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THE IMPACT OF SHIFTING CULTIVATION IN THE FORESTRY ECOSYSTEMS OF TIMOR-LESTE

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Resumo

Assiste-se todos os anos à destruição de milhares de hectares da floresta em consequência da prática de agricultura itinerante de “slush and burn” ou “desmatamento e queima”. Esta actividade causa alterações nos ecossistemas florestais devido à destruição do coberto vegetal e consequentes alterações na fertilidade do solo. Em Timor-Leste, a agricultura itinerante ainda é hoje praticada como forma de agricultura de subsistência, em que se efectua essencialmente a plantação de culturas anuais.

Com base na caracterização da agricultura itinerante em dois sucos do distrito de Bobonaro, Timor-Leste, reflecte-se nos problemas, e nas soluções, causados pelo impacto dessa prática no desenvolvimento sustentável dos ecossistemas florestais de Timor-Leste.

A recolha da informação primária foi realizada através de inquérito por questionário aos agricultores praticantes de agricultura itinerante. O questionário caracterizou o método de agricultura itinerante, ouviu a opinião dos agricultores sobre o derrube e queima das áreas florestais e sobre a importância da floresta.

Na realidade sócia económica de Timor-Leste, a aplicação de soluções técnicas – reflorestação e gestão florestal, mulching e proibição da agricultura itinerante- não é suficiente dada a complexidade da organização política e social das diferentes comunidades que compõem o seu mundo rural. Nas soluções integradas, as soluções técnicas para melhorar a agricultura itinerante são apresentadas e tratadas com a comunidade em que são elementos fundamentais a participação e a responsabilização dos elementos da comunidade e a valorização económica e social dos bens produzidos pelas actividades agrícolas e florestais por toda a comunidade.

Abstract

Every year thousands of hectares of forest are destructed as a result of the practice of swidden agriculture, shifting cultivation or "slush and burn" causing changes in forest ecosystems. In Timor-Leste shifting cultivation is still practiced nowadays as a form of subsistence agriculture.

Swidden agriculture is characterized by slash and burn clearing, by a rotation of fields rather than of crops, and by short periods of cropping (1-3 years) alternating with long fallow periods.

Based on the characterization of shifting cultivation in two Sucos of Bobonaro district, a reflection is made on the impact of this practice in the sustainable development of forest ecosystems of Timor-Leste.

Primary data collection was performed using a questionnaire survey of farmers practicing shifting cultivation. The questionnaire characterized shifting cultivation, and asked farmers' opinion on slash and burning of forest areas and on the importance of forests.

According to the results obtained, in most situations the existing vegetation before the slash was composed of dense forest, the slash is made by the family group, the majority of farmers have been doing the “slush and burn” for more than ten years and the size of the plots where slash is made is less than 2 hectares. The materials resulting from the slash are used for firewood, building materials and fencing. The burning of vegetable residues is done before planting and soil preparation and sowing is done with a lever. Land and forest, despite having an individual use, have a tenure regime of ownership and access in which its nature of common pool good prevails. Every year thousands of hectares of forest are destructed as a result of the practice of swidden agriculture, shifting cultivation or "slush and burn" causing changes in forest ecosystems. In Timor-Leste shifting cultivation is still practiced nowadays as a form of subsistence agriculture.

Palavras-chave: agricultura itinerante; ecossistemas florestais; sustentabilidade; Timor-Leste

Keywords: shifting cultivation, forest ecosystems, sustainability, Timor-Leste

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1. Introduction

In tropical countries, especially during dry season, occurs every year the destruction of thousands of hectares of forest and bushes as a result of the practice of shifting cultivation "slash and burn" or "swidden agriculture". This activity introduces changes on natural ecosystems through the destruction of soil cover vegetation.

Slash and burn is known as the "tractor of poor farmers" in developing countries, mainly in tropical countries. Shifting cultivation is a type of traditional farming system adopted historically in tropical forestry ecosystems, where people do the cutting of the forest and burn the vegetal residues as land preparation for subsistence farming. During few years (2-3) households cultivate it and obtain food and then abandon the land which became unproductive. In the land abandoned, often a secondary forest appears, and after about ten to twenty years, this land may be used again for farming.

This type of farming involves the relocation of sites of cultivation, and in its more traditional and cultural forms, it is a way of farming ecologically viable and economically rational since population densities are low and fallow periods long enough to maintain the fertility of soils. This type of agriculture is, in essence, a form of exploitation of land with long term rotations, being the secondary forest one of the elements of the rotation. The secondary forest is a forest regenerated, in one or several time periods, after a human disturbance of the original forest.

