CHAPTER V

RESULTS OF ANALYSIS AND DISCUSSION

V.1. RESULT OF THE BASE RUN

Although the data available are not sufficient for validation, the simulation of the base-run Baduy shifting cultivation model indicates that the simulation results are reasonable to demonstrate the general dynamic behavior of the real situation in Baduy area.

Each essential component and interrelationships among the component of the Baduy's shifting cultivation will be analysed and described in turn below.

V.1.1. POPULATION SECTOR

An base-run simulation of the population sector in Baduy shifting cultivation in which birth rate, death rate, in-migration rate and out-migration rate are 0.037, 0.016, 0.05 and 0.05 respectively (detailed equations presented in Appendix 2). The run was for 50 years. It shows that population of Baduy increased rapidly over time (Figure 11, 12 and 13).

Initial population recorded 4,600 people. The first, second, and third ten years subsequently it increased to 8,462, 15,000, and 16,000 people, respectively. This result

was higher than the census data calculation. Based on census data, the Baduy population during the 6 year 1980-1986 recorded an increase of 16 per cent, while the result of the simulation, increase of population in first 10 years of 46 per cent. Furthermore, increasing of population after first ten years subsequently increase rapidly concurrent with the increasing of food level. However, after 27 years, population decreases, because food availability to support the population decreases after 11 years. The Baduy society actually collapses in 50 years as population approaches zero because food is inadequate. Food surplus in Baduy reaches zero after 23 years and becomes negative ever since.

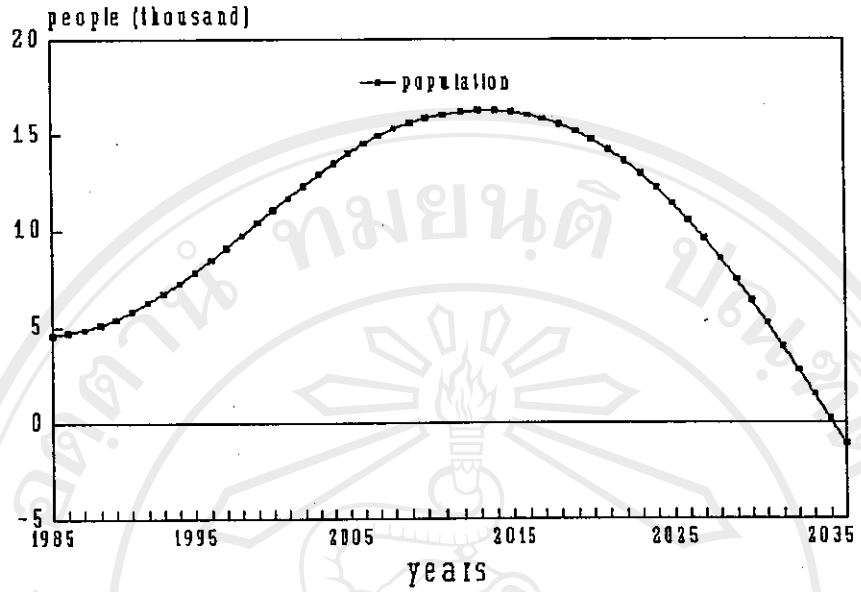

Figure 11 Population of Baduy in base run simulation

The main factors affecting the increasing or decreasing total population in Baduy are birth rate and death rate. Initial birth and death rate are 182 people and 74 people/year, respectively. The first, second, and third ten years subsequently birth rate increases to 508, 592, and 595 people/year, respectively, while death rate increases to 135, 232, and 391 people/year, respectively (Figure 12).

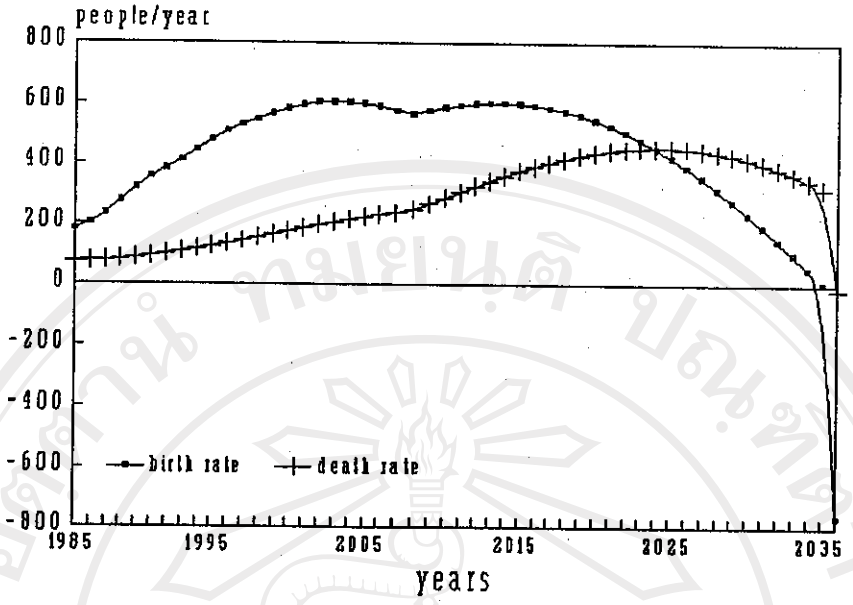

Figure 12 Birth and death rate of Baduy population in base run simulation.

Other factors, such as in-migration and out-migration fraction are also important in the effect on the population (Figure 13). This is because the out-migration rate will determine a decrease in population and in-migration rates will determine an increase in population. Out-migration of Baduy people to outer Baduy to cultivate rice in the uplands of non Baduy areas will result a decline in the population level. These factors are also determined by food surplus. Food surplus increases, so does birth rate and in-migration rate, and vice versa.

Initial in-migration and out-migration rate was 246 people and 230 people/year, respectively. The first, second and third ten years subsequently in-migration rate increased

to 687, 800, and 804 people/year, respectively, while out-migration rate increased to 423, 725, and 1223 people/year, respectively (Figure 13).

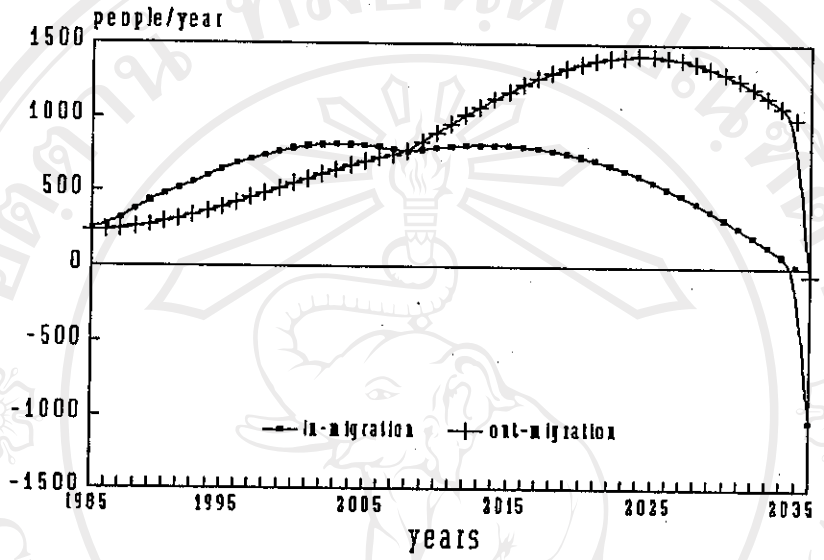

Figure 13 In-migration and out-migration rate of Baduy population in base-run simulation

V.1.2. FOOD SECTOR

V.1.2.1. FOOD IN BADUY AREA

Food level in Baduy is mainly determined by dynamic changes of inputs and outputs of food from non Baduy to the Baduy area and vice versa. In Baduy itself, the food production of each year is determined by agricultural

production of each type land use. Agricultural production is mainly for subsistence, but some products are usually sold in the non Baduy area market. Some agricultural products come from the non Baduy area, when Baduy people have shifting cultivation areas in non-Baduy. Some foods are also bought in the market or from small shops with cash, most of which is obtained from selling agricultural produce or from off-farm jobs. Food outflows are a result of consumption, export and losses. Off-farm employment depends on agricultural production and basic need of the people. If there is a deficit of agricultural production compared to the aggregate level of basic needs of the Baduy people, the off-farm activities will be necessary.

The simulation results show that food level in Baduy increased over time until 11 years, but afterwards the food level decreases (Figure 14). Initial food availability in Baduy is recorded at 442 million rupiah. After ten years it increases to 3,425 million rupiah. After 23 years, it decreases to 244 million rupiah. Beyond 23 years, food deficit in Baduy is experienced. Note that the zero or negative level of food is possible because consumption is already taken into account. Negative level of food means that the population has less than adequate to eat.

