable area analysis

Table 6.1. presents the cultivable area results with different assumed labor inputs.

Table 6.1. Simulated Size of Cultivable Area With Different Assumed Labor Inputs for The Land Preparation

Simulation	Area Cultivable (hectare)				
	Paddy rice	Corn	Beans	Cassava	Total
1	.54	.15	.37	.15	1.21
2	.65	.19	.44	.18	1.46
3	.85	.24	.57	.24	1.90
4	1.21	.34	.83	.34	2.72

Land preparation for paddy rice was carried out in September. Working hours for land preparation were assumed to be 10 hours per day, while probability of a working day during September was assumed to be 0.83 (Appendix B). Working time available for September (30 days) was found by multiplying the working time during September to probability of a working day in September , 10 * 30 * 0.83, which equals 249 hours per month. Assumed labor inputs consist of one man, one woman, and two children under seven years old (simulation 1). Total labor units available for this simulation is 1.5 man. The area that a transmigrant family can cultivate during September was 0.54 ha of land (249 hours * 1.5 man / 692 manhours per ha). 692 manhours per ha was measured working capacity of one man (see section 4.4.1.). The analysis for other simulations and crops were calculated in the same way.

Table 6.1. shows that the cultivable area increases with additional labor units as a small child attains an age more than seven years (simulation 2). The results are a projected increase of 0.25 ha in land utilization.

If a transmigrant family has two children over seven years old and in school (simulation 3), the area cultivated is predicted to be 1.90 hectare. With one additional hired laborer (simulation 4), the transmigrant family can expand the farmland utilization to 2.72 hectare; an increase of more than 43 percent above simulation of a family with two children older than seven years old and in school.

6.2. Labor surplus analysis

Table 6.2. presents the labor inputs availability for each month during one year of growing traditional crops. In this analysis, assumed labor inputs for each simulation was multiplied by the probability of working time for every month during the year. The probability of working time for growing

the crops is listed under file WORKDATA (Appendix B).

Table 6.2. Simulated Labor Availability Condition for Each Simulation for Different Assumed Labor Inputs During Growing The Crops (manhours)

Months	Simulations 1	2	3	4
January	167	200	262	262
February	210	252	329	329
March	251	301	393	393
April	162	194	254	254
May	190	228	297	297
June	197	237	309	309
July	215	258	337	363
August	232	278	363	363
September	374	498	585	585
October	330	396	517	517
November	180	216	282	282
December	179	214	280	280
T o t a l	2,699	3,286	4,225	4,225

The availability of labor input for simulation of one man, one woman, and two children under seven years old (simulation one) for January can was calculated as follows :

1.5 man * 8 hours * 31 days * .45 = 167 manhours

The same calculation is used to analyze the availability of labor inputs each month during one year for different simulation for growing the crops.

The analysis of labor surplus beyond land preparation was obtained by subtracting the labor requirement for each traditional crop from labor available on table 6.2. and the results of the analysis are shown on table 6.3.

Table 6.3. The Labor Surplus Analysis by Months Based on Labor Requirement of Each Simulatiom During Growing The Crops (manhours)

	Simulations			
Months	1	2	3	4
January	81	97	127	62
February	113	135	176	111
March	36	42	55	-89
April	143	171	224	210
May	143	169	223	191
June	119	144	189	134
July	186	223	292	272
August	206	247	323	305
September	374	498	585	585
October	292	351	458	433
November	85	101	132	68
December	85	97	127	62
T o t a l	1,863	2,275	2,911	2,344

Table 6.3. shows that total surplus labor for one year for all simulations is positive. However, there is one negative value for March of the simulation with additional hired labor.

The additional one laborer (simulation 4) allows the preparation of more area than for the other simulations using only family labor. However, a transmigrant family has a problem of caring for all the crops on the additional land prepared during the month of March. To eliminate the labor shortage, the transmigrants may have to reduce the cultivable area or rearrange cropping pattern by dropping one crop.

The analysis for eliminating labor shortage by reducing area cultivated and rearranging cropping patterns will be discussed in page 72 of this chapter.

The surplus capacity of table 6.3. shows that there was extra time for the transmigrant family to do field work, and the transmigrant family would use their spare time to do clearing operation such as removing stumps or woods that were left in the field.

6.3. Productivity and returns analysis

Table 6.4. shows the simulated production of each traditional crop for different assumed labor inputs.

Table 6.4. Simulated Production of Each Traditional Crop for Different Assumed Labor Inputs (Kg)

Simulations	Paddy	Corn	Beans	Cassava
1	810	120	259	1,500
2	975	152	308	1,800
3	1,275	192	399	2,400
4	1,815	272	581	3,400

Table 6.4. shows the simulated increase of production for different assumed labor inputs. Increase in production was the result of the increase of area cultivated by the transmigrant family during land preparation. The highest increase in production, more than 120 percent increase for all production, was found for the simulation with one additional outside laborer during the land preparation operation.

Productivity of a labor unit was defined as the ability of a labor unit to produce a specified number of traditional crops. The values of the productivity of a unit laborer are shown on table 6.5.

Table 6.5. Simulated Productivity of a Unit Labor to Produce Traditional Crops for Each Simulation (Kg/unit labor)

Simulations	Paddy	Corn	Beans	Cassava
1	540.00	80.00	172.67	1,000.00
2	541.67	84.44	171.11	1,000.00
3	542.55	81.70	169.79	1,021.28
4	772.34	115.74	247.23	1,446.81

Table 6.5. shows that there was an increase of productivity for the simulation with one additional laborer (simulation 4) during the land preparation. This increase in productivity is caused by an increase in production of each traditional crop.

Evaluation of financial analysis for each simulation is presented on table 6.6. In this evaluation, the value of rice equivalent was calculated by dividing the net farm income of a transmigrant family by the market price of rice at Rp. 90 per kg (TAD 1978). The net farm income was defined as the benefit to the farmer after substracting the farm production cost from gross farm income. The hired labor cost assumed was at Rp.500 per day which consisted of Rp 350 for field work and Rp 150 for meal (Soedjatmiko 1981).

Table 6.6. Simulated Financial Analysis of Transmigrant Family for Each Simulation (Rupiah)

Items	Simulations			
	1	2	3	4
Gross Farm Income	151,800	182,445	238,995	341,595
Prod. Cost:				
Prod. Input	22,517	27,103	35,243	50,592
Hired Labor	0	0	0	44,500
Bullock	0	0	0	0
Hired Tractor	0	0	0	0
Owned tractor	0	0	0	0
Net farm income	129,284	155,342	203,752	246,503
Rice Equivalent (Kg milled rice)	1,436.48	1,726.02	2,263.92	2,738.93

Table 6.6. shows that the results for all simulations projected net farm income higher than subsistence level for a transmigrant family of four people which was assumed to be

equivalent to 960 kg milled rice. The highest net farm income was gained for a transmigrant family with an additional laborer used in land preparation (simulation 4). The cost of hired labor was covered by a transmigrant's income from selling his farm products. The hired laborer would be paid by the transmigrants after they sold their farm products. Hired labor was used for land preparation during September, February and March, and the total working period for a hired labor was 89 days. Thus, the hired labor cost was Rp. 44,500. During the non-land preparation period, a hired laborer would work outside the farm area.