Shifting cultivation is a system of land use, used on a global scale, with different regional names, known in Brazil as *roça* agriculture, in Zaire and Zambia as Chitimene, in Malay as Ladang and in as Burmese Taungya. From the viewpoint of socio-economic integration, a distinction is made between partial and integral shifting cultivation. In the first system, partial, stands the economic interest of the participants (cash crops, resettlement, agriculture and grazing), while the integral system, shifting cultivation comes from a more traditional way of life, throughout the year, community engaged, largely self-contained and ritually sanctioned (Conklin, 1957).

In view of the intensity of land use, shifting cultivation systems are strongly influenced by population density, were classified by Boserup (1981) in: forest fallow (very sparsely population density - 0-4 inhabitants/Km²); bush fallow (sparsely populated - 4-16 inhabitants/Km²); short fallow (medium population density - 16-64 inhabitants/Km²) and continuous cultivation (dense population density - > 64 inhabitants/Km²). The forest fallow happens when land is a free good or without tenure ownership rules and total forest regeneration and complete restoration of soil fertility is possible. Therefore, the fallow forest is ecologically balanced and due to low population density, is culturally integrated (Raintree and Warner, 1986).

Population density is the driving force in transforming shifting cultivation in forms of agriculture closer to permanent cultivation. Continuous cultivation marks the end of shifting agriculture. The latter, reducing soil fertility, asks for the adoption of new technologies in which modern inputs are essentials to maintain soil productivity (Jong et al. 2001).

In a broader perspective, the types of shifting cultivation vary according to initial vegetation (primary forest, secondary forest, bushes, agro-forest, meadows, pastures and savannahs), the type of users (indigenous communities, colonists, and settlers), the final vegetation (secondary forest, pastures, permanent crops and agro-forestry, plantation crops), and the length of fallow (no fallow or continuous cycle, short fallow - 1-2 years; medium fallow - 3-8 years; long fallow - more than 8 years) (Fujsaka and Escobar, 1997).

Tomás (1973) classified the traditional Timorese agriculture in agriculture over ashes (also called "Ladang"), extensive, almost itinerant with long fallow periods (up to ten years or more), under rainfed regime, with exception for the rice cropped in irrigated lowlands (the "Sawah" Malay).

From a distant past, there was a continuous transformation of natural ecosystems in forms of shifting cultivation by the people of Timor-Leste. Shifting cultivation is one of the main activities of Timorese farmers and is still practiced as subsistence agriculture, which performs essentially the cultivation of annual

crops like corn, beans, cassava, sweet potato and pumpkin. Shifting cultivation in Timor-Leste, identified with the garden cultures, does not involve the displacement of the population from one place to other, but only the movement for a new farmland that belongs to the family and is located on village land area.

The transformation of natural ecosystems has intensified since the late nineteenth century, with the cutting of many forests, some of them sacred, for the introduction of permanent or plantation crops, of which stands coffee, coconut, rubber, cinnamon, cocoa and pepper. Many of these crops were framed in an almost agro-forestry farming system, of continuous exploitation, and nowadays, due to its economic relevance, are yet particularly important coconut and especially coffee.

There are no official data on shifting cultivation in Timor-Leste, but a look at the area (about 90,000 ha) and the number of families (about 70% of total families) who grow the main shifting crop, i.e. corn, one gets an approximate idea of the socio-economic importance of this system of agriculture in Timor-Leste.

According to Marques et. al. (2010), in the forest inventory of Bobonaro district about 66% of the sampling plots show evidence of cutting of forests, about 23% have shifting cultivation practices and 19% show signs of burning.

Soil, climate and orography are key factors in vegetal land cover and agricultural exploitation of natural resources of Timor-Leste. Due to the fact that shifting cultivation is one of the forms of human exploitation of the territory, its consequences are highly dependent on the combination of those three elements. Topography is unfavourable for agricultural activities, around 29% of the territory has low slopes (<5%), 16% medium slopes (5-15%) and 55% shows high slopes (>15%).

The shifting cultivation, practiced by most Timorese farmers, has a substantial impact on reduction of land cover vegetation, on promotion of erosion, on reduction of soil fertility and productivity, on the decrease of water resources quantity and quality, and calls in question the long term environmental sustainability.

The objectives of this study are to characterize and reveal the socio-economic importance of shifting agriculture to rural communities in Timor-Leste, to identify the impacts of shifting cultivation in the environmental sustainability of the ecosystems and to suggest some solutions to mitigate their negative impacts.

The methodology used was based on collecting relevant information in the literature on the subject and on a survey of shifting cultivators in Atabae sub-district, Bobonaro district. The questionnaire characterized the shifting cultivation and asked farmers' opinions about its effects.

2. Shifting agriculture in Timor-Leste

At present the majority of the population of Timor-Leste is involved in "altitude agriculture" using shifting cultivation practices. Depending on the manpower available, each family takes on average between 1 and 2 hectares, using 2 to 3 plots. Some of the cultivated areas are located on fertile soils along rivers or streams, but most are located on the slopes. About 60% of the area cultivated every year is located in slopes' areas and therefore highly subject to erosion (RDTL, 2009).

