

## Dynamics of land use by agricultural colonists in the tropical humid forested mountains of central Peru

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(Accepted by Applied Forest Science Journal of the Japanese Forestry Society, 2003)

### 要旨

ダビッド・ロペス・コルネリオ: 中央ペルー熱帯湿潤林山岳地域における農業移民による土地利用のダイナミクス, 森林応用研究

Huallaga河谷への入植を事例として、アンデス地域における入植者による土地利用について、土地利用指標による分析を行った。その結果、以下のことが分かった。1) 焼畑農業は、現在では通常、移動農業でなく、定住農業による耕地拡大を意味し、また、長い休閑期間を前提とすれば、生態学的にも経済的にも持続可能な手段といえる。2) 過去の失敗した入植プロジェクトでは、人口増加と違法作物の拡大がその原因である。3) 土壌使用の強度は、主にその土地占有時間によって説明される。4) 農家の生産戦略は市場に強く規定される一方、家族労働による休閑、混作といった伝統的農業に依然依存している。5) 農家規模は、その農家で栽培される主要作物を説明する重要な要素である。

キーワード: アマゾン定住政策、土壌劣化、土地利用転換、伝統的システム

### Abstract

Land use practices by Andean colonists in representative points of emigration at Huallaga River Valley are analyzed through a review of the historical processes and census data from the last agricultural census available. It was found that 1) Slash-and-burn agriculture is now commonly a manifestation not of migratory agriculture but of the broadening of sedentarized peasant agriculture and when based on long fallow periods can be an ecologically and economically sustainable practice. 2) The region is characterized by state projects of colonization that failed, a demographic explosion and the widespread of illegal crops. 3) The level of soil use intensification is mainly explained by the time of occupation. 4) The production strategies, although strongly linked with the market, still rely on family workforce, fallowing practices and mixed crops, and 5) The farm size is an important factor that explains the type of dominant crops.

**Key words:** Amazonian settlement practices, land degradation, land use conversion, traditional systems.

### I Introduction

One of the limitations for planning a sustainable development in the Amazonia is the inadequate understanding of the colonists rationality of land use. A stagnant rural economy, mistaken policies that failed to set the country on a path of stable aggregate growth and labor intensive industrialization (Coxhead et al, 2002) and an unrealistic forest law are some of the factors that boosted the emigration of peasants from the Andes. Although through the process of occupation in the Huallaga Valley, certain patterns of production (coffee-fruit-timber triad) have crystallized, giving the region a distinctive economic profile (Santos-Granero and Barclay, 1998); the colonists gradually turned to the propagation of illegal crops (*Erythroxylon coca Lam*) with adverse environmental and socio economical consequences..

Commonly, a population increase forces an intense land use and technological innovation (Boserup, 1965), but due to synergistic links between factors (development projects, logging and expansion of agriculture), is difficult to define and isolate the causality in land use change (Keipi, 1999). Deforestation by slash and burn might be less than previously believed since according to Smith et al (1999) as many as one third of farms still maintain

forest cover. The density of forests might increase or be maintained on arable land capable of supporting crops that would generate more revenue, but require higher intensities of labor and capital use. This study deals with the approach in which settlers create their own strategies of development and innovation. They may find solutions by dealing with ecological, economical and demographical changes. Households make choices between land uses, reflecting different levels of labor required to make land productive, as well as markets for commodities and inputs which define the margins which households can hope to earn. The process of farms fragmentation in the region does not follow the same causal process as in other geographic areas of the country. The Amazonian *minifundio* (small and medium sized holdings) did not receive enough attention from the state planning board because it was assumed that land is an unlimited good. Furthermore, on the colonist perspective, not all land suitable for agriculture has value. Woodlots are maintained not so much as a source of income (although that remains a possibility), but because household resources are not adequate, or are otherwise not needed for cultivating these areas more intensively.

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A transition to systems of sustainable production may entail heavy investment costs in several respects (Deweese, 1991), in terms of increasing income and employment possibilities for the households; in terms of developing incentives for local communities to keep woodlands; and in terms of intervening in the market in a way which ensures stable prices for a diversity of products from the region. Increased productivity, lower costs of hiring labour and an increased efficiency of land markets might promote employment opportunities and reduce demand for agricultural lands.

