A Farm Level Analysis of the Economic Impact of the MARENA Program in Honduras

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Farm Level Analysis of the Economic Impact of the MARENA Program in Honduras

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ABSTRACT:

This study examines the impact of the MARENA Program on farm income, where the latter is measured as the total value of farm output (TVFO). MARENA is a natural resource management program which was implemented in Honduras between 2002 and 2009. The impact of MARENA on TVFO is measured using a 2-period panel data set collected early in the life of the Program (2004) and then again towards the end of its implementation (2008). The methodology relies on Propensity Score Matching and the estimation of a fixed effects income model. The Box-Cox transformation rejects the null hypothesis that the income model is log linear in favor of the linear specification. The data set includes 109 beneficiaries and 262 non-beneficiaries or control farmers. The control group is divided into those located within MARENA's area of influence (neighbors) and those located outside the area of influence (non-neighbors). To evaluate the sensitivity of the results, the matching is done for two different subgroups using the '1-to-1' closest neighbor criterion. The econometric estimates suggest that MARENA has had a positive and significant effect on TVFO, with an average annual increase on the TVFO of beneficiaries of US $296 and US $245 relative to the control depending on the matched sample used. The analysis suggests that MARENA has not had a 'contagion' or 'spillover effect'. Various expected internal rates of return (IRR) figures are calculated under different scenarios and the results indicate that the 12% required IRR can be achieved uniformly. Finally, the fixed effects coefficients are used to calculate (time invariant) Technical Efficiency (TE) scores for the various matched subgroups. On average, beneficiaries exhibit significantly higher TE levels compared to the control.

Keywords: Impact Evaluation; Propensity Score Matching; Fixed Effects; Internal Rate of Return; Technical Efficiency; Honduras

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INTRODUCTION

Many developing countries around the world severely underfund their National Agricultural Research Systems and their publicly provided extension services (World Bank, 2008). This behavior is at odds with the need many of these countries have to improve their competitiveness if they are to become active participants in and benefit from the growing globalization of the economy. Moreover, there is ample research that reveals high rates of return for public investment in both agricultural research and extension in developing as well as developed countries (Alston, *et al*., 2000). In addition, a large number of empirical studies suggest that considerable gains could be achieved by farm level improvements in efficiency but this would require a sustained support for extension services (Bravo-Ureta *et al*, 2007; Battese, 1992).

In Central America, the lack of public support for agricultural research and extension should be seen in the context of significant poverty, as well as a rapidly deteriorating resource base. In this environment, poor farmers try to eke a leaving by cultivating steep slopes, a practice that is associated with deforestation, soil erosion, and declining water quantity and quality, among other severe problems, all of which feeds back to lower farm productivity and worsening poverty rates (Pelupessy and Ruben, 2000). Recognizing these major challenges, the international community has come around to the old idea, proposed by Johnston and Mellor (1961), that agricultural productivity growth is an essential component of any development strategy (World Bank, 2008). Within this strategy, there is increasing pressure on multilateral and bilateral organizations as well as private foundations to provide more assistance to developing country agriculture particularly as we witness growing challenges in meeting the Millennium Development Goals (UN, 2008). At the same time, there is a rising need for documenting the impact of international assistance in achieving the millennium agenda set by donors and developing country governments (World Bank, 2006).

This paper focuses on Honduras where rural poverty and environmental degradation are severe problems (IMF, 2004). Over the past decade, the Inter-American Development Bank (IDB), among other organizations, has provided a significant number of loans to the Honduran Government to fund programs designed to decrease poverty while alleviating the pressure on the environment (IDB, 2004). One such initiative is the MARENA program which is the focus of this paper.

The main goal of MARENA was to promote sustainable rural development by strengthening natural resource management, at both local and regional levels, in an area of influence covering 13,721 Km^2 and close to 930,000 inhabitants. The program sought to reduce poverty and the physical, economic and environmental vulnerability in critical areas in order to improve the quality of life of the benefitted communities. MARENA was based on a concept of territorial management including three river basins and 11 sub-basins where participatory processes defined the priorities and plans of action. The Program was organized into three components and several modules. Module 3 within Component II focused on promoting investments in sustainable production systems with a budget of US $7.6 million for this purpose (Bravo-Ureta, 2009). The major activities undertaken with beneficiaries include training in various aspects of business management and sustainable farming practices, and the provision of funds to co-finance investment activities through local rural savings associations.

