

---

# SHIFTING CULTIVATION SYSTEM A HUMAN ECOLOGICAL ADAPTATION TOWARDS TROPICAL RAIN FOREST ENVIRONMENT

**Harihanto**

Fakultas Ilmu Sosial dan Ilmu Politik  
Universitas Mulawarman

## *Abstract*

*Shifting cultivation is the oldest agricultural system widely practiced until now especially in tropical areas. Since this system requires relatively extensive use of land and uses slash and burn technique it is often labeled as a main cause of deforestation and land degradation. Each household of farmers needs about 1 – 5 hectares of land for shifting cultivation. On the other hand a lot of researchers have different opinions. They believed that shifting cultivation system has positive influenced on environment because it can increase biological diversity. Many studies show that the system does not caused permanent land degradation as long as the fallow period is not too short. Many scientists believe that if the system causes environment degradation then a lot of forested areas in Indonesia will have turned into desert now. Shifting cultivation practiced by Dayak communities in Kalimantan does not cause serious deforestation.*

**Key words :** *shifting cultivation system, ecological adaptations, deforestation, land degradation.*

## **1. Introduction**

Shifting cultivation is the oldest agricultural system widely practiced until now, especially in tropical areas (Gradwohl, *et al.*, 1991; Grandstaff, 1981) in National Research Council, 1993). At least 240 million of farmer around the world (especially in tropical countries), used this system (Graddwohl, *et al.*, 1991). Tahan (1993) said that there are about 400 million farmers. In Indonesia alone, according to Forestry Department (*in* Sayogyo, 1991) there are 1, 2 millions of households performing shifting cultivation, amount of families are approximately six million ( $\pm 3$ , 7% from Indonesian populations), occupying areas of about 11, 4 million acres. The amount has decreased compared with 1996. According to Spencer (*in* Dove, 1988) there were four millions of families covering an area of about 85 million acres. However, Dove (1988) said that; nowadays, there are 20 million Indonesian people performing shifting cultivation.

Many people are still practice and they need a lot of lands (according to Gradwohl, *et al.*, 1991, each

family need for 1 – 5 acre of land)). That is the reason why this system has been labeled as main causes of deforestation and land degradation (see Gradwohl *et al.*, 1991 and Grandstaff 1981 (in National Research Council, 1993). With so many farmers, according to Gradwohl *et al.* (1991) at least 8 million acres of forest in the tropical areas annually should be transformed into shifting cultivation area.

On the other hand, however, many people are disagreeing with the label. Wilbur (1992) (*in* Hubeis, 1993) said that, shifting cultivation also has positive influence to conservation of environment, because it leads to biological diversity. Desmukh (1992) said that there are a lot of research results showing that this system does not cause permanent land degradation. Thus, according to Gradwohl, *et al.*, (1991) that land degradation is not a direct consequence of shifting cultivation. For Indonesia, as Soemarwoto (1991), said it is not true that shifting cultivation has destroyed the lands. If it was true, then most part of our motherland should have been turned into desert, because shifting cultivation has

been practiced in many places in our country for centuries. Kartawinata *et al.*, (1981) found that shifting cultivation in Dayak Communities; in Kalimantan did will not cause critical deforestation. Therefore, discuss whether the shifting cultivation can be causes critical deforestation and land degradation or not as an interesting activity. This point will discuss in this article.

## **2. Discussion**

### **2.1 Adaptation Concept and Cultural Ecology Approach**

Adaptation concept was firstly identified in Biology, particularly in Ecology as a branch of Biology, which explains the relationship of living beings with the environment (Solbrig, 1996). This concept was adopted by human ecology, especially by cultural ecology pioneered by Julian Steward.

There are not any explicit definitions of the concept of adaptation. In many literatures, including "ADAPTATION", written by Wallacea *et al.* (1961), adaptation was explained only by details and examples. Based on the details and examples in Wallacea's *et al.*, 1961; Solbrig, 1966; and Soemarwoto, 1991, adaptation can be defined as an effort or strategy taken by living beings to adapt with the particular environment in order remain survive.

