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**Income sources, poverty, and forest encroachment: Implications for rural  
development policies in Central Sulawesi, Indonesia**

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## **Abstract**

This paper analyses the determinants of income generating activities of rural households in the vicinity of the Lore-Lindu National Park in Central Sulawesi, Indonesia. The focus is on activities which threaten the integrity of the national park (perennial crop production and sale of forest products) and on non-agricultural activities (wage labour and self-employment) which are able to reduce poverty without threatening the national park. The analysis allows to identify factors which are essentially for the design of policies and programmes aiming to promote rural development and to protect the national park. Perennial crop production and activities outside the agricultural sector are particularly important for the less-poor households, whereas the selling of forest products is especially important for the poorest households. The econometric analysis shows that the possession of irrigated land, the access to social capital, and the participation in formal credit markets positively influences perennial crop production, which is a major source of deforestation. The possession of irrigated land, education, and the access to road infrastructure have a negative influence on the sale of forest products which are mainly collected inside the national park. A key factor influencing income from non-agricultural wage labour is the level of education. Policy conclusions with respect to poverty alleviation and protection of the national park are drawn.

## **1. Introduction**

The province of Central Sulawesi is one of the poorest provinces in Indonesia. Suryahadi and Sumarto (2001) classified 28% of the households as poor and more than 42% of the households as vulnerable. The research area surrounding the Lore Lindu National Park (LLNP) is characterised by an increase in the area planted with cocoa from almost zero to 18,000 hectares during the past two decades. This has been a major

source of deforestation, often located inside the LLNP (Maertens, 2003). This ongoing encroachment and the collection of forest products threaten the integrity of the park.

Alternative income sources that are able to reduce poverty as well as reduce the pressure on the national park are needed for rural households.

- 5 This paper aims to identify and analyse the determinants of income generating activities of rural households in the vicinity of the Lore-Lindu National Park. The focus is on activities, which threaten the integrity of the national park (perennial crop production and sale of forest products) and on non-agricultural activities (wage labour and self-employment), which represent alternative income sources. The paper helps to identify
- 10 factors which are essentially for the design of policies and programmes aiming to promote rural development and to protect the national park. Specifically, the following research questions will be addressed: (1) In which income activities are rural households engaged? (2) Do poor households differ from less-poor households in their activities? (3) Which factors influence the participation in different activities? (4) Which factors
- 15 influence the income gained from different activities? (5) Which policy conclusions can be drawn from the results, with respect to poverty alleviation, deforestation, and rural development?

The paper contributes to the scarce empirical literature on the linkages between activity choice of rural households, poverty, and forest encroachment. As a novel feature in this

20 context, the econometric model takes into account simultaneity and endogeneity of activity choice.

## **2. Conceptual framework**

The analysis is based on the livelihood approach, which stresses the multiplicity of activities in which rural households are engaged and emphasises the role of the

household's resources as determinants of activities (Ellis 2000). The conceptual framework used in this work builds on the features of this approach. A similar framework has been used by Zeller and Minten (2000) to evaluate the consequences of market liberalisation on the income of rural households. The household is assumed to maximise its utility, which is a function of the consumption of goods and leisure. It is subject to a time and budget constraint. According to its objective, the household allocates its resources to activities subject to factors which are external to the household (see Figure 1). These activities generate outcomes which will meet the objectives. The activities as well as the income generated have an effect on the stock of resources available to the household in the future as well as on the agro ecological environment.

Figure 1

### **3. Definition and classification of income**

Income is measured for a time period of 12 months and includes both cash and in-kind contributions. All the goods and services produced are valued at market producer prices regardless of their use. Cash-expenditures incurred in the production process are subtracted from the gross-output to derive net incomes (Ellis, 2000). Due to difficulties in valuing firewood, which is only gathered for home consumption, income from forest products contains the value of products sold only.

Income sources are classified according to sectors (agriculture and non-agriculture) and functions (wage and self-employment) as proposed by Barrett et al. (2001), but further disaggregate agricultural self-employment into three different activities: annual crops, perennial crops, and forest products.