The main factors affecting the decreasing in food availability in Baduy area as mentioned earlier are food consumption (FCNS), soil fertility (SFRT) and land use

changes. Changing those parameters in the simulation model has significant effect on food availability. Food consumption determined by number of population. Population

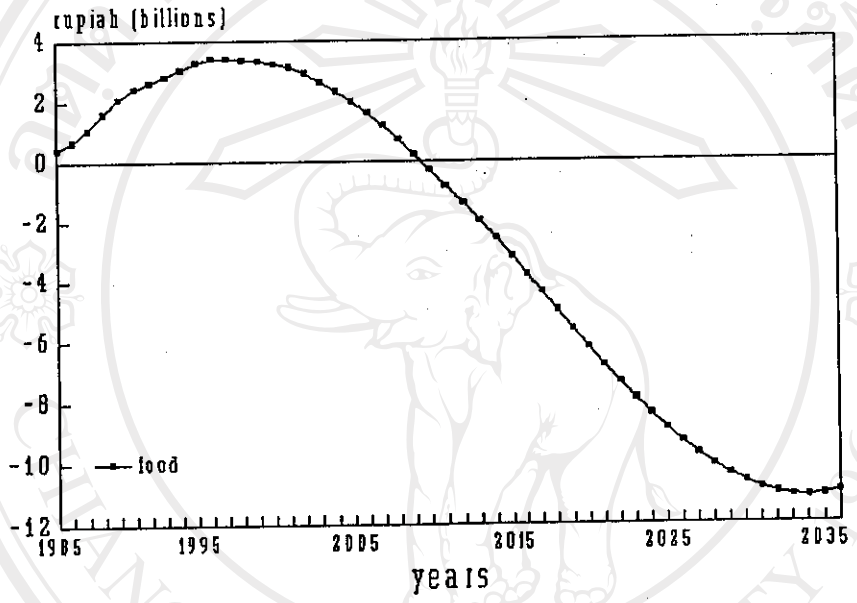

Figure 14 Food in Baduy in base run simulation

increases so does food consumption and vice versa. Soil fertility can determine food availability, because main source of food in Baduy came from agricultural production, which is mainly determined by soil fertility of agricultural land. While land use changes can also determine of soil fertility as well as agricultural production. In this

simulation shows that ladang area as well as soil fertility decreases over time, which has negative effect on agricultural production as well as food availability. While population and food consumption increases over time. Accordingly, food availability in Baduy, although the first ten years increase rapidly, but afterwards the food availability decreases, even after 23 years to be zero.

Besides, as mentioned earlier that food supply in Baduy area has been assumed to be determined by other factors, such as food requirement and food consumption, agricultural production and basic needs of Baduy people, off-farm activities and non ladang production.

V.1.2.2. FOOD SURPLUS

Based upon base line simulation, food supply is assumed to determine on population dynamic. For example, if food surplus (SURPLUS1) increase 1 per cent, it will determine increase of 0.1 per cent of birth and in-migration rate. While, if food deficit increase 1 per cent, it will determine an increase of 0.1 per cent of death and out-migration rate. These food response factors (X1 to X4) are assumed a level of 0.1 per cent to capture some response in birth, death, in-migration, and out-migration at a low level. The results of this run shows that SURPLUS1 at the beginning increases, however, after 10 years there will be a

rapid decrease over time, and after 29 years it will be zero. Therefore, food supply as well as population can be affected by SURPLUS1 (Figure 15). For example, population birth rate after 39 years will be zero, while death rate and out-migration will increase due to food shortage.

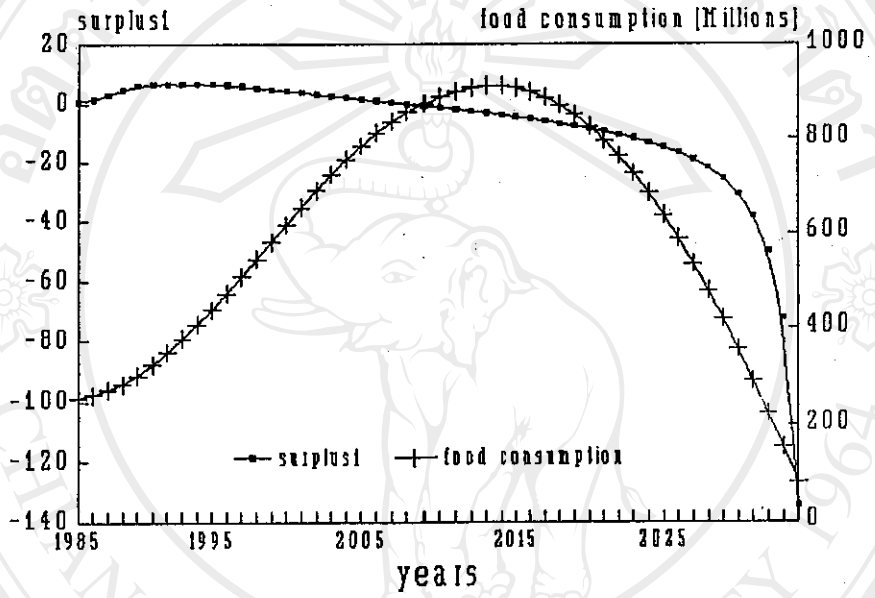

Figure 15 Surplus1 and food consumption (rupiah) of Baduy in base run simulation

V.1.2.3. PLUS2 AND OFF-FARM

Plus2 in the base line simulation is positive, if the aggregate level of the Baduy people basic need requirement over total agricultural production (TAGP) is positive, the off-farm activities will occur or increase. Plus2 indicates the necessity of the population to seek alternative income

sources when agricultural production is inadequate. In this model, no constraint is assumed for the availability of off-farm employment .

The result of this run shows that at the first stage, agricultural production as well as food increase and off-farm income is low, however, after 20 years, agricultural production decreases and off-farm increase, while food consumption a parallel with population dynamic over time (Figure 16 and Figure 17).

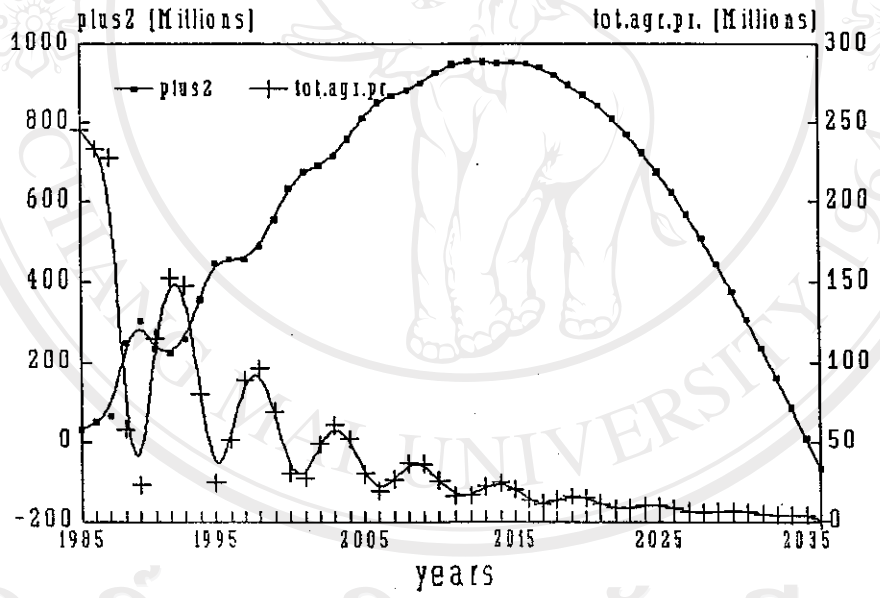

Figure 16 Plus2 and total agricultural production (rupiah) in Baduy in base run simulation

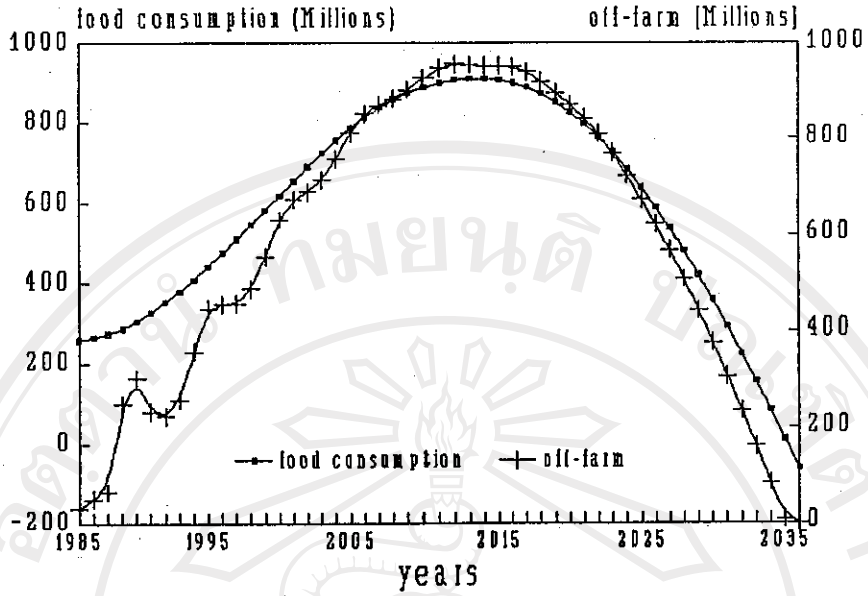

Figure 17 Food consumption and off-farm income (rupiah) in Baduy in base line simulation

V.1.2.4. FOOD SUPPLY IN NON BADUY AREA

Base upon base run simulation, food supply in Baduy area is assumed determined by ladang production of non Baduy area. The output of ladang of non Baduy area is also determined by ladang area in non-Baduy and soil fertility. Ladang area in non Baduy is determined by out-migration rate of outer Baduy people to non Baduy area. Total food supply in Baduy area accordingly can also be increased.

The results of this run show that ladang production in non-Baduy fluctuated and eventually decreases over time (Figure 18). It is because population and out-migration of

outer Baduy at the beginning increase, after 40 years decrease, and soil fertility, which is also assumed to determine ladang production, decreases over time.