## II Materials and Methods

The study areas (Fig. 1) are located in the Upper Huallaga Valley (Huanuco region, Peru) at 08°44'55"-10°20'21" south latitude, and 74°39'00"-77°30'00" west longitude. The natural vegetal formation is the *tropical humid forest* (ONERN, 1962) with residual and alluvial soils of regular depth and fertility, some of difficult drainage (hydromorphic). The total area in the region is 89633 ha, occupied by 8358 farmers (INEI, 1996).



Fig. 1 Location of study areas.

图1 研究对象地

The *Instituto Nacional de Estadística e Informática* (national institute of statistics and informatics) compiled the statistical data at the district and

regional levels during the National Agricultural Census. Complete enumeration of all holdings was carried out. The data were collected through direct interview using a specific form for agricultural units reporting at least 0.5 ha of total land. Agricultural units not reaching the above-mentioned limits were considered to be smallholdings, and only limited information was collected for them. The selected statistical unit is the Agricultural Unit (AU), defined as any piece of land consisting of one or more parcels, totally or partially used for agricultural production, carried out as a technical-economic unit by the agricultural holder, without regard to size, tenure or legal status. They were identified on the territory through cartography.

The method consists in the analysis of historical and statistical data from the 1996 agricultural census for three representative settlements in the Upper Huallaga River, representing the old, intermediate and recent zones of colonization. The bibliographical data concerned the evolution of colonization movements to the region, their characteristics, factors and types; and the statistical data comprehended the number, area and time of possession of AUs per type of land use (annual, permanent and mixed crops, grassland and fallow) for the selected zones. The levels of soil use intensity and fallowing practices were determined and compared considering the effects of human demographic growth, market and the structural changes created by the Land Reform (1960), on the patterns of land use and the fragmentation of farms.

The studied zones were: (1) Tingo Maria, the oldest zone, by 1980 approximately 50 percent of the colonists had been established for 20 years (2) Aucayacu, where a similar proportion of colonists had been established for between 11 and 20 years; and (3) Tocache-Uchiza, the most recently occupied zone, where more than 60 percent of the colonists had been established for less than 10 years. The characteristics of assessed households are shown in Table 1.

The hypothesis is that in areas that have been occupied for the longest time, (1) there is higher population pressure, which is correlated with greater land fragmentation, and (2) producers are better linked with the market, resulting in the transition from subsistence shifting agriculture to a commercial agriculture based on perennial crops. These two factors result in land use intensification, which takes the form of (1) a reduction in cultivated area per agricultural unit and (2) a reduction in the proportion of fallow land.

### III Demographic trends

Associated with a growing population, land use is intense even though only 11% of the land is suitable for agriculture (Santos-Granero and Barclay, 1998). The demographic pressure on the land explains the fragmentation process without a clear process of land concentration. Although the land tenancy structure in the Huallaga valley might be characterized in general as of small holding, important differences are found within the area associated with the length of occupation as well as with demographic pressure on "valuable land".

The values for rural population density vary significantly at the district level, with the highest values corresponding to the districts that have been colonized for longer time.

According to Santos-Granero and Barclay (1998) the mass colonization was perceived by large landholders as a period of disorder and by the Andean migrant colonists as the beginning of a period of order.

Table 1. Basic characteristics of settlers (in percentage) in the Upper Huallaga Valley.

表1 Huallaga 河谷上流域居住者の特性

	Tingo Maria	Aucayacu	Tocache - Uchiza	Total
SAMPLE (number of families)	68.0	128.0	189.0	385.0
ORIGIN				
Natives	4.4	1.6	18.5	10.4
Migrants	95.6	98.4	81.5	89.6
ARRIVAL TIME				
before 1970	26.1	4.0	4.5	8.4
1970 - 1980	26.2	14.3	9.7	14.6
1981 - 1990	26.2	57.1	25.4	37.3
1991 - 2000	21.5	24.6	60.4	39.6
TIME OF RESIDENCE				
more than 20 years	52.3	18.3	14.3	22.9
11 to 20 years	26.2	57.2	25.3	37.1
6 to 10 years	7.7	13.5	39.0	23.8
less than 5 years	13.8	11.0	21.4	16.2
REASON FOR MIGRATION				
need of land	41.0	53.6	57.0	52.8
search of job	39.7	33.7	28.2	32.4
presence of family members	18.0	11.4	10.7	12.3
government support	1.3	1.2	4.1	2.5
REGION OF ORIGIN				
Coastal	6.2	5.6	6.5	6.1
Andean	78.5	72.2	62.3	69.1
Amazonic	13.8	22.2	31.2	24.7
AGE AT ARRIVAL (years)				
less than 15 years	13.8	8.7	6.5	9.0
15 - 19	21.5	12.7	9.1	13.0
20 - 29	29.2	39.7	39.0	37.0
30 - 39	20.0	28.5	22.7	24.0
more than 40 years	15.5	10.3	22.7	17.0

