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Small Scale *Jatropha Curcas* and *Ricinus communis* Production: A Living Standard Approach in the Brazilian Legal Amazon Region

(Expanded abstract)

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Introduction

Since the beginning of 21st century an international debate took shape and nowadays is presented on 10 of every 10 meetings about sustainable development around the world, that is: biofuels, their pros and cons. Concerning the pros, one can understand as being the shift to a cleaner matrix including a renewable source of energy and the positive externalities that are carried on with it, such as carbon sequestration as well as carbon emission avoidance. From the socio-economic point of view, biofuels can positively impact the rural development and diversify the local natural resources' usage such as the enhancement of the rural spaces' multi-functionality and therefore the pluri-activity of the sector and of course, generate strategies that aim at include marginalized people and therefore alleviate poverty, so-called 'pro-poor strategies'.

Brazil has launched a biodiesel program in the year of 2004 – the National Program of Biodiesel Use and Production (PNPB) – which has several objectives such as diminish the import of diesel and therefore its dependence from outside; increase the share of renewable energy on the National Energy Balance; include the small-scale farmers on the biodiesel chain and therefore foster the rural development. However, after 5 years, the impacts of the program are so far uncertain, especially regarding the effectiveness of the inclusion of marginalized people, i.e. the social inclusion advocated by the PNPB.

In this context, the present study aims at analyze the relationship and links between the small scale oil seed production and the social inclusion of poor families into the Brazilian biodiesel chain and therefore check its 'pro-poor' strategy.

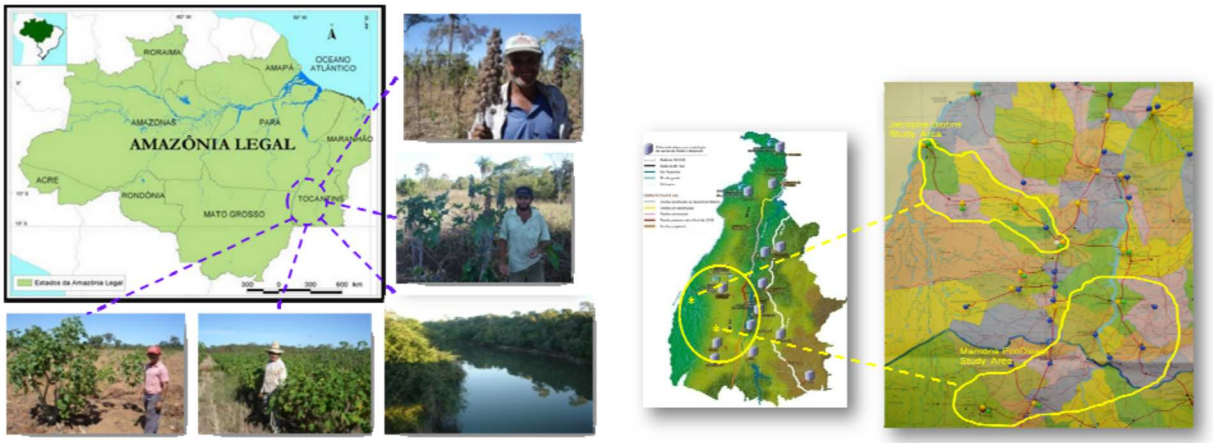
2. Research area

The research was carried out in the Tocantins State, located in the north of Brazil, in a region well-known as Brazilian Legal Amazon. The State is situated in a transition area, presenting vegetation and climate from Amazon rain forest and Cerrado (Brazilian savannah).

Two biodiesel enterprises were on activity in the Tocantins State at the moment the research was carried out. Based on this, one macro study region was selected in the South-west of

the State. In addition and taking into consideration that each enterprise produces biodiesel from different sources of feedstock and also have different types of contracts with the small scale farmers, two sub study regions were chosen within the macro region: (i) *Ricinus Communis* region and (ii) *Jatropha Curcas* region.

Figure 1: Research macro region (a) and the two sub study regions (b)



(a) (b)

3. Methodological aspects

Aiming at to do the data collection and therefore form the database, a comprehensive survey was carried out between April and September 2008 in the two sub study regions. In one sub study region, the oil seed cultivated is the *Ricinus Communis* (Castor bean and also well known as Mamona in Brazil) and in the other sub study area region *Jatropha Curcas* (well known as Pinhao Manso in Brazil) is cultivated. The survey includes smallholders who cultivate oil seeds used to produce biodiesel as well as with smallholders who decided not to cultivate it. The inclusion of non producer smallholders in the survey is necessary to assess the differences and similarities among the families based on the living standard approach (DOPPLER, 1993; DOPPLER, 2004).

Specific questionnaires were applied to smallholders, who were selected randomly: 27 in the case of *Jatropha Curcas* producers; 24 in the case of *Jatropha Curcas* non producers; 25 in the case of *Ricinus Communis* producers; and 25 in the case of *Ricinus Communis* non producers. It is important to highlight that the choice of the municipalities, the rural settlements as well as the smallholders followed statistical procedures.

After the data collection, its assessment and analysis started and therefore links were drawn between the smallholders' living conditions and the main question raised in this research: the social inclusion, i.e. the inclusion of poor rural families in the Brazilian biodiesel chain.

Parametric as well as non-parametric tests were used to demonstrate the statistical differences among the smallholders and a non linear *probit* model (GREENE, 2008) was applied to estimate the relationship between smallholders' living standard and the adoption of oil seed activity. The living standard was used to construct a poverty index and for this purpose, the *fuzzy* set theory (CERIOLI and ZANI, 1995; MICELI, 1998; ZADEH, 1965) was applied to establish some indicators of deprivation. The software STATA was used to support the statistical and the econometric analysis.