According to Wallacea *et al.* (1961), each individual has special character which enables him or her to adapt or survive in particular environment. This special environment often called as ability to adapt. According Soemarwoto (1991), for individual or particular species that is more ability to adapt, more chance to survive. One of the species that have big adaptation ability is human. Along with the ability, human would occupy varies habitat.

According to Wallacea *et al.*, such adaptation ability also applies in special circumstances (1961) with drastic change inside the environment. Such drastic change may be caused by flood, volcanoes eruption, and the fall meteor to the earth. Archeological excavation has found fossils of animal which has become extinct because of its inability to adapt to drastically change which occurred in the earth. The animal is called Dinosaurs. Dinosaurs "failed to adapt". None of living beings which is able to adapt with the environment can will survive; they will become extinct sooner or later. Therefore,

in essence all living beings in the earth become adaptive beings.

Wallacea *et al.* (1961) said that the term environment includes both physical and biological environments. Human Ecology, particularly Steward's Cultural Ecology has added the term "Social Environment" (*social milieu*) into the term environment. Adaptation performed by an individual includes: (1) morphological adaptation, (2) physiological adaptation, (3) attitude adaptation, (4) population adaptation. And so do with Solbrig (1966) who said that adaptation is not merely morphological; it also is physiological and attitude. Soemarwoto (1991) adds that attitude adaptation (inside social system) can be in the form of socio cultural regulation and is called as cultural adaptation. It can happen, for example, in technology use.

Morphological adaptation is an adaptation, which occurs through body shape change. Eskimo people who live in cold areas have short body for example, so that, it will reduce heat loss, in order to makes his or her body remains warm and healthy.

Physiological adaptation is an adaptation, which occurs through physiological process inside the body. For example, Indian people who live in high mountainous of Andes have adapted with the low oxygen concentration. They can live and works under the circumstance.

Attitude adaptation occurs in learning process taken by community or individuals. Villagers avoid starvation danger by adapting to food stock. During harvest activity they eat hulled rice, during famine they eat cassava. This kind of adaptation is performed based on the years of experience where in dry season famine often occurs.