### **4. Econometric issues**

Participation in an income activity is analysed by estimating binary response Probit

models. Similar models have been widely used in the literature, for example in Corral and Reardon (2001) and Lanjouw et al. (2001). A feature of all these income activities is that many households do not participate in them, which can cause sample or, more precisely, self-selection bias (Wooldridge, 2002). As the commonly used Heckit model is not able to account for the simultaneity of activity choice and because in Tobit models the selection process is modelled only implicitly, we follow an approach proposed by Taylor and Yunez-Naude (2000) for the analysis of activity incomes. They use a seemingly unrelated regression model in which the dependent variables are censored by unobserved latent variables. Moreover, they control for the endogeneity of activity choice by including the activity specific Inverse Mills Ratio (IMR) as right-hand variables in the corresponding activity income equations. The econometric approach follows a generalisation by Lee (1978) of an estimation principle by Amemiya (1977). Only assets which are expected to affect the income level of that activity are included as explanatory variables in the corresponding income equation. Winters et al. (2002) and Yunez-Naude and Taylor (2001) used the same approach in similar settings.

## **5. Income and activities**

In the research area perennial crop production is the most important activity contributing 24% to the total household income (see Table 1). Income from enterprises and rents contributes to 17% and non-agricultural wage labour to 13% of the total household income. Overall, agricultural self-employment and wage labour activities together contribute to 70% of total household income, with the remaining 30% coming from non-agricultural activities. Nonetheless, participation of households in non-agricultural activities is much lower. Only 18% of households reported income from non-agricultural self-employment. In the case of wage labour activities outside

agriculture, just 17% of the households earned income from this activity. In contrast, 81% take part in the production of annual crops and 76% cultivate perennial crops.

#### Table 1

The analysis so far referred to all households, but how does this change if we look at  
 5 different wealth groups? Applying a poverty index as calculated in Abu Shaban (2001), incomes and activities have been differentiated by poverty terciles: poorest (poverty group 1), poor (poverty group 3), and less-poor households (poverty group 3).

Agricultural self-employment activities are the most important source of income for all socio-economic groups, but for the poorest households they contribute almost three-  
 10 quarters to their total household income (see Table 2). The same also applies for income from forest products and agricultural wage labour, which is more important for the poorest households than for the poor and less-poor households. For income derived from outside the agricultural sector it is the other way around. Self-employment outside agriculture is particularly important for households that are better off. Also, the number  
 15 of households participating is statistically different between socio-economic groups for all activities except for the cultivation of annual crops. Participation in the sale of forest products and in agricultural wage labour activities is comparatively low for households that are better off. In the case of perennial crop production and non-agricultural activities it is the other way around. In the production of perennial crops 87% of the  
 20 better-off households are involved, whereas only 67% of the poorest households generate income from this activity. In non-agricultural self-employment and in non-agricultural wage employment 26% and 25% of the better-off households participate, respectively.

#### Table 2

## 6. Results of the econometric analysis

In all models a common set of explanatory variables has been used to enable comparisons of the influence of variables across models. Table 3 presents a description of the regressors used.

5 Table 3

### 6.1 Participation by activity

Table 4 presents the regression results for activity participation, with coefficients with a significance level greater than 90% in bold. The possession of land has a strong positive influence on the participation in annual and in perennial crop production. The first relationship is not surprising, since annual crops are grown on irrigated as well as 10 rainfed land. In the case of perennial crops, which are grown on rainfed land only, the positive influence of irrigated land owned may indicate that participation in the production of perennial crops, which are mainly cash crops, requires at least some production of rice for home consumption. The possession of irrigated land also reduces 15 the likelihood of participation the selling of forest products. The possession of other assets reduces participation in agricultural wage labour, whereas it increases the likelihood of participation in non-agricultural self-employment activities. This indicates that less-poor households are more likely to participate in the latter activity, whereas poorer households tend to participate in agricultural wage labour activities.

20 Table 4

The highest level of schooling of the adult household members influences participation in the selling of forest products and in wage labour activities. Secondary and tertiary education decrease the probability of participation in agricultural wage labour, but increase the likelihood of participation in non-agricultural wage labour. Indigenous



households are more likely to participate in agricultural wage labour and in the selling of forest products. Borrowing money from the Bank Rakyat Indonesia (BRI) during the last 5 years increases the probability of participating in perennial crop production. This result suggests that formal loans are used to start the production of perennial crops.

- 5 Increasing distance to a tarmac road reduces the likelihood of participating in wage labour activities and in the selling of forest products.

## 6.2 Income by activity

While the previous section evaluated the probability of participation in activities, this section analyses factors influencing the level of income from each activity. The same  
 10 income activities are used with the same set of explanatory variables, but only those physical assets that are expected to influence the income level of a certain activity are included. Table 5 presents the regression results, with coefficients with a significance level greater than 90% in bold.

As expected, the area of land owned plays an important role not only in crop  
 15 production, but also in the selling of forest products and in wage labour activities. Thus, the very labour intensive production of paddy rice not only reduces the likelihood of participation, but also reduces the income gained from these activities.