Despite the effort and financial resources invested to promote rural and environmental programs in Central America little work has been done to examine the impact of such initiatives. The lack of research on this field is likely due to cost considerations and lack of adequate data collection efforts by project implementers. MARENA is an exception on this regard, since the collection of farm-level data to monitor and evaluate the program was a priority from the beginning.

The objective of this paper is to conduct an evaluation of the impact of Module 3 in Component II of MARENA on farm level beneficiaries. To reach this goal we first obtained a comparable data set including beneficiaries and a control group using Propensity Score Matching (PSM) techniques. To evaluate the indirect impact of MARENA on non-beneficiary farms living within the area of influence of the project, the data also includes farms located outside of this area. Then, we compare the difference between the value of agricultural production of the studied groups using fixed effects models. In addition, we examine the internal rate of return of the Program under different scenarios and we evaluate the differences in technical efficiency among the project's beneficiaries and the control groups.

The rest of this paper is organized as follows. The next section presents a review of the literature followed by a description of the data and methodology. We then discuss the key results and end with concluding remarks.

REVIEW OF THE LITERATURE

Bresciani and Valdés (2007) argue that improving the income of rural households is an essential strategy to reduce poverty in less favorable areas due to close linkages with the labor and food markets, and a high multiplier effect on other sectors of the economy. Furthermore, Vosti and Reardon (1997) claim that to reach an adequate level of economic development in peasant economies it is necessary to address the 'critical triangle' of economic growth, poverty alleviation, and environmental sustainability. Consistent with this view, alternative strategies have been implemented by governments, international donors and multilateral banks to improve the economic well-being in the rural areas of developing countries. Unfortunately, there is a limited number of quantitative studies analyzing the factors associated with rural household income in Central America.

Among the few available articles, López and Romano (2000), and López (2000) evaluate, respectively, the determinants of household income in Honduras and El Salvador. Both studies use socioeconomic and farm-household characteristics to develop a *per capita* income model. López and Romano (2000) concluded that to improve rural income in the area under study, it is necessary to promote the development of the labor and credit markets and improve human capital by expanding extension systems and rural education. Using a multiple equation household income model, Bravo-Ureta *et al.* (2006) analyzed the effect of participating on two natural resource management programs in El Salvador (PAES) and Honduras (CAJON) on the income of beneficiaries. Their results suggest that output diversification, soil conservation practices and structures, and the adoption of forestry systems have a positive and statistically significant association with farm income. Also, farmers who own land enjoy higher farm incomes than those who do not.

The income studies just mentioned provide useful insights but do not focus on the evaluation of the impact that can be attributed to the interventions analyzed. Table 1 shows recent studies that have used impact evaluation methods to explicitly quantify the welfare effects that can be attributed to various projects conducted in rural communities in several countries. It is worth noting that none of these studies focuses on Central America.

Sadoulet *et al.* (2001) evaluated the impact of the PROCAMPO program in Mexico on rural household income. The aim of this program was to compensate farmers, using cash transfers, for potential lower commodity prices stemming from the incorporation of Mexico to

NAFTA. Using a difference-in-difference (DID) income model, the authors found that PROCAMPO had a positive indirect effect on their beneficiaries' household income. Sadoulet *et al.* (2001) argue that the cash transfer program helped in reducing credit constraints allowing farmers to improve production and productivity and, consequently, their income levels.

Godtland *et al*. (2004) analyzed the impact of farmer-field schools (FFS) in Peru and find that participating farmers were able to raise their average potato output by 52% in a normal year. Feder *et al*. (2004), using data for rice-growing villages in Indonesia, also examined the impact of FFS and found no significant impact of yield growth or reduction in the use of pesticides. The authors used DID estimates along with fixed effects to address selection bias arising from time-invariant unobservable characteristics; however, they did not use any matching techniques to ensure that the control and treated groups had similar observable characteristics. Along the lines of the Feder study, Praneetvatakul and Waibel (2006) evaluated the impact of FFS in Thailand between 2000 and 2003 and found that pesticide expenditures were reduced by the extension intervention.