The most commonly cultivated crops are maize, cassava, beans and some vegetables. The cropping period lasts about 3 years and then the land is abandoned to fallow for some years, after which it is cultivated again without proper conservation measures. Almost all families make a new annual vegetable garden, but the garden made in one year is never the unique source of food. Since the same land can be cultivated at least two to three years in a row, the family retains in cultivation two or three of the old parcels.

Table 1 shows the number and the percentage of households that produce the different cultures. The cultures identified with shifting cultivation -maize, cassava, vegetables and other seasonal crops- are produced by more than 60% of Timorese households.

Table 1 – Households in production of different crops

Crops	Household in crop production	% household in crop production
Rice	60966	31.3
Maize	131516	67.5
Cassava	134233	68.9
Vegetables	103779	53.2
Temporary fruits	124766	64.0
Permanent fruits	131854	67.6
Coffee	66679	34.2
Coconuts	116562	59.8
Other temporary crops	118163	60.6
Other permanent crops	127569	65.4
Total household	194962	100.0

Source: DNE, 2006

As documented by Brito (1971), in Timor-Leste the largest extension of arable land was in the past, and still is in the present, cultivated under the system of "shifting cultivation", a process always applied in home gardens. The basis for this type of agriculture is the hard work of cutting the trees and bushes. After the burn of materials, hedge fences are made surrounding the cultivated fields to protect them from harmful actions of domestic and wild animals. All these works are done by men, during the dry season (August / September). The men are also responsible for seeding and harvesting the crops, while women can help them and perform weeding.

According to Metzner (1977) there are two types of shifting cultivation in East Timor: the "fila rai" and "lere rai". The first is an older system (less developed) which mix crop rotation with fallow period of varying size and is used in soil recently deforested and therefore organic matter is not required; while the second is the result of increasing population pressure which leads to the adoption of a technique to prepare the soil, generally involving six to eight people, working side by side and using incipient instruments as tools for tillage.

There are three processes to prepare the fields for the cultivation of garden, which are still observed in the territory and which are dependent on the slope degree (Brito, 1971; Tomás, 1973). On land with steeper slope, the farmers only open a small hole with a sharp stick at one end (spigot or lever designated in Tetum as "becin-suac" or "al-suac" depending of the material), and in each hole are placed two or three grains of corn, beans and squash, all at the same time, the hole is immediately covered with the feet.

In compact and gently sloping soils, land is turned over, one or several people, queued, jab sticks more or less deeply in the soil, which operate as a lever, pulling a piece of land that falls facing down.

Finally, the process of terracing, important in areas such Quelicai, Bagueia, Turiscas, Maubisse and Hatobuilico requires extensive use of manpower. The terraces may be made of stone, as in Bagueia, or made of crumpled balls of land, as in Hatobuilico. The terracing technique represents an arrangement of space for agriculture much more advanced than a simple hedge fence.

Along the south coast, where there are two rainy seasons per year (December-March and May-July) it is possible to make a second crop each year, so new fires are made during the "uai-loro-kiic", the short period between the two summer rainy seasons, which roughly corresponds to the month of April. In this region, one of the crops, as a rule, is intended for domestic consumption, and the other, marketed if possible (Tomas, 1973).

The co-plantation in the same field of different crops offers many advantages, ahead of which no doubt is the almost instinctive defence against irregularities of rainfall. As crops are not equally susceptible to variations in rainfall, the food crisis is never total, and to a certain extent, it is possible the substitution of some agricultural products by others.

The survey allows us to say that no significant changes occurred in the process of shifting cultivation described above. and practiced during the Portuguese colonial occupation, and what happens at the present.

The activity of cutting and slashing the forest is practiced by almost all the farmers (87.1%) for at least 10 years. The land used for shifting cultivation is a mix of new and previous used land (51.6%), previous used land (32.2%) and new lands (16.1%). The land subject to cut and slash is located in the household village, on an average distance of 2 km. Land ownership subject to shifting cultivation is dominated by individual property (51.6%) and state-owned (35.5%).

The criteria for select the sites for shifting cultivation is dominated by the best soils, dense forest and return to previous locations, reported by 71.0%, 58.1% and 48.4% of respondents respectively. The type of vegetation subject to cut and slash is dominated by dense forest (61.3%) and herbs (45.1%). The cut and slash of the forest are made by the family group (61.3%), individuals (25.8%) and community (12.9%). The farmers cut and slash an average area of 1.7 ha, and about 50% of farmers cut and slash an area of less than 1 ha.

All farmers have plots of land that they leave in fallow, with 71% of farmers reporting having plots that never are put in fallow; usually the plots located close to the house. The farmers who do not have fixed garden plots (29%) are those that contribute in a greater degree to the slash and burn of the new forest area.

