Using household types for improving livelihood strategies of smallholders: coffee and cocoa producers in the Northern Amazon of Ecuador

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Abstract

Supporting smallholders' livelihoods in fragile and biodiversity rich regions such as rainforests is a priority of many development agencies and national governments. These regions tend to be characterized by recent settlements, increasing population and infrastructure, as well as land use competing activities that put pressure upon fragile ecosystems. Research aimed at improving livelihood strategies often focuses on increasing yields and productivity, but fails to account for alternative measures such as improving agricultural practices, changing land use or improving commercialization. This paper uses household types defined according to different land use patterns in the northern Amazon region of Ecuador to explore limitations and identify future options for improving livelihood strategies based in the small-scale production of coffee and cocoa. Results for application to four types are discussed, which highlight the utility of the method and identify trade-offs in terms of environmental and social goals versus profitability. Lessons are drawn that can inform public policies oriented to improving livelihood strategies of small producers of coffee and cocoa in the Amazon region without compromising the environment.

Keywords

Household types, Amazon, Ecuador, livelihoods, coffee, cocoa

JEL Code

N56, Q12, Q24, Q56, Q57

1. Introduction

The northern Amazon region in Ecuador was one of the last to be colonized in the country. The Law of Agrarian Reform and Colonization, passed on July 11, 1964 under Decree 1480 by the military Junta then in power (Viteri, 2007) encouraged new settlements by colonists from different parts of Ecuador. Severe droughts in the South of Ecuador and the beginning of oil exploration in the seventies also pushed for new settlements in previously pristine areas of the country (Gondard and Mazurek, 2001).

These new settlers began with the cultivation of coffee and cocoa so that Robusta coffee (*Coffea canephora*) and national[1] cocoa (*Theobroma cacao*) became the predominant crops in the region. For decades, these crops have been a source of employment and foreign currency for the nation. For instance, between 2002 and 2011, they represented 7.0% of non-petroleum exports of Ecuador (BCE, 2012).

Smallholders needed to develop livelihood strategies for coping with production in an area lacking basic infrastructure, public services and access to the markets (Rosset et al., 2011). For many years, the lack of presence of the State implied that the room was open only for cooperation agencies and NGOs, very often replicating development models from elsewhere in a patronizing mode, which resulted in a systemic lack of cooperation between farmers (Viteri Salazar and Ramos-Martin, in press).

Land use and use of resources in Ecuadorean Amazon (i.e., its societal metabolism) is very complex due to the numerous interactions between oil industry, biodiversity, agricultural production and recent human settlements in constant growth, with a clear increasing pressure on land use. The short-term effect of the increasing colonization is an expansion of the agricultural frontier with pressure on previously non-colonized areas and a loss of biodiversity (Muchagata & Brown, 2000). As shown, contrary to what happens in other regions of Ecuador and Latin America (Toledo, 2011) where land concentration is the norm, this region is characterized by distribution of land, with farms averaging 33 ha (table 1). However, in recent years large monocultures belonging to private firms (pastures, oil palm, and rubber) have been established.

When considering sustainability of production, some authors (Fuente, 2009; Toledo, 2000) defend the need to account for cultural issues, self-sufficiency, production diversification and a respectful management with natural resources (Bebbington, 1991). However, agriculture is driven by the requirements of the market and population growth, with negative effects on biodiversity as those originated by the so-called "green revolution" (Guzman and Gonzalez, 2007). Many smallholders have received biased technical 'assistance' by sellers of agro-inputs, resulting in an overuse of chemicals that generated increasing production costs, and the abandonment of coffee production (Bellamy, 2011) in favor of stockbreeding.

[1] Ecuador grows a unique variety of cocoa known as "national." This cocoa variety is characterized by its post-harvest processing, during which there is a short fermentation period which results in a mild chocolate with rich flavor and aroma and which is known internationally as "fine aroma cocoa" (Quingaísa and Riveros, 2007).