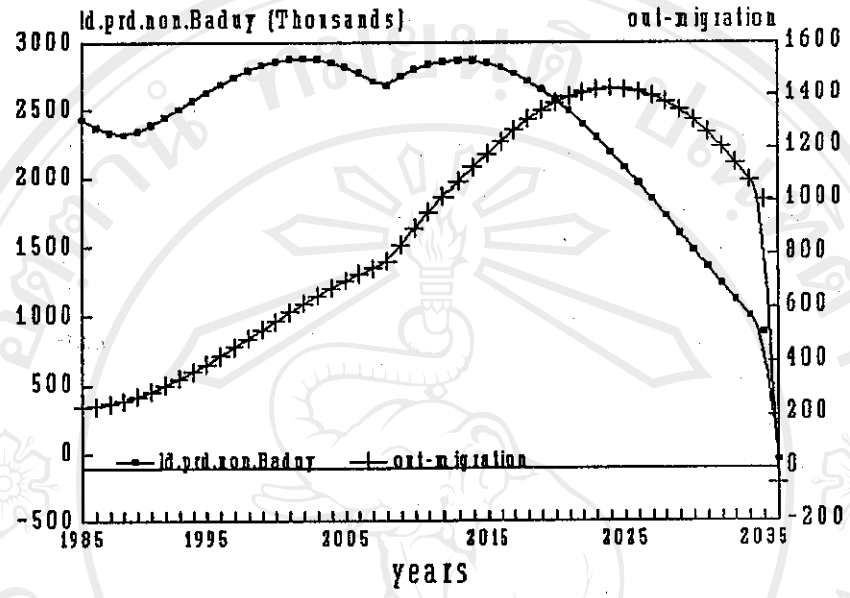

Figure 18 Food supply (rupiah) in non-Baduy area and out-migration rate (people) of Baduy people in base run simulation

V.1.3. LAND USE SECTOR

Base run simulation of the land use sector of Baduy's shifting cultivation model was done using base line data for area of ladang , reuma of fallow time one year (RMA1) , reuma of fallow time two years (RMA2), reuma of fallow time three years (RMA3), reuma of fallow time four years (RMA4),

monoculture garden area (MNGDA), mixed-garden area (MXGDA) and man-made forest area (MMFA). They are 736 ha, 76 ha, 76 ha, 76 ha, 1536 ha, 107 ha, 50 ha, and 25 ha, respectively. Immature reuma area as well as mature reuma area is determined by forest cutting area for planting rice. The acreage of reuma area is needed for planting rice is 0.16 ha per person per year. However, constraining cutting only available of mature reuma, such as reuma of fallow time four years (RMA4). Outputs from ladang became inputs for monogarden fraction, about 50 per cent of the total ladang area. And outputs on mono garden area become inputs to mixed garden and reuma area, 30 per cent and 69 per cent of the total area of monogarden, respectively (detailed equations are presented in Appendix 2).

The results of run for 50 years show that ladang area, monogarden area, reuma of fallow time one year, reuma of fallow time two years, reuma of fallow time three years, and reuma of fallow time four years fluctuate over time and lastly decrease. While mixed-garden area and man-made forest area (mmfa) increase over time (Figure 19). Ladang area fluctuates over time and eventually decreases. The first, second and third ten years subsequently it is recorded at 247 ha, 137 ha, and 150 ha, respectively. Within 50 years ladang area is recorded at 32 ha. Reuma of fallow time one years in the first, second and third ten years subsequently it becomes 172 ha, 234 ha, and 205 ha, respectively. Within

50 years it is 88 ha. Reuma of fallow time two years, in the first, second, and third ten years is 389 ha, 326 ha, and 211 ha, respectively. In 50 years, is recorded 77 ha. Reuma of fallow time three years, in the first, second and third ten years subsequently it recorded 522 ha, 313 ha, and 165 ha, respectively. Within 50 years, it reduces to 78 ha. Reuma of fallow time four years or more mature secondary forests, in the first, second, and third ten years subsequently, it is 458 ha, 210 ha, and 124. In 50 years, it is reduced to 178 ha. While mixed-garden and man-made forest increase over time. Initial mixed-garden and man-made forest are recorded 50 ha and 25 ha, respectively. The first, second and third ten year subsequently mixed garden increases to 713 ha, 1089 ha, and 1298 ha, respectively, and man-made forest area increases to 131 ha, 266 ha, and 418 ha, respectively (Figure 19 and Figure 22).

In this model shows that secondary forests, particularly mature secondary forest decrease over time because they are cut into ladang and monogarden area. Besides, some area of ladang, monogarden and reuma1 can be also converted into man-made forest and mixed-garden area. Due to lack of mature forest in their area, therefore, many people of outer Baduy, after cultivating rice in ladang, they usually out-migrate to rent land in non Baduy area. They will come back again to their area from non Baduy area after reuma area ready to be cultivated again. In this case,

out-migration of outer Baduy to non-Baduy area is one of solutions of outer Baduy to solve agricultural land shortage in their area. In other words, out-migration is one solution of outer Baduy people in management fallow time in their area.

These figures reasonably approximate the dynamics of the behavior of land use systems in Baduy. For example, currently the mixed garden is developing rapidly. Some commercial crops have been introduced to this area, such as coffee and clove. Although according to traditional law, these crops are still forbidden (taboo) to be cropped in inner Baduy. The development of mixed garden area has come about through the conversion of monogarden being planted by mixed annual and perennial crops. The Baduy people in the past usually planted annual crops as monoculture gardens using mostly sweet potato and cassava after harvesting rice in ladang. After harvesting these annual crops, the monoculture garden as well as ladang area were abandoned and allowed to develop into secondary forest by natural succession. Because of mixed garden development, the mixed-garden area will be increasing, while monogarden as well as reuma of fallow time four year (mature reuma) is declining. Even, in the future if agricultural land not enough to support population, after mature reuma of fallow time four years disappears, reuma of fallow time three or two years will be cultivated directly after harvesting rice in ladang.

In this case, fallow time or RMA2 and RMA3 area will be decreased over time.

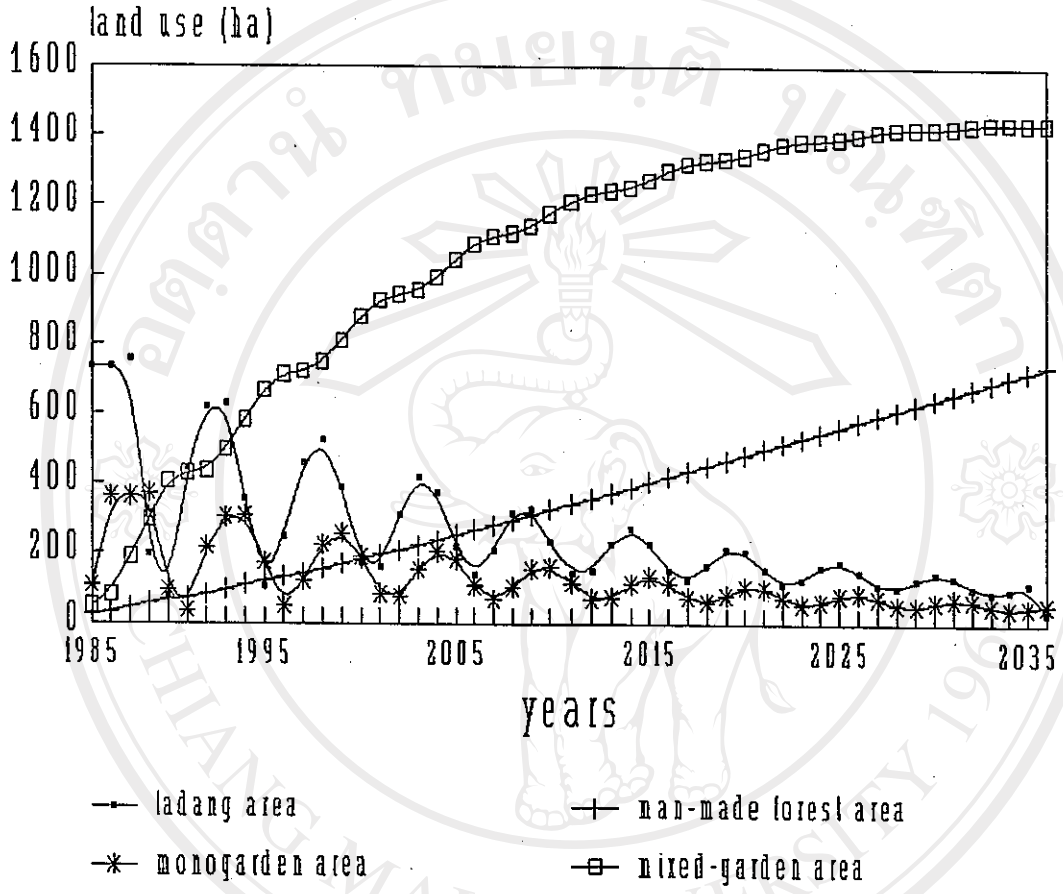

Figure 19 Land use systems (ha) in Baduy in base run simulation

V.1.4. SOIL FERTILITY SECTOR

Simulation of the soil fertility sector of the Baduy shifting cultivation, uses baseline data in which inputs to beginning soil fertility are considered to be derived from mature secondary forest or reuma of fallow time four years (SFRT4=1900 kg rice). Then, during cropping time, the soil fertility is used by crops and losses by erosion is 50 per cent of the initial of soil fertility of fallow time four years. Remaining soil fertility after using by crops during cropping time will get increment of soil fertility after land fallowed one year ore more years. The increment soil fertility annually during fallow time is 1.25, 1.15, 1.15, and 1.15 for the first, second, third, and fourth year, respectively.