The cost of production was calculated in the file PRODCOST. The data on production input costs per ha of each traditional crop were listed in this file. Production cost for each simulation was the total cost of production of the traditional crops. Simulation with one additional laborer has the highest production cost of Rp.50,592 while a transmigrant family with two small children (simulation 1) has the lowest cost of production at Rp. Rp.22,517. The highest simulated net income with one additional labor at Rp.246,503 was achieved because of a larger area utilized (2.72 ha compared to 1.21 hectare for simulation 1, 1.46 ha for simulation 2, and 1.90 ha for simulation 3).

Although all simulations showed the value of rice equivalent to be higher than the subsistence level, there was some labor surplus and a negative value as shown in table 6.3. To utilize all labor more efficiently the mixed crops and areas of traditional crops was adjusted and simulations were run to obtain more optimun results.

One simulation assumed a crop mix of paddy, beans, and cassava without corn. The next simulation assumed that paddy rice was not planted. The transmigrant would buy rice from the market after they sell their farm products. For this purpose, corn was planted together with beans and cassava. Tables 6.7. and 6.8. present the timetables for these two simulations.

Table 6.7. Timetable for Planting, Growing, and Harvesting Paddy Rice, Beans, and Cassava.

No.	Crops	Months
1.	Paddyrice	November - March
2.	Beans	April - July
3.	Cassava	March - November

Table 6.8. Timetable for Planting, Growing, and Harvesting Corn, Beans, and Cassava

No.	Crops	Months
1.	Corn	October - February
2.	Beans	April - July
3.	Cassava	March - November

Results of simulation without corn and simulation without paddyrice can be seen on table 6.9.

Table 6.9. Results from the Two Simulations

Items	Paddy, Beans, and Cassava	Corn, Beans, and Cassava
Cultivatable area (ha)		
paddy	.85	0
corn	0	.85
beans	.57	.57
cassava	.48	.48
Total		
Farm Production (Kg)		
paddy	1,275	0
corn	0	680
beans	399	399
cassava	4,800	4,800
Productivity (kg/unit labor)		
paddy	542.5	0
corn	0	289.36
beans	169.79	169.79
cassava	2,042.55	2,042.55
No. of month with negative values of labor surplus	0	0
Financial analysis (Rp.)		
gross farm income	299,475	244,650
production cost	34,994	34,216
bullock cost	0	0
net farm income	264,481	210,434
Rice equivalent (Kg milled rice)	2938.68	2338.15

The purpose of the analysis was to utilize labor more efficiently during all months and to eliminate the labor shortage. This analysis assumed that all farm operations were done by the transmigrant family consisting of parents with two children older than seven and in school.

The projected area planted for paddy rice, beans, and cassava is 0.85 ha of paddy, 0.57 ha of beans, and 0.48 ha for cassava. These cultivable areas were determined by the working capability of the transmigrant family during land preparation in September, February, and March. By dropping the corn crop from the cropping pattern and reducing the area planted for paddyrice, the problem of labor shortage was eliminated.

The total cultivatable area without corn was the same as the previous analysis of a transmigrant family of four, the net farm income of the transmigrant family increased by more than 25 percent. This incremental net income was caused by reduction of production cost of the transmigrant and a 100 percent increase in cassava production. The incremental net income of the rice equivalent also increased from 2,263 Kg to 2,938 Kg or a 30 percent increase.

The crop mix without paddy projected a lower rice equivalent of about 20 percent compared to the mixed crop with no corn. The assumed price of corn per kilogram was 28 percent lower than for rice per kilogram, thus it lowered the farm income.

The rice equivalent of the crop mix without paddy was 2,338 kg milled rice or almost 144 percent higher than the assumed subsistence level for four people. The shortage of labor during the growing season (March) was also eliminated.

6.4. Analysis of power inputs used in land preparation.

The following analysis was intended to study the transmigrant family income that might result from using animal traction and a tractor as power inputs. A crop mix of paddy, beans, and cassava was used for the basic analysis. This cropping pattern was used because this pattern showed that the transmigrant family can utilize the planted area of each crop and there was no labor shortage.

The animal traction simulation assumed the use of a moldboard plow with a 0.25 m width and a working speed of 1.22 km per hour (Soedjatmiko 1981). The field efficiency for animal traction was assumed at 0.54 (GMU 1978). The animal was custom hired.

For the custom-hired tractor analysis, all data were taken from Soedjatmiko (1981). The hand tractor was equipped with rotary tiller with 20 to 24 blades (54 - 64 cm wide). During the simulation run, a rotary tiller with an assumed 60 cm width was used. The working speed of a tractor was 2.33 km per hour, and the field efficiency was assumed to be 0.64 (GMU 1978). The cost of a custom-hired tractor was Rp. 16,700 per hectare. The equivalent cost for the operator's meal was Rp 900, while cost of the operator itself was included in the cost of the custom-hired tractor.

Another simulation assumed that the transmigrant owned a tractor. During the land preparation operation, the transmigrant would hire out his tractor to others. This was done to reduce his cost of ownership. The tractor price was assumed to be Rp 1,650,000. Fuel and oil costs for the tractor were Rp 50 and Rp 500 per liter respectively.

Table 6.10. shows the results of analysis using power inputs.

Table 6.10. Simulated Result of Assumed Power Inputs

Items	Simulations		
	animal	custom hired tractor	owned tractor
Financial analysis (Rp.)			
Revenue :			
gross farm income	299,475	299,475	299,475
Custom hired inc.	0	0	285,570
Total revenue	299,475	299,475	585,045
costs :			
production cost	34,994	34,994	34,994
custom hired bullock	45,550	0	0
custom hired tractor	0	33,350	0
fixed cost	0	0	181,500
operating cost	0	0	7,720
owned tractor cost	0	0	189,220
net farm income	218,931	230,951	306,831
Rice equivalent (Kg milled rice)	2,432	2,566	4,009

From the analysis of table 6.10., the bullock as power input costs amounted to Rp. 45,550. These costs consisted of Rp 27,550 cost for land preparation of 1.90 ha and Rp 18,000 for the cost of the operator's meal for 20 days. The bullock power input simulation projected a 12 percent lower net farm income as compared to the simulation of a crop mix with no corn. The rice equivalent for simulation using a bullock was found at 2,432 kg milled rice.