Source : INEI III (1996)

Four stages of immigration are differentiated:

1) 1850-1900. Related with the coca cultivation for traditional use in the Andes. The Indian and mixed population settled in the occidental side of the valley in Andean shaped towns articulated through small roads.

2) 1900-1960. Related with the gum extraction (*Hevea brasiliensis*) along the Huallaga River with Tingo Maria as the accumulation centre. By 1914 the gum market declined and the farmers returned to the subsistence agriculture. The Second World War recovered its demand briefly, however the permanent expansion begun after 1945-50 with the construction of new roads.

3) 1960-1975. Efforts to colonise with state intervention begun with the law 8621 (1930), which fixed an area next to Tingo Maria for agricultural use. By 1943 the Marginal Road (links Lima, Huanuco, Tingo Maria and Pucallpa) was concluded. Commercial crops (tea, coffee, tobacco) were introduced besides wood exploitation and the *latifundio* system expanded (Bedoya, 1982). There were problems of administration, crops failure and weak technical assistance. Low soil fertility and insufficiency of roads, basic services and credits forced the abandonment of conceded farms. The government promoted collective forms of property and exploitation. Each settler was given a private and a collective farm, but these lasts were too far from the family unit. Scarcity of labour impeded families to extend their activities outside their own properties and most of them did not have experience in co-operative land management. That individualism was not related with a lack of group identity but with a refusal of imposed collective forms by the land reform (Bedoya and Aramburu, 1986). Moreover, new migrants settled on unutilised collective areas increasing the tenancy confusion.

4) 1975-2000. Period related with the expansion of coca plantations and a significant decrease of government support. In the country, approximately 40,000 households had 36000 ha planted for coca, 7134 ha were eradicated but other 9700 ha appeared during 1999-2002 (El Comercio, 2003). The effects of the eradication campaigns still are not clear.

Although the difficulty to differentiate the colonisation limits with those identified by the national censuses (based on the political division of departments, provinces and districts), the population increased eleven times in the last four decades (Fig. 2). Population changes until 1940 contrast with the fast and constant growth during the last three decades. The proportion of rural population keeps a high level (7352 in 1940 and 78472 in 2000) but the urban

population is increasing (from 4091 in 1940 to 56128 in 2000).

The relation of urban and rural population remained constant, with 2/3 parts classified as rural and 1/3 as urban. Approximately 77% of the settlers arrived after 1960, and around 40% in the last decade, meaning that the demographic expansion is recent and concentrated in a short period. In Tingo Maria 52% of the settlers dwelled for more than 20 years, in Aucayacu the 57% remained for 11 to 20 years, and in Tocache-Uchiza the 60% did for less than 10 years; evidencing an adaptation to the new environment. Ephemeral establishment was not registered. Urbanisation is notable in the old areas, where public services and commercial firms are located, and most of the inhabitants (except in Tingo Maria) are farmers.

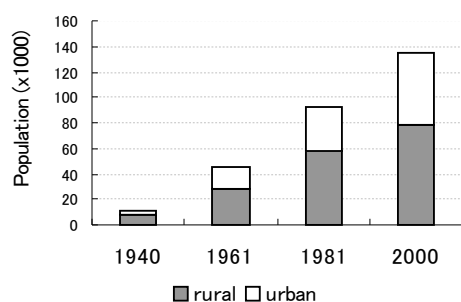


Fig. 2 Demographic trends in the Upper Huallaga Valley.