Given a run for 50 years, the results show that soil fertility during cropping time or ladang phase decreases over time (Figure 20). Initial soil fertility of ladang phase (SFRT0), reuma of fallow time 1 to 4 years is recorded at SFRT11, SFRT2, SFRT3, and SFRT4 recorded 950, 1188, 1366, 1570, and 1806 kg rice, respectively. Ten years subsequently it decreased to 572, 715, 822, 945, and 1,088 kg rice, respectively.

In this model, soil fertility by fallowing 4 years tends to be not adequate to maintain productivity. The yield declined about 10 per cent in every 4 years. Agricultural

yield as well as food availability in Baduy, therefore, has been affected by decreasing soil fertility of agricultural land over time (Figure 20).

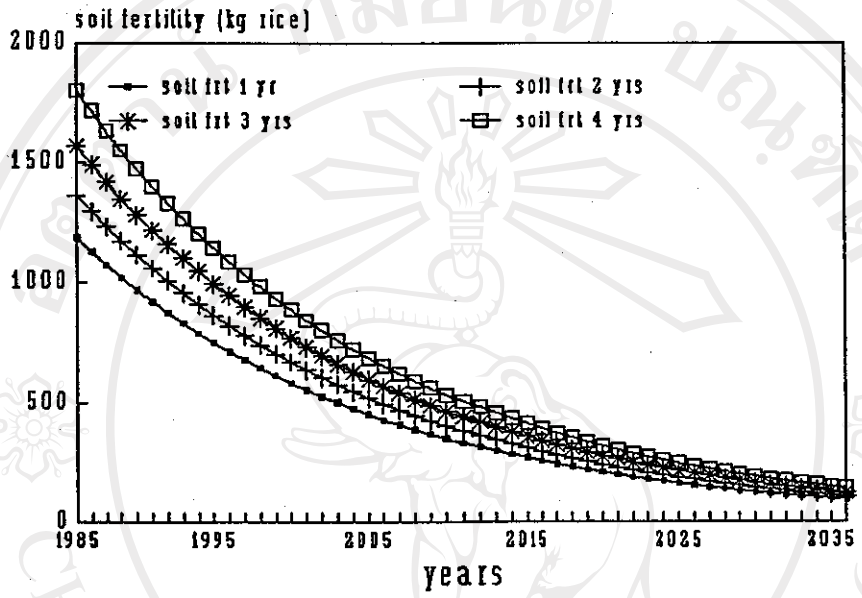

Figure 20 Soil fertility in Baduy in base run simulation

Based on the results above, it can be concluded that the role of land fallow in the Baduy shifting cultivation is very important for improvement of soil fertility after it is used by crops or after losses due to soil erosion during the ladang period. Soil fertility factor is significant in determining agricultural production in Baduy's shifting cultivation because agricultural production will be decreased due to decrease of soil fertility.

V.2. TEST OF HYPOTHESES

With regards to the hypotheses in this study, as mentioned earlier in section (III2.2.), the results of the simulation of the model generally confirm them with specific parameters.

V.2.1 THE FIRST AND THIRD HYPOTHESES

-The first hypothesis, shifting cultivation in Baduy area can not sustain sufficient food supply to its population, given the current rate of growth in population and current practices;

-The third hypothesis, shifting cultivation in Baduy can not sustain forest areas given the current rate of growth in population and current practices.

The first hypothesis can be affirmed by analysing interrelationships between food consumption and food level of base run simulation (Figure 21).

The population of Baduy has been increasing over time. The population increases will also mean increase the consumption of food. The food supply in supporting population, however, although in the first stage increase over time, later after 11 years, food level decreases.

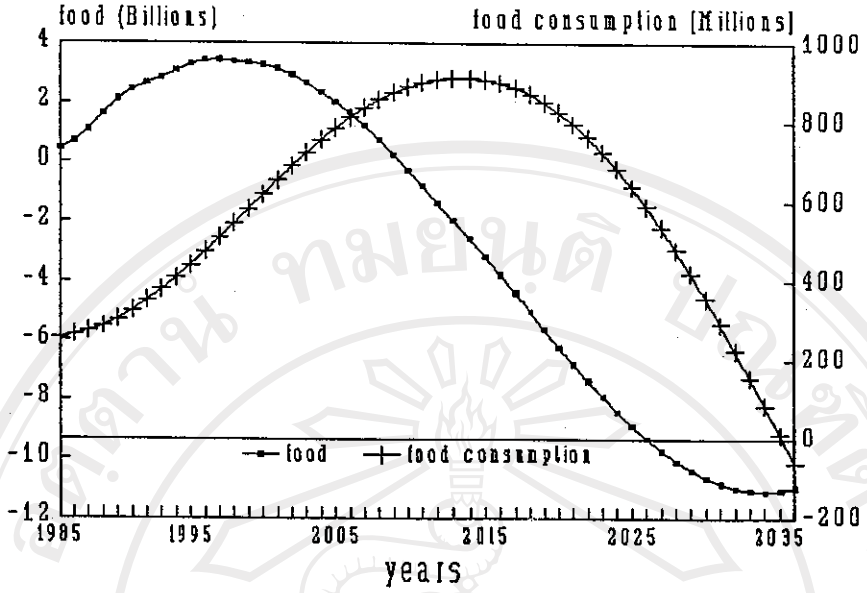

Figure 21 Food consumption and food level (rupiah) in Baduy in base run simulation

Food surplus after 23 years becomes zero. This is because food supply depends on the dynamic of agricultural production, food imports, food exports and food losses. The agricultural production depends on soil fertility. Decreases in soil fertility determine decreases in agricultural production. Furthermore, the level of food export and the cash income will also be decreased. Accordingly, based upon Figure 21, in the long terms, it can be predicted that shifting cultivation in Baduy area can not sustain sufficient food supply to its population, given the current rate of growth in population and current practices.

Based upon base run simulation, the population of Baduy can be supported adequately by food supply for only 23 years, after such time the Baduy's cultivation system is working its way to collapse. Soil fertility in ladang phase with 4 years fallow time four years is not adequate to maintain productivity , thus yield declines over time (Figure 20). Therefore, a continual decline of fertility can determine a significant negative effect on food availability in Baduy.

The third hypothesis can be affirmed by analysing of the land use changing of base line simulation (Figure 19), particularly changing of secondary forest (reuma) area (Figure 22).

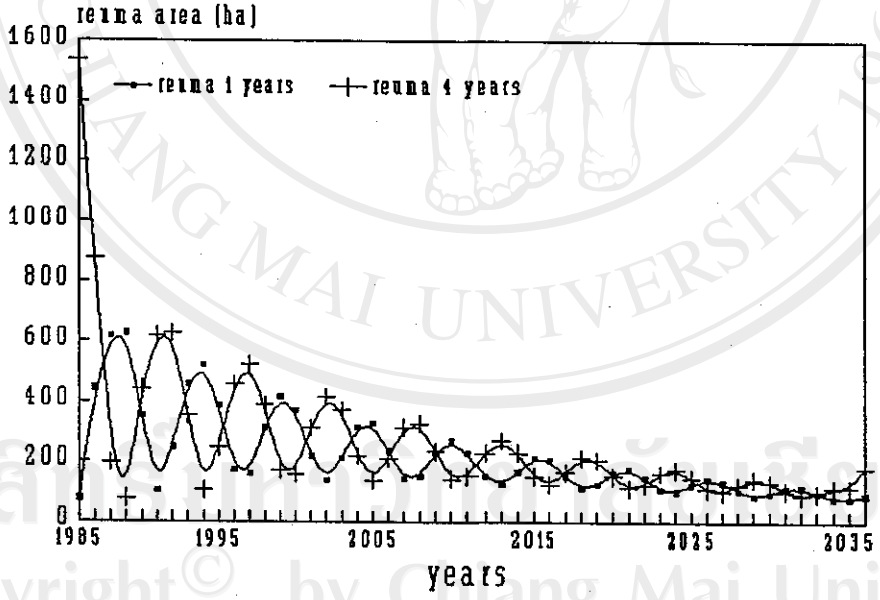

Figure 22 Forest area (reuma) in Baduy in base run simulation

Based upon base-run simulation, secondary forest area in different maturity show decreases over time. This is because the demand of mature forest to cut for practicing of shifting cultivation in Baduy area increases over time in accordance with increasing population. Although in the Baduy's shifting cultivation model, some people of outer Baduy usually migrate to non Baduy area, the secondary forest tends to decrease over time. The mature secondary forest area is the most critical point. Based on base run simulation, initial mature forest (RMA4) recorded 1,536 ha. The first ten years subsequently it decreased about 70 per cent and afterward also decrease over time (Figure 22). The secondary forest of fallow time one, two and three years, at the first stage, increase due to high outflow of land abandonment from ladang. After twenty years, such areas also decrease over time. It is caused by decreasing of mature secondary forest stock due to conversion of permanent agriculture system, such as mixed garden and man-made forest and settlement area. Initial secondary forest fallow time one, two, and three years is recorded at 76 ha. Ten years subsequently it increased to 172 ha, 388 ha, and 522 ha, respectively. In fifty years, subsequently it decreased to 88 ha, 76 ha, and 78 ha, respectively. Accordingly, it can be predicted in the long run, if population increase rapidly over time, the secondary forest can not sufficient to support current farming practices.