The simulation of a custom hired tractor projected a transmigrant's net income higher than animal traction. The actual net income of a custom hired tractor was Rp 230,951 which was Rp 12,020 higher than for the custom hired bullock. Increases in the transmigrant's net income were a result lowered operating costs when using a custom-hired tractor compared to a custom-hired bullock. In simulation with a custom-hired tractor, land preparation was done in two days. The cost of land preparation was Rp 31,730 and operator cost was Rp 1,800. The increase of net income of Rp 2,318 was equivalent to 134 kg of milled rice.

The simulation of a farmer owned tractor resulted in the highest net farm income of the transmigrant family when compared to other simulations. Net income of the transmigrant with this simulation was Rp 306,831 or equivalent to 4009 Kg milled rice. This projection was the result of additional income the transmigrant received from renting his tractor to other farmers. The cost of ownership or fixed cost of simulation for the transmigrant who owned his own tractor was Rp. 181,500. This ownership cost was covered by renting his tractor to other farmers. Soedjatmiko (1981) in his research found out that tractor owner's return was almost double from his costs. Simulated owned tractor shows that the transmigrant return from custom work was about Rp 96,000.

VII. CONCLUSION AND RECOMMENDATION

7.1. Conclusions

Several conclusions can be made from this study and are as follows :

1. A system model was developed and tested for productivity of the transmigrant family which provides the means to study productivity and land utilization under various conditions and with different input resources.

2. Simulation studies were made with secondary data pertaining to labor, animal, and tractor inputs and with various resource assumptions.

   a. A transmigrant family of four with no outside laborers could utilize 1.9 hectare of land with a crop mix of paddyrice, beans, and cassava; or a crop mix of corn, beans, and cassava.

   b. The hiring of one laborer for land preparation increased the land utilization capability of a transmigrant family to about two hectares based on assumptions made.

   c. Based on assumptions made, a transmigrant family's farm income was Rp 218,914 for a custom-hired bullock, Rp 230,951 for a custom-hired tractor, and Rp 306,831 for a transmigrant family owned a tractor.

3. The simulation studies made provide examples of how the systems model might be utilized in the planning of land and resource allocation to transmigrant families.

7.2. Recommendations for futher research

1. The data used in the transmigration family model was taken from research carried out by Gadjah Mada University. It is suggested to take direct measurement of manual labor, bullock, and tractor on transmigration sites to improve the model.

2. Futher research on the capability of human labor is needed. To increase the reliability of the model, the capability of a man, a woman, and children need futher development and verification.

3. Futher research on the farm production of different crops using man, animals and tractor is needed to find out the differences in incremental farm production as affected by power inputs used on land preparation.

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APPENDIX A

APPENDIX A

Appendix A consists of rainfall and rainy days data for transmigration sites of Tajau Pecah. This monthly data was taken by Gadjah Mada University when they did research on the transmigration program in Tajau Pecah. The rainfall data were taken for the years 1952 - 1976.

Appendix A Distribution of rainfall and rainy days
Pleihari, South Kalimantan, 1952 - 1976

Year		January	Feb.	March	April	May	June	July	August	Sept.	October	Novemb.	Decemb.
1952	mm	474	304	417	164	41	37	154	146	39	167	282	342
	days	18	17	13	9	9	2	6	4	6	13	17	22
1953	mm	316	207	423	302	327	92	47	21	38	133	195	394
	days	20	20	23	15	15	5	9	1	4	7	16	20
1954	mm	253	262	311	151	191	192	508	204	103	200	420	610
	days	19	13	18	16	13	12	15	13	7	14	22	22
1955	mm	440	343	218	447	171	304	311	199	160	234	422	272
	days	23	16	16	19	15	18	23	15	12	14	24	22
1956	mm	573	111	495	178	205	268	127	34	78	198	273	542
	days	17	19	18	6	12	19	7	7	5	12	11	27
1957	mm	562	384	447	193	174	38	164	130	0	38	202	504
	days	19	17	21	13	13	5	14	11	0	4	11	27
1958	mm	279	398	344	503	295	34	106	132	101	319	309	492
	days	20	21	21	26	16	6	6	15	8	16	17	24
1959	mm	335	178	338	282	285	223	114	10	25	21	108	174
	days	20	17	19	16	18	17	6	4	4	3	16	2
1960	mm	330	208	175	199	170	3	56	68	56	51	248	180
	days	21	14	12	19	13	2	7	10	7	3	19	12
1961	mm	548	205	94	90	48	216	2	2	11	106	224	385
	days	16	11	6	9	6	11	1	1	1	4	10	19
1962	mm	561	398	193	168	137	127	114	52	22	162	219	861
	days	22	19	10	11	7	9	9	3	3	16	14	19
1963	mm	503	362	101	65	99	0	0	41	0	23	138	416
	days	28	15	5	4	6	0	0	2	0	11	4	12
1964	mm	210	256	345	375	179	180	49	0	213	212	332	264
	days	12	13	10	11	4	6	2	0	12	16	20	13
1965	mm	268	192	286	184	168	30	107	0	0	46	134	347
	days	12	11	14	9	9	1	1	0	0	1	7	11

Appendix A (cont'd)

1966	mm	268	397	417	178	74	208	78	84	104	228	319	476
	days	9	11	12	9	6	8	3	4	5	11	12	16
1967	mm	288	378	155	284	118	181	75	86	0	58	114	185
	days	12	10	10	13	9	6	3	1	0	4	7	8
1968	mm	433	248	424	141	47	182	49	47	30	111	328	515
	days	16	16	11	12	3	6	5	4	1	7	10	15
1969	mm	335	210	537	281	186	85	165	74	105	97	202	597
	days	16	9	17	10	7	4	7	4	2	5	9	16
1970	mm	229	223	348	265	175	203	258	83	127	110	447	594
	days	15	9	13	11	10	6	10	3	7	8	21	21
1971	mm	481	165	300	166	115	177	38	160	235	198	589	301
	days	15	21	14	10	9	4	3	8	7	11	29	16
1972	mm	396	303	132	128	88	59	16	0	0	27	199	226
	days	15	11	12	13	8	7	1	0	0	1	7	10
1973	mm	280	200	357	124	316	200	238	129	179	67	283	370
	days	7	6	11	8	15	12	12	12	8	15	16	12
1974	mm	215	495	177	259	100	113	241	20	406	216	378	248
	days	7	6	11	12	5	7	11	3	10	12	14	12
1975	mm	354	248	407	253	199	232	294	136	335	297	298	374
	days	21	15	16	16	14	7	5	6	15	13	11	6
1976	mm	522	315	247	83	30	58	12	2	17	163	184	125
	days	11	10	9	6	7	12	3	1	5	14	21	20
Total	mm	9453	6985	7688	5463	3938	3442	3329	1860	2384	3482	6872	9794
	days	411	347	342	303	249	192	169	132	129	235	365	404
Mean	mm	378	279	308	219	158	138	133	74	95	139	275	392
	days	16	14	14	12	10	8	7	5	5	9	15	16
SD	mm	119	92	123	106	83	87	118	63	106	85	114	169
	days	5	4	5	5	4	5	5	5	4	5	6	6
CV (%)	mm	31	33	40	48	53	63	89	85	112	61	41	43
	days	31	29	36	42	40	63	71	100	80	56	40	38

Source: Meteorology station, Gunung Mukti in GMU (1978)

APPENDIX B

APPENDIX B

Appendix B consists of five files that were used in the transmigration family model. Data used for this model was taken mainly from research carried out by Gadjah Mada University of Yogyakarta in 1978.