Soil preparation begins with the burning of residues prior to sowing; either on new lands or in the lands that farmers cultivated for several years, the seeding is done with the lever, "becin-suac" in Tetum, to open the holes for the seeds. The dominant crops are at a first level of importance, maize, cassava and pumpkin (\approx 90%); at a second level, sweet potatoes and peanuts (\approx 40%); and at third level, upland rice and tunis (\approx 20%).

The average number of years of cropping in shifting cultivation in the same field is about 5.7 years, with an equal distribution of farmers using the land up to 3 years, between 3 and 6 years, and over 6 years.

After shifting cultivation, around half of the farmers reforest the land with teak, the others leave the land in fallow. For the future, most farmers (61%) expressed no intention to increase the area of shifting cultivation, while 29% intended to expand the area of shifting cultivation.

Schematically, we can say that the use of land for shifting cultivation in Timor-Leste can be represented by the Diagram 1, and divided into three steps: clearing, agriculture and fallow. Following the falling and cutting of forests and bushes, wood materials are used by households. The burning of residues is made as preparation for sowing. The land is cultivated during several years, after which, farmers abandon it for long periods, to restore soil fertility through the growth of secondary forest.

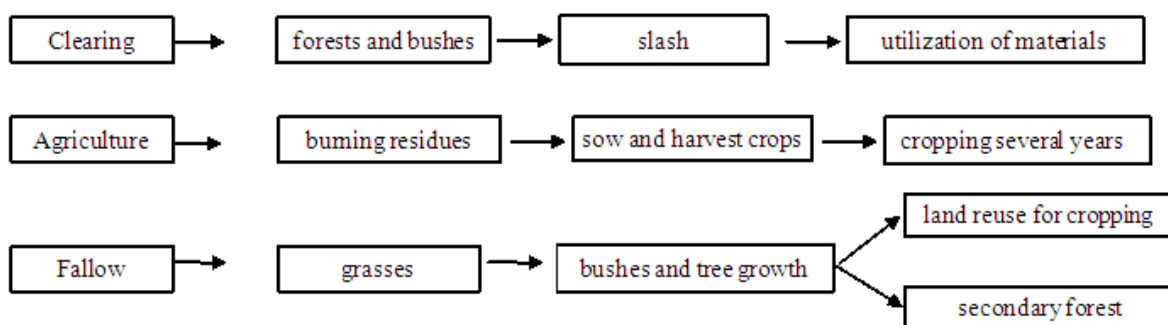


Diagram 1 – Shifting cultivation stages in Timor-Leste

In addition to income obtained from crops, the materials from cutting the forest are utilized by farmers for domestic use (fuel wood, building materials and fences to their cultivation sites) and sold in the market.

According to Egashira et al. (2006), in the past, shifting cultivation was well practiced by Timorese farmers with a sustainable management of land and fallow periods up to 15 years were common. However, the fallow period was reduced due to the limited availability of land, mainly caused by an increasing population growth.

The slash and burning remains, but without moving to new lands, there is a conversion from shifting cultivation to continuous cropping.

3. Problems of shifting cultivation in Timor-Leste

The practice in Timor-Leste of an itinerant (or shift or slashing) agriculture has direct negative impacts on the forest area and biodiversity, on soil fertility and productivity, and on quantity and quality of water resources, in addition to a set of effects on the goods and services produced by forests. These effects can be seen in a local, regional and global perspective. At local level, is important the productivity of shifting agricultural systems in meeting food and income household needs, as well as its long term sustainability which includes the risks of rainfall and diseases and pests; at regional level the functions of river in supplying water and preventing floods and natural disasters; at global level carbon sequestration and biodiversity.

Impact on forests and biodiversity

By the fall and cut of the trees, slashing agriculture contributes in a significant manner for deforestation, with the associated loss of all economic and ecological good and services produced by the vegetal cover. Deforestation leads to a direct loss of biodiversity and, by soil exposition to weather, to subsequent losses of fertility and productivity.

The conditions of forests in Timor-Leste are nowadays, as in the past, severe. There was a significant reduction in the forest area from 1986 to 2009, in both, dense forest and medium density forest and an increase in the area occupied by agricultural activities (Laranjeira et al., 2010; RDTL 2009). The rate of deforestation is estimated to be around 1.1% per year.

The main reasons for deforestation are the need of farmers of doing shifting cultivation in order to meet their family feeding requirements, the use of wood for domestic consumption and sale, and finally, the illegal cutting of trees that are often sold at ridiculous prices, for example 1 kg of sandalwood for 5 USD (Mota, 2002).

Impacts on soil

According to Gonçalves (1963), the direct action of man in the intensification of erosion process is done through an inappropriate technical use of land. The human presence almost always determines a change in the vegetal cover and if human influence is marked continually by the slashing and burning, followed by crops that forget any measure of soil conservation, so, the degradation starts, and soil loss can be total.