Skoufias (2005) studied the effect of PROGRESA on the well-being of rural families in areas of extreme poverty in Mexico. The impact of the project was measured using a statistical analysis which included farmers associated with the program as well as a control group. The results show that in a two year period PROGRESA decreased poverty by 17% in its area of influence with respect to the control area.

Rodríguez *et al.* (2007) evaluated a rural development project aiming to improve income among coconut producers in the Philippines. These authors implemented a DID income model which included farmers associated with the project and a control group using a balanced panel data set for a two-year period. The authors show that the implementation of this project had positive and significant effects on poverty reduction among beneficiaries. They also conclude that one of the most important restrictions facing small scale farmers in the area under study was credit availability.

More recently, other studies that use matching techniques and DID methods to analyze interventions in several developing countries include the work of Nakasone (2008) for Peru on land Titling programs, Dillon (2008) for irrigation in Mali *et al.* (2008) for livestock in Uruguay, Cerdán-Infantes *et al.* (2008) for grapes in Argentina, and Essama-Nssah *et al*. (2008) for tea farming in Rwanda (Table 1).

The present study contributes to the limited literature focusing on the impact evaluation of natural resource management projects by examining the impact of MARENA on its beneficiaries. We make an effort to capture possible spillover effects on non-beneficiaries living within the Program's area of influence and we also make use of the fixed effects estimates to calculate average technical efficiency levels for the different groups under study. Available data on the cost of implementing the Program along with the benefits estimated from our econometric work are used to compute expected internal rates of return under alternative scenarios.

METHODOLOGICAL FRAMEWORK AND DATA

The impact of MARENA is measured by the difference in the total value of farm output (TVFO) between individuals who participated in the MARENA program (treated), and the incomes of individuals who did not (control). This difference is known as the treatment effect. Formally, consider a farmer *i* in time period *t* and let the dummy variable $D_i = 1$ if the farmer received the treatment, and $D_i = 0$ if the farmer did not, and Y_i is the potential outcome. is Then, the average treatment effect (ATE), conditional on X_i is given by:

$$E[Y_i | X_i = x, \mathbf{D_i} = 1] - E[Y_i | X_i = x, \mathbf{D_i} = 0] . \qquad (1)$$

Clearly, both outcomes cannot be observed at the same time for the i^{th} individual, which constitutes one of the main analytical problems in impact evaluation (Ravallion, 2008). Therefore, to implement this model, it is necessary to find a group of farmers not associated with the project (control group) that resembles beneficiary farmers as much as possible prior to project implementation (i.e., baseline). The Propensity Score Matching (PSM) method is often used to generate such control group. PSM yields a 'score' equal to the probability of receiving treatment, considering both treated and non-treated groups, given a set of predetermined covariates. The PSM approach used here requires first the implementation of a Logit model to estimate the probability that a farmer in the sample will become associated with the project (participation model). Then, every beneficiary is matched with a farmer in the control group and such matching can be done using various alternative procedures (Cameron and Trivedi, 2005). PSM does not completely eliminate biases that might stem from observable characteristics across the treatment and control groups but, according to Imbens and Wooldridge (2008) among other authors, it provides a good approximation. In this paper, matching is done using the '1-to-1 nearest neighbor' criterion (Sianesi, 2001).

Once the control group is selected, the impact of the project on the TVFO of its beneficiaries can be estimated using a DID estimator assuming that panel data is available (Ravallion and Chen, 2005), as is the case in the present study. In general terms, the DID approach compares the difference between the income of beneficiaries and non-beneficiaries at the baseline versus the difference in income at a point typically close to the end of the implementation of the project.

In estimating the treatment effect, another source of bias can arise stemming from unobserved characteristics (e.g., managerial skills) which can be controlled using a fixed effects estimator (Rodriguez, 2007). Therefore, the impact of the project can be estimated using the following model:

$$Y_{it} = \alpha_0 + \rho B_{it} + \gamma N_{it} + \lambda T_t + \beta X'_{it} + \sum_{i=1}^{n} \alpha_i F_i + \varepsilon_{it} \qquad i = 1,.., n;\ \ t = 1,2.. \qquad (2)$$

where Y_{it} is TVFO, B_{it} is a dummy that measures the treatment effect, N_{it} is a dummy if the farmer is not a beneficiary of MARENA but lives within its area of influence, T_t is a dummy variable equal to 0 for the baseline, X_{it} is a vector of observed control variables, F_i is the farm fixed effects, ε_{it} is an error term and the greek characters are parameters to be estimated (Angrist and Pischke, 2009). In this study, the control group is composed of two subgroups, Neighbors and Non-Neighbors, in an attempt to capture spill over or contagion effects, as explained below.