Table 1.B. Filename : WORKDATA

Months	Hours	Days	PWD
1	8	31	.45
2	7	28	.57
3	7	31	.51
4	6	30	.60
5	6	31	.64
6	6	30	.73
7	6	31	.74
8	6	31	.81
9	6	30	.83
10	6	31	.68
11	7	30	.50
12	8	31	.45

Table 2.B Filename : LABDATA

Months	Paddyrice	Corn	Beans	Cassava
1	180	0	0	0
2	180	398	0	0
3	380	40	398	25
4	0	30	40	0
5	0	240	30	0
6	0	0	210	0
7	0	20	70	0
8	0	0	70	0
9	398	0	0	0
10	70	0	0	0
11	160	0	0	60
12	180	0	0	0

Table 3.B. Filename : PROJCROP

Crops	Kg / hectare
Paddyrice	1500
Corn	800
Beans	700
Cassava	10000

Table 4.B. Filename : PRODCOST

	Cost (RP. / ha)			
Items	Paddyrice	Corn	Beans	Cassava
Fertilizer	10,000	10,000	10,000	10,000
Seeds	1,500	15,000	9,000	0
Others	46,500	3,735	6,352	42,000

Table 5.B. Filename : PRICEDAT

Crops	Price (Rp / Kg)
Paddyrice	70
Corn	50
Beans	100
Cassava	10

APPENDIX C

APPENDIX C

Appendix C consists of a computer program for the Transmigration Family Model. This program was written in BASIC language using QUICKBASIC of MICROSOFT.

```
'Hari Respati
'Farmsize Model for Transmigration Program
'A MS Thesis
'June 30, 1988
'
'***************************************************************

COLOR 3, 0
DIM  m$(12),  CAP(12,  4),  crop$(4),  crop(4),  projcrop(4),
prod(4), item$(3)
        m$(1) = "January   "
        m$(2) = "February  "
        m$(3) = "March     "
        m$(4) = "April     "
        m$(5) = "May       "
        m$(6) = "June      "
        m$(7) = "July      "
        m$(8) = "August    "
        m$(9) = "September "
        m$(10) = "October   "
        m$(11) = "November  "
        m$(12) = "December  "


        crop$(1) = "Paddy  "
        crop$(2) = "Corn   "
        crop$(3) = "Beans  "
        crop$(4) = "Cassava"

        item$(1) = "Fertilizer"
        item$(2) = "Seed      "
        item$(3) = "Others    "

****************************************************************

CLS
PRINT ""
PRINT ""
PRINT " ** A SYSTEMS MODEL ANALYSIS OF TRANSMIGRATION **"
PRINT " *******  FAMILY PRODUCTIVITY AND RETURNS  ******"
PRINT ""
PRINT "              -- a computer program --"
PRINT ""
PRINT ""
PRINT ""
PRINT ""
PRINT "                   June 30, 1988"
PRINT ""
PRINT ""
PRINT "                East Lansing, Michigan"
PRINT ""
```

```
PRINT ""
PRINT
PRINT ""
PRINT ""
flo$ = "scrn:"
GOSUB getkey

'**********************************************************

MainMenu:
        CLS
        LOCATE 8
        PRINT "    *********  M A I N   M E N U  **********"
        PRINT
        PRINT "                      [1] Manual Labor Land
PRINT ""                             Preparation"
        PRINT "                     [2] Power Input Land
      PRINT ""                             Preparation"
        PRINT "                     [3] Labor Surplus Calculation"
        PRINT " "
        PRINT "                     [0] Exit"
        PRINT
        PRINT
        INPUT "                          Your Choice : ", Choice
        IF Choice = 1 THEN
           GOTO StartLabor
        ELSEIF Choice = 2 THEN
           GOTO StartPower
        ELSEIF Choice = 3 THEN
           GOTO LaborData
        ELSEIF Choice = 0 THEN
           GOTO tamat
        END IF

        BEEP
        GOTO MainMenu

'***********************************************************
StartLabor:
        CLS
        PRINT "****** Manual Labor Land Preparation ********"
        PRINT ""
        PRINT "Basic information:"
        PRINT ""
        INPUT "When do you start preparing the land (Jan=1)";
              mo
        INPUT "How many men are available to work"; man
        PRINT ""
        INPUT "Is there any woman working in land
              preparation"; jwb$
        IF jwb$ = "yes" OR jwb$ = "YES" OR jwb$ = "Y" OR jwb$
```

```
            = "y" THEN
            GOTO woman

        ELSEIF jwb$  = "no" OR jwb$ = "No" OR jwb$ = "NO" OR
             jwb$ = "n" OR jwb$ = "N" THEN
          wc = 0
          wcs = 0
          GOTO children
        END IF
woman:
        PRINT ""
        PRINT "Woman worker information:"
        INPUT "How many women have children under seven years
              old "; wc
        PRINT "(Write  0 for next question if you've answered
             the above question)"
        INPUT "How many women have children more than  seven
             years old"; wcs

children:
        PRINT ""
        INPUT "Are  there any children working in land
               preparation"; jwb$
        IF jwb$ = "yes" OR jwb$ = "YES" OR jwb$ = "Y" OR jwb$
           = "y" THEN
           GOTO ChildrenCalculation
        ELSEIF jwb$  = "no" OR jwb$ = "No" OR jwb$ = "NO" OR
         jwb$ = "n" OR jwb$ = "N" THEN
           cs = 0
           cns = 0
           GOTO continue
        END IF

ChildrenCalculation:
        PRINT ""
        PRINT "Children workers information:"
        INPUT "How many children go to school"; cs
        INPUT "How many children do not go to school"; cns

continue:
        PRINT ""
        INPUT  "What  is  file  name  for  WORKing  DATA";
FWORKDATA$
        PRINT ""
        OPEN FWORKDATA$ FOR INPUT AS #2
        GOSUB GetOutput

LaborCalculation:

        w1 = wc * .5
        w2 = wcs * .75
        wt = w1 + w2
```

```
        c1 = cs * .3
        c2 = cns * .5
        ct = c1 + c2
        L = man + wt + ct

LaborPrint:
        CLS
        PRINT #1, ""
        PRINT #1,"*****   Working time available (hours per
                month)  *****"
        PRINT #1, " "
        PRINT #1,"¦----------------------------------------¦"
        PRINT #1,"¦ month     hours    ,days     pwd       ¦"
        PRINT #1,"¦----------------------------------------¦"
        FOR I = 1 TO mo
              INPUT #2, H, D, PWD
              WK = H * D * PWD
        NEXT I
  PRINT #1, USING "¦     \           \    ###            ##
         #.##  ¦"; m$(mo), H, D, PWD
        PRINT #1,"¦----------------------------------------¦"
        PRINT #1,
        PRINT #1, "¦--------------------------------¦"
        PRINT #1, "¦   Working time available       ¦"
        PRINT #1, "¦--------------------------------¦"
        PRINT #1, USING "¦   #####                      ¦"; WK
        PRINT #1, "¦--------------------------------¦"
        PRINT #1,
        PRINT #1,
        GOSUB getkey
        PRINT #1,
        PRINT #1,
        CAP = L * WK
        area = CAP / 690
        unarea = 2 - area
        PRINT #1, "*****   Total labor unit available  *****"
        PRINT #1,
        PRINT #1,"¦---------------------------------------¦"
        PRINT #1,"¦ Man Woman Children    Total labor unit¦"
        PRINT #1,"¦---------------------------------------¦"