Most soils used for shifting cultivation belong to the class of cambisols and associations and vertisols, occupying 912,605 hectares, which represent approximately 61.1% of the territory. These soils have average productivity and susceptibility to erosion from low to medium (RDTL, 2009).

According to Egashira et al. (2006) shifting cultivation in Timor-Leste has negative effects on soil in the following aspects: erosion, decline in fertility, acidification and sedimentation of the lowlands.

The most significant problem of deforestation and inappropriate agricultural techniques is soil erosion which contributes decisively to the reduction of the productive value of land in Timor-Leste. As a result of deforestation, soils are degraded by erosion caused by the combination of forest clearance and bad farming techniques, in a particular climatic context conducive to severe erosion processes (Lança and Parreira 2006).

The repeated burning of natural resources for shifting cultivation in the dry season, exposes the soil to erosion. Soil erosion from agricultural land is mainly due to deforestation and burning; after burning no vegetation remains in the field at the beginning of the rainy season. According to Mota (2002), it is estimated that the loss of soil is put at 26 tonnes/ha/year, very high taking in consideration that the world average is around 10 tonnes/ha/year).

The decline in soil fertility, evaluated from the organic matter content in soil, is another significant problem associated to land degradation in Timor-Leste. According to Egashira et al. (2006) low levels of organic matter, high density and soil acidification observed in experimental plots indicate a reduction in soil fertility caused by poor land use management.

Soil erosion degrades not only the land with slope and which have already been eroded, but also destroys the lowlands of irrigated agriculture, through the deposition of eroded soil on it. The physical removal of sediments from low farmland is difficult due to the high cost necessary for such operation. When soils are not adequate for the cultivation of rice any more, rice is replaced by maize and cassava, less demand and valuable crops.

The deforestation of hillsides in Timor-Leste, in association with a recent geological context, means that landslides occur with some frequency and that are in many parts visible in the landscape. These landslides have costs that can be measured by the degradation of roads and the impracticability of buildings.

Impact on soil productivity

The practice in East Timor of a shifting cultivation with a fallow period of short duration, associated with thin soils, leads to a limited recovery effect of fallow on soil fertility. This is what happens in the mountain range that occupies most of the territory, where almost 50% of the area has slopes greater than 20%.

Shifting cultivation with short fallow, "Lere rai", has a negative effect on productivity because the fallow does not allow recovery of soil fertility (Figure 1).

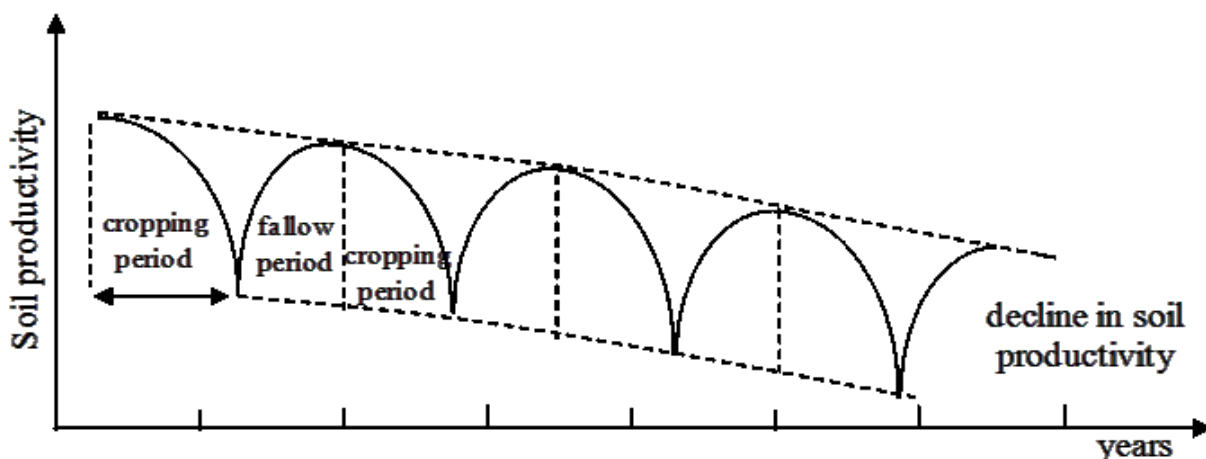


Figure 1: Soil Productivity under Lere rai
Source: Lança and Parreira (2006)

Shifting cultivation with long fallow, "fila rai" has a neutral effect on soil productivity because it allows restoring the soil fertility (Figure 2).