図2 Huallaga 河谷上流域の人口推移

Source: INEI (2002)

In the agrarian cooperatives established by the land reformation, the desertion rates were higher than 80% of the initial population (Cencira, 1974). Many of them moved to a new location through the slash and burn practice during the “dry season” (May-July). However, desertion levels in groups locally organized were of only 15-20% (Aramburu et al, 1982). The reasons for immigration are mainly land shortage (53% of cases) and seek of employment. The yields per hectare of rice and yellow maize are 15% and 30% lower than in the Upper Mayo and Central Huallaga regions (Aramburu et al, 1982). However, land frontier has served as the employer of last resort. The abundance of low-skilled labor precipitated the agricultural expansion. Relatives that settled down are also an important attraction for migration (Bedoya and Aramburu, 1986).

#### IV Expansion of the agricultural frontier

Land seems of free access to new migrants because most of it is left under fallow for five or more years. Old

owners take advantage of that by selling the land to new colonists or by legally demanding their leaving of the area. Because of the coca boom and the policies for its eradication, the new project of rural development (PEAH) faced the situation in a wider area, with a bigger and more dynamic population. According to table 2 the main types of production units are:

a) *Family farms*. Constituted by 5713 farms. Most farms are small and lack productivity-improving investments, such as irrigation. Around 45% are under exploitation; the remaining area is covered by primary and secondary forest. In Tingo Maria, Aucayacu, Tocache and Uchiza only 7% of settlers use fertilisers, 16% insecticides and herbicides and 21% high yield seeds (INEI, 1996). For smallholders the permanent crops are an alternative for sustaining a production without significant use of external goods. Household agricultural units are the most important for its extension. The convenience of their average size (26.5 ha) should be further studied since in the long term smallholder agriculture leads to faster agricultural growth than one achievable under high land concentration. (van Ginkel et al, 2002).

b) *Co-operative production and state enterprises*. Currently, 10 of 14 enterprises are dealing with socio-economic problems of viability. Around 1194 farmers are associated in groups that comprehend 12 (Huallaga cooperative) to 300 members (Jardines de Te cooperative). A state enterprise (Endepalma) owns 5250 ha, employs 800 workers and produces oil palm at 20 ton/hour (INEI, 1996).

c) *Logging contracts*. Wood harvesting and processing was a pioneer activity and is restricted to 90 species. Although the law demands reforestation, it is rarely practiced. Sawed logs production in the Huanuco region decreased from 46531 m<sup>3</sup> in 1980 to 16049 m<sup>3</sup> in 1991 (INRENA, 1994).

d) *Coca farms*. There are two types of coca croppers, the mono croppers and those that combine them with other products. The expansion of coca crops conditioned a new flow of immigrants and expanded the labour demand.

#### V Land use systems, farm dimensions and economic rationality

Farmers alter their crop shares more or less predictably, in line with changes in expected prices and yields. They switch land among crops so as to avoid the uncertainty associated with income volatility, especially as driven yield variability. Different crops elicit different responses. Land and family labour constraints bind at different points for different crops.

Table 2 Types of production units in the Upper Huallaga Valley.

表2 Huallaga 河谷上流域の生産ユニットの類型

Type	number	average area (ha)	total area (1000 ha)
Family farms	5713	27	154.3
Agricultural cooperatives	14	3180	44.5
small loggers	143	17	2.4
logging enterprises	53	3055	162.0
coca farms	unknown	3	14.5

Source : INEI III (1996)

The rate of cultivated areas in the oldest, intermediate, and recent settlement regions are 32, 22 and 20% respectively. However the average cropped area is similar in the three zones (around 6 ha/farm). In young farms dominate the annual crops (maize, beans and rice), while in old farms permanent crops (cacao, coffee, coca, fruits, etc). In Tingo Maria and Aucayacu the average area per farm planted with permanent crops (coca, citric, coffee and cacao) are high (3.4 ha and 2.5 ha respectively).

The average farm size decreases with the advance of colonization age (19.5, 26.8 and 30.7 ha in Tingo Maria, Aucayacu and Tocache-Uchiza respectively). Tingo Maria has a higher rate of total area used (54% compared with 40.3% and 37.3% in the intermediate and recent regions respectively). Consequently, the rate of farms under fallow and forests are lower in Tingo Maria (72.1 and 54.4% of farms respectively) than in Aucayacu (91.4 and 72%) and Tocache-Uchiza (87.9 and 67.2%).