An alternative to stockbreeding in tropical regions is shade-grown coffee and cocoa under agroforestry systems (Ferguson et al., 2009; Moguel and Toledo, 1999; Perfecto et al., 2007; Philpott et al., 2008). The increased awareness of the negative impacts of intensive agriculture is pushing for the introduction of more sustainable practices involving three dimensions: the ecological, the economic and the socio-cultural, driving to a sustainable system whenever is "economically viable, ecologically adequate and cultural and socially acceptable" (Sarandón, 2009). Ecological or organic agriculture is based on the circular flow of energy (Guzman and Gonzalez, 2007), precisely the traditional productive way of smallholders (less than 3 ha of coffee and/or cocoa in production). The majority of producers are in this situation (Ofori-Bah and Asafu-Adjaye, 2011; Valkila, 2009), basing their production on the very few assets available that constitute their own capital (social, financial, natural, physical and human). Shade-grown agriculture, in both primary or secondary forests, represents a sustainable way of making compatible production with biodiversity conservation (Beer et al., 1997; Belsky and Siebert, 2003; Perfecto et al., 1996; Purseglove, 1968; Young, 1994). However, this activity is still under pressure by the market, the climate and plagues (Belsky and Siebert, 2003), putting smallholders at the beginning of the value chain, assuming more risks and receiving less income (Blackman & Naranjo, 2012; Díaz et al., 2009). Production could improve if vertical integration of the different activities was in place through changes in practices and new functionalities within the value chain, inserting smallholders in forward steps and not just production (Díaz et al., 2009).

Thus, the aim of this research is: i) to characterize environmental pressure implied by different land use patterns; ii) to analyze how different land use patterns improve livelihoods in terms of income; iii) to evaluate how some public policies may have an impact in smallholders income.

2. Concepts and methods

2.1. Livelihoods

The modern origin of the word livelihood is linked to the human and sustainable development policy debates from the 80s (Morse and McNamara, 2013; Scoones, 2009; Solesbury, 2003). It was proposed as a key concept to operationalize sustainability and development, especially in rural and poor contexts. The early definitions of livelihoods were established in terms of food and money to meet basic needs (Chambers, 1989; WCED, 1987). Later, the 1992 Earth Summit of Rio de Janeiro Agenda 21 stated that everyone must have the opportunity to earn a sustainable livelihood, widely popularizing the sustainable livelihood approach (SLA). Thus, the livelihoods were associated to the capabilities, assets and activities required for a means of living in a sustainable way (Ashley and Carney, 1999; Carney, 2003, 1998; Chambers and Conway, 1992; Scoones, 1998).

In the last decade, more complex approaches based on the complexity and system theories have been developed to deal with the sustainable livelihood concept (Giampietro, 2003; Morse and McNamara, 2013; Niehof and Price, 2001; Scheidel, 2013) incorporating aspects like lifestyles, internal and external constrains, purpose, agency, quality, etc. This paper follows these recent approaches and contributes to recent work using household typologies for studying sustainable livelihoods (Scheidel et al., 2013; Williams et al., 2015).

2.2. Study site and methods

The research took place in the provinces of Orellana and Sucumbíos, which represent a large fraction of the northern Amazon region of Ecuador and hosts over 23,000 peasants (Viteri Salazar, 2013). These provinces perform rather poorly in terms of socio-economic variables. For instance, the extremely poor in year 2011 were 20.7% of total population, as opposed to the national average of 11.6% (INEC, 2012). This outcome is not fully understood as the region has enormous resource endowments that benefit smallholders. Indeed, the average size of a farm in the region is 33.9 ha, being 50 ha 40 years ago, and higher than the 20 ha considered the optimal size for generating income for a household (Viteri Salazar, 2013).

The information used is mainly primary, result of an extended field work that included visiting 96 households, which were visited in site, interviewed and to whom a questionnaire was applied to elicit socio-economic, environmental, productive and time use information. This information was completed with official and non-official existing information, in order to be able to establish four typologies of households according to their productive practices, land use and source of income.