To estimate the model in equation (2) we have a panel data set that includes 109 MARENA beneficiaries and a control group comprised of 262 households in each of two time periods. The control group includes 145 households living inside the area of influence of the Program and 117 located outside this area. The data were collected during the 2003-04 agricultural year (baseline) and then four years later for the 2007-08 production cycle. The data include information on socioeconomic characteristics of the household as well as alternative sources of income, quantity of inputs and outputs, costs and revenues. Table 2 defines all the variables included in both the participation (Logit) and income models.

RESULTS

Selection of the Matched Groups

As indicated, PSM was used to match beneficiaries with a control group. In doing so, we first fitted a Logit model to estimate the probability of being a MARENA beneficiary for each household in the baseline sample. Thus, the dichotomous dependent variable equal to 1 if the household is a beneficiary and 0 otherwise. The estimated Logit equation can be written in general terms as:

BENEF = *f* (AGLAND, CAFEECO, NUMBER, ALTITUD, AGE, EDUC, ORGA, ASSIST, DIVER) (3)

All variables are defined in Table 2 and descriptive statistics are presented in Table 3.

The matching was first done using all available data to estimate the Logit model based on the '1-to-1 nearest neighbor without replacement' criterion (Leuven and Sianesi, 2003). Then the model was re-estimated using only the Non-Neighbor subgroup. The results of the Logit models, shown in Table 4, are consistent across the two samples used. Specifically, the null hypothesis that all coefficients are simultaneously zero is rejected consistently at the 1% significance level. In addition, the percentages of correctly predicted responses are high (higher thah77%). In general, households participating in a farmer organization, receiving technical assistance, producing a diversified cropping plan and using ecological practices are more likely to be beneficiaries of MARENA. Conversely, famers cultivating larger farms are less likely to be beneficiaries.

The matched subsamples from both Logit models are determined for those propensity scores that fall within the common support area[4] (Caliendo and Kopeinig, 2005). This procedure yields a total of 100 pairs, 56 neighbors and 44 Non-Neighbors, when the total sample is used for the matching (N=400), and 102 pairs when only the Non-Neighbors are used (N=408). Table 5 presents descriptive statistics for each group.

A *t-test* was conducted before and after matching for the baseline data to determine whether the means of observed characteristics of the beneficiary households are statistically different from the non-beneficiaries. For the matched groups, the results of the *t-tests* show that most of the observed characteristics are not statistically different which means that the independent variables satisfy the balancing property (Leuven and Sianesi, 2003).

Impact of MARENA on its Beneficiaries

The Unmatched Total Sample (UTS) along with the two matched data sets - Matched Total Sample (MTS) and Non-Neighbors Only (MNN)- are used to estimate the following equation using the fixed effects framework:

TVFO = *f* (BENEF, NEIGHBOR, YEAR, TLAND, EXPEND, LABOR, ORGA, TITLE) (4)

where all variables are as defined in Table 2.

The estimates for the three TVFO equations using the UTS, MTS and MNN data configurations are presented in Table 7. The F statistic in all three cases is significant at the 1%; thus, the null hypothesis that all slope coefficients are equal to zero is rejected. The Box-Cox transformation (Cameron and Trivedi, 2009) is used to test the Cobb-Douglas versus the linear

[4] The common support area represents the intersection of propensity score ranges for the treatment and control groups.

specifications and the latter is favored in all three cases. We should note that the linear functional form has been used by other authors including Rodriguez *et al.* (2007) and Saudolet *et al.* (2001) in their impact evaluation studies. Both the UTS and MTS equations present four statistically significant slope parameters (10% or better) while the MMN has only two significant parameters. The corrected R^2 for the UTS regression is 0.54, compared to 0.74 and 0.76 for the MTS and MNN cases, respectively.