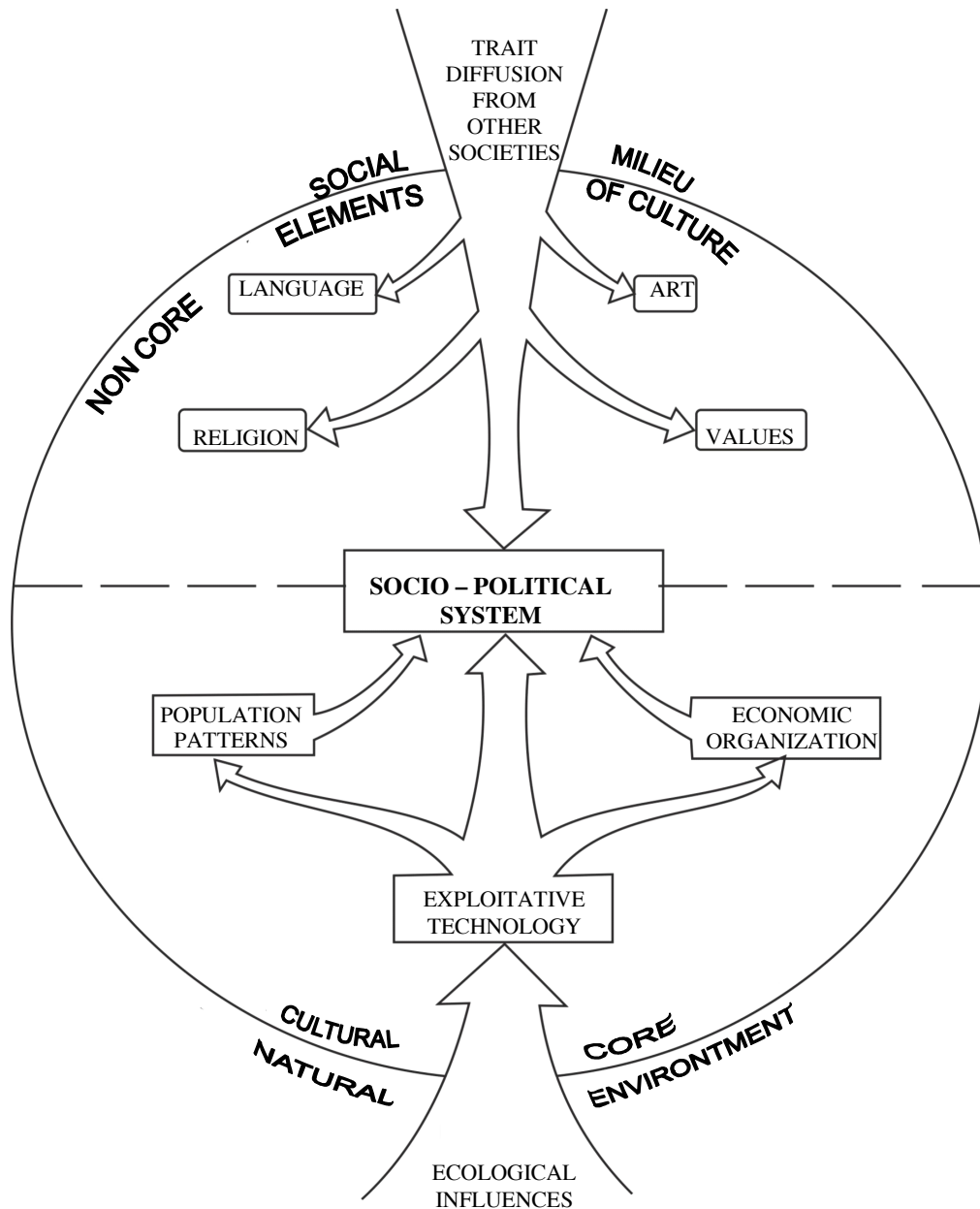
Population adaptation takes place by population regulation. There are certain species that have regulation mechanism or internal operation of population. If population exceeds the area carrying capacity, there will be more individuals that die caused by lack of space and food. In modern community (social system) this kinds of adaptation is done in a conscious manner, such through Family Planning Programe.

Steward (1995) applied the adaptation concept (ecology) inside Human Ecology to explain the relationship of human culture to the environment condition. He saw that culture as a product of human adaptation process to the environment. This concept based on hypothesis that "in particular environment

it will grow social or institutional regulation with particular pattern, called as cultural core”.

According to Steward (1955), there are four cultural cores, which resulted in human adaptation with the environment, or as a place where human’s can perform adaptation. The four cultural cores are: (1) exploitation technology, (2) economic organization, (3) population pattern, and (4) socio-

political system. The growth of exploitation technology is influenced by natural environment through ecological influences. In turns, this exploitation technology influence the form of economic organization and population patterns of the related communities, and all three (technology, exploitation, economic and population pattern) influence the socio-political system. This socio-



**Figure 1. Culture-Ecology Model by Steward**

political system also is influenced by trait diffusion (cultural elements) from the external (neighbor) as social environment. There is also trait from outside which is assimilated by related community as cultural element, non-core element of culture and it does not influence the socio-political system (Figure 1).

In the study, Cultural Ecology approach suggested by Steward can be used will to explain shifting cultivation practiced by communities in tropical rain forest related with their nature environment circumstance. The adaptation concept is applied by farmer communities as one of ecosystem component, especially seen in the position as social beings (according to applied approach), not as biological being.

