Title: Payments for Agro-biodiversity: An Analysis of Participation in Jambi's Conservation Agreements for Rubber Agroforests, (Sumatra) Indonesia

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Abstract:

While Jambi Province is pioneering reduce emission from deforestation and degradation (REDD) program through *Hutan desa* (or village forest), eco-certification of jungle rubber is currently negotiated to couple with REDD for saving the remaining rich biodiversity in the area. The conservation agreements (CAs) with smallholder-rubber farmers in the villages of Jambi are an initial effort to realize the bigger payments for ecosystem services schemes (i.e. REDD and eco-labeling schemes). In this paper, the main objective was to identify factors influencing the adoption of payments/rewards for ecosystem services schemes initiated by the Rewarding Upland Poor for Environmental Services (RUPES) program. First, we characterized the households in the rubber agroforests both the participants and non-participants of CAs using survey questionnaires. Based on the results, we conducted econometric analysis and found that human capital (age, education, and size), household economic factors, and information variables significantly influence the participation in CAs. The results from this study share similar insights on PES adoption from other developing countries (Zbinden and Lee, 2005).

Keywords: payments for ecosystem services, conservation agreements, rubber agroforests, agro-biodiversity, eco-certification, REDD, Jambi Province

INTRODUCTION

Land-use and land-cover change is one of the most important anthropogenic causes of agro-biodiversity loss (MA, 2005b). Agro-biodiversity by definition is essentially the biodiversity present in and supported by agricultural landscapes (Kuncoro et al., 2006), and has been selected and modified by thousands of years of human utilization to better serve human needs (Wood, 1993). Agro-biodiversity is crucial, since it is the source of many agro-ecosystem benefits and services that are of local and global value (e.g., food, non-timber forest products and medicinal plant sources). However, it is threatened because most commercial production focuses on a few major crops (e.g. oil palm and other monoculture plantations) to meet the demand of the increasing population (Thies, 2000). The use of economic incentives such as Payments/rewards for Environmental Services (P/RES) is becoming increasingly accepted for conserving agro-biodiversity (Bennett and Balvanera, 2007). In Indonesia, where rubber agroforest areas are considered to support agro-biodiversity (Kuncoro et al., 2006), it is threatened by monoculture tree expansion including oil palm plantations, and mechanisms that will act as incentives to prevent the conversion is seen as an urgent need (Ekadinata et al., 2010). Pascual and Perrings (2007) perceive the agro-biodiversity change in the landscape as an investment/disinvestment decision made in the context of a certain set of preferences, value systems, moral structures, endowments, information technological possibilities, and social, cultural and institutional conditions.

In this paper, the objectives are to 1) introduce the two P/RES schemes for conserving rubber agroforests in Jambi province, 2) identify different factors influencing the participation of the households to these P/RES schemes, and 3) determine the possible effect of the identified factors and variables.

Environmental services provided by jungle rubber

Rubber agroforest, also known as ‘jungle rubber’ (Gouyon et al., 1993, Williams et al., 2001), is the dominant land use in Bungo District, Jambi Province (Sumatra), Indonesia (Figure 1). It is a traditional multi-strata agroforestry system in Indonesia that extends over an area of more than 2.6 million ha mostly in the forest margins of Sumatra and Kalimantan (Williams et al., 2001). This land use is the major rural livelihood of the people living there. The farming system practiced since 1904 allows natural vegetation to grow amongst the rubber trees. Farmers selectively nurture some economically valuable plants to create a mix of food, medicine, timber and fiber producing trees (Leimona and Joshi, 2010).