The parameters of particular interest are those associated with the dummy variables BENEF and NEIGHBOR. The parameter for BENEF is positive and statistically significant in the three equations in Table 7. The value of this parameter is lowest (14,988) for the UTS model, and the value for the other two models are relatively close, 22,825 for the MTS and 18,874 for the MNN regressions. The variable NEIGHBOR appears in two of the three models and its parameter is not statistically significant suggesting that contagion effect is not present.

The 22,825 parameter value for BENEF in the MTS model suggests that the total impact of MARENA on TVFO over the four years encompassed by the data, with respect to the combined control group (Neighbors and Non-Neighbors) amounts to US $1,183 or a simple annual average equal to US $296 per household at an exchange rate of HNL $19.3 per US Dollar. If we now focus on the MNN model, the parameter for BENEF suggests a simple average annual MARENA effect equal to US $245. It is instructive to note that these numbers are quite similar and we would expect the true impact to be somewhere within these fairly narrow bounds. Thus we use these computed average effects on beneficiaries to calculate alternative internal rates of return for MARENA.

Table 8 presents four scenarios of expected rates of return for the component of the MARENA Program evaluated in this paper. Scenarios 1 and 3 show an Internal Rate of Return

(IRR) equal to 41% and 27% resulting from an impact on beneficiaries for the MTS and MNN groups, respectively. Scenario 2 indicates that to get an IRR of 12% only 8,600 beneficiary families are needed per year from 2007 to 2009 for the MTS. The corresponding number of families for the MNN sample is 10,800 (Scenario 4).

Finally, we are interested on the level of technical efficiency (TE), which is a proxy for managerial ability (Ahmad and Bravo-Ureta, 1995), for the various subgroups in our sample. For this purpose, we use the fixed effects coefficients to calculate (time invariant) TE scores for each farm (Coelli *et al*, 2005).[5] As shown in Table 9, the TE for beneficiaries is consistently higher than for the control farmers. Specifically, for the Total Unmatched Sample, the average TE for beneficiaries is 66.5% while that for Neighbors and Non-Neighbors is 61.8% and 62.5%, respectively. The average TE from the Total Matched Sample is 47.2% for beneficiaries, 43.3% for Neighbors and 43.7% for Non-Neighbors. The figures for the MNN grouping are 68.1% for beneficiaries and 63.8% for Non-Neighbors. The statistical significance of the difference between relevant pairs of average TE scores is given at the bottom of Table 9.

An important area of future work is to elucidate the TE levels for each relevant group at the baseline compared to the endline and to test whether the intervention has an impact on TE, i.e., on managerial performance. In principle, this is similar to the decomposition of productivity growth into technological change, which in this context would be a jump in the TVFO function (frontier) from the first to the second period, and into TE which reflects how close farmers are to the relevant TVFO function (frontier) in each time period. Some methodological progress has

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[5] Technical efficiency is calculated from the fixed effects parameters as $TE_i = \alpha_i / max_i\{\alpha_i\}$ given the linear function form used (Coelli *et al*, 2005, p. 276), where α_i is the coefficient of the i^{th} farm dummy variable in eq. 2. Around 96% of the fixed effect parameters are significant at the 1% level.

been done along these lines (Kumbhakar et al., 2009; Bravo-Ureta et al., 2009) but additional efforts are needed in order to formulate a full decomposition.

CONCLUDING REMARKS

This study uses the Propensity Score Matching technique along with a fixed effects estimator to examine the impact of a major agricultural and environmental development component of the MARENA Program on the farm income of its beneficiaries. These methods reduce potential biases stemming from differences in observed factors between treated and control groups as well as from unobserved characteristics such as managerial skills.

Very similar results are obtained from two alternatively matched subgroups which suggest that MARENA has indeed contributed significantly to the well-being of beneficiaries. Specifically, over four years of implementation, the contribution of MARENA to the average annual value of farm output per beneficiary ranges from US $296 to US $245, depending on the matched subsamples used, relative to the control group that lives outside the area of influence. Furthermore, the results suggest that MARENA has not had an impact on non-beneficiaries living within its area of influence (contagion effect). To our knowledge, this type of contagion effect, although discussed in the literature, has not been well documented and is a subject that warrants further attention. An implication of contagion would be that beneficiaries, particularly those that are leaders within their villages, could be included in farm extension efforts directed to their communities. This would be a cost effective way to reach non-beneficiaries to enhance spillover effects, and thus expand upon the work done by extensionists that are typically hired in projects to provide technical assistance.