## **2.2 Environmental Condition of Tropical Rain Forest as Agricultural Development Limitation**

According to Dasmann *et al.* (1977), there are many ecological factors in tropical rain forest areas that turn into agricultural development limitation. These are: (1) complexity and ecosystem diversity of tropical rain forest is too high, (2) high rainfall, (3) relatively large temperature, (4) relatively high sunshine with small day length variation, (5) amount and (6) abundant of biota.

The complexity and diversity of tropical rain forest is caused by actual season differences based on the level leveling (altitude) of a place from the sea surface, and large difference in soil type. This factors cause vegetation diversity, so that tropical rain forest are not similar in both species composition and its structure. High diversity of tropical rain forest followed often by low population number per species. Therefore, species can get instable, easy to be disturbed from outside. Because of the high diversity and complexity of tropical rain forest ecosystem, it requires much time, brain much power to understand it correctly (Harihanto, 1995).

Weather, soil and biota get interacted and form the tropical rain forest area with different types. Better agricultural technique in a tropical rain forest area are not applied certainty in others tropical rain forest which has different of soil, vegetation and culture. It can be dangerous if agricultural technique in cold areas is can applied in tropical rain forest without any modification. According to Dasmann *et al.* (1997), both suggestions have made a serious mistake in the last land use in tropical rain forest, and causes

economical lost and environment degradation for a long-term period.

According to Holdridge (1976) (*in* Dasmann *et al.*, 1977), rainfall in tropical rain forest are high, usually above 200 cm per year, even in many places are more than 800 cm. The rainfall exceeds or equals with the potential evapo-transpiration. The impact is local vegetation will become get sensitive to wet loss in a short-term period, and open land are easier to be eroded and cleaned so that it gets empty and infertile.

The temperature of tropical area has tendency to be variety, with large of range, between 18°C to 35°C or more. The tropical area gets high sunlight during the year with relatively small day length . It causes that vegetation prefers to sea surface level, and accelerate open land to become empty and infertile because of the change of structure (alterations) – flabby clay transformed as hard such as concrete brick.

In tropical area, invertebrate species, insect in particular are abundant. Often, these factors become a limitation of population growth. This biota interact with climate, rocks, and earth core mineral, formed and transform the tropical soil to be most linked ecosystem, so that it becomes obstruction for agricultural development. Without natural vegetation, soil production will immediately disappear, and without animal vegetation will not survive.

Most tropical soils are categorized as *ferralsol* (latosol = laterit soil) which has already really mouldered, apart of minerals which useful for plants has cleaned, the only remains are silicate with iron, aluminium or manganoxide. The soil fertilization conservation depends on forest vegetation, which can protect soil from cleaning and moldering and return mineral to soil surface from deeper soil layer or main material.

Most of tropical rain forests have nutrient element, which is bounded to biota. Soon, forest decay, provided by many soil fauna, returns fauna rapidly into circulation. However, without these processes, soil sterile relatively. Then, land fertility in tropical rain forest bounded on forest system. This fertilization will disappear if the forest is displaced by long interval plant, short rooted and short cycle. Such land opening for agricultural usually indicated with small success. If vegetation cut away and as

anxious let to decomposition or *in situ* burned, nutrient element in biota will be returned to soil. Soon, it will provide highly fertile to soil. However if the soil is uncovered continuously from the sun and the rain, the bacteria will immediately decompose organic material, and cleaning activities causes nutrient element get lost. Land becomes solid, lost of air chamber and capacity to endure the water, the fertile get lost, agricultural plant will fail.

The second biggest soil category in tropical area is *akrisol* (podsolik red-yellow) which about acid. This soil kind has new added acceleration nutrient element. Because moldering defeated by lost acceleration of nutrient element by cleaning, has low alkali exchange capacity.

### **2.3 Shifting Cultivation System in Tropical Rain Forest, A Strategy of Human Adaptation to the Environment**

From the perspective of Cultural Ecology, the shifting cultivation (performed generally by slash and burn technique), which is widely practiced by communities in tropical rain forest, is actually an exploitation technology or production manner to gain food supply as their cultural adaptation to the environment, especially in soil condition. The soil condition in tropical rain forest area as elaborated above, commonly, has several limitations factor for agricultural development (see Dasmann *et al.*, 1977). Ladamay (1993) in his research on shifting cultivation in South-East Sulawesi (Sulawesi Tenggara), conclude that shifting cultivation is a realization of human adaptation process with the environment.