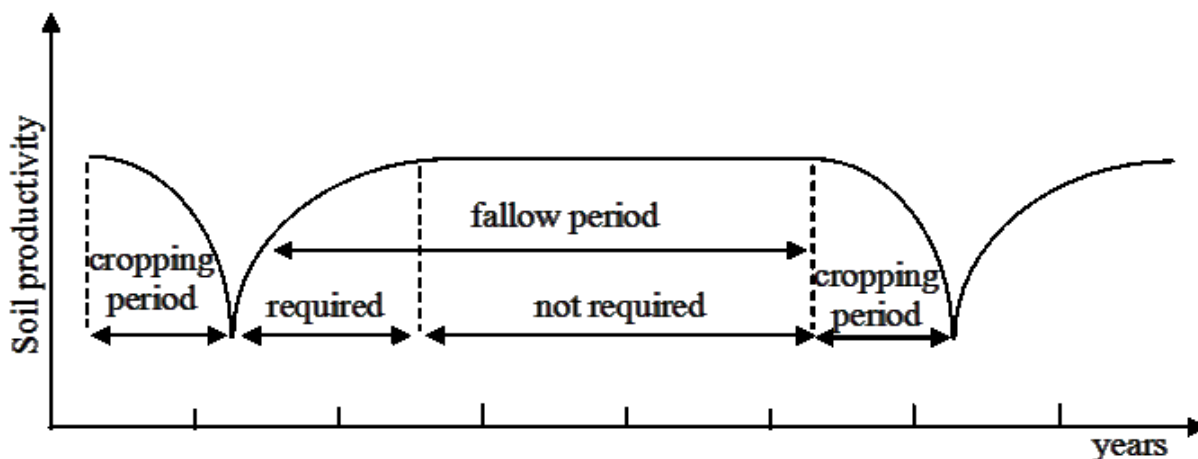


Figure 2: Soil Productivity under “fila rai”

Source: Lança and Parreira (2006)

Due to the population pressure, the sizes of fallows have been reduced. For shifting cultivation of Timor-Leste the ideal number of years of fallow, for maintaining soil fertility, making proper use of it, is greater than ten years (Figure 3).

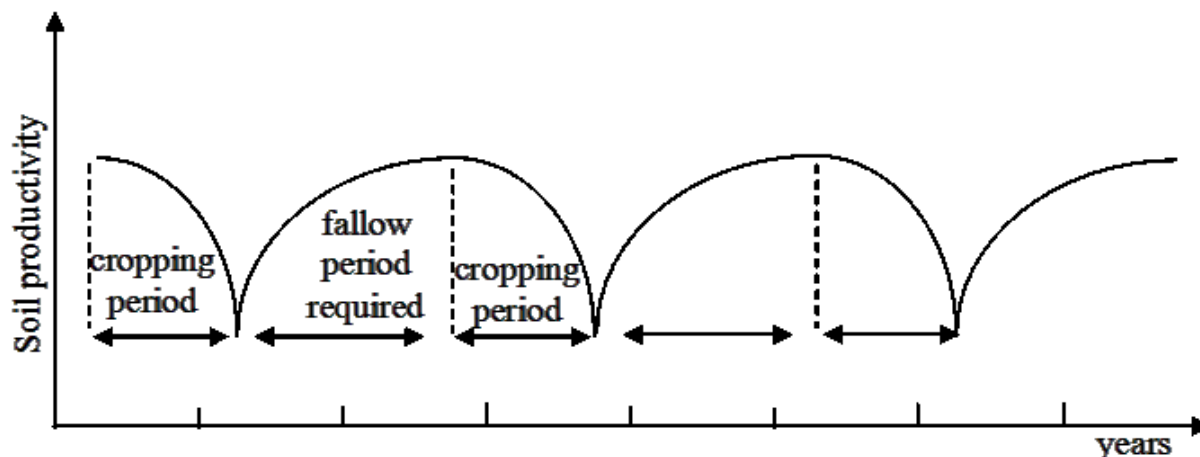


Figure 3: Ideal number of years of fallow for maintaining soil productivity

Source: Lança and Parreira (2006)

Impact on water resources

The major water resources in East Timor are the rain, springs and streams. The level and geographic distribution of these resources depend largely on the amount of rainfall and on its distribution during the year and by agricultural region.

The system of agricultural irrigation in Timor-Leste is mainly by surface irrigation, with springs and streams acting as water sources. Greater deforestation and erosion leads to a lower capacity of the soil to hold water. This fact could lead to disruption of water supply for human consumption and for agriculture, to a lowering of water quality and to the deterioration of terrestrial and marine sedimentation. The extent of damages is difficult to quantify in financial terms (Mota, 2002).

Impact on goods and services produced by the forest

The forest plays an important role for the rural population of Timor-Leste because it provides goods and services for direct use by hunting and gathering species for food, medicine, handicrafts and building materials.

In addition to the goods and services of direct use, the forest provides a set of goods and services of indirect use within the regulatory function. In this we highlight the following goods and services: climate regulation, regulation of floods and natural disasters, preventing erosion, maintaining soil fertility and soil formation, maintenance of the water cycle and nutrients, water supply, waste recycling, and place of habitat and refuge for wildlife, plants and animals.