The data infers that a stable technology persists even though the total farm area is decreasing. The fact that utilized areas is similar in the three zones, reveals the limiting effect of capital and workforce scarcity. The agricultural strategy is defined by the relative age of colonisation and the farm size (which determines the type of dominant crop).

According to table 3 the annual crops are more frequent on farms within 8 years of age (79 of 128 farms), while permanent crops dominate in older farms (86 of 140 farms). Farms with mixed crops and grasses are fewer (14 and 6 of 289 farms respectively). The relation between permanent and annual crops is similar during the first 8 years of possession. Farms of all ages with permanent crops comprehend the 48.4% (140 farms), farms with annual crops the 44.3% (128 farms). The total frequency of farms per range of age is homogeneously distributed.

Table 4 indicates that the total number of farms over 30 ha is almost twice the total of farms under 10 ha. Permanent crops (in 48.4% of the total of farms) dominate on farms until 20 ha of size (107 of 170 farms), and annual crops (in 44.2% of the total of farms) on farms over that size (92 of 155 farms). The appearance of grasses is scarce in all farm sizes (8 of 351 farms), being significant only on farms bigger than 30 ha (5 farms) and on farms within 15-20 ha (2 farms). Mixed crops (in 5.1% of total farms) are indistinctly distributed in all sizes being more frequent on farms within 10-15 ha (2 farms) and 20-30 ha. (5 of 18 farms). The association of annual and permanent crops allows incomes at the short term and a reduced cost of plantation respectively; as well as to successfully face potential losses of harvests or price

years	permanent	annual	mixed	grasses	Total
1-4.	26	36	3	2	67
4-8.	28	43	5	2	78
8-14.	37	26	4	2	69
>14	49	23	2	2	76
Total	140	128	14	8	290*

fluctuations.

Table 3 Number of farms by type of land cover and time of possession in the Upper Huallaga Valley.

表3 Huallaga 河谷上流域の土地被覆別・占有期間別農家数.

(\*no data available in 62 farms)

Source : INEI III (1996)

Associating annual and permanent crops gives a source of incomes at the short term and allows the introduction of permanent crops with reduced initial cost without endangering the family work capital. Although intensive cropping diminishes the areas with secondary forest (or regeneration) and imply the disappearance of farms for self-supply, persists an aversion to the absolute specialisation. Around 74% of the total of farms have annual and perennial crops at different rates and stages of growth. In Aucayacu (26.8 ha per farm) the difference between permanent and annual crops is levelled for being a land in transition, while in Tocache-Uchiza (30.7 ha per farm) dominate the annual crops (Figure 3).

Farm age also determines the destination of harvests (trade or family self-consumption). At early stages the settler consolidates his economy establishing mixed crops. After some years that characteristic remains, 65% of farmers in the region keep an area for daily self-supply, while commercial monocrops in the Huallaga valley only

reach 4% of the total farms in the valley. They grow up as fallow period increases with the decline of soil productivity.

Table 4 Number of farms by type of land cover and size of farms in the Upper Huallaga Valley.

表 4 Huallaga 河谷上流域の土地被覆別・規模別農家数.

Farm size (ha)	permanent	annual	mixed	grasses	Total
< 10	33	12	4	0	49
10-15.	35	17	5	0	57
15-20.	39	34	1	2	76
20 - 30	31	38	5	1	75
> 30	32	54	3	5	94
Total	170	155	18	8	351

Source : INEI III (1996)

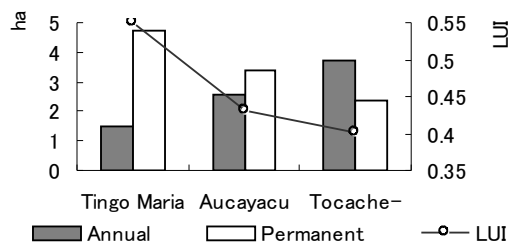


Fig. 3 Distribution of annual and permanent crops (average per farm in ha) and respective LUI by zone).