Through the comparative history method, Meggers (*in* Bresler, 1968) found that, slash-and-burn agricultural method in shifting cultivation, firstly found in among the South American people who live in 2nd<sup>1</sup> type area in tropical forest cultural level, that is tropical forest area that has limited potency for agriculture. In Europe the Danubian I cultural level has also found similar agricultural practice for the first time, however with a difference reason (Table 1). Koentjaraningrat (1974) said that historically, shifting cultivation is a result of development process of cultural and technology.

In South America, the system was practiced after population gets increase in number in order to get supplies of food. Earlier people like as the Europe community in Paleolithic cultural level, they get the food supply from hunting, fishing and gathering.

Because of the limited potential for agriculture, then they were forced to conduct in shifting. After planting for 2 – 3 years, the fertility gets decrease and agricultural results will decreases as well. The old agricultural field is let to be dried for years to improve itself (gain more nutrient element which needed by plants).

According to Desmukh (1992), each family of farmers opens 1 to 5 acres of forest for 2 to 3 years planting periods and idle periods about 10 years. Thereby, each farmers family needs 4 to 5 cultivation locations.

To increase soil fertility they often burn or decay forest vegetation *in situ* prior to planting. Used land also is chosen as an indicator especially forest vegetation. Only the land that is considered to be fertile is chosen as farming area. All these action indicate that they already adapt to environment in gaining food supply.

In Europe, the emergence of shifting cultivation in Danubian I cultural level was caused by the recognition of agricultural plant *serealia* from the Near East. At the time (Paleolithic culture) the Europe community had no knowledge of farming system, (they were engaged in hunting, fishing, and gathering). The agriculture plant was in Near East cultivated through slash and burn agriculture, even though soil condition are allow for them to cultivated in occupy. Then, shifting cultivation that has emerged in Europe in Danubian I culture level is not a from of adaptation to the environment. Therefore, it was practiced again after agriculture tools were discovered: wood plow, bronze axe, harvest machine.

Based on the data from South America and Europe, it can be said that shifting cultivation is the oldest agricultural system in human history. Also, it can be concluded that shifting cultivation is a culture core of farmer community in tropical rain forest, because only them who has this kind of system as a strategy to adapt with their environment.

---

<sup>1</sup> Meggers (*in* Bresler, 1968) classified South American area into four types based on potential for planting that the same with four area or cultures level that was found by Steward (cited by Meggers *in* Bresler, 1968) there (see details of Table 1).

**Table 1. Correlation between agricultural productivity and culture.**

<b>South America</b>					
Culture	Subsistence	Settlement Pattern	Technology	Sociopolitical System	Religion
Andean	Intensive agricultural Irrigation Fertilization	Cities to 100.000 population	Full occupational specialization	King Hierarchy of officials Social classes	Hierarchy of gods Hierarchy of priests Temples and idols Public ceremonies
Circum-Caribbean	Improved agricultural Seafood	Towns up to 3 000 population	Division of labor by occupation	Chieps Social stratification	Shaman or chief acts as priests Tempel and idols Offerings
Tropical Forest	Slash-and-burn agriculture Haunting Fishing Gathering	Villages of 50 -1 000 population	Divison of labor by sex and age	Headman No difference in rank	Bush spirits <sup>1</sup> Shaman, mainly for curing
Marginal	Hunting Fishing Gathering	Nomadic single or multifamily bands	Divison of labor by sex and age	Headman No difference in rank	Bush spirits
<b>Europe</b>					
Danubian VII and VIII	Improved agriculture Iron plow Fertilization Fallow	Fortified cities covering 12 acres or more	Full occupational specialization	Kings and lesser chiefs Social classes	Shrines
Danubian VI	Improved agriculture Crop and fallow Wooden (?) plow Bronze ax and harvesting tools	Villages of about 38 houses	Division of labor by accupation	Chiefs with local authority Differences in rank	Ritual object and charms
Danubian I	Slash-and-burn agriculture Domestic pigs and cattle	Hamlets of 13 – 26 houses	Division of labor by sex and age	No evidence of difference in rank	Female figurines
Paleolithic	Hunting Fishing Gathering	Nomadic bands	Division of labor by sex and age	No evidence of difference in rank	

