Farmers' Willingness to Invest in Agroforestry in Campeche, Mexico: Does Human Capital Matter

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Abstract

This paper presents results from a survey aimed at analyzing farmers willingness to invest in agroforestry near the Calakmul Biosphere Reserve in the state of Campeche in Southeastern Mexico. One hundred seventy-five farmers were interviewed from January through March of 1998. The survey included questions pertaining to levels of human capital investment made by individual farmers. The objective of this paper is to empirically test the hypothesis that reducing uncertainty through investment in human capital increases the likelihood of participation in an agroforestry development program. A model based on Keynes notion of profit expectations and weight is developed in order to gain some insight into agroforestry adoption behavior. Results support the hypothesis that particular forms of human capital investment improve the likelihood of participation.

Key Words: Agroforestry; Uncertainty; Adoption behavior; Human Capital Investment

I. INTRODUCTION

Conventional wisdom suggests that agroforestry systems, capable of providing substantial economic and ecological benefits to households and communities, should be readily adopted by farmers. Nevertheless, many attempts to promote agroforestry have resulted in inadequate rates of adoption (Zinkhan and Wear, 1992). Studies continue to show higher net present values (NPVs) for agroforestry systems when compared to monoculture systems, (Dunn, et al.,1990), (Wannawong, 1991), (Sullivan, 1992), (Current, Lutz and Scherr, 1995), yet the statistics for farmers in developing countries show low rates of adoption, and in cases where adoption does occur, many farmers eventually abandon the new agroforestry system of production in favor of other systems (usually a traditional system) with a lower NPV.

Why is this the case? Are we not to trust the conclusions of Schultz (1964) that peasant farmers are rational utility maximizers or have we overlooked something in our rush to promote agroforestry? A recent article in the journal Agroforestry Systems acknowledges some major knowledge gaps in the agroforestry profession, as identified by social scientists working in the field. This list includes, but is not limited to 1) understanding adoption behavior, and 2) issues pertaining to risk and uncertainty (Mercer & Miller, 1998).

Current economic models, when applied to agroforestry adoption, predict systems with higher net present values should be readily adopted yet adoption rates are low. Adopting an agroforestry system requires more than a simple calculation of an internal rate of return or a net present value. It requires a certain amount of confidence, on behalf of the farmer, that the information pertaining to the profitability of agroforestry is believable. In this paper we develop a model based on Keynes' notion of profit expectation and the "weight" one attaches to profit forecasts, in order to more accurately predict farmer investment in agroforestry.

Specifically, this paper asks the question: how does the uncertainty of outcomes affect the probability of participating in an agroforestry development program and are there particular forms of human capital investment that improve the likelihood of participation? Using new, farm-level data, collected in Southeastern Mexico from January through March of 1998, this paper empirically tests the relationship between particular forms of human capital and the likelihood of participating in an agroforestry development program. This information will begin to fill the gaps identified by Mercer and Miller (1998).

The remainder of the paper is structured as follows: Section II reviews Keynes' theory of investment and the notion of "weight." Section

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III makes the connection between agroforestry and Keynes and also develops the model for predicting adoption behavior. Section IV briefly describes the data. Section V specifies the model. Section VI presents results and section VII concludes with some implications derived from the model and suggestions for further evaluation.

II. KEYNES' NOTION OF "WEIGHT"

Keynes argued that profit expectations and the degree of confidence one has in the profit forecast determine investment decisions (Anderson and Goldsmith, 1997). If forecasts are deemed reliable by the decision-maker, then they will be more inclined to base investment decisions on their forecasts. Keynes argued that forecasters may lack the confidence to act upon their expectation of future profits if they attach little "weight" to their predictions (Anderson and Goldsmith, 1997).

In the Treatise (Keynes, 1971), Keynes discussed three distinct notions of the weight assigned to evidence: relevance, completeness, and balance. According to Runde (1990), most economists adopt the first view that weight on information used in forming decisions is contingent upon the relevance of information considered (Anderson and Goldsmith, 1997). For Keynes, weight as relevance captured the notion of confidence by accounting for the amount and quality of information that goes into prediction. Keynes argued that as the relevant information at the disposal of the individual increases, the "weight" of the argument increases. Entrepreneurs may be "very uncertain" about evidence if they lack the relevant information to interpret the profit forecast. In other words, the decision-maker places more "weight" to propositions derived with superior information (Anderson and Goldsmith, 1997). In the Treatise, Keynes emphasizes how weight can drive behavior (pp.293-294),

> "The greater the weight of evidence in respect of a forecast the more substantial the basis on which to rest our conclusion, and presumably, the more confident we will be that the forecast is an appropriate guide to action."

In Keynes' view insufficient confidence results in the precarious nature of long-term expectations and it is this precariousness that leads to insufficient investment. Therefore, no matter the information that is presented to farmers, if they are not in a position to understand and/or place any confidence in their own interpretation of the information, they will be less likely to invest in agroforestry.