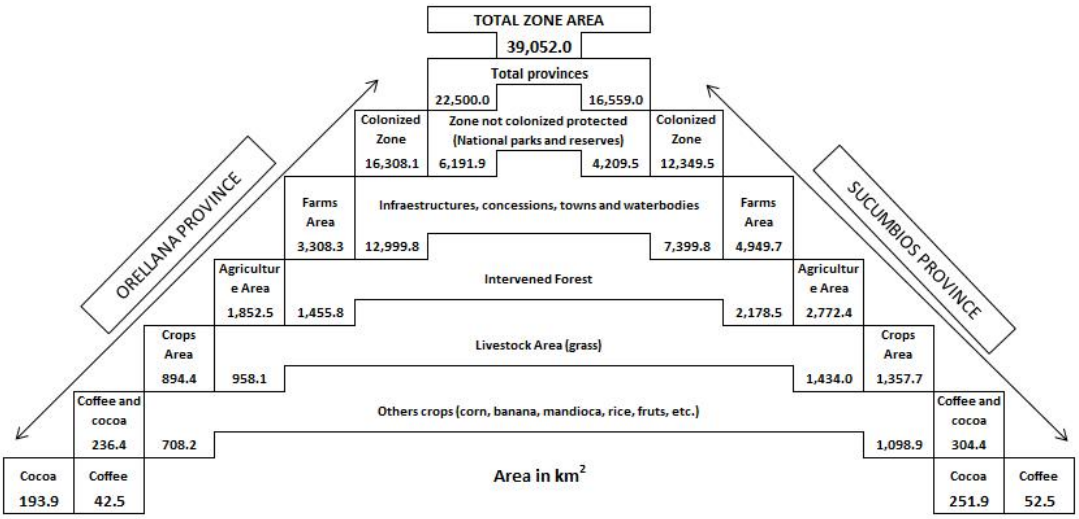
Based on the expenditure on agricultural inputs, thresholds for external input use were defined in the following way: Low Input Use (LIU), for those households with input expenditure below 10% of average household income; Medium Input Use (MIU) for those with expenditures between 10-25% of average income; and High Input Use (HIU) for those households with more than 25% of their income allocated to inputs. Monetized subsidies

were also accounted for as part of household income: fuels (petrol, diesel, and LPG), electricity, human development bond[2], and agricultural assistance programs.

Smallholders of this sector usually own around 30 hectares, where multiple land uses are carried out. Human activity is basically dedicated to agriculture, in both their own land and as day-workers. Land in production is just a fraction of total available land. A small area is used for both self-sufficiency and local markets (maize, cassava and fruits). However, most of the time and land in production is dedicated to coffee and cocoa production.

Figure 1 represents the land budget for the two provinces based on the Agricultural Census of 2001, unfortunately the last one available official registry of land uses. It can be noticed that there is still a large fraction of forests (both in protected areas and within private properties). The area allocated to pastures is larger than that for agricultural production although, in economic terms, is less relevant. Land in production for coffee and cocoa represents less than 25% of total land in production, but is very relevant in cultural and economic terms.

Figure 1. Land use distribution (km^2) in the provinces of Orellana and Sucumbíos



3. Results

The universe of peasants is composed of thousands of producers with very diverse behaviors, all of them embedded in a very complex rural societal metabolism. One way of analyzing them is by using typologies of farming systems or household typologies according to their practices (Giampietro, 2003; Pastore et al., 1999; Scheidel et al., 2013; Williams et al., 2015).

3.1. Household types

Household types were defined according to different patterns of land use and production. Very often, these patterns are related to cultural identity and the origin of settlers. One characteristic that is found in all of them is the need for crops that guarantee a permanent

[2] Subsidy for low-income households attached to certain obligations. In 2013, about 2 million households benefited from these 35 US$ per month. More information at http://www.mies.gob.ec/

inflow of cash. In all the cases, apart from coffee and cocoa they have "other crops" (plantain, maize, cassava, rice and fruit trees) that help in achieving food security of households.

The definition of the typologies is important as they are not only different in terms of land use patterns, but also regarding impacts upon the environment, be it through the use of synthetic inputs, the implementation of monocultures or the expansion of the agricultural frontier and the consequent reduction in the forested area.

The typologies include farmers who share at least one of the cash crops defined here: Typology 1 plant coffee and cocoa (CC); Typology 2 only cocoa (C); Typology 3 has coffee, cocoa and oil palm (CCP); and finally, Typology 4 only has coffee (Cf). Table 1 characterizes the typologies and shows the area for the combination of crops, the households involved, the level of inputs used, as well as the number of working days per hectare and per year required.