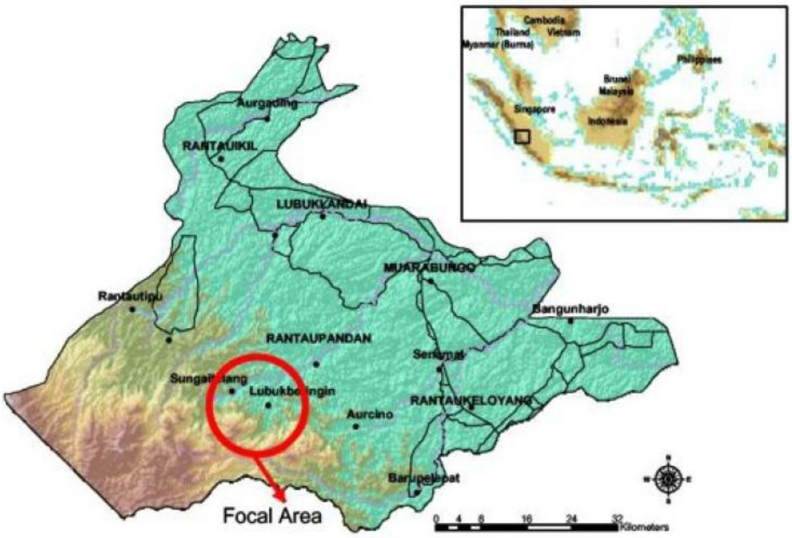

Figure 1: Map of study site in Bungo district, Jambi Province, (Sumatra) Indonesia (Source: ICRAF)

Laumonier (1997) recognized jungle rubber as an important agro-ecosystem type in the island of Sumatra. With about 60-80% of the total plant species found in neighboring primary forests (Beukema et al., 2007), this rubber agroforest is the most forest-like form of agroforestry (Long and Nair, 1999). Thus, rubber agroforest is an important refuge for forest biodiversity in the lowland (Tata et al., 2008) and has a high biodiversity value including Red List and threatened species (Beukema et al., 2007, Griffith, 2000, Schroth et al., 2004, Rasnovi, 2006). Moreover, rubber agroforest provides ecosystem services such as soil conservation, protection of water quality, carbon sequestration and landscape beauty (Joshi et al., 2003, Suyanto et al., 2005). For example, the woody biomass in a typical old rubber agroforests could hold carbon stocks of more than 20 Mg C/ha above the time averaged value of rotational agroforests (Tomich et al., 2004).

In spite of the positive ecological benefits of rubber agroforest, its latex productivity is very low. Joshi *et al*. (2006) compared the yield productivity of complex rubber agroforest to rubber monoculture, which is 400 to 600kg of dry rubber ha/year and 1000 to 1800kg ha/yr, respectively. However, farmers benefit from other resources in the rubber agroforest such as food, fruits (e.g., durian, mangosteen, coffee, etc.), fodder, fuel wood and timber (Gouyon et al., 1993, Michon, 2005).

Conservation agreements: initial effort to establish reward schemes

Conservation agreements (CAs) were developed under the Rewarding Upland Poor for Environmental Services (RUPES) program of the World Agroforestry Centre (ICRAF). The main purpose of these agreements was to develop and test schemes for agro-biodiversity conservation appropriate for jungle rubber. CAs is initial step towards institutionazing payment schemes for agro-biodiversity. Villamor and van Noordwijk (*under review*) describe in detail the establishment of conservation agreements (CAs) in the study site.

The CAs include agreement schemes such as 1) provision of high yielding (cloned) rubber seedlings planted along the old rubber trees; 2) establishment of communal rubber agroforests; 3) installation of micro-hydro power plants (improvised mini-hydro power generators that provide electricity to the villagers); and 4) establishment of mini-reservoirs in the river to produce fish stocks for local food consumption.

Support funding was provided by the RUPES Program to the communities as fulfillment of the RUPES goals to preserve the biodiversity-rich jungle rubber ecosystem taking into consideration the economic needs of the community. These agreements will prove to all external parties the commitment of the farmers to manage their rubber agroforests through CAs in which local wisdom practices for conservation are incorporated. The agreements include the farmers' biodiversity-conserving rubber agroforest practices, the way in which the communities will manage their rewards and how they will monitor the agreements.