        PRINT #1, USING "¦ ##  ##.##  ##.##       ##.##   ¦";
                  man, wt, ct, L
        PRINT #1,"¦---------------------------------------¦"
        PRINT #1,
        PRINT #1,
        PRINT #1, "***** Total area cultivable *****"
        PRINT #1,
        PRINT #1,"¦---------------------------------------¦"
        PRINT #1,"¦Working capacity     Area cultivable
                   Area uncultivable ¦"
        PRINT #1, "¦(manhours / month)   (ha)      (ha)   ¦"
        PRINT #1,"¦---------------------------------------¦"
```

```
        PRINT #1,  USING "| #####  ##.##  #.##|"; CAP, area,
                unarea
        PRINT #1,"|--------------------------------------|"
        PRINT #1,
        PRINT #1,
        PRINT #1,
        CLOSE
        GOSUB getkey
        GOTO MainMenu


'****************************************************
StartPower:
        CLS
        PRINT "****** Power Input Land Preparation ********"
        PRINT ""
        PRINT "Basic information:"
        PRINT ""
        INPUT "When do you start preparing the land (Jan =
            1)"; mo
        INPUT "What  is your animal or tractor working speed
             (km / hour)"; s
        INPUT "What is the width of your plow or rotary
         tiller (meter)"; w
        INPUT "What  is the field capacity of your work (0 -
              1)"; eff
        PRINT ""
        INPUT "What's the file name for WORKing DATA";
        FWORKDATA$
        PRINT ""
        OPEN FWORKDATA$ FOR INPUT AS #2

        GOSUB GetOutput

PowerCalculation:

        EFC = (s * w * eff) / 10

PowerPrint:
        CLS
        PRINT #1,
        PRINT #1, ""
        PRINT #1, "          ***** Effective capacity *****"
        PRINT #1,
        PRINT #1,"|--------------------------------------|"
        PRINT #1,  "|    Speed      Width     Efficiency
                        Effective Capacity   |"
        PRINT #1, "|  (km/hour)   (meter)     (decimal)
                      (hectares / hour)    |"
        PRINT #1, "|--------------------------------------|"
  PRINT #1,  USING "|  ##.##  ##.##  #.##          ###.##
                      |"; s, w, eff, EFC
```

```
        PRINT #1, "¦-------------------------------------¦"
        PRINT #1,
        PRINT #1,
        GOSUB getkey
        PRINT #1,
        CLS
        PRINT #1,
        PRINT #1, "             ***** Area cultivable *****"
        PRINT #1,
        PRINT #1, "¦------------------------------------¦"
        PRINT #1,  "¦     Month        Eff. Cap. (Ha/hour)
                     hours    Days    PWD    ¦"
        PRINT #1, "¦------------------------------------¦"
                FOR I = 1 TO mo
                        INPUT #2, H, D, PWD
                        area = EFC * H * D * PWD
                        unarea = 2 - area
                NEXT I
  PRINT #1, USING "¦    \        \        ###.##      ##   ##
                     #.##  ¦"; m$(mo), EFC, H, D, PWD
        PRINT #1, "¦------------------------------------¦"
        PRINT #1,
        PRINT #1,
        PRINT #1, "¦------------------------------------¦"
        PRINT #1,  "¦       Area cultivable (Ha)
                      Area uncultivable (Ha)  ¦"
        PRINT #1, "¦--------------------------------------¦"
  PRINT #1, USING "¦   #####.##     ####.##              ¦";
                     area, unarea
        PRINT #1, "¦--------------------------------------¦"
        PRINT #1,
        CLOSE
        GOSUB getkey
        GOTO MainMenu


'**********************************************************

LaborData:
        CLS
        PRINT ""
        PRINT "*****Labor Surplus Calculation ************"
        PRINT ""
        PRINT ""
        PRINT " Planted area information:"
        INPUT "How many hectares of paddy rice do you want to
               plant "; crop(1)
        INPUT "How many hectares of corn do you want to
         plant"; crop(2)
        INPUT "How  many hectares of beans do you want to
          plant"; crop(3)
        INPUT "How many hectares of cassava do you want to
```

```
            plant"; crop(4)
        PRINT ""
        PRINT " Labor input information:"
        INPUT "How  many men are available in the planting
               operation"; man
        PRINT ""
        INPUT "Is there any woman working in the planting
           operation"; jwb$
        IF jwb$ = "yes" OR jwb$ = "YES" OR jwb$ = "Y" OR jwb$
           = "y" THEN
                GOTO WomanInfo
        ELSE
                GOTO ChildInfo
        END IF

WomanInfo:
        PRINT ""
        INPUT "How many women have children under seven
               years old"; wc
        INPUT "How  many women have children more than
       seven years old"; wcs

ChildInfo:
        PRINT ""
        INPUT "Is there any child working for planting
       operation"; jwb$
        IF jwb$ = "yes" OR jwb$ = "YES" OR jwb$ = "Y" OR jwb$
            = "y" THEN
            GOTO ChildAsk
        ELSE
            GOTO continue1
        END IF

ChildAsk:
        PRINT ""
        INPUT "How many children go to school"; cs
        INPUT "How many children do not go to school"; cns
        PRINT ""

continue1:
        PRINT ""
        PRINT "Data file information:"
        INPUT "What is the filename for WORKing DATA"; FWT$
        INPUT "What is the filename for LABor DATA"; FLB$
        PRINT ""
        OPEN FWT$ FOR INPUT AS #2
        OPEN FLB$ FOR INPUT AS #3
        GOSUB GetOutput

LaborInputCalc:
        m = man * 1
        woman = (wc * .5) + (wcs * .75)
```

```
        children = (cs * .3) + (cns * .5)
        L = m + woman + children

LaborInputPrint:
        CLS
        PRINT #1, ""
        PRINT #1, "      ***** Labor unit available *****"
        PRINT #1,
        PRINT #1,"|-------------------------------------|"
  PRINT #1, USING "| available man  : ###.##      |"; m
  PRINT #1, USING "| available woman  ###.##      |"; woman
  PRINT #1, USING "| available children:###.##|"; children
        PRINT #1, "|-------------------------------------|"
  PRINT #1,  USING "| Total labor unit available :  ####.##
                  man   |"; L
        PRINT #1,"|-------------------------------------|"
        PRINT #1, ""
        PRINT #1, ""
        PRINT #1, ""
        PRINT #1, ""
        GOSUB getkey

ManhourPrint:
        PRINT #1, "                    *****   Manhours available
(manhours) *****"
        PRINT #1, ""
        PRINT #1, "|-------------------------------------|"
        PRINT #1,  "|   Month   Paddy rice  Corn        Beans