Although our results reveal rates of return in excess of the typical 12% cut-off rate, the data available does not make it possible to infer whether the stream of benefits extends beyond the life of the project which is an important consideration when time comes to judge the sustainability of these types of investments. This is clearly another area that requires additional work.

Table 1. Recent Papers Analyzing Project Interventions in Developing Countries.

Study (First Author, Year)	Country	Intervention/Project: Indicator	Panel
Cerdán-Infantes, 2008	Argentina	Extension: Grape, Yield and Quality	Yes
Lopez, 2008	Uruguay	Livestock: Management, Productivity and Specialization	Yes
Essama-Nssah, 2008	Rwanda	Privatization Program: Tea Sector	No
Dillon, 2008	Mali	Irrigation: Value of Agricultural Production	Yes
Nakasone, 2008	Peru	Land Titling Program and Labor Allocation	Yes
Rodriguez, 2007	Philippines	Agricultural Development: Coconut Producers	Yes
Praneetvataku, 2006	Thailand	Farmer Field Schools: Rice Yields and Pesticide Use	Yes
Skoufias, 2005	Mexico	PROGRESA: Welfare Impact of Rural Households	Yes
Feder, 2004	Indonesia	Farmer Field Schools: Rice Yields and Pesticide Use	Yes
Godtland, 2004	Peru	Farmer Field Schools: Potato Farmers	No
Saudolet, 2001	Mexico	PROCAMPO: Cash transfer for Agricultural Production	Yes

Table 2. Definition of Variables.

Variable	Unit	Definition
TVFO	HNL*	Total value of farm output
BENEF	Dummy	1 if the household is a beneficiary of MARENA
NEIGHBOR	Dummy	1 if the household is not a beneficiary of MARENA and lives within its area of influence
NNEIGH	Dummy	1 if the household is not a beneficiary of MARENA and lives outside its area of influence (excluded category)
EXPEND	HNL	Total expenditures on purchased farm inputs
LABOR	HNL	Total value of family labor plus hired labor expenses
TLAND	Hectares	Total farm land
AGLAND	Hectares	Total land devoted to agricultural production
DIVER	Dummy	1 if household produces crops in addition to maize and beans
CAFEECO	Dummy	1 if the household produces coffee using ecological practices
ALTITUD	Dummy	1 if the farm is located at an altitude higher than the mean
AGE	Years	Age of household head
EDUC	Years	Years of schooling of the household head
NUMBER	Number	Number of people in the household
ORGA	Dummy	1 if the household head participates in farmer organizations
TITLE	Dummy	1 if the household has legal title to at least some of the land farmed
ASSIST	Dummy	1 if the household receives technical assistance
YEAR	Dummy	0 = 2004, 1 = 2008

* HNL stands for Honduran Lempiras where US$ 1 = HNL 19.3

Table 3. Descriptive Statistics for Variables Included in the Logit Model.

Variable	2004	
	Mean	SD
Beneficiaries (N=109)		
AGLAND	1.80	0.12
CAFEECO	0.02	0.01
NUMBER	6.20	0.26
ALTITUD	0.46	0.05
EDUC	3.50	0.26
AGE	46.61	1.38
ORGA	0.73	0.04
ASSIST	0.44	0.05
DIVER	0.52	0.05
Control Neighbor (N=145)		
AGLAND	2.62	0.51
CAFEECO	-	-
NUMBER	5.93	0.21
ALTITUD	0.55	0.04
EDUC	3.59	0.27
AGE	45.81	1.10
ORGA	0.24	0.04
ASSIST	0.26	0.04
DIVER	0.46	0.04
Control Non-Neighbor (N=117)		
AGLAND	3.22	0.52
CAFEECO	0.01	0.01
NUMBER	6.01	0.24
ALTITUD	0.49	0.05
EDUC	3.04	0.27
AGE	50.96	1.34
ORGA	0.26	0.05
ASSIST	0.21	0.04
DIVER	0.42	0.05

Table 4. Logit Results for Participation in MARENA for Two Alternative Groups.