Based on the performance of the contract holders, with the technical assistance of RUPES, the villages will negotiate and build their case for rubber latex eco-certification and reduce emissions from deforestation and degradation (REDD) schemes as presented in the following subsection. These market-based incentive schemes seem to be the only way to save the remnants of jungle forest and prevent it from being converted to rubber monoculture and oil palm plantations (Feintrenie and Levang, 2009).

REDD as a national P/RES scheme

Indonesia is not only the leader in terrestrial C-emissions (Ekadinata et al., 2010) it is also a leader in its commitment to Nationally Appropriate Mitigation Action (NAMA) as a basis for building global trust and achieving global cooperation to manage climate change. The *Hutan Desa* (village forest) agreement in Indonesia was facilitated by expectations of REDD benefits flowing to government agencies (Akiefnawati et al., 2010). The first village forest in Indonesia was Lubuk Beringin village with an area of 2,800 ha, which is composed of watershed protection forest and production forest where no concession rights exist. Under the Ministry of Forestry #P.49/Menhut-II/2008, the management of the village forest will be given to the local village organization. It entails the development of village forest plans, and management and allocation of benefits derived from the forests. A village rule (PERDUS) guides the villagers on how to manage the water and utilize the forest both timber and non-timber products. Under the rule, villagers are not allowed to clear cut the forests. The designated village forest has to be administratively part of the village; the right to manage is valid for 35 years and is renewable for another 35 years subject to approval of the work plans.

Hutan desa is one of the areas identified by the Indonesian government that qualifies for REDD+ schemes (for further relevance of *Hutan Desa* to international REDD debate see Akiefnawati et al., 2010). Indonesian REDD policy intervention strategies that could be applied to *Hutan desa* are (1) development of more effective conservation and management protected areas, and (2) development of more effective management of production forests. PERMENHUT No. P30/2009 provides the Indonesian REDD guidelines for qualified areas that include establishment of reference emission levels (REL), monitoring and reporting to national and sub-national designating authorities, verification and certification, among others. It is expected that the REDD schemes will be implemented in 2012. External agents such as ICRAF and NGOs (e.g., WARSI) are helping the Lubuk Beringin village forest organization to meet the requirements. Once compliance with all requirements has been achieved, the revenue-sharing appropriate for *Hutan desa* is 20% for the government, 50% for the community and 30% for the developer (www.dephut.go.id). A discussion about the forest definition in Indonesia is now on-going to allow the rubber agroforest to be included as a land use in the REDD+ scheme (which includes peat swamp).

Rubber eco-certification/labeling as local P/RES scheme

Studies on rubber agroforests in Jambi province claimed that the physiognomy and functioning of the rubber agroforests are close to that of the natural forest ecosystems (Michon and de Foresta, 1994, van Noordwijk, 2002). Although most of the complex rubber agroforests have disappeared in Malaysia and Thailand, around 2 million ha of rubber agroforests are still thriving in Indonesia (Gouyon, 2003, Akiefnawati et al., 2011). If left neglected, they will soon be converted to agriculture and industrial plantations. And since very little primary forests are left in the country, maintaining these forests is the only option to support the high forest diversity in the area. In the absence of specific incentives, there is no reason why smallholders will agree to forego the benefits of more profitable land uses for the sake of biodiversity conservation.

The eco-certification or eco-labeling of rubber agroforest has been explored by ICRAF for the last decade as a mechanism for conserving biodiversity habitats and furthering economic development in rubber-growing areas. This kind of scheme guarantees that the production practices used to generate a product meet a set of eco-standards, or that the raw-materials of the product are produced in bio-diverse systems, and verifies that producers have used management practices that conserve environmental services (Bennett, 2008). Thus, selling of eco-labeled rubber-latex at a price higher (price premium) than the average (farm gate) price would increase the farmers' economic returns from rubber agroforests.