図 3 1 年生作物・多年生作物の農家あたり平均面積および土地使用強度指標

Source : INEI III (1996)

Their commercial exploitation is not significant. Crop changes (from self consumption to intensive as irrigated rice, mechanised yellow maize and cattle) keep the physiognomy and rationality of the local peasant economy. Although the diffusion of coca crops changes the productive aspects, they do not eliminate the structural characteristics of the peasant unit. A coca plantation, based on non-remunerated family labour, generates more rents without developing a “farmer economy” oriented by the capital.

The purpose of harvested goods also explains the patterns of dominant crops, in Tingo Maria 75% to 95% of the harvests are sold and the rest self consumed. The rates are lower in Tocache-Uchiza (55% to 60%). Relative land availability allows a wider flexibility for crops selection. Monocrops attempt against a mixed economy

and forces the settler to depend on a market with prices he does not control. Production for self-consumption has more advantages and fewer risks than to acquire them in the market. Another analysis requires the volume and credit costs that usually are designated to the settlers but results scarce and expensive for all the legal productive activities of low profitability. Also, Land use under common property have to be further analysed since they work best in areas facing low migratory pressure (Keipi, 1999) and in other regions they failed to provide sufficient incentives to conserve and invest in land.

### VI Fallowing practice

Fallow is still being applied in most of the farms, including the aged ones. Almost 75% of farms are in fallow and more than half of them still have forested zones. At micro level, each farm keeps fallow by sectors at different rates. Fallowing is unavoidable when there is no irrigation or intensive use of external inputs and it may be more for coping with weeds, insects, disease, or moisture deficiency than for declining fertility (Denevan, 2001).

The market economy and demographic expansion forced a decrease in the fallow and introduced perennial commercial crops. 54% of the total cropped area in Tingo Maria is under agricultural and grazing use, while in the other zones it descends to 40% and 37% of the farm area respectively. The average area under fallow per cultivated hectare in Tingo Maria is 0.8 ha, in Aucayacu is 1.52 ha, while in Tocache-Uchiza rises to more than 1.54 ha. The average rate of fallow is similar in the three zones (around 35%). The area under primary forests is twofold in farms of recent colonisation (10.8 ha) compared to those in Tingo Maria (5.5 ha), but the area quota under secondary forest is also similar in the three zones (around 31%).

### VII Soil use intensification

According to Boserup (1965), the intensification of soil use requires progressively higher labour inputs, but the resulting productivity increases at lower rates, being relatively inefficient in both terms, and thus is resisted unless there is pressure from population growth. The process is associated with a decrease of farms size, an increase of agricultural areas (Neil and Tykkylainen, 1998) and environmental degradation (UNAS, 1995). In a situation of relative easiness to access new land, settlers try to increase the number of cultivated hectares. When the available space diminishes the alternative is to intensify cropping or diminish the relative weigh of areas under fallow. Intensification increases with the occupation

time, until it arrives a point of decay. Another factor of intensification is the modification in the pattern of crops. Intensification occurs at macro level, a higher proportion of land is under exploitation in old settlements. Within farms, land allocation is responsive to relative crop prices and yields (Coxhead et al, 2002). A *land use intensity index* (LUI) cited by Santos-Granero and Barclay (1998) and based on Boserup's concepts about the relationship between demographic pressure and agrarian change was utilized to determine the degree of land use intensity that relates the total cultivated area (ha) and total area in the property (ha).

Land use intensity = total crops / (total crops + fallow).

According to the formula, the higher the rate of cultivated area with respect to the total area in use, the higher the index of land use intensity. Coefficients of land-use intensity range from 0.0 to 1.0. The lowest values correspond to more extensive land use, whereas the highest values (tending to 1.0) correspond to more intensive land use. Forested areas are not considered as a "crop" category and although agroforestry systems are uncommon, the cropped area is not counted twice in cases of mixed crops. A greater percentage of perennial crops indicate a higher degree of LUI. Table 5 indicates that in all zones the LUI increases with the decrease of farm size. The farms in Tingo Maria have the smaller average size (19.5 ha), followed by Aucayacu (26.5 ha) and Tocache-Uchiza (30.7 ha). A correlation exists between farm size and the pattern of crops and between length of occupation and LUI. The first factor determines the type of dominant crop. However, the intensification process must be analysed considering other characters related to resources management. In extensive systems of land use the area under fallow is higher to those effectively worked, while in intensive ones the need to apply it is not cognizable.