Variable	Total Sample	Beneficiary & Control Non-Neighbors Only
	Coeff. (SE)	**Coeff. (SE)**
AGLAND	-0.374***	-0.425***
	(0.099)	(0.122)
CAFEECO	4.008**	3.621*
	(1.976)	(2.264)
NUMBER	0.042	0.033
	(0.053)	(0.064)
ALTITUD	-0.468*	-0.426
	(0.279)	(0.340)
AGE	-0.011	-0.020*
	(0.010)	(0.012)
EDUC	-0.035	0.006
	(0.050)	(0.066)
ORGA	2.282***	2.269***
	(0.288)	(0.346)
ASSIST	0.655**	0.877**
	(0.287)	(0.3653)
DIVER	0.499*	0.592*
	(0.290)	(0.364)
CONSTANT	-1.278**	0.050
	(0.605)	(0.844)
Likelihood Ratio Test (χ^2 [8 df])	108.93***	86.89***
Pseudo R^2	0.24	0.27
N	371	226
Predicted Correctly (%)	78.98	77.43

* p<0.10; ** p<0.05; *** p<0.01

Table 5. Descriptive Statistics before and after the Implementation of MARENA for the Matched Total Sample (MTS).

	2004		2008	
Variable	**Mean**	**SD**	**Mean**	**SD**
Beneficiaries (N=100)				
TVFO	26,274.98	31,398.79	40,363.30	79,597.06
TLAND	5.32	16.87	5.79	19.74
EXPEND	9,438.26	11,880.49	7,577.56	9,770.21
LABOR	38,729.47	24,015.51	39,363.59	23,923.73
TITLE	0.56	0.50	0.82	0.39
ORGA	0.73	0.45	0.75	0.44
DIVER	0.48	0.50	0.68	0.47
Control Neighbors (N=56)				
TVFO	50,317.36	74,106.69	42,820.62	62,671.60
TLAND	3.11	4.69	3.87	6.12
EXPEND	15,761.07	43,223.22	9,997.14	18,227.51
LABOR	38,169.82	21,413.39	42,644.60	25,022.95
TITLE	0.68	0.47	0.86	0.35
ORGA	0.57	0.50	0.39	0.49
DIVER	0.46	0.50	0.77	0.43
Control Non-Neighbors (N=44)				
TVFO	57,019.26	80,131.38	51,111.36	70,050.13
TLAND	10.27	24.31	10.16	29.28
EXPEND	14,171.18	30,998.59	16,358.87	35,749.84
LABOR	36,289.32	18,689.32	41,991.05	25,153.84
TITLE	0.64	0.49	0.86	0.35
ORGA	0.61	0.49	0.39	0.49
DIVER	0.45	0.50	0.82	0.39

Table 6. Descriptive Statistics before and after the Implementation of MARENA for Beneficiaries and Control Non-Neighbors (MNN).

Variable	2004		2008	
	Mean	**SD**	**Mean**	**SD**
Beneficiaries (N=102)				
TVFO	28,028.77	36,025.42	43,825.92	86,906.63
TLAND	5.72	17.27	6.10	19.87
EXPEND	11,128.59	17,003.97	7,738.72	9,929.97
LABOR	39,512.94	24,447.16	41,784.94	33,431.67
TITLE	0.56	0.50	0.82	0.38
ORGA	0.74	0.44	0.75	0.43
DIVER	0.49	0.50	0.69	0.47
Control Non-Neighbors (N=102)				
TVFO	47,458.24	78,159.92	43,459.84	65,483.21
TLAND	11.45	45.79	11.35	42.35
EXPEND	11,148.11	21,935.79	14,548.08	33,648.24
LABOR	36,868.97	22,311.44	39,744.27	24,837.95
TITLE	0.59	0.49	0.85	0.36
ORGA	0.28	0.45	0.25	0.44
DIVER	0.42	0.50	0.71	0.46

Table 7. Regression Results for Total Value of Farm Output: MARENA Beneficiaries and Non-beneficiaries.