Table 1. Land use by household typology

Typology	General variables				Land use distribution of production, ha (average farm size 33.9 ha)						
	% of Producers	Surface (ha)	# of Households	Input use	Coffee	Cocoa	Palm	Other	Grazing	Forest	Working days required Typology/year/ha
1. CC	60	29,462	14,616	MIU	0.5	1.5	0	5.4	9	17.5	52
2. C	32.2	20,928	7,849	MIU	0	2.7	0	2.9	9.4	18.9	39
3. CCP	4.4	10,869	1,083	LIU	0.7	1.8	7.8	15.7	6.8	1.4	46
4. Cf	3.3	1,092	812	LIU	1.3	0	0	6.8	1.8	24	88

Table 1 shows the predominance of cocoa combined with coffee. This may respond to a strategy of income diversification, trying to minimize negative impact of both market price and production fluctuation upon household income. Peasants producing only cocoa are ten times more than those producing coffee. This outcome could be related to the labor requirement of each crop. While cocoa requires only 39 working days/ha/year, coffee is more labor intensive, requiring 88 working days/ha/year, especially during the harvesting phase in which only red beans are picked, ensuring uniformity in the quality of the coffee harvested.

Tables 2 to 6 show a complete economic detail of income, expenditures and surplus for each household typology.

Table 2. Farm income per activity US$

Typology	Agricultural production									Livestock	Total
	Coffee	Cocoa	Palm	Cassava	Maiz	Rice	Plantain	Fruits	Wood	Animals	
1. CC	32.3	67.7	0.0	6.8	24.0	2.7	24.8	4.9	12.1	63.8	**239.0**
2. C	0.0	96.4	0.0	4.9	16.8	4.4	9.4	0.3	1.8	125.5	**259.6**
3. CCP	22.0	60.0	775.0	28.5	20.0	0.0	0.0	45.0	0.0	103.8	**1,054.3**
4. Cf	13.9	0.0	0.0	11.1	33.3	0.0	11.1	0.0	100.0	0.0	**169.4**

Table 3. Additional income US$

Typology	Off-farm activities			Valuation of non-monetary income		
	Day laborer	Business	Other	Self-consumption	Subsidies	Total
1. CC	74.0	36.4	65.3	66.6	47.0	**289.3**
2. C	125.3	13.8	24.3			**277.0**
3. CCP	0.0	41.5	150.0			**305.1**
4. Cf	156.4	0.0	0.0			**270.0**

Table 4. Income by source, US$

Typology	Farm activities	Self-consumption	Off-farm activities	Subsidies	Total
1. CC	239.0	66.6	175.7	47.0	**528.3**
2. C	259.6		163.4		**536.6**
3. CCP	1,054.3		191.5		**1,359.4**
4. Cf	169.4		156.4		**439.5**

Table 5. Expenditures US$

Typology	Goods				Services				Other	Total
	Food	Medicines	Clothes	Agricultural inputs	Telephone	Transport	Gas	Electricity		
1. CC	250.7	28.2	22.4	80.3	11.6	29.9	4.6	11.3	16.0	**455.0**
2. C	214.0	27.9	16.2	82.9	7.2	25.6	3.8	8.4	32.9	**418.9**
3. CCP	251.6	18.5	19.3	867.5	7.5	10.5	3.9	12.5	23.5	**1,214.8**
4. Cf	166.6	10.0	46.7	2.0	3.7	30.3	3.2	8.3	46.7	**317.5**

Table 6. Surplus by household typology US$

Typology	Income	Expenditure	Surplus
1. CC	528.3	455.0	73.4
2. C	536.6	418.9	117.7
3. CCP	1,359.4	1,214.8	144.6
4. Cf	439.5	317.5	122.0

The diversity of crops found in the households contributes to improve household self-consumption. The economic activity shown in the tables above somehow links land use with the market as a source of income by selling agricultural (i.e. coffee, cocoa, plantain, maize, cassava, rice) and animal products (i.e., hens, milk, eggs). The use of farming inputs has been considered, and required goods and services have been monetized. Off-farm work has been accounted for as a source of income that is present in most of the households. Subsidies provided by the central government were also accounted, such as: a) fossil fuels: LPG, diesel and gasoline, subsidies associated to redistribution policies from the central government on oil revenues from oil extraction activities in the region; b) electricity, through the "dignity fare" [3], and c) through the human development bond. Moreover, subsidies from agricultural development programs were also estimated, which usually include tools, inputs, seeds and saplings. In order to fully account for income, a monetized figure for self-production of "other crops" and "grass" was included, a valuable source of food products for households.