Shifting cultivation, producing changes in vegetal cover, contributes to forest degradation and to the reduction of goods and services with direct and indirect use. The survey data indicate that the vegetation after shifting agriculture is dominated by shrubs, bushes and herbs. The transformation of forest into savannas' vegetation zones contributes, in the short term, to reduce the set of goods and services of direct use; and in the long term, to significantly reduction or elimination of the goods and services comprised in regulatory function.

The forest in East Timor is one of the natural resource that has more importance in rural development of the country, through the goods produces and that are used directly by people in their day-to-day or by producing goods that are indirectly used.

From the set of goods and services produced by the forest and used in everyday life, the order of importance given by farmers is as follows: firewood, building materials, timber, hunting and medicinal plants.

Table 2 – Products collected in the forest

	Households	Percentage
Fuel wood	31	100
Building materials	28	90,3
Wood	11	35,5
Hunting	11	35,5
Medicinal plants	10	32,3

Source: Jesus, 2010

The surveyed farmers (83.9%) are aware that forest cutting have a negative effect on the goods and services produced by forests through changes in rainfall and spring water, land loss, climate change, reduction of wild animals and plants and products collected in the forests (Table 3).

Table 3 – Household perceptions on forest fell and cut (% of households)

	Yes	No	Do not know
Loss something with forest fall and cut	83.9	0.0	16.1
Change climate	77.4	3.2	19.4
Change rainfall regime	87.1	0.0	12.9
Change water sources	87.1	0.0	12.9
Increases soil losses	83.9	0.0	16.1
Reduce wild fauna	77.4	0.0	22.6
Reduces wild plants	71.0	0.0	29.0
Reduces hunting	74.2	0.0	25.8
Reduces vegetables products collected	61.3	0.0	38.7
Reduces other products collected	67.7	0.0	32.3

Source: Jesus, 2010

4. Solutions for shifting cultivation in Timor-Leste

Traditional agricultural systems of shifting cultivation were developed by farmers to better utilize the available soil resources and climatic sequences. The main objective was, and is, food production to feed the household and, if there is surpluses to sale in markets.

Shifting cultivation in East Timor has been developed over a long period of time and went through a series of experiments that were passed from generation to generation. In most situations, the traditional system of shifting cultivation is environmentally stable and works as long as farmers are available to live at a level near the subsistence (Viegas, 2003). An increase in well-being means an improvement in production of agricultural goods, which requires an improvement in productivity, even in soils where the fall in productivity does not occur quickly.

Any intervention aimed to improve the shifting cultivation systems should consider the following passage from Richards (1985):

"Any reform of shifting cultivation, if the reform is needed, may imply an obligation to convince the local farmer to modify their methods of production. Therefore, it seems more necessary to first understand the principles of traditional systems of agriculture before trying to impose new and alternative (and possibly untested) methods to a conservative people."

In this perspective is important to find solutions that enable, for most farmers, food production in mountainous areas, considering that the problem is not strictly technical, but it has a fundamental human component. The priority should be to find solutions that are not only sustainable, but also respond directly to the concerns and needs of the people.

As seen in Table 3, most farmers surveyed have the perception that they lose something with the cut of the forest, which may indicate their predisposition to accept changes in their way of doing traditional agriculture, certainly since these changes do not jeopardize the survival of their household.

Technical solutions

The type of observed rainfall is torrential and most of the territory is mountainous and sloping, therefore the forest cover is essential to provide protection to the soil, at soil and water conservation levels, and key in preventing its degradation.

Among the technical solutions presented to address the problem of shifting cultivation and deal simultaneously with the soil fertility, are the appropriate reforestation and forest management programs, the mulching, and, the easiest but almost impossible to implement, the ban of shifting cultivation.

It is noteworthy that in 1906 was created the first law that regulated the cutting and burning of trees, to prevent the archaic habit of indiscriminate cut of them and to help to retain more indigenous farms in certain locations. Despite this prohibition, the issue of slashing and burning was referred almost permanently throughout the twentieth century in the various studies and reports on Timor.

In order to prevent the deforestation of the forest land and keep forest land cover in good conditions, reforestation programs should be encouraged in which the selection of appropriated species to plant and technology used are key elements.

Forest management is one of the techniques to deal with the problems of this type of agriculture and to protect the forest areas in rural and in mountainous and hilly areas, beside that is crucial to give more importance to the forestry sector and to help define the areas of forest production. Thus, briefly the flat areas should be used for food production, the intermediate zones should be used as agro forestry zones and the altitude zones for forest production.

To regulate the cutting by local people of forest trees for fuel and other uses is important to use the tarabando. The tarabando could be describe as a set of traditional rules of access, use, and management of natural resources, mainly forests. Tarabando allows the preservation of the forest based on traditional culture and can serve as a useful reference for forest protection, avoiding over-exploitation and illegal timber extraction.