Adopted from Meggers (*in* Bresler, 1968)

<sup>1</sup> Kung Bushmen ethnic group are hunter and gatherer in Kalahari Desert in Southern Africa (Keesing, 1981).

Shifting cultivation system by slash and burn that were developed in South America provides the community to live in villages with 50 to 100 people. With the amount of people it is not necessary for the people to have too large area or range compared with the area for hunting, fishing, and gathering, which forced them to live in a nomadic way. Even though they still practiced hunting, fishing and gathering while doing shifting cultivation at the same time, the shifting cultivation has marked the beginning of permanent residence in South America. This is in line with Steward's Cultural Ecology which says that exploitation technology can impact population pattern (Figure 1)

Beside that, exploitation technology or production mode is shifting cultivation in South America has an influence on their society's religion. It can be seen from the known shaman, especially on healing and the bush spirits. The society from marginal culture level who lives in nomadic way by hunting, fishing and gathering only know the bush spirit only.

But, the mode of production by shifting cultivation which was already known to the area or tropical forest culture of the South American society seems to have little impact on their social politic system. It can be seen from the fact that their social political system is the same with the social political system of the society from other region or marginal level culture. In this system the role of leader (village leader) seems to be more needed along with as the increase in the number population.

The data provided by Meggers on Table 1 does not include economic organization of shifting cultivation society. So the analysis about it can not be done. However, from many experiments about shifting cultivation (Dove, 1988; Tahan, 1993; and Sundjoyo, 1994) it can be concluded that shifting cultivation societies generally have not known a form of formal economic organization. Like their social organization, the economic organization has the character of *gemeinschaft*; they live by mutual assistant, and help each other. They are economically subsistence, planting just to meet their needs and supplement their income by hunting and fishing.

#### **2.4 The positive and Negative Facets of Shifting Cultivation and Development possibility**

The following literatures studied about shifting cultivation: Kartawinata *et al.*, 1991; Geertz, 1983;

Dove, 1988; Gradwohl *et al.*, 1991; Soemarwoto, 1991; Desmukh, 1992; Soedjito, 1992; *National Research Council*, 1993; Ladamay, 1993; Tahan, 1993; and Sundjoyo, 1994. It can be concluded that shifting cultivation system is a manifestation of human adaptation in tropical rain forest area to their environment with limited potency for planting. Beside have positive facets, this system has negative facets. These negative facets is caused and strengthened by education level of shifting cultivation level, which is still low, and we can say if they never get formal education. They just use experience only.

The primary positive facets are: (1) efficient, (2) conserve germ plasma and raise for biological diversities, (3) it is can apply on tropical rain forest area with low density. The efficiency of this system can be proven by the result from Desmukh (1992) and Soemarwoto (1991) research - energy gains (output) in form of food of the system are most rather than the input.

Sudjito (1992) said that shifting cultivation of Dayak communities in East Kalimantan are germ plasma of paddy maintainer. They raise many kind of local rice, which cannot be found in other place. On the other hand Soemarwoto (1991) said that the farmers already known about cross breeding among cultivate and wild types which resulting superior type. Shifting cultivation usually raise many kinds of crop on one field, from annual crop until perennial crop. This system also has ecological meaning which covers the conservation principles (Kartawinata *et al.*, 1991). The farmers have no cutting of any kind of vegetation in forest, only certain vegetation which will be cut. And so with the soil, they choose specific characteristic of soil for planting (usually fertile soil). The farmers will be choosing the secondary forest which is easy to work. Conservation of fertile soil always is done by burning and decomposed of forest vegetation.