LUI goes from 0.65 to 0.43 and 0.40 in the old, intermediate and recent farms (figure 3). The index is related to the time of settlement and demographic pressure. It decreases with the age of possession. Low LUI values (0.1 to 0.2) are related to farms in which for each worked hectare there are more than 4.4 ha of secondary vegetation, and higher LUI values (0.7 to 0.9) are related with 0.2 ha of them per cropped hectare; meaning that the relative weight of secondary forest decreases with the increase of LUI values in all regions.

Farms with a LUI from 0.3 to 0.4 are the most frequent (107 of 351 cases). Figure 4 indicates that annual crops dominate in farms with LUI from 0.1 to 0.4 (50 to 50.5% of total farms), while permanent crops in farms with LUI

higher than 0.5 (constituted by the 55 to 63% of the total of farms). Also, farms with grasses appear only when the LUI ranges from 0.1 to 0.2 (8% of total farms) and mixed crops keeps a similar rate (around 5%) for all LUI indexes.

The 68% of farms in Tingo Maria farms are worked with LUIs classified as high and very high (0.5 to 0.6 and 0.7 to 1.0 respectively). In Aucayacu 62% of the farms are worked with LUI values from 0.1 to 0.2 and from 0.3 to 0.4, being these lasts more frequent. In Tocache-Uchiza the 68% of farms have also low LUI values (mostly from 0.1 to 0.2). However, some farms in Tingo Maria have similar size to those found in Tocache and Uchiza, but with LUI values between 0.6 and 1.0. In these lasts zones there is a diffusion of small farms with extensive crops given that farmers are aware of unutilised land around their holdings.

Table 5. LUI in the Upper Huallaga Valley by zone and farm size.

表5 Huallaga 河谷上流域の地域別・農家規模別土地利用強度係数

	Tingo Maria	Aucayacu	Uchiza - Tocache
0 - 5 ha	0.77	0.62	0.47
5 - 10 ha	0.70	0.51	0.57
10 - 20 ha	0.58	0.47	0.48
20 - 30 ha	0.43	0.39	0.37
All size classes	0.55	0.43	0.40

Source : INEI III (1996)

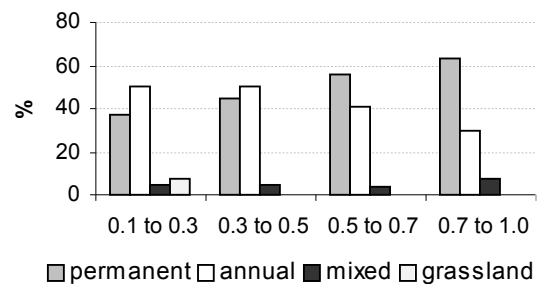


Fig. 4 Land cover type per range of LUI values in the Upper Huallaga Valley.

図4 Huallaga 河谷上流域の土地使用強度指標ごとの土地被覆割合。

Source : INEI III (1996)

Contrarily, deintensification result from the progressive degradation of soils in areas under prolonged use; because of the greater economic agglomeration in old zones of colonization given the comparative advantages conferred

by their location. A deintensification process does not imply a reversion of the local economy to an earlier state or a loss of its commercial character. Areas with perennial crops and areas under a process of deintensification continue to be associated with the market economy.

## VII. Social relations of production

Even though the transition to the market, family labour still is the most important for production. Mistakes in programs of past colonisation are partially explained by the assumption that the productive units were constituted by capitalist farmers, but settlers organise themselves according to a peasant rationality. The weight of non-remunerated family work and its relation with salaried workers, are also important. In Peru, coffee is the crop with the greatest labour requirements after coca (Santos-Granero and Barclay, 1998). Three to seven years after being planted the work requirements fluctuates between 0.6 to 0.8 workers/ha/year. Demand for additional work totals 5000 workers/ha/year (Aramburu et al, 1982). A source of inequality in farm size is the demographic differentiation. As households begin, grow, and mature, changes in land holdings reflect the fluctuations in the demand for land associated with each stage (Chayanov, 1966). A young household forms and expands acquiring land to meet needs. The pressure decline and the holding area may contract as children mature and leave the household. An increasing population combined with inheritance result in a successive subdivision of land at the death of the owner. Males predominate (1.2 males per female), the relation is stronger in Tocache (1.4) and Uchiza (1.3), and lower in Aucayacu (1.1) and Tingo Maria (1.0). The relation is also higher in rural (1.5) than in urban (1.2) areas. Male dominate in the age groups 20 to 24 and 25 to 29 years old. That characteristic seems to be an Andean strategy of colonisation, where only the family heads and young male temporarily migrate first. The rural population has a young age biased structure, 44.3% of them are under 15 years. In Uchiza and Tocache it is 45.6% while in Tingo Maria it is 37.4%.