                      Cassava     |"
  PRINT #1, USING "|###.##  ha    ###.##  ha   ###.## ha
                   #.## ha    |"; crop(1), crop(2), crop(3),
                  crop(4)
        PRINT #1, "|-------------------------------------|"

        FOR I = 1 TO 12
            INPUT #2, H, D, PWD
            PRINT #1, "| "; m$(I);
            FOR j = 1 TO 4
                WK = H * D * PWD
                CAP(I, j) = L * WK * crop(j)
                PRINT #1, USING "         #####"; CAP(I, j);
            NEXT j
            PRINT #1, "     |"
        NEXT I

        PRINT #1, "|-------------------------------------|"
        PRINT #1, ""
        PRINT #1, ""
        PRINT #1, ""
        GOSUB getkey

LaborSurplusPrint:
```

```
        PRINT #1, ""
        PRINT #1, "***** LABOR SURPLUS CONDITIONS *****"
        PRINT #1, "                  ( mnahours)"
        PRINT #1,"¦-----------------------------------------¦"
        PRINT #1,  "¦  MONTHS          CAPACITY          LABOR
                REQUIREMENT    SURPLUS   ¦"
        PRINT #1, "¦-----------------------------------------¦"
        TotalCapMonth = 0
        TotalLaborReq = 0
        TotalSurplus = 0
        FOR I = 1 TO 12
            LaborReq = 0
            TotalCapCrop = 0
            FOR j = 1 TO 4
              INPUT #3, ln
              LaborReq = LaborReq + crop(j) * ln
              TotalCapCrop = TotalCapCrop + CAP(I, j)
            NEXT j
            Surplus = TotalCapCrop - LaborReq
  PRINT #1, USING "¦ \ \ ##,###   ##,###   ###  ¦"; m$(I),
         TotalCapCrop, LaborReq, Surplus
            TotalCapMonth = TotalCapMonth + TotalCapCrop
            TotalLaborReq = TotalLaborReq + LaborReq
            TotalSurplus = TotalSurplus + Surplus
        NEXT I
        PRINT #1,"¦--------------------------------------¦"
  PRINT #1,  USING "¦ Total       :    ##,###
          ##,###  ##,###     ¦"; TotalCapMonth,
 TotalLaborReq, TotalSurplus
        PRINT #1, "¦--------------------------------------¦"
        CLOSE
        GOSUB getkey
        GOTO ProdFin


'*******************************************************

ProdFin:
        CLS
        PRINT "P R O D U C T I O N  A N D  F I N A N C I A L"
        PRINT "                  A N A L Y S I S"
        PRINT ""
        PRINT "[1] Production and Productivity Analysis"
        PRINT "[2] Production Cost Analysis"
        PRINT "[3] Profit Analysis"
        PRINT ""
        PRINT "          "
        PRINT ""
        PRINT ""
        PRINT
        PRINT
```

```
        GOSUB GetOutput
        FProjCrop$ = "a:projcrop"
        FProdCost$ = "a:prodcost"
        FWORKDATA$ = "a:workdata"
        FPriceData$ = "a:pricedat"
        OPEN FWORKDATA$ FOR INPUT AS #2
        OPEN FProjCrop$ FOR INPUT AS #4
        OPEN FProdCost$ FOR INPUT AS #5
        OPEN FPriceData$ FOR INPUT AS #6

'**********************************************

productionAnalysis:
        CLS
        PRINT " ***** PRODUCTION AND PRODUCTIVITY *****"
        PRINT "          ***** ANALYSIS *****"
        PRINT ""
        PRINT ""
        PRINT ""
        PRINT "Basic information:"
        PRINT ""
        INPUT "What is data file for PROJected CROP"; file$
        INPUT "What  is the file name for PRODuction COSTs";
              a$
        INPUT "What is the file name for PRICE DATa"; F$
        PRINT ""
        PRINT ""


ProductionPrint:
        CLS
        PRINT #1, ""
        PRINT #1,
        PRINT #1, "Farm Production of a Transmigrant Family "
        PRINT #1, " "
             PRINT #1,"|-------------------------------|"
             PRINT #1, "|  Crops              Planted Area
                          Production     Productivity  |"
             PRINT #1,  "| (hectare) (kilogram) (Kg/unit
                    labor) |"
             PRINT #1, "|------------------------------|"
        Totprod = 0
                FOR I = 1 TO 4
                        INPUT #4, projcrop
                        prod(I) = crop(I) * projcrop
                        Provi = prod(I) / L
        PRINT #1, USING "| \      \   ##.###   ###,###
                   ####.##|"; crop$(I),  crop(I),
             prod(I), Provi
                NEXT I
              PRINT #1, "|-------------------------------|"
```

```
        PRINT #1,
        PRINT #1,
        PRINT #1,
        GOSUB getkey

'*******************************************************

ProductionCostAnalysis:
        CLS
        PRINT #1, "***** Production Costs Analysis *****"
        PRINT #1, "                 (Rupiah) "
        PRINT #1, ""
              PRINT #1, "¦------------------------------¦"
              PRINT #1, "¦   Items  Paddy  Corn  Beans
                         Cassava   ¦"
              PRINT #1, "¦-------------------------------¦"



        PRINT #1,  USING "¦ Planted area (Ha) :    #.##
                          #.##  #.##  #.##¦"; crop(1),
                   crop(2), crop(3), crop(4)
              PRINT #1, "¦--------------------------------¦"
                   Totprod = 0
                   FOR I = 1 TO 3
                     PRINT #1, "¦ "; item$(I); "       ";
                     FOR j = 1 TO 4
                       INPUT #5, prodcost
                       item = crop(j) * prodcost
                       Totprod = Totprod + item
                       PRINT #1, USING " ###,### "; item;
                     NEXT j
                     PRINT #1, "   ¦"
                   NEXT I
              PRINT #1, ¦------------------------------¦"
        PRINT #1,  USING "¦ Total production costs (Rp):
                    ##,###,###.##¦"; Totprod
              PRINT #1, "¦- -----------------------------¦"
              GOSUB getkey

'*********************************
PowerInputCost:
        CLS
        PRINT " ***** COST OF POWER INPUT *****"
        PRINT ""
        PRINT " [1] Manual Labor Power Input"
        PRINT " [2] Bullock Power Input"
        PRINT " [3] Tractor Power Input"
        PRINT " [4] Own Tractor"
        PRINT ""
        PRINT " [0] No Power Input"
        PRINT '
```

```
        PRINT '

        INPUT " Choose Power Input (1,2,3,4 or 0) ", jwb
        MCost = 0
        BLCost = 0
        TRCost = 0

        IF jwb = 1 THEN
           GOTO ManualCost
        ELSEIF jwb = 2 THEN
            GOTO bullockcost
        ELSEIF jwb = 3 THEN
            GOTO tractorcost
        ELSEIF jwb = 4 THEN
            GOTO OwnTractor
        ELSEIF jwb = 0 THEN
            GOTO ProfitAnalysis
        ELSE
            BEEP
            GOTO PowerInputCost
        END IF