According Desmukh (1992) this system fits to apply on infertile soil in tropical rain forest, which has low population density. In addition, this system is resulted from human adaptation with environment, which has limited potentials for planting. But population in that area must be controlled, because high population density can shorten of the fallow period and increase land expansion or logging because this system needs larger area.

Negative facets of shifting cultivation are:

- 1) It requires larger area. Every household farmer needs about 4 to 5 locations which have 1 to 5 ha every location (see Gradwohl *et al.*, 1991).
- 2) The output is limited and decreasing along with the soil fertility decrease after 2 to 3 time planting during 2 to 3 years.
- 3) It cannot be applied in densely populated area, because of above reason.

The positive facets are a lot more than the negative ones. The system is a result of human adaptation with environment which has limited potentials for planting. Hence it can be implemented under specific circumstances like:

- 1). Implemented on low density. So, fallow period can not be shortened and the expansion or logging will not happen.
- 2). Implemented on secondary forest in order not to destruct the primary forest.
  - 1) Only little part of forest will be opened for planting, and then the field will kept on around and protect by forest. By this, erosion and depletion of nutrient by rain or sunshine can be minimized (abundant sunshine will enlarge laterisation). At field which have topography elevation, planting must be doing with leave over tree on hill to hold the erosion.
  - 2) A farm is better be cultivated with perennial crops as soil cover by at the same time considering the plant space in order not to disturb the primary crops (Harihanto, 1995b)
  - 3) Crop rotation is applied to maintain soil fertility.
  - 4) Crop rotation of stimulant is applied to increase the result.

- 5) Applied, considering specific conditions, such as: (1) topography, (2) microclimate, (3) soil properties and (4) local culture (knowledge and experience).

Beside that, this system can be developed and implemented outside the ecosystem of nature forest by adopting and applying the positive facets, for example, applying a fallow period, exploiting litter and trunks as nutrient source, and diversities of crop. An example of application of this system outside the natural forest ecosystem is *talun* garden in west Java, which is cultivated with various crops and using litter fall (bamboo leaf) as nutrient primary source. This system can developed on the farm that has market orientation. For example, plantation of tobacco in Deli which use eight months fallow period to take a rest farm after use and gets heavy pressure (see Soemarwoto, 1991). But, the challenge is how to make the farmers sure about the advantage from this system. For the farmers fields that have been left are a disadvantage because they already have been controlled by economic money.

### 3. Closing Remarks

Shifting cultivation generally has been practiced with slash and burn techniques are a result of human adaptation with tropical rain forest that has limited potentials for planting. This is the oldest system in human history. Because it is resulted from human adaptation with the environment, it can be implemented in tropical rain forest. Shifting cultivation system can be kept for subsistent cultivation under specific circumstances, and so will become a sustainable system. Shifting cultivation can develop for farming which have market orientation outside natural forest ecosystem by adapting and implementing the positive facets.

### References

- Dasmann, Raymond F. ; John P. Milton and Peter H. Freeman. 1973. *Ecological Principles For Economic Development* (translated by Idjah Soemarwoto, *Prinsip Ekologi Untuk Pembangunan Ekonomi*, 1977). PT. Gramedia. Jakarta.
- Desmukh, Ian. 1986. *Ecology and Tropical Biology* (translated by Kuswata Kartawinata and Sarkat Danimihardja: *Ekologi dan Biologi Tropika*). Yayasan Obor Indonesia. Jakarta.
- Dove, Michael R. 1988. *Sistem Perladangan di Indonesia, Suatu Studi Kasus di Kalimantan Barat*. Gadjah Mada University Press. Yogyakarta.