V.3. ALTERNATIVE RUNS

Based upon current practices the Baduy's shifting cultivation, as mentioned earlier by analysing a set of base run simulation, it can be predicted that the system is difficult to maintain its sustainability in the long run. Because the population and food consumption increase over time, while, the soil fertility, secondary forest area and food supply tend to decrease over time.

The Baduy's shifting cultivation, however, can also predicted to prolong the sustainability in the future, if the system with the current farming practices can be improved, such as by providing off-farm jobs, restricted population growth and improvement in soil fertility. By some improvements of the system, therefore, the base run simulation model will be changed. For analysing such aspects, modification of base runs or alternative runs is needed . The following section will describe and discuss the alternative runs of Baduy's shifting cultivation model, which are also used for verification of the second and fourth hypotheses.

V.3.1. THE SECOND AND FOURTH HYPOTHESES

Base upon the first and third hypotheses, as mentioned earlier the Baduy's shifting cultivation can not sustain

sufficient food supply and forest areas given the current rate of growth in population and current practices. By set of alternative runs the second and fourth hypotheses can be analysed in turn below.

-The second hypothesis, shifting cultivation in Baduy area, on the other hand, can sustain sufficient food supply to its population, given a restricted rate of growth among traditional farming population and current practices.
-The forth hypothesis, shifting cultivation in Baduy area, on other hand, can sustain forest areas given a restricted rate of growth among the traditional farming population and/or improvement in practices.

The second and third hypotheses can be verified by improving the Baduy's shifting cultivation. For example, it can be done by reduction of population growth and improvement of soil fertility.

V.3.1.1. RESTRICTED POPULATION GROWTH

Reduction of population growth rate in Baduy can be promoted by family planning. By reducing the birth rate at low level, it can determine reduction of food consumption. For example, if birth rate is simulated 2 per cent (0.020) compared to (0.037), while other parameters remain constant,

the result of this run shows that population increases over time lower than the base run simulation. Here, food availability increases although food surplus is depleted after 28 years. Population in 50 years recorded 2,083 people and the Baduy society persists on (Figure 23).

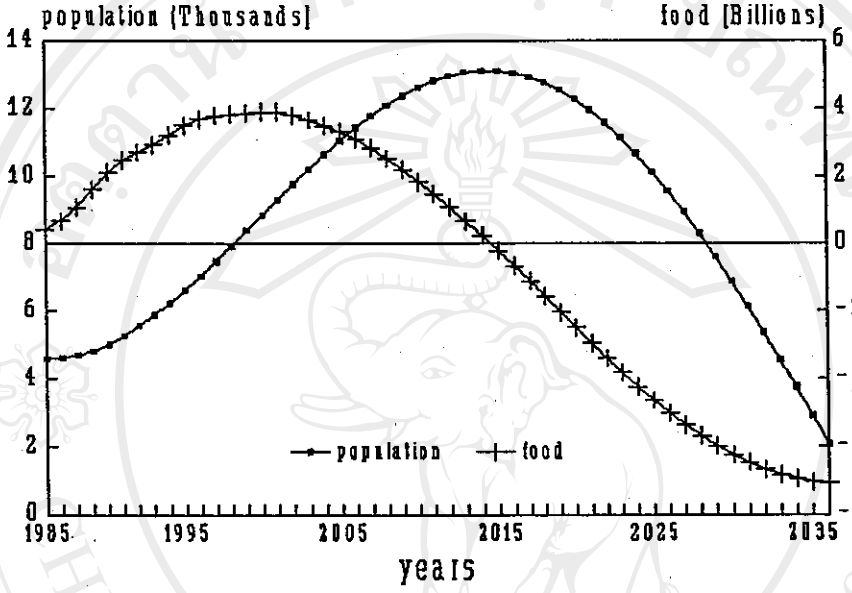

Figure 23 Population and food supply (rupiah) in Baduy with the birth rate of 2.0 per cent per annum

V.3.1.2. IMPROVEMENT IN SOIL FERTILITY

Another way that can be done in solving insufficient food supply to its population in Baduy is by improving soil fertility, such as with an application of organic fertilizer. It means that the reduction in fertility by

cropping and erosion will be lower than base-run simulation. Furthermore, remaining soil fertility after crop harvest and the increase in soil fertility due to fallow will greater than in base-run simulation.

For example, based upon base run simulation increment of soil fertility after 1 year fallow is 25 per cent above soil fertility after cropping, with some improvements of soil fertility, the increment of soil fertility after 1 year fallow can be 31 percent above soil fertility after cropping. The result of this run shaw a smaller rate of reduction in soil fertility (Figure 24). Food availability in Baduy increases higher than in base run simulation. Food surplus is depleted after 33 years, while population in 50 years is recorded at 30,000 people (Figure 25).

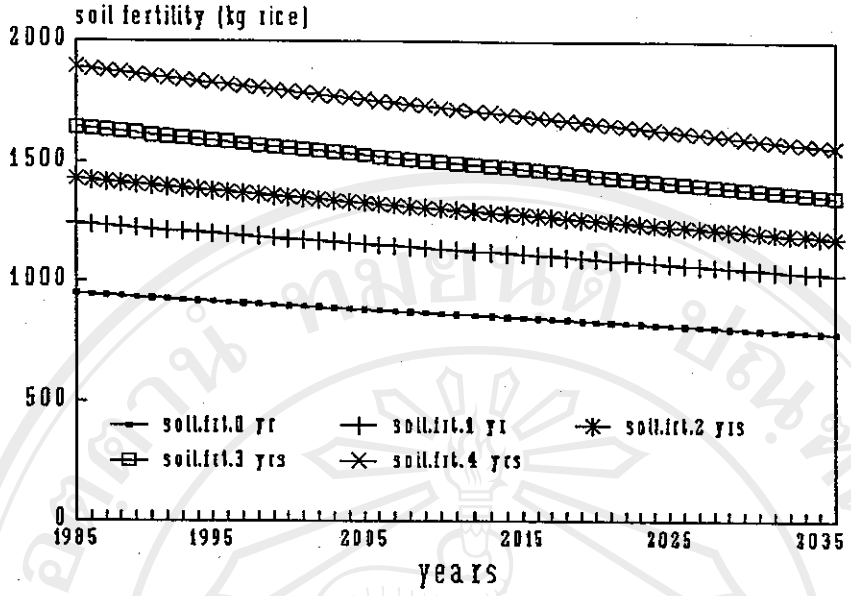

Figure 24 Soil fertility of Baduy by simulation increment of sfrt1=1.31 X sfrt0

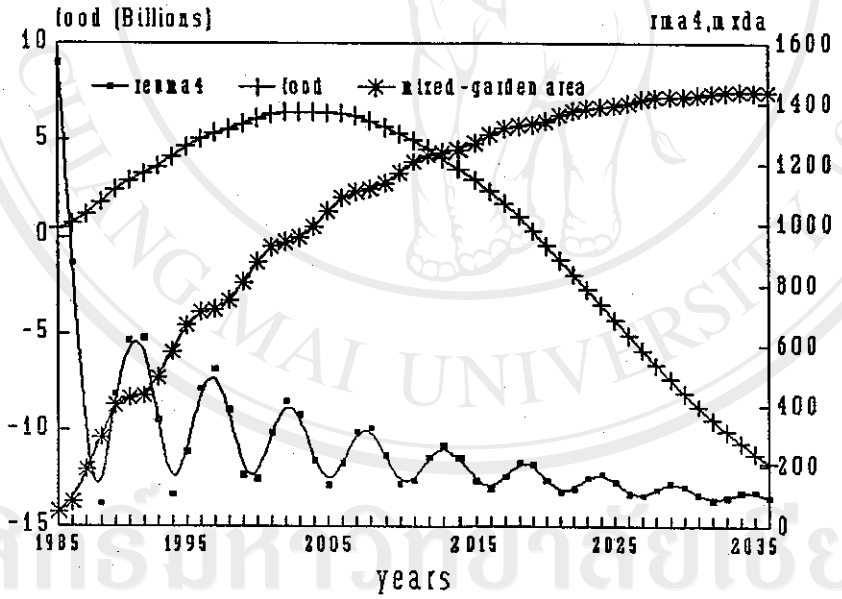

Figure 25 Food, population, mixed garden area (mxgda) and 4-years reuma area (rma4) of Baduy with 31 percent increment in soil fertility after 1-year fallow (SFRT1=1.31*SFRT0)

Therefore, by improvement of soil fertility, agricultural production as well as food availability will increase.

From these analyses, it can be concluded that by promoting family planning and improving soil fertility in Baduy can increasing food availability. However, based upon the simulation above, the increasing of food surplus is enjoyed less than 50 years. Therefore, some improvements are still needed. For example, some more improvement in soil fertility can be done. The inputs of nutrients, apart from obtaining naturally from burning of vegetation, can be purposely applied. By this new option, for example, increment of soil fertility after 2 years fallow at 24 per cent compared to 15 percent of previous year level, the result of this run shows that soil fertility of fallow land increases over time (Figure 26). Therefore, food supply can support population longer than 50 years (Figure 27).