The average family size is 6.6 members, however, a big family is not necessarily an economic burden since all participate in the production process. The nuclear farm is the main occupation for 95-100% of the families. The settlers can be shepherds or farmers but in most cases both 90% to 95% of farmers employ domestic non-remunerated labour and 38% of them contract workers to cover one third of the annual volume of journals. Long-established farm owners with an average of eight hectares of commercial crops (37%) use mainly salaried

workforce. The cultivated area is bigger at higher number of house dependants. The relation is clearer in Tocache-Uchiza when that number is higher than three (Fig. 5). The opposite is the case when owners do not have children, in which case the comparatively higher cropped area (Tingo Maria case) might be explained by the hiring of temporal work force.

The combination of both resources (family work and monetary income) determines the rate of use per farm. In an economy with surplus labour such as in the Huallaga valley, land yields decline with the increase in farm size owing to the greater absorption of family labour and lower costs of supervision.

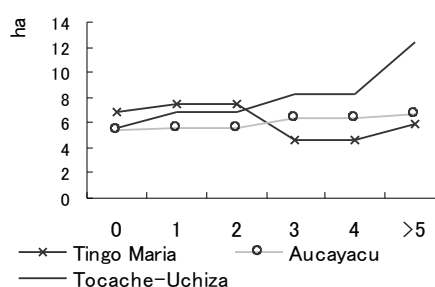


Fig. 5 Cropped areas according to the number of house dependants (10-25 years old) and zone of colonization.

図5 家計あたり扶養人口ごと作物面積。

Source : INEI III (1996)

## VIII Conclusions

Most settlers have more than a decade of stable residence in the region. The demographic increase during the last four decades conditioned a decrement in farm size and consequently a process of agricultural innovation. Regardless of tenancy policies, deforestation is likely to persist if settled areas do not offer sufficient employment to potential migrants. However, it will have to be further confirmed if the decline in farm size does not necessarily mean a decline in forest resources (Warner, 1995).

The processes of intensification are not necessarily associated with a higher use of pesticides and fertilizers but with the length of occupation. One of the mechanisms for achieving greater land-use intensity is the production of permanent (perennial) crops. This change is not related with the disappearance of farms rotation and fallow; diverse rates of them are kept in farms of all sizes. The settler determines the production strategies according to the size of his farm and the availability of land in the area. In all studied zones the LUI increased as the farm size decreased (property fragmentation).

A change in crop patterns in which permanent crops replace annual traditional crops is a process of innovation.

Crop diversification is an adaptation to the diversity of soil conditions and price fluctuations. The persistence of fallow by sectors is explained by the availability of land (lower land availability results in reduced opportunities for rotation) and limiting factors (capital scarcity, employment of only family workforce and slow incorporation of crop improvers).

The intensification process (as a ratio of cropped area/fallowed area) follows peasant rationality and is directly related to the family consumption needs. In spite of non-remunerated family work dominance, temporal hired labour is common, especially in older settlements with dominance of permanent commercial crops. Although intensification in established agricultural areas can reduce deforestation by tying up labour and/or capital, it should be further confirmed if that process in frontier areas might have the opposite effect as it would make agriculture more profitable on new lands and thus promote further agricultural expansion. Family labour force still is the source of production, however temporal hired labour is complementary. New instruments and institutional forms considering the local self-organization might replace incentives to further land expansion, as for example a differentiated land tax according to their use.

#### **XIX Acknowledgements**

The author wishes to give special thanks to Mr. Yamamoto Nobuyuki for his valuable comments and the translation of texts into Japanese language; and to Mr. Anwar Arfen Khan and Mr. Murukesh Balan for proofreading the final manuscript. Any mistakes that remain are the author's responsibility. The Japanese Ministry of Education provided funding for this study.

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