Mulching is the surface coverage of the soil with organic materials, a practice that is simple, but effective for the prevention of erosion and declining of soil fertility. The organic residues, as corn stalks and weeds, composts made from animal excrement, and fallen leaves of trees, are considered as suitable and available materials. In addition to this the legume crops (Macuna) and trees in line, called "alley cropping", could be used (Egashira et al. 2006).

One important question is if the materials used in organic soil cover should be burned or not. Egashira et al. 2006 recommends the conversion of "slashing and burning" in "slashing and mulching". This is a simple technique and adequate to prevent soil degradation and to keep the soil alive, making the soil healthier and leading to improvements in the quantity and quality of agricultural production.

Integrated solutions

In the socio economic context of Timor-Leste, technical solutions are not sufficient given the complexity of political and social organization of different communities and integrated solutions are demanded. In integrated solutions, technical solutions to improve shifting cultivation, are presented and dealt with the community. Fundamental elements of integrated solutions are community participation and accountability, and social and economic valuation of goods produced by farming and forestry activities by all community.

With regard to participation, it is noted that the successful implementation of any project aimed to foster changes in the people's livelihoods strategies and practices depend on the adhesion of different members, or all members, of the community.

Once ensured the community participation, accountability for compliance with the rules is critical to the success of the project. Here, in addition to the application of formal rules laid down in legal laws, the establishment of traditional/local rules of operation and penalties, such as "tarabando", may be an option to be taken by the community, and usually is the more effective option.

Finally, the economic and social valuation of goods produced is crucial, bearing in mind that new solutions to be adopted can never question the basic survival of households. In the economic valuation is necessary to consider not only the private goods (corn, beans and wood) that are valued by the market by selling the products, but also the assets with a public nature (soil protection, forest protection, water protection). These public goods are not valued by the market and, in most cases, have only benefits in the long term. Because there is no short-term benefits that contribute to the survival of communities is difficult to convince the communities about the goodness of their production. In this circumstance the state has a key role in supporting the production of such goods.

The Amarasi model practiced in the community of Amarasi in West Timor, is an agro-forestry system of farming which makes crop rotation of corn and other food crops with the production of forage for cattle fattening in an atmosphere of nitrogen fixation by *Leucaena leucocephala* where fertilizers are redundant. This system is easily adopted by shifting cultivation farmers. *Leucaena leucocephala* trees are planted in most of the land plots and every year a part of the trees is cut and the roots placed to cover the land and burned before planting maize (Jones, 1983). This model started to be implemented around 1930, during the colonial Dutch period and its acceptance and full application in the whole Amarasi community asked for and led to an adaptation of traditional laws of land use and management as well as to the application of sanctions to non-compliers.

Another example of an integrated solution is the implementation of the pilot project for management of natural resources in the village of Dare. This project has two components: 1) the production of carp, goats and sandalwood which occupy about 1 ha and 2) the restriction of shifting cultivation in the whole Forest Suco which covers, in principle, all 1,413 ha of jurisdiction of the forest Suco (RDTL, 2005). In this project, participation is a key element and allowed the creation of a set of rules for the management of natural resources by the community. However, given the sensitivity of the matter, no Tarabando rule was established to penalize violations of the prohibition rule of shifting cultivation.

5. Conclusion

Shifting cultivation is one of the main activities of Timorese agriculture and shows that sociological factors are an important contribution to the changes of the type of forest cover observed in the territory. This deforestation have been increasing since the XIX century when many forest lands were cleared for coffee plantation, and more recently to facilitate the war against the Timor-Leste guerrilla and due to population growth.

Shifting cultivation practiced in Timor-Leste is the basis of subsistence in rural areas, does not imply change in home residence of household and is very close to the integral system, once food produced is mainly used for self consumption and shifting cultivation is integrated in family and community life. The population density, 66,6 inhabitants per Km², tell us that many parts of the country are in the beginning continuous or permanent cropping.

As in the past, shifting cultivation today is intended primarily for garden crops, mainly corn, beans, cassava, pumpkin and sweet potato. The slash is done in areas covered with dense forest and the resulting material is used for firewood, fencing and building materials.

The technology of shifting cultivation is similar to that described in the Portuguese colonial period, the burning of residues is done before planting and soil preparation and sowing are made with a lever.

Shifting cultivation land is abandoned after some years of cultivation due to loss of soil fertility. After the abandonment, some farmers do reforestation with teak and other definitively abandon the land in fallow.

Regarding the importance of the forest, farmers use it as a source of firewood, building materials, timber, hunting and medicinal plants. Farmers are aware that when cut down the forest they lost something and that cutting of forest negatively affects the climate, rainfall, water supply, soil quality, and the size of populations of animals and wild plants and quantity of products obtained from the forest. Therefore seems to exist space for improvements and changes.

The improvement in methods of use of forest land for agriculture involves integrated solutions, in which the technical measures recommended are assumed by farmers and their families in terms of participation, accountability and economic valuation.

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