Though there is no market yet for certified rubber products, interest has been shown by a tire manufacturing company to develop a "green rubber tire", and negotiations are currently underway. Research has been conducted to establish indicators (Tata et al., 2006) that would be required by certification agencies such as the Forestry Stewardship Council (FSC). About 30% of the natural rubber latex is used for tire making, and the production of natural rubber is mainly in Asia. Hence, there is a great potential to develop the market, as a great number of natural rubber consumers are still untapped (Gouyon, 2003). Based on the current negotiations with the tire manufacturer, clean and dry green rubber costs 3US$[1]/kg (Akiefnawati, pers.com.). The price is twice that of the farm gate price. A lot of research is currently being done, since eco-certification of natural rubber latex is so promising (Akiefnawati et al., 2011).

However, there are still constraints and bottlenecks that would affect the decisions of farmers to adopt the scheme. These are:

- Compliance with the set certification standards could be difficult for the farmers;
- To date, no factories are willing to receive eco-certified rubber;
- Conflict with government policy that promotes for oil palm companies (no government policy supports rubber agroforests conservation); and
- The market for certified-rubber is still underdeveloped.

METHODOLOGY

Study site

The study site is located in Bungo district, Jambi province, (Sumatra) Indonesia (see Fig 1). Within the district, three adjacent villages under the Bathin III Ulu sub-district were selected, namely: Lubuk Beringin, Laman Panjang, and Desa Buat. The villages are near the foothills of Kerinci Seblat National Park. Except for Desa Buat, these villages are considered poor and have poor access to market roads and electricity infrastructures due to their distance from the district centre (i.e. 2- hour drive by motorbike). The population status of the three main villages is presented in Table 1. Their main source of food is rice and the main source of

[1] 1 USD = 9,150.00 Rupiah (at the time of writing)

income is rubber (*Hevea brasiliensis*) and occasionally durian and other local fruit and medicinal plants obtained from the rubber agroforests.

Table 1 Population status in the study site, Jambi Province, 2003

Village	Population			No. of persons per km^2	Population density	No. of households	Average number of persons per household
	Male	Female	Total				
a. Lubuk Beringin	184	212	396	27.22	14.55	102	4.02
b. Laman Panjang	366	365	731	41.17	17.76	182	4.04
c. Buat	566	514	1,080	93.28	11.58	267	4.25
Total	**1,116**	**1,091**	**2,207**			**551**	

(Source: 2003 Statistic of Rantau Pandan Sub-District)

The majority of the population belongs to two ethnic groups namely, Jambi and Minang. They follow the traditional practice of a joint-family or lineage ownership of land wherein a matrilineal inheritance system is applied to paddy fields and a patrilineal inheritance system to rubber fields (Suyanto et al. 2005). Each village has appointed village heads and community rules (i.e. PERDUS) in managing their village forests (Akiefnawati et al. 2010). The people in these villages have strong ties with each other and respect very much their village elders.

Binary logistic regression model for P/RES adoption

Though there is limited literature on the adoption of P/RES schemes, the methodology for this research can be drawn from and supported by the previous literature on the economics of technology adoption and farm and forestry program participation (Zbinden and Lee, 2005; Neupane et al., 2002; Knowler and Bradshaw, 2007). The binary logistic (Bi-logit) regression analysis was used to model the decision of household agents to adopt or not to adopt P/RES schemes. The model is based on maximization of an underlying utility function, which is assumed to be consistent with individual household behavior (Zbinden and Lee, 2005). The model characterizing P/RES adoption is specified as:

$$Log\ \left(\frac{P_i}{1-P_i}\right) = \log it(P_i) = \beta_0 + \beta_1 X_i + \beta_2 X_2 + ... + \beta_k X_{ki}$$

where: *i* denotes the *i*-th observation in the sample, *Pi* is the predicted probability of adoption, which is coded with 1 (willingness to adopt) or with 0 (not to adopt), $\hat{a}_i$ is the intercept term, and $\hat{a}_1$, $\hat{a}_2$, ..., $\hat{a}_k$ are the coefficients associated with each explanatory variable X_1, X_2, ...X_k.