'**** CALCULATION OF POWER INPUT COST ****


ManualCost:
        CLS
        PRINT ""
        PRINT "Basic information for hired labor:"
        PRINT ""
        INPUT "How many hired laborer are used in farm work";
              a
        INPUT "When is hired labor used (Jan = 1)"; mo
        INPUT "How many Rupiah is the labor cost per day"; CD
        INPUT "How  many rupiah  is the  cost of the meal per
              day"; CM
        FOR I = 1 TO mo
           INPUT #2, H, D, PWD
        NEXT I
        TOTCROP = crop(1) + crop(2) + crop(3) + crop(4)
        CAP = a * H * D * PWD
        MCost = (CD + CM) * (TOTCROP * 690) / (CAP / D)
        GOTO ProfitAnalysis

bullockcost:
        CLS
        PRINT ""
        PRINT "Basic information for bullock operation:"
        PRINT ""
        INPUT "When is a hired bullock  used (Jan=1)"; mo
        INPUT  "How  many  rupiah  for  a  custom  hired  for
               bullock"; RP
```

```
        INPUT "How  many rupiah is the cost of the operator's
               meal"; CM

        CLOSE #2
        OPEN FWORKDATA$ FOR INPUT AS #2

        FOR I = 1 TO mo
           INPUT #2, H, D, PWD
        NEXT I
        TOTCROP = crop(1) + crop(2) + crop(3) + crop(4)
        TempVal = 6 / (TOTCROP / EFC)
        IF TempVal = INT(TempVal) THEN
                WorkDays = TempVal
           ELSE
                WorkDays = INT(TempVal) + 1
        END IF
        BLCost = (RP * TOTCROP) + CM * WorkDays
        GOTO ProfitAnalysis


tractorcost:
        CLS
        PRINT ""
        PRINT "Basic information for tractor custom hired:"
        PRINT ""
        INPUT "When is a custom  hired  tractor  used  (Jan =
               1)"; mo
        INPUT "How many rupiah for a custom hired tractor per
              hectare"; RP
        INPUT "How many rupiah is the operator's meal"; CM

        CLOSE #2
        OPEN FWORKDATA$ FOR INPUT AS #2
        FOR I = 1 TO mo
                INPUT #2, D
        NEXT I
        CLOSE #2
        TOTCROP = crop(1) + crop(2) + crop(3) + crop(4)
        TempVal = 12 / (TOTCROP / EFC)
        IF TempVal = INT(TempVal) THEN
                WorkDays = TempVal
           ELSE
                WorkDays = INT(TempVal) + 1
        END IF
        TRCost = (TOTCROP / RP) + CM * WorkDays
        GOTO ProfitAnalysis


OwnTractor:
        PRINT ""
        PRINT "Basic information for Own Tractor:"
        PRINT ""
```

```
INPUT "When is the tractor used "; mo
INPUT "What is the purchase price of your  tractor";
     TRp
INPUT "What is the diesel fuel price per liter "; FRp
INPUT "What is the oil price per liter"; ORP
INPUT "What is the operator's wage per day"; WRp

'**********
' TAXES,  HOUSING, AND INSURANCE FOR A TRACTOR WILL BE
 ASSUMED
' 2 % OF TRACTOR'S PURCHASE PRICE (ASAE STANDARD 1984)

' FUEL CONSUMOTION  (FCOST) AVERAGE IS 1.2 LITERS /
HOUR
' OIL  CONSUMPTION (OCOST) AVERAGE IS 0.042 LITERS /
HOUR
' OPERATOR WAGES (LCOST) AVERAGE IS RP.500 PER DAY
' REPAIR AND MAINTENANCE COST (RMCOST)  IS ASSUMED 1.2
 % PER  100 HOURS WORK TIMES 90 % OF THE PURCHASE
PRICE
' (TAKEN FROM SOEDJATMIKO 1981)
'************

FixCost = TRp - (.1 * TRp) / 10 + (.02 * TRp)



CLOSE #2
OPEN FWORKDATA$ FOR INPUT AS #2
FOR I = 1 TO mo
        INPUT #2, D
NEXT I
CLOSE #2
TOTCROP = crop(1) + crop(2) + crop(3) + crop(4)
TempVal = 12 / (TOTCROP / EFC)
IF TempVal = INT(TempVal) THEN
        WorkDays = TempVal
   ELSE
        WorkDays = INT(TempVal) + 1
END IF

FCOST = 1.2 * LRp * (TOTCROP / EFC)
OCOST = .042 * ORP * (TOTCROP / EFC)
RMCOST = (.012 / 100) * (TOTCROP / EFC) * .9 * PRp
LCOST = WCOST * WorkDays

OpCost = FCOST + OCOST + RMCOST + LCOST

OwnCost = FixCost + OpCost
```

```
'***********************************************************

ProfitAnalysis:
        CLS
        PRINT #1, ""
        PRINT #1, "          ***** Profit Analysis *****"
        PRINT #1, ""
        PRINT #1, "|---------------------------------------|"
        PRINT #1, "|Crops  Production (Kg)  Revenue (Rp)   |"
        PRINT #1, "|---------------------------------------|"
        TotRevenue = 0
                FOR I = 1 TO 4
                        INPUT #6, pricedat
                        Revenue = prod(I) * pricedat
                        TotRevenue = TotRevenue + Revenue
                        PRINT #1, USING "| \      \
                        ###,###   ###,### |"; crop$(I),
                 prod(I), Revenue

                 NEXT I
        PRINT #1, "|---------------------------------------|"
  PRINT #1, USING "| Total Revenue (Rp):     ###,###,###   |"
                   ;  TotRevenue
        PRINT #1, "|----------------------|"
  PRINT #1,  USING "| Total Production Cost (Rp):
                   ###,###,###   |"; Totprod
  PRINT #1, USING "| Manual Labor Cost (Rp): ###,###,###   |"
                   ; MCost
  PRINT #1,  USING "| Bullock Cost (Rp):
                                 ###,###,###   |"; BLCost
  PRINT #1, USING "| Tractor Cost (Rp):     ###,###,###   |";
                   TRCost
  PRINT #1, USING "| OwnTractor (Rp) :###,###   |"; OwnCost
                   Profit =  TotRevenue - Totprod - MCost -
                  BLCost - TRCost - OwnCost
        PRINT #1, "|--------------------------------------|"
  PRINT #1, USING "| Profit (Rp): ###,###   |"; Profit
        PRINT #1, "|--------------------------------------|"
                 RiceEquivqlent = Profit / 150
  PRINT #1, USING "| Rice Equivqlent (Kg) :    ##,###.##   |"
                   ; RiceEquivqlent
        PRINT #1, "|--------------------------------------|"

        CLOSE
        GOTO akhir

GetOutput:
        INPUT "Where do you want the result to be printed (1=
                screen, 2= printer or 3= file)"; result

        IF result = 1 THEN
```

```
           flo$ = "scrn:"
        ELSEIF result = 2 THEN
             flo$ = "lpt1:"
        ELSEIF result = 3 THEN
            INPUT "What's the filename"; flo$
        ELSE
            BEEP
            GOTO GetOutput
        END IF
        OPEN flo$ FOR OUTPUT AS #1
        RETURN

getkey:
        IF flo$ = "scrn:" THEN
             LOCATE 25, 20
             PRINT "Strike Any Key to Continue ";
             Colek$ = ""
GetKey0:
             Colek$ = INKEY$
             IF Colek$ = "" THEN GOTO GetKey0
        END IF
        RETURN




akhir:
        INPUT "Do you want to reanalyze again"; jwb$
        IF jwb$ = "yes" OR jwb$ = "YES" OR jwb$ = "Y" OR jwb$
           = "y" THEN
           GOTO MainMenu
        ELSE
           GOTO tamat
        END IF


tamat:
        END
```