Table 5

Education has a similar effect on incomes than on participation. The income from the  
 20 selling of forest products increases when none of the adult household members finished primary school compared to households in which at least one adult member finished primary school. In contrast, secondary education reduces incomes from this activity.

Tertiary education increases the income from non-agricultural wage labour. Ethnic affiliation has a strong and statistically significant effect on income from perennial crop

production and non-agricultural self-employment. The distance to the next tarmac road has a statistically significant influence on income from agricultural wage labour activities and the selling of forest products.

## **7. Conclusions**

5 An important area of concern is the income derived from perennial crops, because coffee and cocoa are a major source of deforestation. Perennial crop production is more important for better-off households and the econometric analysis shows that the possession of land and the participation in credit markets positively influences participation in perennial crop production. The positive influence of borrowing money  
10 from the BRI on participation suggests that such loans are used to start the production of perennial crops, which accelerate the conversion of forest into cocoa plantations. Therefore, formal credit should be redirected into activities which do not threaten the integrity of the national park. Nevertheless, all such policies aiming to protect the park should be accompanied by better law enforcement, either through the National Park  
15 Authority or community agreements (for an evaluation of such agreements in the research area see Mappatoba, 2003).

Apart from deforestation, another area of concern is the sale of forest products, which are mainly collected inside the national park. Income from forest products is particularly important for the poorest households. The level of education, particularly primary and  
20 secondary education, and the distance to tarmac roads have a negative influence on the sale of forest products. Therefore, policy measures to reduce the sale of forest products might be to improve the access to primary and secondary education and rethink the already proposed road extension plans. In the political discussion, there are still plans to build new roads inside the national park, linking, for example, the sub district of Lure

Utara with Lore Selatan (ANZDEC, 1997). Alternative plans to build these roads further away from the national park boundaries would be preferable. Another discouraging factor is the area of irrigated land owned. Fostering the construction of irrigated rice fields for poor households can absorb their labour force and prevent them from  
5 collecting forest products.

The descriptive analysis shows that non-agricultural activities are particularly important for less-poor households, whereas poor households are more engaged in agricultural activities. Reardon et al. (1998) call this the “interhousehold paradox”: the poorest households, while having the greatest need for non-agricultural income, are also the  
10 most constrained. The econometric analysis shows that the endowment of other assets is one such constraint in the case of non-agricultural self-employment. Poorer households, because of their lower endowment with physical capital not related to agriculture, have fewer opportunities to participate and derive income from non-agricultural self-employment. Therefore, potential non-agricultural activities have to be carefully  
15 evaluated as to whether they suit the assets owned by poor households.

Another key factor influencing income from non-agricultural wage labour is education. The improvement of the access to secondary and tertiary education is a prerequisite for wage labour employment outside the agricultural sector. Therefore, rural development policies could promote the establishment of additional junior and senior high schools.  
20 But, the demand for better-educated people also has to be improved, especially in the private sector. So far, the state is the most important employer and governmental budgets are tight.

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**Table 1: Income and participation by activity**

	Income (IDR 1000)	% of total income	Number of households participating	% of all households
<b>Total household income</b>	5909	100	278	96
<b>Agricultural income –</b>				
<b>Self-employed</b>	3521	59	236	81
Income from annual crops	1165	20	221	76
Income from perennial crops	1460	24	183	63
Livestock Income	477	8	49	17
Income from forest products	399	7	134	46
<b>Agricultural income –</b>				
<b>Wage labour</b>	626	11	51	18
<b>Non-agricultural income –</b>				
<b>Self-employed</b>	991	17	50	17
<b>Non-agricultural income -</b>				
<b>Wage labour</b>	766	13		

Source: STORMA project A4 household survey

Number of observations=291

**Table 2: Income and participation by activity and poverty group**

Poverty group	Income in % of total household income			% of households participating		
	1	2	3	1	2	3
<b>Agricultural income -</b>						
<b>Self-employed</b>	73	54	57	96	96	95
Annual crops	23	26	16	86	79	78
Perennial crops	23	17	28	67	77	87
Livestock income	6	3	11	73	52	65
Income from forest products	21	7	1	30	14	4
<b>Agricultural income -</b>						
<b>Wage labour</b>	17	19	5	47	58	31
<b>Non-agricultural income -</b>						
<b>Self-employed</b>	3	10	25	7	21	26
<b>Non-agricultural income -</b>						
<b>Wage labour</b>	6	17	14	10	18	25