The coefficients in the logistic regression were estimated using the maximum likelihood estimation method using SPSS package version 16.

Specification of variables

Dependent variable

To willingly adopt or not to adopt the P/RES scheme ($H_{\_policy}$) is the dependent variable for this Bi-logit model. Based on the above theoretical framework, the farmer may choose options (i.e., to participate or not to participate) in the P/RES scheme if the highest utility is generated according to the available resources and the natural and institutional constraints.

Explanatory variables

The independent variables hypothesized to influence households' decisions are presented in Table 2. These variables can be grouped into farmers' and farm characteristics, farm operational income and information on or participation in conservation schemes. Farmers' characteristics such as age and educational status are often used, although to the influence on decision making of these variables differs from farmer to farmer. Younger farmers tend to be more explorative, while older ones tend to keep to their old ways (Wossink and van Wenum, 2003). Other studies showed different effects (Vanslembrouck et al., 2002). Age and education were found to be positively significant in the willingness to engage in P/RES both in the upstream and downstream areas in Thailand (Neef, 2010). Labor demand, availability and allocation are often found to be central in determining adoption and program participation decisions (Neupane et al., 2002). For example, agroforestry may be an attractive option in the long run when family labor is scarce (Zbinden and Lee, 2005).

Farm biophysical characteristics such as distance to road, area planted for rice, rubber or being fallowed (often related to farm size) have been found in other studies to be important factors explaining farmers' environmental behavior (Kristensen et al., 2001, Knowler and Bradshaw, 2007, Neef, 2010). Farmers with large farms are more likely to be able to sacrifice a portion of land for conservation without jeopardizing their household food security or short-term income-generating potential (Zbinden and Lee, 2005). Neef (2010) found that paddy rice as the main crop of a household is highly significant in the decision to engage in the P/RES scheme.

The financial characteristics of such as percentage of income from different sources may influence the decision of a farmer to adopt a new scheme. Studies have shown that the impact of income, gross income and farm profitability on adoption was positively correlated (Somda et al., 2002, Gould et al., 1989, Saltiel et al., 1994). However, adoption of conservation practices that are often characterized by high up-front costs would reduce attractiveness to the farmers (Pannell et al., 2006). For this research, farmers with lower income are hypothesized to adopt the P/RES schemes.

Information on or participation in conservation schemes such as conservation farming (Knowler and Bradshaw, 2007, Neef, 2010) is frequently found to positively correlate with the adoption of the schemes. It is also positively correlated with the education of farmer's household, which is often assumed to influence the adoption decision because of the link between education and knowledge or awareness. A lack of knowledge about the conservation agreements and incentive programs would hamper the farmers' participation or adoption (Wossink and van Wenum, 2003).

Table 2 Potential and explanatory variables influencing household decisions

Variable	**Definition**
HH_{age}	Age of household head
$H\_{education}$	Household education status
$H\_{rdistance}$	Household house distance to road (m)
H_{motor}	Number of household motorcycle vehicle
H_{labor}	Availability of household labor (number of workers)
$H\_{landhold\_per}$	Landholding per capita (ha/person)
H_{rice}	Total land area of rice (hectare)
H_{ladang}	Total land area of fallowed farm (hectare)
$H\_{complex}$	Total land area of complex rubber agroforest farm (hectare)
$H\_{gincpers}$	Gross income per capita of household (US $/person/year)
$H_{\_RICEinc}$	Percentage income from paddy rice (%)
$H_{\_RUBinc}$	Percentage income from rubber agroforest (%)
H_{LIVinc}	Percentage income from livestock (%)
$H_{\_ACT}$	Household activities based on conservation agreement

Survey and data sources

The socio-economic data for this analysis were derived from an extensive household survey conducted in the target villages in February-March 2010. A total of 95 household respondents (90 males and 5 female heads of the household) were randomly selected and interviewed. From these 95 households, 76 were participants in the CAs while 13 were non-participants.