APPENDIX D

APPENDIX D

Appendix D consists of an example of computer program of A SYSTEMS MODEL ANALYSIS OF TRANSMIGRATION FAMILY PRODUCTIVITY AND RETURNS. This example was taken from simulation five of chapter five.

A SYSTEMS MODEL ANALYSIS OF TRANSMIGRANT FAMILY PRODUCTIVITY AND RETURNS

A COMPUTER PROGRAM

******** M A I N   M E N U ********

[1] Manual Labor Land Preparation

[2] Power Input Land Preparation

[3] Labor Surplus Calculation

[0] Exit

Your Choice :

BASIC INFORMATION :

WHEN DO YOU START PREPARING THE LAND ?

HOW MANY MAN IS AVAILABLE TO WORK ?

IS THERE ANY WOMAN WORKING FOR LAND PREPARATION ?
HOW MANY WOMEN HAVE CHILDREN UNDER
SEVEN YEARS OLD ?
HOW MANY WOMEN HAVE CHILDREN OLDER THAN
SEVEN YEARS OLD ?

IS THERE ANY CHILD WORKING FOR LAND PREPARATION ?
HOW MANY CHILDREN GO TO SCHOOL ?
HOW MANY CHILDREN NOT GO TO SCHOOL ?

OUTPUT OF MANUAL LABOR LAND PREPARATION :

CROP	: CASSAVA
MONTH	: FEBRUARY
WORKING HOURS	: 10 HOURS
WORKING DAYS	: 28 DAYS
P W D	: 0.50
WORKING TIME AVAILABLE	: 140 HOURS
LABOR UNIT AVAILABLE	: 2.35 MAN
WORKING CAPACITY	: 329 MANHOURS
AREA CULTIVABLE	: 0.48 HECTARE

*** LABOR ANALYSIS FOR GROWING THE CROPS ***

BASIC INFORMATION OF PLANTED AREA :

HOW MANY HECTARES OF PADDY RICE DO YOU
WANT TO PLANT ? 0.85

HOW MANY HECTARES OF CORN DO YOU
WANT TO PLANT ? 0

HOW MANY HECTARE OF BEANS DO YOU
WANT TO PLANT ? 0.57

HOW MANY HECTARES OF CASSAVA DO YOU
WANT TO PLANT ? 0.48

BASIC INFORMATION ON LABOR INPUTS :

HOW MANY MAN IS AVAILABLE FOR PLANTING ? 1

IS THERE ANY WOMAN AVAILABLE FOR PLANTING
OPERATION ? YES

HOW MANY WOMEN HAVE CHILDREN UNDER
SEVEN YEARS OLD ? 0

HOW MANY WOMEN HAVE CHILDREN OLDER THAN
SEVEN YEARS OLD ? 1

IS THERE ANY CHILD AVAILABLE FOR PLANTING
OPEARTION ? YES

HOW MANY CHILDREN GO TO SCHOOL ? 2

HOW MANY CHILDREN NOT GO TO SCHOOL ? 0

LABOR SURPLUS ANALYSIS (MANHOURS) :

MONTHS	CAPACITY	REQUIREMENT	SURPLUS
JAN	280	153	127
FEB	329	153	176
MAR	393	335	58
APR	254	23	231
MAY	297	17	280
JUN	309	122	189
JUL	338	41	297
AUG	363	41	323
SEP	585	0	585
OCT	517	60	458
NOV	282	165	117
DEC	280	153	127

PRODUCTION AND FINANCIAL ANALYSIS

[1] PRODUCTION AND PRODUCTIVITY ANALYSIS

[2] PRODUCTION COST ANALYSIS

[3] NET FARM INCOME ANALYSIS

FARM PRODUCTION ANALYSIS :

CROPS	AREA ha	PRODUCTION kg	PRODUCTIVITY kg/ unit labor
PADDY	0.85	1,275	542.55
CORN	0	0	0
BEANS	0.57	399	169.79
CASSAVA	0.48	4,800	2,042.55

PRODUCTION COST ANALYSIS (RUPIAH):

ITEMS	PADDY	CORN	BEANS	CASSAVA
FERTILIZER	8,500	0	5,700	4,800
SEEDS	1,275	0	5,130	0
OTHERS	3,953	0	3,621	2,016

T O T A L : 34,994

FINANCIAL ANALYSIS (RUPIAH) :

ITEMS	
Revenue :	
PADDY	95,625
CORN	0
BEANS	59,850
CASSAVA	144,000
T O T A L	299,475
PRODUCTION COST	34,994
MANUAL LABOR COST	0
BULLOCK COST	0
TRACTOR COST	0
COST OF OWN TRACTOR	0
PROFIT	264,481
RICE EQUIVALENT (KG MILLED RICE)	2,938.68