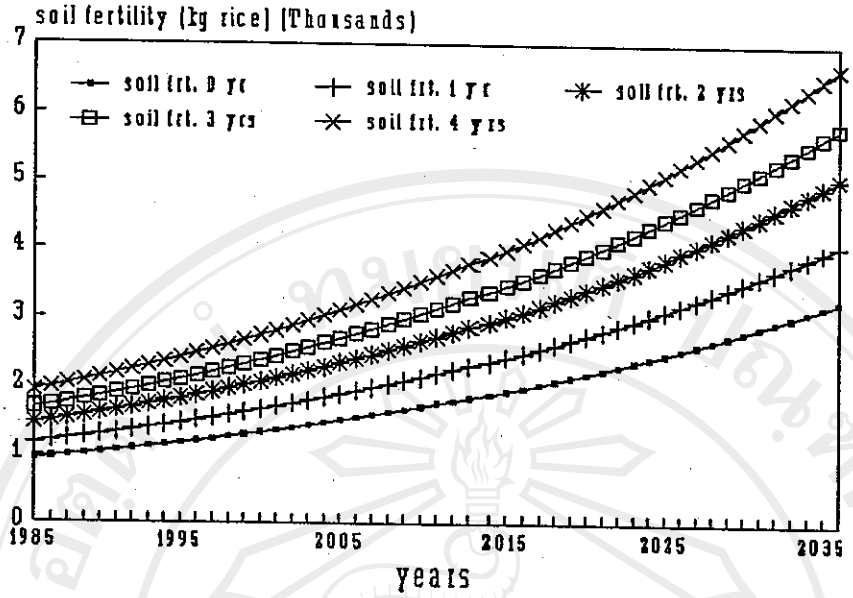

Figure 26 Soil fertility of Baduy with 24 per cent increment of soil fertility in the second year fallow (SFRT2=1.24*SFRT1) and 25 per cent increment in the first year fallow (SFRT1=1.25*SFRT0)

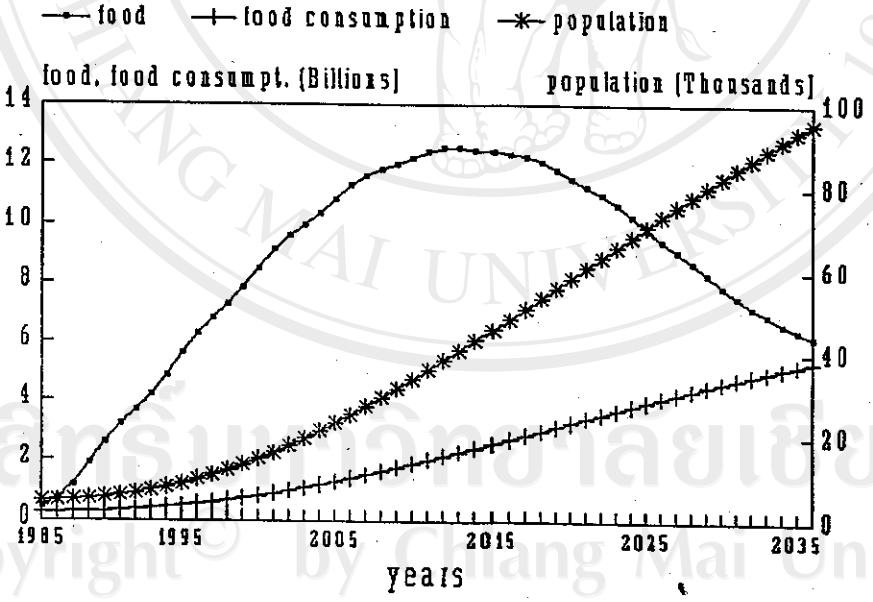

Figure 27 Food, population and food consumption of Baduy with increment of SFRT2=1.24*SFRT1 and SFRT1=1.25*SFRT0

With these results, it can be concluded that as long as soil fertility can be maintained or managed, the changes of land use sector, do not have high negative effect on food availability in Baduy.

From the set of alternative runs which are used for the analysis and verification the second and fourth hypotheses, it can be concluded that generally the second hypothesis can be verified. It is mainly by improving the shifting cultivation in Baduy area, it can help to prolong food supply to its population. The fourth hypothesis, on the other hand, can not be verified by this set of alternative runs. The forest area in Baduy area tends decrease over time, although the soil fertility as well as food supply are enhanced by some improvement the system. For example, by restricted population with simulation of birth rate in low level, such as 2 per cent, as mentioned earlier, the secondary forest in different maturity still decrease over time. Initial value of reuma with fallow time one, two, three and four years is recorded at 76 ha, 76 ha, 76 ha, and 1,536 ha, respectively. First ten years subsequently, it is changed as almost same as base run simulation, i.e. 172 ha , 389 ha, 522 ha, and 458 ha, respectively, afterwards, those secondary forest areas in different maturity decrease over time. According to this result, it can be predicted that as long as the Baduy people has practices the shifting cultivation and some fertilizers are not used, the forest

area in Baduy can be under pressured from population over time. In the long run, the Baduy's shifting cultivation can not sustain forest areas, which is affirmation of third hypothesis and rejection of the fourth hypothesis.

V.3.1.3. NO RELATIONSHIP BETWEEN FOOD AND POPULATION

For the first set of runs, it is assumed that there is an interrelationship between food supply and population growth. A simulation can be made when there is no relationship between food supply and population growth, which is simulated by X1=X2=X3=X4=0. The results of this run indicate as follows.

Population in Baduy increases rapidly over time higher than base run-simulation. Initial population is recorded at 4,600 people. After the first, second and third ten years subsequently it increased to 5,663 people, 6,971 people, and 8,581 people, respectively. Within 50 years, the population it increased to 13,000 people (Figure 28). This result is different from base-run simulation, being rather unrealistic. This is because this model shows that rapid population growth does not have any interrelationship with the natural resources, particularly with food supply.

Food supply shows at the first, second and third ten years subsequently increases higher than base run simulation. Afterwards it decreases and within 50 years the

food supply approaches zero. However, although food supply approaches zero within 50 years, population still increases rapidly over time. Initial food is recorded at 442 million rupiah. After first and second ten years subsequently it increased to 3,854 million and 4,759 million rupiah. Afterward it decreases over time. Because by increasing of population rapidly, the food consumption is also increased over time (Figure 29).

Ladang area at the first instance increases over time higher than base run simulation due to a rapid population increase and adequate available mature secondary area. However, after 40 years ladang area decreases over time due to limitation of mature secondary forest and rapidly development of mixed-garden and man-made forest and settlement area (Figure 30).

The off-farm income increases over time and it is also higher than base run simulation, because it is function of population, food consumption and basic need of the people. Initial off-farm is recorded at 30 million. At the first, second, and third ten years subsequently it becomes 289 million, 400 million, and 503 million rupiah.

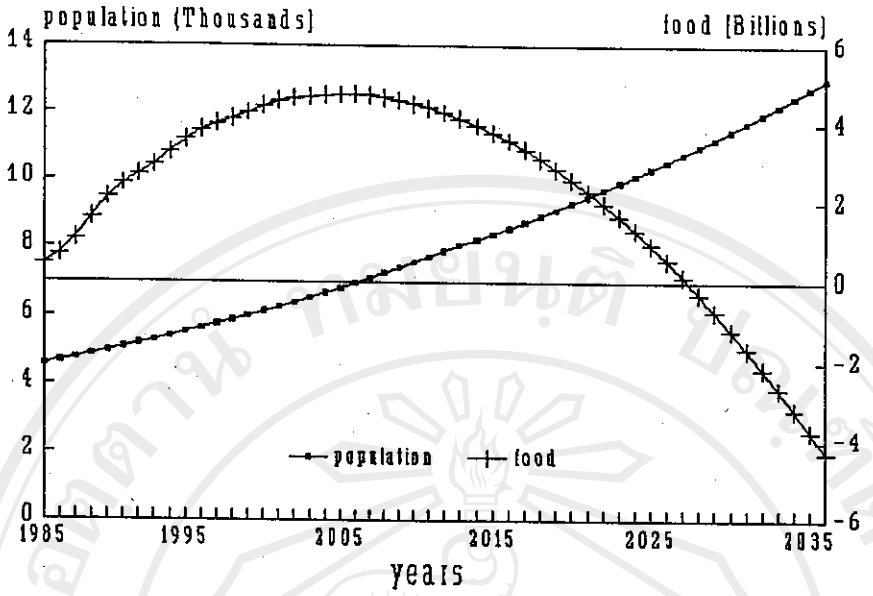

Figure 28 Population of Baduy by using simulation X1=X2=X3=X4=0

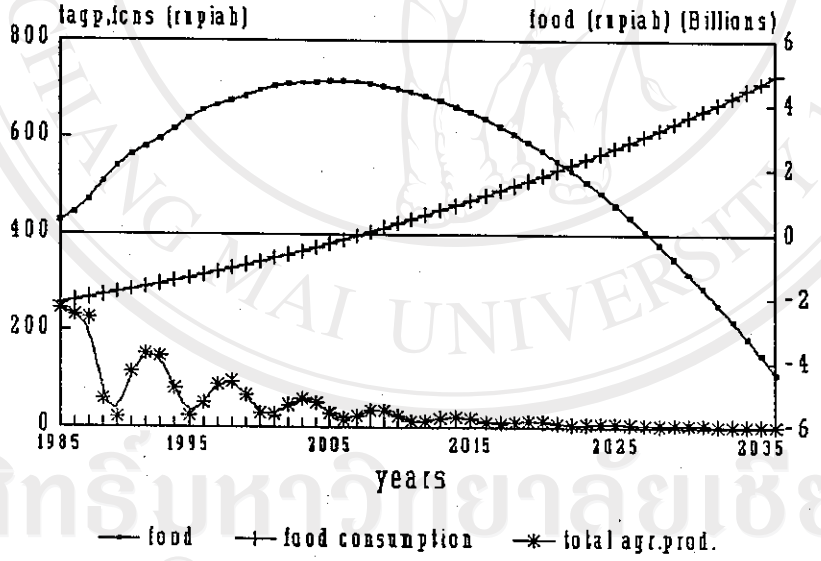

Figure 29 Food, food consumption, and total agricultural production by simulation X1=X2=X3=X4=0