The survey questionnaires covered the households' access to five core capitals of the livelihood framework namely, financial, human, natural, physical, and social capitals. Based on the survey, a descriptive statistical analysis was used to analyze the data and households were categorized by applying K-mean clustering analysis (KCA) using SPSS software (version 16).

RESULTS AND DISCUSSIONS

A descriptive statistics of the households is summarized in Table 3. The difference between the households lies on the key variables e.g. dependency ratio, landholding per person, rice area (ha), and gross income per capita. Household type 1 is thus named 'rubber-rice farmers', and household type 2 is named 'rubber-based farmers'.

Table 3 Descriptive statistics for key categorizing variables for each classified household group, 2010

Variable	Household group	N	Mean	Std. deviation	Std. error	95% confidence interval for mean		X_{min}	X_{max}
						Lower bound	Upper bound		
Education of household	1	33	1.06	0.704	0.123	0.81	1.31	0	2
	2	62	1.15	0.568	0.072	1.00	1.29	0	2
	Total	95	1.12	0.616	0.063	0.99	1.24	0	2
Labor availability	1	33	3.45	1.460	0.254	2.94	3.97	1	7
	2	62	3.29	1.623	0.206	2.88	3.70	1	8
	Total	95	3.35	1.563	0.160	3.03	3.67	1	8
Dependency ratio	1	33	0.240	0.3139	0.0547	0.129	0.352	0	1.0
	2	62	0.654	0.4414	0.0561	0.542	0.766	0	1.5
	Total	95	0.510	0.4462	0.0458	0.419	0.601	0	1.5
Landholding per person (ha)	1	33	1.74	2.00	0.34	1.02	2.44	0	11.12
	2	62	1.18	1.16	0.148	0.88	1.48	0	5.06
	Total	95	1.38	1.52	0.156	1.06	1.68	0	11.12
Rice area (ha)	1	33	1.12	0.696	0.121	0.87	1.37	0	2
	2	62	0.50	0.449	0.057	0.38	0.61	0	2
	Total	95	0.71	0.621	0.064	0.59	0.84	0	2
Gross income per capita	1	33	1983.94	3.03	528.22	907.98	3059.89	32.08	11918.12
	2	62	627.96	670.92	85.21	457.58	798.34	0.51	3148.70
	Total	95	1098.98	1.96	201.26	699.38	1498.58	0.51	11918.12
% income from rice	1	33	55.73	41.48	7.22	41.02	70.44	0	99.99
	2	62	65.24	41.23	5.24	54.77	75.72	0	100.00
	Total	95	61.94	41.34	4.24	53.52	70.36	0	100.00

Note: N = group size (i.e., number of households in each group); $\boldsymbol{X_{min}}$ = minimal value of the variable X; $\boldsymbol{X_{max}}$= maximal value of variable X.

Factors affecting P/RES participation of "rubber-rice farmers" (household type 1)

The results of the Bi-logit model are summarized in Table 4 for household type 1 together with the maximum likelihood estimation that was used to estimate the coefficients. Chi-square tests show that the empirical Bi-logit model is significant (p<0.093) in explaining P/RES scheme participation by farmers of the group. The Nagelkerke's pseudo-R^2 is 0.589, which indicates 59% of the total variation in the probability of P/RES participation is explained by the selected explanatory variables. Out of 14 explanatory variables (see Table 2), a total of 8 variables were used for the model, of which 6 variables correspond to farmers' and farm characteristics, and 2 variables are related to farm operation income. The combination of all variables was not possible due to the very small samples of household type 1 (n=32), thus the Bi-logit regression was conducted several times until the best pseudo-R^2 result was reached. The model has a good overall predictive power of 87.9%, and predicted the willingness to adopt P/RES with 92.9% and not to adopt it with 60.0%.