Source: STORMA project A4 household survey

Number of observations=291

**Table 3: Variable descriptions and summary statistics**

Variable	Description	Mean	Std. dev.	Min.	Max.
wetown	Irrigated area owned (ha)	0.32	0.54	0	4.52
dryown	Rainfed area owned (ha)	1.34	1.67	0	10.50
valotass	Value of other assets (IDR 1 mill)	3.30	9.23	0	170.20
livunit	Livestock units owned	0.58	0.91	0	6.36
depratio	Dependency ratio	0.70	0.61	0	5.00
Highest level of schooling of the adult household members <sup>a</sup>					
educ1	not finished primary school	0.05	0.21	0	1
educ3	finished secondary school	0.29	0.45	0	1
educ4	finished tertiary school	0.27	0.44	0	1
soccap	Social capital index	1.96	2.49	0	16.00
ethnicity	Ethnicity of head of household (1=non-indigenous)	0.19	0.39	0	1.00
nloan	Household received loan from BRI in last 5 years (1=yes)	0.06	0.24	0	1.00
distroad	Walking distance house - road (hours)	1.43	3.62	0	13.00
Sub district dummies <sup>b</sup>					
kecdum2	Sub district dummy for Palolo	0.22	0.42	0	1.00
kecdum3	Sub district dummy for Sigi-Biomaru	0.36	0.48	0	1.00
kecdum4	Sub district dummy for Kulawi	0.23	0.43	0	1.00

Source: STORMA project A4 household survey

Number of observations=291

Notes: <sup>a</sup> In contrast to finished primary school. <sup>b</sup> In contrast to the sub district of Lore



**Table 4: Probit results for activity participation**

Activity					non-	non-
	annual	perennial	forest	agricultural	agricultural	agricultural
	crops	crops	products	wage	wage	self-
Regressors				labour	labour	employment
wetown	<b>19.45</b>	<b>19.63</b>	<b>-15.51</b>	-11.63	0.47	5.77
dryown	0.02	<b>7.18</b>	<b>2.82</b>	0.40	-1.99	1.55
valotass	0.01	-0.19	-1.15	<b>-3.13</b>	-0.07	<b>1.21</b>
livunit	<b>4.63</b>	1.27	0.70	-1.98	-2.36	0.44
depratio	-0.56	3.44	2.16	<b>-11.45</b>	1.53	-2.36
educ1	3.11	-13.19	<b>13.42</b>	-22.92	-7.58	4.95
educ3	-1.95	-4.31	-3.99	<b>-19.33</b>	<b>9.84</b>	5.44
educ4	-1.95	0.10	-2.07	<b>-16.49</b>	<b>12.57</b>	-0.55
soccap	-0.22	<b>2.07</b>	0.32	<b>2.55</b>	0.55	0.36
ethnicity	-0.07	-4.38	<b>-11.52</b>	<b>-18.06</b>	-3.12	9.82
nloan	<b>-6.44</b>	<b>27.14</b>	-14.85	-12.83	<b>17.03</b>	-6.32
distroad	<b>0.75</b>	1.26	<b>-1.89</b>	<b>-3.19</b>	-2.38	0.12
kecdum2	<b>-5.44</b>	<b>16.54</b>	-8.19	<b>46.20</b>	<b>-13.22</b>	-6.21
kecdum3	<b>-3.84</b>	8.99	<b>-11.17</b>	<b>16.98</b>	<b>-9.22</b>	<b>19.77</b>
kecdum4	<b>-4.31</b>	<b>21.48</b>	9.66	-3.71	-5.11	2.21
Pseudo R <sup>2</sup>	0.85	0.53	0.63	0.65	0.48	0.50
% correctly predicted	84	80	82	68	83	83

Source: STORMA project A4 household survey

Number of observations=291

Notes: The coefficients in the table are the percentage change in the probability for an infinitesimal change in each independent, continuous variable and the discrete change in the probability for dummy variables. Coefficients with a significance level greater than 5 90% are in bold.