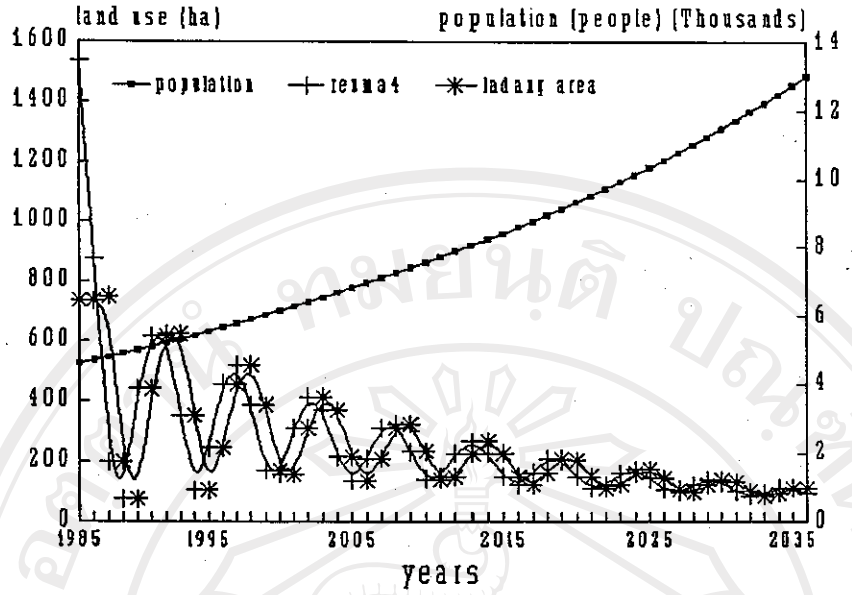

Figure 30 Population, reuma, and ladang area by simulation X1=X2=X3=X4=0

V.4. POLICY ANALYSIS

Shifting cultivation in Baduy area has been practiced since a long time ago. This system is characterized by short periods of cropping alternated with longer periods of fallow. The abandonment of fields fallowed by shifting to other fields is the key element in management of soil fertility because fallow period is important to reestablish soil fertility after decreasing soil fertility during cropping. As mentioned earlier, as long as population density is still low and fallow periods are long enough to restore soil fertility, shifting cultivation in Baduy area can be sustainable in the long run. Shifting cultivation in Baduy area, however, has been pressured by rapidly

increasing population over time. The Baduy people has tried to manage sustainable shifting cultivation in several ways. For example, they managed shortage of agricultural land, by renting land in non-Baduy area. Another way is to enhance their income, particularly in outer Baduy, is that they grow commercial crops, such as coffee and clove. Accordingly, the population and agricultural land in Baduy area has changed dynamically over time in pursuing equilibrium.

Based upon population analysis, the results show that out-migration of Baduy people, particularly outer Baduy people, to non-Baduy area has increased over time in accordance with increasing total population. As mentioned earlier, the initial out-migration recorded 230 people. The first, second, third ten years subsequently it increased to 423, 725, and 1223 people, respectively (Figure 13). For practicing shifting cultivation in non-Baduy area, they rented land in cash or by share cropping. They will go back to their areas in Baduy, if fallow land or reuma area are ready to be cultivated again. By this system, the sustainability of reuma area as well as soil fertility in Baduy area have been maintained for a long time. In practicing shifting cultivation in non-Baduy area, however, they usually plant rice not only in agricultural land, but also in government's forest area. Since they usually practice shifting cultivation in government's forest area, it has caused some anxieties, particularly for the Forestry

State Corporation (Perhutani). Accordingly, the practice of shifting cultivation of outer Baduy people in non Baduy area has been forbidden for a long time. Although in the implementation there are some problems, it is foreseen in the future, that this policy will be more pressured. The prohibition of practicing shifting cultivation in Baduy area by the government tends to be condoned because of some reasons, such as the autonomy as well as traditional law (hukum adat) of Baduy people which is acknowledged by the government. New permanent border between Baduy and non Baduy area has also been built since 1985. Besides, the Baduy people assume that they have some wisdom in managing as well as cultivating their land. Policy government in treating Baduy's shifting cultivation in non-Baduy area tends has more pressure than in the Baduy area. However, government policy in prohibiting practice of shifting cultivation of outer Baduy in non Baduy area can have serious impact on sustainable shifting cultivation system in Baduy area. Because as mentioned earlier that the outer Baduy essentially needs land in non-Baduy area for maintaining fallow land as well as soil fertility in Baduy area. If they are forbidden practice of shifting cultivation in non-Baduy area or out-migration will become zero, food supply, agricultural land and soil fertility level in Baduy area will be less than base-run simulation to support population in the long run. While base-run simulation of the

Baduy shifting cultivation has been predicted in analysing hypotheses earlier that it can not be sufficient in providing food supply , maintaining forest area and soil fertility in long run. Furthermore, sustainability of shifting cultivation system in Baduy will be in question for the future.

Figure 31 shows the impact of out-migration being zero, while other parameters are considered constant. Population and food supply changed highly. Population in Baduy area increase rapidly from initial number of 4600 people to 12000, 25000, and 47000 people after 10, 20, and 30 years, respectively. While food surplus also decreases rapidly, becoming zero in 16 years (Figure 31). Food supply, land use sector and soil fertility level will also less than base-run simulation over time.

On the contrary, because of the outer Baduy people rent land and stay in non Baduy area, there was no in-migration rate for certain year. In this case, in-migration rate can be simulated become zero, while other parameters remain constant. The result of this run shows that food availability in Baduy can support of population higher than base run simulation (Figure 31). It is because the population growth in Baduy is lower than base-run simulation. Furthermore, it can effect on food consumption, food availability as well as soil fertility less than base run simulation.

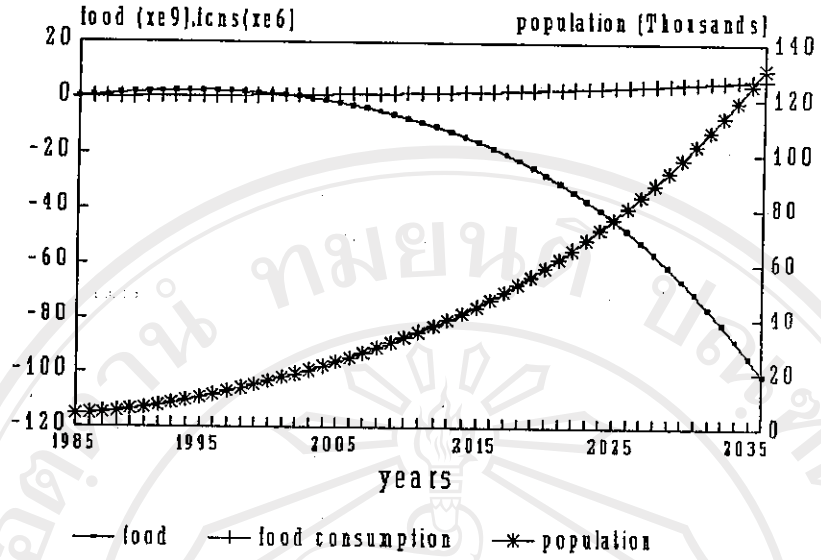

Figure 31 Population, food consumption, and food level of Baduy with out-migration (MOF)=0

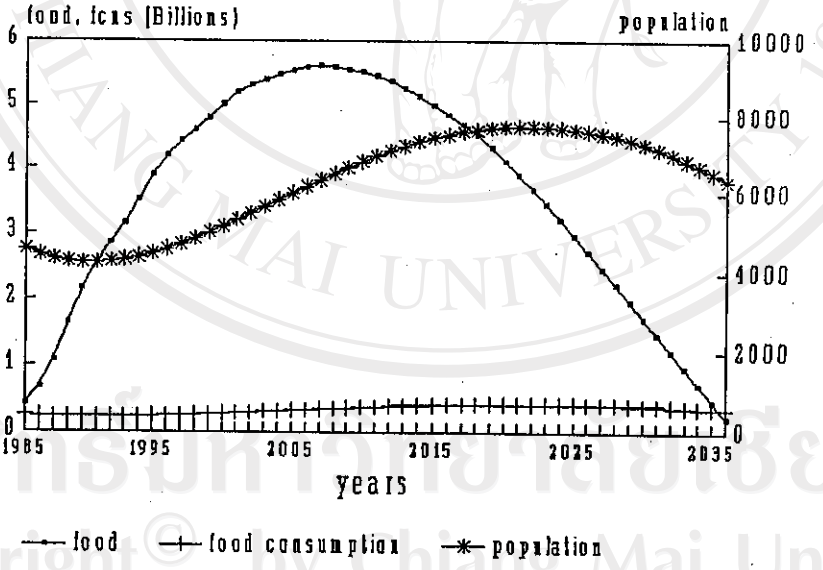

Figure 32 Population, food consumption, and food level of Baduy with in-migration (MIF)=0