The nexus between the farm and the environment is given by the pressure that crops impose on the forest and the ecosystem services they provide. When the field work was carried out, no single farmer was involved in any payment-for-ecosystem services scheme.

3.1.1. Typology 1: coffee and cocoa producers

14,616 peasants are part of this typology (Table 1), producing Robusta coffee, and National and CCN51 cocoa[4]. This land use pattern generates circa 100 US$ of income per month, while "other crops" (about 5 ha) are responsible for a fraction of consumption as self-production and generate about 64 US$ extra cash by selling surplus products in the market. 9 ha of pastures are used mainly for subsistence stockbreeding, and to a lesser extent for the market, generating an amount of 25 US$ per month. However, this typology expends about 80 US$ in agro-inputs. Finally, the rest of the farm contains about 18 ha of forest, that produces some wood for the household, and some for the market (about 12 US$ per month). Forests are also important because they act as savings for the household and also because they are a valuable source for animal protein (game and fish).

This typology produces coffee and cocoa in a 3:1 proportion. In order to adequately attend that combination of crops, 104 working days/year (832 hours) would be needed. However, they only allocate half that amount, generating an income flow of about 1,200 US$ per year. Taking into account that the wage for a working day is 13 US$, households make 60% more in gross terms (without deducting input expenditures), or 23.1 US$ per working day. This apparent positive cash flow is also rewarded by the increase in self-esteem implied by generating income in their own farm. Total monthly income for this typology goes up to 528.3 US$, an amount covering 84% of the Cost of the Household Basic Basket[5] (CHBB – 628.3 US$ according to INEC (2014)). Off-farm activities provide for 30% of household

[3] Subsidy of US$ 0.05 per kWh (from the official Price of US$ 0.09 to US$ 0.04) for a monthly consumption of 110 kWh in the Sierra and 130 kWh in the Coastal regions, the Amazon and Galápagos, for households in quintiles 1 and 2 according to the National Institute of Statistics and Censuses (INEC).

[4] In 1965, the Ecuadorian researcher Homero Castro developed a cocoa clone from the double hybridization of genetic material from the *Trinitario* and *Forastero* varieties of Amazonian origin (CCN51). It is resistant to fungal diseases and gives high yields (International Plant Nutrition Institute, 2014).

[5] The Household Basic Basket refers to the products that a four member household requires to satisfy their needs. INEC uses that basket for the calculation of inflation.

income. Despite these characteristics, this typology is the one with lower surplus, being only 73.4 US$.

3.1.2. Typology 2: cocoa producers

This household typology gathers 32% of peasants and covers 47% of the cocoa cultivated in the area. It has been subject to many public and private aid programs. Every peasant has 2.7 ha of cocoa, with only 200 kg of dry cocoa/ha/year, a yield well below the potential. Income generated is 96.4 US$ per month. Peak of production falls between March and July, moment in which more cash is available. Combining self-production and sales of other crops brings an extra 154.8 US$, using 12.3 ha. In relative terms, income generated by the production of cocoa is higher than that of other crops and pastures. Off-farm income is also 30% of total income, higher than that reported for cocoa. Total income amounts to 536.6 US$, covering 85% of the CHBB, almost the same as typology 1. However, the remaining surplus is higher at 117.7 US$, 60% above typology 1.

Peasants allocate 52 working days per year, equivalent to an income of 22.2 US$ per working day. This typology has more expenditure in inputs, falling under MIU type. On the other hand, the surface occupied by forests is more than half of the farm, at 19 ha, providing for fish, game, wood and firewood, an alternative to LPG.

3.1.3. Typology 3: coffee, cocoa and palm producers

Typology 3 adds oil palm to coffee and cocoa production as cash crop. These farmers are located mainly in the province of Orellana, as the provincial government has encouraged this crop in the last years. Around 8,000 ha (30% of total oil palm cultivation) belongs to smallholders. A majority of the surface corresponds to young plantations (4 to 8 years) which have not reached their peak production yet.

Coffee and cocoa use about 2.3 ha, while oil palm uses 7.8 ha, generating a combined monthly income of 857 US$. This level of income is apparently high, although it involves a HIU use. More than half of the farm is cultivated intensively with other crops, implying that the area left to forests is residual. Therefore, the environmental impact of this typology is much higher.