**Table 5: Selectivity corrected estimates of income equations**

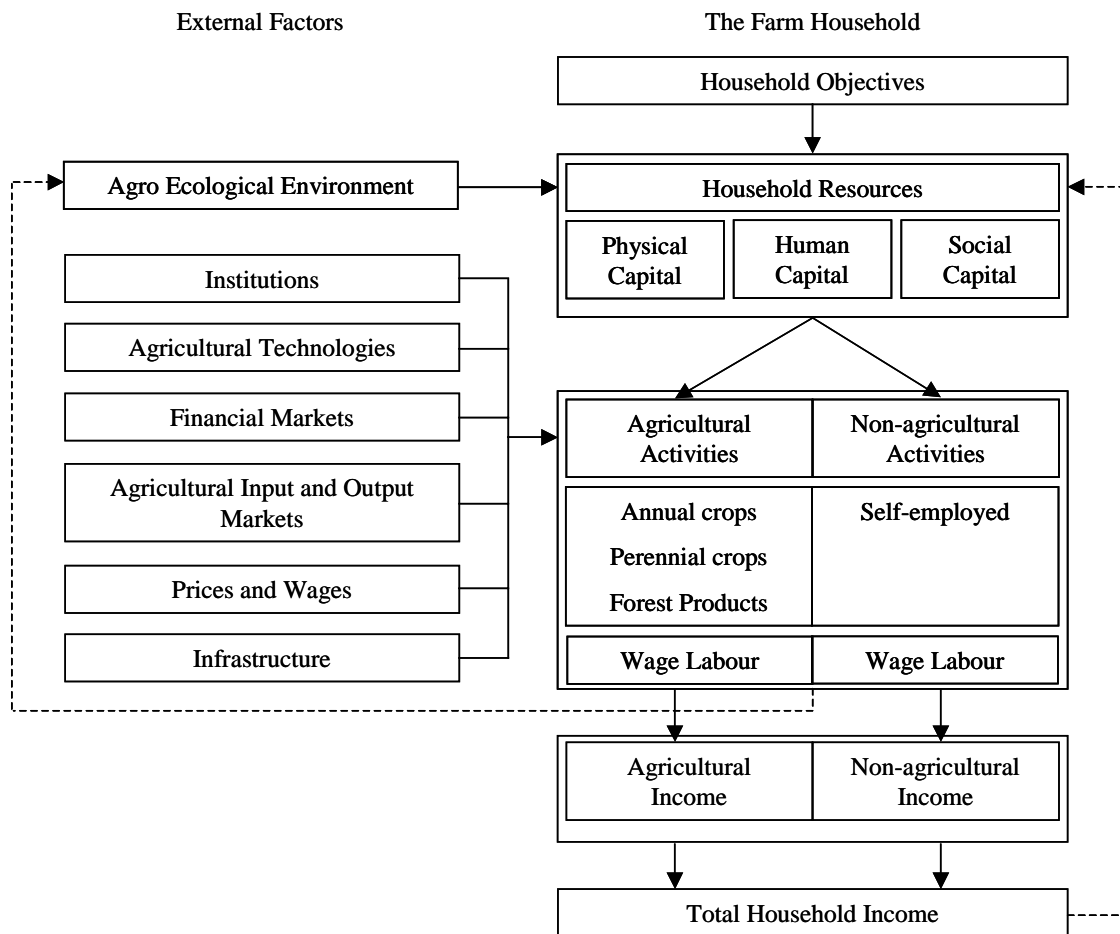
Activity					non-	non-
	annual	perennial	forest	agricultural	agricultural	agricultural
	crops	crops	products	wage	wage	self-
Regressors				labour	labour	employment
wetown	<b>360</b>	315	<b>-313</b>	<b>-222</b>	<b>-418</b>	
dryown	103	<b>679</b>		-48	<b>-128</b>	
valotass			-2		-5	<b>79</b>
livunit	<b>572</b>					
depratio	-84	-459	12	<b>-316</b>	-49	-5
educ1	-181	-160	<b>637</b>	-208	-221	171
educ3	43	-265	<b>-350</b>	-158	348	16
educ4	-88	387	-311	<b>-333</b>	<b>887</b>	107
soccap	<b>108</b>	-71	23	16	-28	-23
ethnicity	350	<b>1079</b>	-30	-144	103	<b>569</b>
nloan	314	-211	-382	<b>-459</b>	<b>3047</b>	-299
distroad	25	-6	<b>-127</b>	<b>-68</b>	21	-3
kecdum2	-600	<b>2283</b>	-333	31	<b>-1542</b>	<b>-584</b>
kecdum3	88	<b>1251</b>	<b>-436</b>	-237	<b>-1444</b>	21
kecdum4	-395	<b>1577</b>	<b>748</b>	-152	<b>-1560</b>	11
constant	540	-636	<b>876</b>	<b>1348</b>	<b>1852</b>	200
Inverse Mills	<b>785</b>	<b>828</b>	<b>1304</b>	<b>855</b>	<b>2333</b>	<b>1237</b>
Ratio						
R <sup>2</sup>	0.60	0.71	0.80	0.71	0.79	

Source: STORMA project A4 household survey

Number of observations=291

Notes: Coefficients with a significance level greater than 90% are in bold.

**Figure 1: Conceptual framework**



Source: Adapted from Zeller and Minten (2000, p. 25)