Table 4 Bi-logit model estimation of P/RES participation by rubber-rice farmers (n= 32 households)

Variable	Definition	Coefficient (*B*)	Sig.
(constant)		3.516	0.489
Farmer's characteristics			
$H_{\_edu}$	Education of household head (level)	2.683	0.105
$H_{\_mem}$	Household number of group memberships	2.759	0.119
$H_{\_size}$	Household size	0.890	0.200
$H_{\_depratio}$	Dependency ratio of household	3.104	0.211
Farm characteristics			
$H_{\_rice}$	Size of rice field (ha)	-2.353	0.186
$H_{\_rdistance}$	House distance to road (m)	0.000	0.485
Farm operation income			
$H_{\_RUBinc}$	% income from rubber agroforest	-0.089	0.086
$H_{\_RICEinc}$	% income from rice	-0.048	0.359

Fitness and accuracy of the model:
Likelihood ratio test (chi-square statistics): 13.589 df = 8 p = 0.093

Variable	Definition	Coefficient (*B*)	Sig.
Pseudo R^2= 0.589 (Nagelkerke); 0.338 (Cox & Snell)			
Percentage correct predictions:			
	Household willingness not to adopt:	60.0%	
	Household willingness to adopt:	92.9%	
	Overall percentage**:**	**87.9%**	

Among the variables that are affecting the decisions of the household agents are $H_{\_edu}$ (+), $H_{\_mem}$ (+), $H_{\_size}$ (+), $H_{\_depratio}$ (+), $H_{\_rice}$ (-), $H_{\_rdistance}$ (+), $H_{\_RUBinc}$ (-), and $H_{\_RICEinc}$ (-). However, only percentage income from rubber agroforest was found to be significant (0.10). The probability of a household to adopt to P/RES increases with increasing education, has more group memberships, number of household members with a high dependency ratio, and house distance to road. On the other hand, the probability to adopt to P/RES increases when the household has small rice field and has low income from rice and rubber production. This corresponds to findings on farm size and number of years of education (Zbinden and Lee, 2005).

Factors affecting P/RES participation of "complex-rubber based farmers" (household type 2)

In Table 5, the results of Bi-logit are summarized together with the maximum likelihood estimation that was used to estimate the coefficients for household type 2. Chi-square tests show that the empirical Bi-logit model is highly significant ($p<0.000$) in explaining P/RES participation by farmers of the group. The Nagelkerke's pseudo-R^2 is 0.709, which indicates that 71% of the total variation in the probability of P/RES participation is explained by the selected explanatory variables. A total of 12 explanatory variables included in the model were found to be important, of which 8 variables are related to farmers' and farm characteristics, 3 variables are related to farm operation income, and one variable corresponds to conservation agreement policy participation. The model has a very good overall predictive power of 91.9%, and predicted the willingness to adopt P/RES with 95.9% and not to adopt it with 76.9%.

For household type 2, variables that significantly influence the decisions are $H_{\_age}$ (-), $H_{\_size}$ (+), $H_{\_rice}$ (-), $H_{\_complex}$ (-), $H_{\_RICEinc}$ (-),$H_{\_gincpers}$ (-), and $H_{\_ACT}$ (+). The probability to adopt P/RES scheme is higher with younger household heads and agree with the findings of

Wossink and van Wenum (2003), that younger farmers are explorative. With respect to farm size, it has been regularly hypothesized that owners of large farms are more willing to adopt a new technology or scheme (Knowler and Bradshaw, 2007), and this was observed for this household type. Households with bigger areas of rice fields and (complex) rubber agroforests have a low probability of adopting P/RES schemes. The same trend can be observed for rice income and annual gross income per capita of the household. Participation in conservation activities such as planting clonal rubber seedlings significantly influences the probability of adopting the P/RES scheme.