Variables	Unmatched Total Sample (UTS)	Matched Total Sample (MTS)	Matched Non-Neighbors Only (MNN)
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
BENEF	14,988*	22,825*	18,874**
	(9,079)	(12,683)	(9646.37)
NEIGHBOR	1,779	-266.06	
	(8,494)	(13,953.89)	
YEAR	-528.85	-11,114.63	-7,060.607
	(6,546)	(10,773.79)	(7198.55)
TLAND	454 **	2,119.44**	420.10
	(207)	(976.58)	(724.89)
EXPEND	0.232 ***	0.2651**	-0.17777
	(0.084)	(0.15103)	(0.18454)
LABOR	0.424 ***	0.43878**	0.5439***
	(0.133)	(0.2134)	(0.1759)
ORGA	3,260	-3,966.16	-3,265.73
	(6,829)	(8853.79)	(9,024.41)
TITLE	175	6,436.38	7,739.29
	(6,382)	(8,709.919)	(8,830.04)
CONSTANT	16,359 **	6,253.67	12,569.35
	(7,492)	(12,200.84)	(11,294.25)
F	4.3***	2.32**	2.53**
Box-Cox Test H_0: $\Theta=0$	57.9***	11.71***	15.81***
R^2	0.54	0.74	0.76
N	742	400	408

* p<0.10; ** p<0.05; *** p<0.01

Table 8. Analysis of MARENA'S Expected Internal Rate of Return.

Matched with Beneficiaries, and Control Neighbors and Non-Neighbors (MTS)									
Year	No. of Benef.	Outflow	Scenario 1			Scenario 2			
			Inflow	Net flow	NPV	No. of Benef.	Inflow	Net flow	NPV
2003	-	675,736	-	(675,736)	(675,736)	-	-	(675,736)	(675,736)
2004	205	361,253	60,475	(300,778)	(268,552)	205	60,475	(300,778)	(268,552)
2005	825	750,156	243,375	(506,781)	(404,003)	825	243,375	(506,781)	(404,003)
2006	3,228	1,079,109	952,260	(126,849)	(90,289)	3,228	952,260	(126,849)	(90,289)
2007	13,686	3,163,173	4,037,370	874,197	555,568	8,600	2,537,000	(626,173)	(397,945)
2008	13,686	1,597,192	4,037,370	2,440,178	1,384,622	8,600	2,537,000	939,808	533,272
2009	13,686	-	4,037,370	4,037,370	2,045,457	8,600	2,537,000	2,537,000	1,285,323
Total		7,626,620	13,368,220	5,741,600	0		8,867,110	1,240,490	(17,928)
TIR					41%				12%
Total Value of Farm Output (TVFO)/Year - Beneficiaries =			$295						
Matched with Beneficiaries and Control Non-Neighbors (MNN)									
Year	No. of Benef.	Outflow	Scenario 3			Scenario 4			
			Inflow	Net flow	NPV	No. of Benef.	Inflow	Net flow	NPV
2003	-	675,736	-	(675,736)	(675,736)	-	-	(675,736)	(675,736)
2004	205	361,253	50,020	(311,233)	(277,887)	205	50,020	(311,233)	(277,887)
2005	825	750,156	201,300	(548,856)	(437,545)	825	201,300	(548,856)	(437,545)
2006	3,228	1,079,109	787,632	(291,477)	(207,468)	3,228	787,632	(291,477)	(207,468)
2007	13,686	3,163,173	3,339,384	176,211	111,985	10,800	2,635,200	(527,973)	(335,537)
2008	13,686	1,597,192	3,339,384	1,742,192	988,566	10,800	2,635,200	1,038,008	588,993
2009	13,686	-	3,339,384	3,339,384	1,691,836	10,800	2,635,200	2,635,200	1,335,074
Total		7,626,620	11,057,104	3,430,484	0		8,944,552	1,317,932	(10,104)
TIR					27%				12%
Total Value of Farm Output (TVFO)/Year - Beneficiaries =			$244						
Exchange rate: US $1=Lps. 19.3; Interest rate =12%									

Table 9. Means for The Technical Efficiency Measures Recovered from Fixed Effects Parameters.

	Unmatched Total (UTS) (1)	Matched Total (MTS) (2)	Matched Non-Neighbors Only (MNN) (3)
(A) Beneficiaries	66.5%	47.2%	68.1%
(B) Control Neighbors	61.8%	43.3%	
(C) Control Non-Neighbors	62.5%	43.7%	63.8%

Note: For each column, (1) to (3), t-tests were performed for the following null hypothesis of the equality of means: Ho: mean(A)=mean(B), mean(A)=mean(C) and mean(B)=mean(C). All null hypothesis were rejected at the 1% level of significance. The only exception is for column (2), mean(B)=mean(C).

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