Off-farm income comes from renting vehicles or machinery, or from trade. This household typology demands high amounts of labor. In optimal conditions, it would demand 460 working days/year. Although the income level is high, the level of input requirements is also high. This situation may change in the near future when plantations reach their peak yield.

3.1.4. Typology 4: coffee producers

This household typology shows the lower levels of land use. Coffee uses a reduced surface of only 1.3 ha with old or low quality plantations which generate only 14 US$ per month, complementing income with other crops. There is no use of inputs, so they fall into the LIU category. In optimal conditions they would need 118 working days/year, however they allocate less than a half, resulting in a very low profitability. These peasants would double their income if they worked off-farm instead of producing coffee; however, coffee is a cultural issue for them.

The low income level makes other crops crucial in terms of self-consumption, as well as for generating some extra cash equivalent to 55 US$ by using 6.8 ha. Total income (once self-consumption production is monetized) amounts to 439.5 US$, the lowest of all typologies, covering just 70% of CHBB. On the other hand, being the land use the less intensive, forest

occupies 75 % of the land, becoming the second source of income, after off-farm work, with 25% of total income.

3.2. Scenarios of potential income generated by the different household typologies

This section presents an exercise to estimate the potential income by typology. The results are presented in Tables 7 to 10. Potential yields for every crop, human time availability (for working days needed per hectare), better practices and use of improved varieties were used in our calculation, but existing land use was considered instead. Pastures include income from animals for work, consumption or selling; Forest includes subsidies coming from the "socio-bosque" program[6].

Table 7. Typology 1, Potential monthly income

Activity	Surface (ha)	Current monthly income (US$)	Potential yield/ year / ha	Unit value (US$)	Potential monthly income (US$)
Coffee	0.54	32.28	200.00	15.00	136.21
Cocoa	1.47	67.72	14.00	105.00	180.18
Grazing	9.00	63.77	1.00	360.00	270.00
Forest	17.52	12.14	1.00	30.00	43.80
Other products	5.37	63.11	12.00	50.00	268.28
Off-farm employment		93.35			
Self-consumption		66.60			66.60
Other activities		65.28			
Total	**33.90**	**464.25**			**965.06**

Table 8. Typology 2, Potential monthly income

Activity	Surface (ha)	Current monthly income (US$)	Potential yield/ year / ha	Unit value (US$)	Potential monthly income (US$)
Cocoa	2.67	96.09	14.00	105.00	326.62
Grazing	9.42	125.62	1.00	360.00	282.63
Forest	18.94	1.82	1.00	30.00	47.36
Other products	2.87	36.14	12.00	50.00	143.41
Off-farm employment		110.20			
Self-consumption		66.60			66.60
Other activities		24.28			
Total	**33.90**	**460.73**			**866.62**

[6] Socio-Bosque is a project run by the Ministry of the Environment with several goals: conservation, CO_2 emission reduction (by land use changes and deforestation avoidance), carbon sequestration, and improving smallholder's livelihoods. It establishes a maximum compensation of 30 US$/ha/year for untouched forest under a scheme of payment for ecosystem services (MAE, 2010).

If better practices and varieties were in place, typologies 1 and 2 would double their income, increasing time allocated to their own plots at the expenses of off-farm working time. This seems not to be a difficult change that public and private aid agencies could promote easily. Lack of access to secure monthly income may be the likely cause for this not happening, as income depending on production is seasonal, while income from off-farm activities is regular.

Table 9. Typology 3, Potential monthly income

Activity	Surface (ha)	Current monthly income (US$)	Potential yield/ year / ha	Unit value (US$)	Potential monthly income (US$)
Cocoa	0.46	60.00	14.00	105.00	56.73
Coffee	1.83	22.00	25.00	15.00	57.06
Palm	7.75	775.00			0.00
Grazing	6.75	103.75	1.00	360.00	202.50
Forest	1.38	0.00	1.00	30.00	3.44
Other products	15.74	93.50	12.00	50.00	786.80
Off-farm employment		41.50			
Self-consumption		66.60			66.60
Other activities		150.00			
Total	**33.90**	**1,312.35**			**1,173.13**

Typology 3 shows an apparent reduction in income, which could be compensated if land currently used for oil palm was allocated to forest or other crops. This solution, however, is not realistic as there is a huge investment already compromised in existing oil palm plantations. This possibility could be considered on a long-term basis and following policies that may restrict this crop.