Table 5 Bi-logit model estimation of P/RES participation by household type 2 (n= 63 households)

Variable	**Definition**	**Coefficient *(B)***	**Sig.**
(constant)		3.599	0.551
Farmer's characteristics			
$H_{\_age}$	Age of household head	-0.192	0.096
$H_{\_edu}$	Education of household head (level)	1.471	0.474
$H_{\_mem}$	Household number of memberships	-0.437	0.742
$H_{\_size}$	Household size	1.247	0.085
$H_{\_depratio}$	Dependency ratio of household	1.920	0.513
Farm characteristics			
$H_{\_rice}$	Size of rice field (ha)	-2.285	0.097
$H_{\_complex}$	Size of complex rubber agroforest (ha)	-0.392	0.067
$H_{\_rdistance}$	House distance to road (m)	0.003	0.216
Farm operation income			
$H_{\_RUBinc}$	% income from rubber agroforest	-0.046	0.231
$H_{\_RICEinc}$	% income from rice	-0.167	0.081
$H_{\_gincpers}$	Gross income per capita of household (US $/person/year)	-0.001	0.405
Conservation agreement policy participation			
$H_{\_ACT}$	Household activities based on conservation agreement (weighted value)	0.847	0.026

Fitness and accuracy of the model:
Likelihood ratio test (chi-square statistics): 37.676 $df = 12$ $p = 0.000$
Pseudo R^2= 0.709 (Nagelkerke); 0.455 (Cox & Snell)

Variable	Definition	Coefficient *(B)*	Sig.
Percentage correct predictions:			
	Household willingness not to adopt:	76.9%	
	Household willingness to adopt:	95.9%	
	Overall percentage**:**	**91.9%**	

CONCLUSIONS (AND IMPLICATIONS)

Since agroforestry as a land-use for climate change mitigation is not yet fully recognized under the current REDD strategy, studies have shown that rubber agroforests are worth conserving due to the ecosystem services it provides (Bennett 2008; Tata et al. 2008; Tomich et al. 2004). But if considered, we are not sure how potential payments from REDD would really benefit the local rubber farmers. Thus, the eco-certification schemes for rubber agroforests was developed to directly flow the benefits to local farmers.

The results of the Bi-logit regression models show the different variables that influence the participation of the households to P/RES schemes. These range from factors associated with farmers' and farm characteristics, farm income operation, and participation in/ information of the conservation agreement policy. Agro-biodiversity conservation through P/RES schemes in a rubber agroforest landscape of Bungo District is greatly affected by these factors, which influence the decision making of the local farmers. The main factors affecting the farmers' adoption of Costa Rica's PSA (Pagos de Servicios Ambientales) program (Zbinden and Lee 2005) such as farm size, human capital and household economic factors and information, were quite similar to the factors identified in this study. Though there are few studies conducted on the adoption of PES schemes in the developing countries, it is too early to make some generalizations, rather more research studies of similar objectives are suggested.

Engel et al. (2008) identify social inefficiency as one of the problems in PES programs. Social inefficiency as they explained, happens either the failure to adopt practices whose social benefits exceed their costs, or in the adoption of practices whose benefits are smaller than their costs. Accordingly in both cases, social welfare is reduced over what it might have. Since the CAs schemes did not involve monetary payments, the results of this study will give insights to induce households to adopt the P/RES schemes.

From the results, we could identify useful variables, which could help programs like RUPES and government agencies to create or establish criteria and indicators for households' eligibility to accept rewards or payments from programs such as REDD schemes. Thus, they would help to reduce free-riders and to target households who are very much involved in the process. Also, policy makers could better target households that need follow-up activities or support to ensure the success of P/RES schemes. Ekadinata et al. (2010) recommend a priority setting for eco-certification of rubber agroforest by identifying the areas where there is a high percentage of rubber agroforests. Thus, this research provides significant variables or factors for each type of households that would possibly adopt the P/RES scheme.

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