- Geertz, Clifford, 1983. *Involusi Pertanian, Proses Perubahan Ekologi di Indonesia. Lembaga Penelitian Sosiologi Pedesaan dan Yayasan Obor Indonesia*. Bhratara Karya Aksara. Jakarta.
- Gradwohl, Judith dan Russel Greeberg. 1988. *Saving the Tropical Forest* (translated by Hira Jhamtani: *Menyelamatkan Hutan Tropika*. 1991). Yayasan Obor Indonesia. Jakarta.
- Harihanto, 1995a. *Pengentasan Kemiskinan Melalui Pembangunan Dengan Pendekatan Ekosistem*. Post Graduate Programme, Bogor University (not published paper).
- Harihanto, 1995b. *Mengembangkan Perladangan Berpindah Menjadi Salah Satu Pilihan Penggunaan Lahan Secara Berkelanjutan*. Post Graduate Programme, Bogor University (not published paper).
- Kartawinata, Kuswata.; Andrew P. Vayda.; Timoty C. Jesup and R. Sambas Wirakusumah. *Pengembangan Cagar Biosfer Sebagai Alternatif Pembangunan Di Apokayan, Kalimantan Timur*, in *Berita Ilmu Pengetahuan dan Teknologi*: 2 (1981). Lembaga Ilmu Pengetahuan Indonesia (LIPI) Jakarta.
- Keessing, Roger M. 1981. *Cultural Anthropology, A Contemporary Perspective, Second Edition*. Translated by Samuel Gunawan: *Antropologi Budaya, Suatu Perspektif Kontemporer*, Penerbit Erlangga, Jakarta
- Koetjaraningrat. 1974. *Beberapa Pokok Antropologi Sosial*. Dian Rakyat. Jakarta.
- Ladamay, Omn, Ilah. 1993. *Aspek-Aspek Konservasi Dalam Tradisi Perladangan Berpindah di Sulawesi Tenggara*. Post Graduate Programme, Bogor University (not published thesis).
- Meggers, Betty J. 1968. Environment Limitation on the Development of Culture, in *Environment of Man* (Jack B. Bresler, ed.). Addison Wesley Publishing Company. London.
- National Research Council. 1993. *Sustainable Agriculture and the Environment in the Humid Tropics*. National Academy Press. Washington D.C.
- Sayogyo. 1991. *Kasus Petani Ladang Pindah Dalam Pembangunan Desa*. Paper was presented in National Seminar on Development of Rural Communities in Central Kalimantan Region. Palangka Raya.
- Soedjito, Herwasono. 1995. *Keanekaragaman Sumberdaya Alam dan Budaya Kawasan Konservasi Kayan Mentarang: Potensi dan Tantangan bagi Pembangunan Propinsi Kalimantan Timur*. WF Indonesia Programeme – Kayan Mentarang Project, General Directorate of Forest Protection and Nature Conservation, Institute of Science Indonesia and Regional Government of East Kalimantan Province (not published paper).
- Soemarwoto, Otto. 1991. *Ekologi, Lingkungan Hidup dan Pembangunan*. Penerbit Djambatan. Jakarta.
- Solbrig, Otto T. 1966. *Evolution and Systematic*. The Macmillan Company. New York.
- Steward, Julian H. 1995. *Theory of Culture Change*. Urbana: University of Illinois Press.
- Sundjoyo. 1994. *Keadaan Sosial Ekonomi dan Budaya Peladang, Teknik Perladangan Berpindah dan Kerugian yang Diakibatkan di Areal Hak Pengusahaan Hutan (Studi Kasus di PT Sari Bumi Kusuma)*. Post Graduate Programme, Bogor University (not published thesis).
- Tahan. 1993, *Analisis Sosial Ekonomi Perladangan Berpindah di Wilayah Kabupaten Kotawaringin Barat*. Post Graduate Programme, Bogor University (not published thesis).
- Wallace, Bruce and Adrian M. Srb. 1961. *Adaptation*. Englewood Cliffs, N.J. Prentice Hall Inc.