Table 10. Typology 4, Potential monthly income

Activity	Surface (ha)	Current monthly income (US$)	Potential yield/ year / ha	Unit value (US$)	Potential monthly income (US$)
Coffee	1.34	13.89	25.00	15.00	42.02
Grazing	1.75	0.00	1.00	360.00	52.50
Forest	24.00	100.00	1.00	30.00	60.00
Other products	6.81	55.55	12.00	50.00	340.27
Off-farm employment		120.33			
Self-consumption		66.60			66.60
Other activities		0.00			
Total	**33.90**	**356.37**			**561.39**

In the case of typology 4 there is an income reduction from forests, as socio-bosque does not allow harvesting trees. This reduction could be compensated with income from "other crops". According to this analysis, typology 4 would still fall short for covering the CHBB by 4.4%, an amount that could be achieved with off-farm work.

A last consideration to be taken into account is that the central government has the project "reactivating Ecuadorian coffee production" that runs from 2012 through 2020. Under the project, 24,000 ha will be put in production with the *Robusta* variety, with a maximum of 4 ha per household. As every hectare implies 88 working days/year, the project would generate 8,800 direct jobs full time.

4. Discussion

The interviewed peasants stated that the increase in the use of agro-chemicals is related to the strong incidence of sales agents in the region, who have introduced themselves as "advisors", delivering biased analyses and with a lack of control on dosages. The main agro-chemicals used in the region are herbicides, followed by insecticides, fungicides and fertilizers. For typologies 1 and 2 they represent a relevant share of household expenditures, at about 15%. Despite of these practices, the use of agro-chemicals is still low in the region, except for typology 4 (oil palm plantations), probably for budget restrictions. Due to the lack of capacitation in the use of agro-chemicals, the practices for oil palm plantations are being replicated for other crops. This has a double negative effect in economic terms for smallholders as it increases production costs, and in environmental terms as it increases pollution with no reason. The central government is fighting these practices with some projects (i.e. Sistema de Innovación Tecnológica Participativa) oriented to recover traditional production practices more in line with the environment.

Income from coffee and cocoa production represents about 19% of total household income for typologies 1 and 2 despite their low yield, whereas is only 8% for typologies 3 and 4. Typology 3 earns more from other crops and oil palm and typology 4 gets the most from off-farm work, although production at the farm still plays a cultural role.

Under these circumstances, typology 4 performs very well in environmental terms, and very close to typology 2 in economic terms, thus the need for increasing their income via improving agricultural practices, selection of plants and particularly by changing commercialization (Viteri Salazar and Ramos-Martin, in press), making it possible to raise in the value chain. Unless measures supporting productive activity of this typology were implemented, a shift towards typologies 1 and 2 could be expected, or even worse towards typology 3 by selling or renting their land.

The analysis of the surplus generated by each typology helps identifying the reasons why households have chosen different productive patterns. It can be seen how cocoa has replaced gradually the cultivation of coffee. This is coherent with our results, as typology 2 has a higher surplus than typology 1, which has the lowest surplus of all and depends largely on off-farm work for guaranteeing its livelihood. Until ten years ago, large landowners dominated oil palm plantations. Only recently, smallholders have engaged in oil palm, giving birth to typology 3. Despite the fact that plantations are still young (4 – 8 years), they already

show the highest surplus (144.63 US$), however, from an environmental point of view is the least interesting of all, as forest only covers 4% of land, and the number of families that are benefited from that is very low. One could understand why private enterprises and even the central government are interested in this typology (profits, but also greater GDP and taxes). However, this typology also represents more environmental and social impacts, and a greater degree of dependency for the households (a large fraction of their income is expended in buying agro-chemicals from the very same intermediaries who commercialize palm oil). These reasons make this typology, in our view, not an option for future development.

The increased income of the region should be oriented towards policies that diversify and increase household income, for instance by encouraging associative work in cooperatives, processing coffee and cocoa to add value to production, or by engaging in new activities such as agro-tourism, making households more resilient towards the evolution of international prices for coffee and cocoa and seasonability.