Therefore, the practice of shifting cultivation of outer Baduy in non-Baduy is essential. To overcome some negative impact of practicing shifting cultivation of outer Baduy in non-Baduy, particularly in forest land area, a special regulation is needed. The Baduy people should be involved in managing forest land by the Forest State Corporation. It can be done by social forestry projects that have been known and have been practiced in some places since long time ago with the popular name as " sistem tumpang sari ". In this system, the cultivator will give certain plots of land for production. It is a forest area which has been opened for forest rejuvenation. They can allow planting of rice in the production forest land. During rice planting and other annual crops in certain plots of production forest, they have responsibility to take care of the young forest trees that have been grown for the Forestry State Corporation purposes. After about two years, forest trees will have grown tall enough, with dense average canopy, while the annual crops can not be grown well any more, because annual crops cannot get enough sunlight. The cultivator must move to other fields or come back to their area in Baduy. In this system it will get mutual benefit for both cultivators and the Forest State Corporation. The cultivator will get land in order to practice shifting cultivation, while the Forestry Sate Corporation will get cheap labor. Besides, the Baduy people have been recognized

to be skillful and expedient in practicing shifting cultivation. Moreover, share-cropping among Baduy people and the Forestry State Corporation can be arranged. Because share cropping system has been recognized as well as practiced by the Baduy people for quite a time, the same approach can be done for the practice of shifting cultivation of outer Baduy in agricultural land of non Baduy people, even it this system has been practiced traditionally by the Baduy people. Therefore, practicing shifting cultivation of outer Baduy in agricultural land of non Baduy is not necessary be forbidden as long as they do not ruin the environment. In this system it has also some mutual benefits for both Baduy and non Baduy people. The Baduy people can get agricultural land to practice shifting cultivation in non-Baduy area, while non Baduy people will get agricultural produce or labor due to lack of labor in non-Baduy area.

Another way in which the Baduy people manage for a sustainable shifting cultivation in their area is through introduction of commercial crops planted in mixed garden, such as coffee and clove. Based upon the analysis of the dynamic model of land use sector in Baduy, the results showed that both mixed garden and settlement and man-made forest increased over time. However, the mature reuma will decrease over time (Figure 19). Mixed gardens are usually planted with certain commercial crops mixed with other

crops, such as fruits, vegetables, fire woods, etc. Therefore, the development of mixed garden in Baduy has some positive impact for the future because from the mixed garden some benefits, in terms of socio-economic as well as environment can be obtained. From the mixed garden the people can harvest some agricultural produce, which in return and give cash income as well as for home consumption. The harvesting time can be done subsequently every time through a year because in mixed gardens a variety of crops can be harvested through a year due to different flowering and harvesting times. In the mixed garden system it can be predicted also that it is more resistant to outbreak of pests than in monoculture systems. Besides, if the cultivator fail to harvest certain crops they still can harvest from other crops. Mixed garden has also some beneficial function like conservation of crops genetic and soil productivity. Because in the mixed garden has variety of crops, domesticated crops as well as semi wild crops, therefore, it can conserve crops genetic in nature (insitu conservation). For example, although local rice varieties in non-Baduy villages has been found very rare, currently, in Baduy area has been found 80 varieties. Some rare non rice crop varieties are also still found in Baduy area. Many crop varieties in mixed garden will also create the structured layer of crop canopies, which can control against soil erosion by protecting the top soil caused by kinetic energy

of water during the rainy season. Many varieties of crops in mixed garden can also provide large amount of litter as sources of humus, therefore, it can be useful in maintaining soil fertility. While, soil erosion caused by runoff in rainy season can be reduced due to high water infiltration on top soil which dense covered by humus.

Development of mixed garden as predicted will benefit the socially and economically as well as the environment, so it is not necessary for policy makers to comply hardly in prohibiting shifting cultivation in Baduy area. However, policy makers can accelerate by providing spontaneous trends of land use changes, such as development of mixed garden. It is hoped that with development of mixed garden, shifting cultivation practices will be lessened through time. Because the mixed garden provides high income to the people, therefore, labor, capital and time will be given more attention to develop mixed garden systems. Besides, the development of mixed garden from shifting cultivation system tends to be permanent agriculture, therefore, indirectly reducing the practice of shifting cultivation. Finally it is also possible to integrate rice production in mixed garden system for the future. In other words, although mature reuma will be decreased or will disappear, rice production can be integrated in mixed garden systems. The composition of mature reuma vegetation can be replaced by more domesticated plants such as fruits. However, because the cutting or

pruning of vegetation becomes limited before planting rice due to dominance of domesticated plants in mixed gardens, some organic fertilizers are needed for its compensation, such as composts, kitchen wastes, etc. Exiting of traditional non-farm activities, such as making handicrafts and weaving must be also accelerated by government because it has some benefits to provide Baduy's household income. Furthermore, population pressure on agricultural land can be reduced.

Therefore, based upon analysis of the model, development of shifting cultivation in Baduy for the future generally can be considered from 3 scenarios.

In the first, policy makers would like to see the shifting cultivation in Baduy stopped altogether. However, as mentioned early it must be understood that this will create negative consequences as well as solving problems. The government should consider developing resettlement programs, in surrounding areas of Baduy area, as well as in other areas. In the development of permanent agriculture as part of the resettlement program, appropriate technology, ecological aspects, socio-economic and cultural aspects should be considered. It must be recognized that according to traditional law (adat), all Baduy families must practice shifting cultivation. The practice of shifting cultivation in Baduy has extremely strong associations with the people's religion and culture. Site selection, cutting of shrubs,

pruning the trees, planting rice, the first and second weedings, and harvesting of rice must all be done in specific time period and all are associated with traditional ceremonies. If the Baduy people were to no longer practice shifting cultivation, they could be condemned and banished by their society. Therefore, in the development of Baduy farming systems, shifting cultivation or planting rice in up-land fields, must be considered as essential factor or integral part to be combined with other development in the permanent agricultural sector.

In the second scenario, policy makers would like to allow the Baduy society to continue practicing shifting cultivation without any restrictions. However, as mentioned early this alternative has high associated risks. According to the simulation analysis, shifting cultivation as it is now practiced will not be sustainable over the long-term. If the practicing of shifting cultivation continues under current conditions, ultimately, the Baduy people could expand their shifting cultivation practices both in their own areas and in non Baduy areas as well. People might expand shifting cultivation in their areas by opening reserve forests, such as in the first zonation area. In another hypothetical case, outer Baduy people could enter inner Baduy for practicing cultivation, because in inner Baduy, population density is still low and there is adequate agricultural land. If this were to happen it could create

serious conflicts between inner and outer Baduy. At the same time, natural resources as well as the Baduy culture would be degraded

Where inner Baduy people to expand the practice of shifting cultivation in non Baduy areas, it would adversely effect both government forest areas (perhutani areas) and the agricultural lands of non Baduy people. Expanding shifting cultivation in government forest would create conflicts with forest authorities, while expanding in non forest areas would create continuous conflict between Baduy people and non Baduy people. However, problem in non Baduy it can be solved as mentioned early.

The third scenario, policy makers would like to allow the Baduy society to continue practicing shifting cultivation with some restrictions as well as some improvements. For example, soil fertility in swidden fields as well as fallowed land should be improved. In swidden fields, crop yields can be increased by enhancing yield per area of individual crops as well as enhancing crop varieties on the same unit of land. This purpose the government might consider extending appropriate subsidies, such as for fertilizers. Organic fertilizer has a high chance of acceptance by the people, while chemical fertilizer is difficult for them to accept because it is expensive and it is also currently forbidden by their culture. Use of chemical fertilizers in up-land cultivation elsewhere has

also had serious ecological to eutrophication effects downstream. In fallow fields several interventions are possible. For example, the restoration of soil fertility must be accelerated. This can be done by applying organic fertilizers, such as compost and by planting by leguminous nitrogen fixing crops. Leguminous crops can be selected from local varieties, which are commonly found in the Baduy area. Among them are albizia (Albizia falcataria), ki toke (Albizia lebbeck), angsana/barwood (Pterocarpus indicus), dadap/swamp immoratele (Erythrina variegata), petai/locus bean (Parkia speciosa), ipil-ipil (Leucaena leucocephala), hiris/pigeon pea (Cajanus cajan), johar (Cassia siamea), jengkol (Pithecelobium jeringa), jaat/goa bean (Psophocarpus tetragonolobus) and roay/hyacinth bean (Dolichos lablab). Those crops are important not only for improving soil fertility but also would provide economic benefit to the people, as fire wood, building materials and vegetables. Compost and other fertilizers could be applied for improving soil fertility in fallow fields as well as in swidden fields. Dung of live stock, particularly from common live stock in this area, chickens, can be used as organic fertilizers. Other potential sources of organic fertilizers, are kitchen waste i.e. ash from stoves, rice husk and crop residues. Use of these would maintain soil fertility by natural recycling at cheap cost. Besides effort to develop agricultural activities, family planning must also be

promoted in this area. Promotion of family planning will be important for slowing the rate of population growth. By implementing such an integrated program agricultural land and food supplies would remain adequate for supporting the population in the Baduy area over the long-term. By this concept, it hopes that development of shifting cultivation in Baduy area can be sustainable in the future.