4. Conclusions

After the comprehensive survey and information collection, the data analysis was done and the main results regarding the objective of the present article is presented below.

Aiming at have more accuracy in the analysis of the links between smallholders' living standard and oil seed activity adoption, a *fuzzy* index of poverty (FIP) was constructed aiming at and estimate this relationship.

In this context, variables related to economic field such as family income *per capita*, ownership of durable goods, transport mean, toilet facilities and water piped into dwelling were selected as well as some social variables such as head educational level, social capital, crowding factor, health situation, food security, resource dependence and drinking water shortage.

Table 1: *Fuzzy* indicators of deprivation (ξ_i)

	Definiton	
Indicators of deprivation (ξ_j)	Indicator's nature	*Fuzzy* model
1. Family income per capita	Continuous	Trapezoidal
2. Durable goods	Polytomous	Linear
3. Transport mean	Polytomous	Linear
4. Toilet facilities	Dichotomous	Traditional
5. Water piped into dwelling	Dichotomous	Traditional
6. Head educational level	Polytomous	Linear
7. Social capital	Polytomous	Linear
8. Crowding factor	Continuous	Trapezoidal
9. Health situation	Polytomous	Linear
10. Food security	Polytomous	Linear
11. Resource dependence	Dichotomous	Traditional
12. Drinking water shortage	Dichotomous	Traditional

The fuzzy set was applied to both sub study regions. This was necessary once the smallholders were located in different areas and have contracts with different biodiesel enterprises under different conditions. Below one can see the main results regarding the *fuzzy* index of poverty in the two sub study regions in question.

Table 2: *Fuzzy* poverty index decomposed for *Ricinus Communis* and *Jatropha Curcas* regions

Indicators of deprivation ξ_j	***Ricinus Communis* region**		***Jatropha Curcas* region**	
	Fuzzy proportion of poor $\bar{u}(\xi_j)$	Weights ω_j	*Fuzzy* proportion of poor $\bar{u}(\xi_j)$	Weights ω_j
1. Family income per capita	0.7802	0.0242	0.6423	0.0388
2. Durable goods	0.4050	0.0883	0.3088	0.1029
3. Transport mean	0.5200	0.0639	0.3725	0.0865
4. Toilet facilities	0.2500	0.1354	0.3873	0.0831
5. Water piped into dwelling	0.4200	0.0847	0.3922	0.0820
6. Head educational level	0.5800	0.0532	0.6275	0.0408
7. Social capital	0.4600	0.0758	0.5294	0.0557
8. Crowding factor	0.3144	0.1130	0.2941	0.1072
9. Health situation	0.3100	0.1144	0.3824	0.0842
10. Food security	0.3100	0.1144	0.2059	0.1384
11. Resource dependence	0.6400	0.0436	0.2941	0.1072
12. Drinking water shortage	0.4000	0.0895	0.4314	0.0736
***Fuzzy* index of poverty (FIP)**	0.3932		0.3638	

The *fuzzy* index poverty (FIP) for the both regions show a non negligible 39.32% average rate of deprived families regard to indicators of deprivation in *Ricinus Communis* region and 36.38% average rate of deprived families in *Jatropha Curcas* region.

The next step was a non linear *probit* model formulation aiming at assess the relationship between the FIP and the adoption (or not) of the oil seed activity.

$$Y_j = \alpha + \beta X_j + \mu_j \qquad (j = 1, \dots, n) \qquad (01)$$

Where *Y* corresponds to the adoption (Y=1) or not adoption (Y=0) of the oil seed activity (dependent variable), and *X* corresponds to the *fuzzy* index of poverty, but in this case, a *dummy* variable once the families were divided in poor (1) and non-poor (0) based on the FIP estimated in the table 2 (independent variable). So in the case of *Ricinus Communis* region:

$$X = \begin{cases} 1 \; if X_j \geq 0.40 \\ 0 \; if \; otherwise \end{cases} \qquad (02)$$

And in the case of *Jatropha Curcas* region:

$$X = \begin{cases} 1\ if X_j \geq 0.37 \\ 0\ if\ otherwise \end{cases} \quad (03)$$

Two regressions were established and the results can be seen in the table below.

Table 3: Regression results for non linear *probit* model

	***Ricinus Communis* region**			***Jatropha Curcas* region**		
	Coef.	SE	*z-statistic*	Coef.	SE	*z-statistic*
Constant	-0.3186	0.2256	-2.59*	0.7810	0.2924	2.67*
FIP *(dummy)*	0.9080	0.3873	2.34*	-1.2447	0.3823	-3.26*
Number obs	50			51		
LR χ^2			5.70*			11.27*

Notes: SE = standard error
* Significance level of 0.01

According to the results of the *probit* model, one can observe that regarding the *Ricinus Communis* region the sign of the coefficient FIP is positive, i.e. a poor family has, on average, a higher probability to adopt the oil seed activity than a non poor family. This outcome shows that in this region the 'pro-poor' strategy is taking place and therefore the social inclusion advocated by the PNPB is working, in other words, the poor families are being included in the Brazilian biodiesel chain.

However, when one looks to the other region, *Jatropha Curcas* region, one observes that the sign of the FIP coefficient is negative, showing that the poor families have, on average, a lower probability do adopt the oil seed activity when compared to those who are considered non poor. Here, it is clear that the social inclusion is not occurring and the 'pro-poor' strategy is not taking place, once the poor families are not being included in the biodiesel production process.

Changes in the predicted probability were also estimated and show that in the case of *Ricinus Communis* region, being a poor family increases the probability of adopting oil seed activity by 34%, on average. But in the case of *Jatropha Curcas* region, the trend is the opposite, i.e. being a poor family decrease the probability of adopting oil seed activity by 46%, on average.

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