The study has also found a weak link between farmers and current 'payment for environmental services' schemes such as "socio bosque". The low participation rate is probably due to the strict policies of that program. In our view, a more successful approach would be that of accepting applications to the program by farmers with 'under the shadow' coffee and cocoa crops (shadow of at least 30-40%) that have engaged in organic certification programs. In this way, the incentives would be double for the farmers.

Table 11 presents the results of a scenario based on a series of assumptions that helps in making clearer the comparison between typologies. Our unit of analysis is here 1,000 ha and the performance of the four typologies is compared in terms of number of households reaching the CHBB, the surplus generated, the expenditure in inputs, the surface of forest that is conserved and the labor requirement. It presents the number of households that would be supported for every 1,000 ha in every typology, with the restriction of being able to cover 100% of the CHBB. This exercise implies changing land use, increasing land in production in typologies 1, 2 and 4 and diminishing it in typology 3. It appears that typology 3 could support more families, with just 2.5 ha of oil palm, however this scenario is not so realistic as the minimum surface for being profitable is around 5 ha.

Table 11. Indicators per 1,000 ha

Typology	# households reaching 100% of CHBB*	Surplus (US$)	Expenditure in inputs (US$)	% of forest	Required working time (Day laborer / year)
1. CC	25.7	1,661.1	2,368.9	51.7	2,696.32
2. C	25.5	2,618.5	2,446.7	55.9	2,654.83
3. CCP	68.3	4,266.2	25,590.0	4.1	31,456.27
4. Cf	20.3	2,535.1	59.0	70.8	2,388.96

* Cost of the Household Basic Basket (projected)

In terms of surplus, typologies 2 and 4 show similar values, however, typology 4 allows for more forest conservation. Typology 3 is still the one with higher surplus, at the expenses of

having the highest expenditures in inputs, resulting in ambiguous outcome, and with the attached intensification of land use at the expenses of the forest.

Finally, in terms of labor required, all the typologies could be implemented just with the availability of working time at the household, but typology 3, which still requires hiring day workers. Should this typology be promoted, it would have large social and environmental impacts, as it could attract new settlers that would demand basic services, increasing pressure over natural resources.

5. Conclusions and policy recommendations

In order to properly plan land use in the region an updated registry is seriously needed since it is becoming more intensive, diminishing the area dedicated to forest. An adequate regulation of land use could restrain an eventual expansion of cropland, restraining current trends moving from small agro-forestry plots towards intensive croplands. Agricultural policies must be aimed at avoiding the progressive splitting of farms, as smaller farms imply breaking with existing biological corridors, therefore threatening biological diversity. Furthermore, oil extraction activities and associated subsidies need attention since they can attract more colonists to the region, imposing even more pressure to land use.

Agricultural extension programs should address some of the weaknesses found such as production practices, market prices information, cooperativism and credit. Since Ecuador is implementing electronic money countrywide and the country has one of the highest rates of penetration of smartphones in Latin America, farmers could use cellular phones to have access to banking and credit. National funding agencies could encourage these processes by crediting subsidies into e-money accounts, by channeling credits through them or even making those platforms available to farmers for commercial purposes. This would help farmers to by-pass intermediaries and would help government authorities to keep track of economic transactions for fiscal and policymaking purposes.

The relative independence of typologies 1, 2 and 4 from agro-chemicals can be seen as an opportunity for these producers to engage in organic certification, which would increase their income notably.

Under the agricultural practices identified in the region, a large fraction of coffee and cocoa would comply with the requisites for being considered organic. To support this change the role of public policies is key, by means of re-directing subsidies from agro-chemicals to fund certification applications. However, the lack of policies (for cooperative work and for adding value to products) makes difficult to peasants to take advantage of this, and they end up mixing their mostly organic production with conventional one. As an example, producers receive, on average, 1.5 US$/kg for golden bean[7] coffee, while the same kilogram of organic coffee costs about ten times more for an European customer at the supermarket.

[7] Golden bean refers to the bean ready for commercialization (export), having gone through the processes of drying and hulling (Reglamento general a la Ley Especial del Sector Cafetalero, Registro Oficial Nº 767, 25 de agosto de 1995, págs. 1-5, http://faolex.fao.org/docs/pdf/ecu3389.pdf)

As it is seen from this research, the conditions are present for public policies to readjust production and promote product processing so that sustainable livelihood of smallholders can be guaranteed and current forest cover would not be threatened.

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