III. KEYNES AND AGROFORESTRY

Using Keynes to Understand Agroforestry Adoption

Questions pertaining to the adoption of new technologies and/or methods of production and the issue of uncertainty are intricately related. For the farmer, investing in agroforestry entails undertaking an activity with an uncertain outcome. The incentive behind planting trees on farms is to diversify outputs, reduce the uncertainty associated with draughts, and increase cash income (Scherr, 1995). However, planting trees is labor intensive, returns are not immediate and tree planting may be a new activity for the farmer. Therefore, even though farmers are presented with information pertaining to the long-term benefits of planting trees, they may place very little "weight" on this profit forecast made by the agroforestry practitioner, due to the lack of relevant information they have about agroforestry.

"Peasant skepticism about innovation is thought to be largely related to imperfect knowledge of innovations and agronomic practices appropriate to them" (Ellis, 1988). For subsistence farmers, uncertainty has a seriously inhibiting effect on production, for they cannot afford to suffer setbacks, which might mean deprivation or even starvation. Innovations, i.e. agroforestry, often introduce more uncertainty to the farmer than traditional methods of production. This uncertainty inhibits the diffusion and adoption of innovations, which could potentially improve the output and incomes of peasant farm families (Low, 1974).

The farmer is making an investment decision. Part of this decision is based on the information presented by the agroforestry practitioner. This is the profit forecast. The farmer who is more confident in interpreting the information or who places more "weight" on the forecast will be more likely to invest. In other words, the farmer with greater uncertainty of outcome will be less likely to adopt agroforestry as a method of production. The more relevant information the farmer uses when interpreting the information from the agroforestry practitioner, the less uncertainty about the outcome, hence an increased likelihood of

participation. Unfortunately, we have no direct measure for associating uncertainty and the decision to adopt. However, we can look at indirect evidence of the link between uncertainty and adoption.

Schultz, (1964), was the first to recognize the connection between human capital formation and the peasant farmer's ability to utilize new technologies. Blaug, (1972), also points out how human capital effects one's ability to capitalize on opportunities:

> "the better educated are generally more flexible and more motivated, adapt themselves more easily to changing circumstances, benefit more from work experience and training, act with greater initiative in problem-solving situations, and, in short, are more productive than the less educated, even when their education has taught them no specific skills."

Therefore, when human capital increases, we expect the "weight" farmers attach to information to increase and the likelihood of participation to increase.

A Simple Model for Adoption

In general, whether or not the farmer invests in agroforestry has to do with whether or not the farmer perceives the benefits of the system to outweigh the costs associated with implementing the system and how confident the farmer is in his own prediction of the potential costs and benefits. This decision is firmly rooted in the economic concept of utility maximization (Ellis, 1988). The farmer is trying to maximize utility, which is a function of both expected income and other things.

Farmer: Max U (EI, x)

Assuming the utility function is weakly separable, we look specifically at the expected income associated with agroforestry. The farmer can choose to invest in agroforestry or not. Simply stated, the farmer will invest in agroforestry if he expects his income to be greater with agroforestry than without.

Invest in Agroforestry if: EI (AF) > EI (no AF)

There is evidence showing NPVs associated with agroforestry are higher than NPVs for monocultures and other forms of traditional agriculture (Dunn, 1990, Sullivan, 1992), yet adoption/investment rates are low. This is where the "uncertainty" argument comes into play. All the evidence in the world can be presented to farmers about the benefits of agroforestry, but if the farmer has very little "relevant" information of his own, he will place very little "weight" on the evidence presented. Therefore, investing in agroforestry is now a function of the profit forecast (information presented by the agroforestry practitioner) and the "weight" the farmer places on this information.

Investment in AF = f (profit forecast, weight)

Since we have no direct measure of "weight" our model substitutes human capital investment, which we have argued reduces uncertainty allowing the farmer to place more "weight" on the agroforestry practitioner's information.

Weight = f (HC investment)

The model will test whether or not investment in human capital by the individual farmer is, in fact, related to the decision to invest in agroforestry.

Invest in Agroforestry = f (HC investment)

Perhaps more important are the specific ways in which farmers have invested in their own human capital and which of these is related to interest in participating in an agroforestry development program. The variables of human capital formation (and expected results) to be tested in the model are:

Human Capital Investment = f (ED, EXP, PART, TREE)

- **(ED) Education** : Farmers with more education are more likely to participate.
- **(EXP) Farming experience:** Farmers who are more familiar with agricultural and forestry activities will be more likely to participate in an agroforestry program.
- **(PART) Comfort with participation:** Farmers who participate in forest development programs are more likely to participate, because they have better knowledge of how to take advantage of such opportunities.

- **(TREE) Experience with trees:** Farmers currently growing trees on their farms are more likely to participate.

**Descriptions of these variables are found in table 2.*

IV. BACKGROUND & DATA

The data for this research was collected in the State of Campeche, in the southeastern corner of Mexico near the buffer zone of the Calakmul Biosphere Reserve. The reserve extends over 723,185 hectares (1.7 million acres) and its forests are contiguous with those of the Peten in Guatemala and the northwest forest of Belize. In 1993 UNESCO's Man and the Biosphere program accepted Calakmul into its international network of biosphere reserves. The innovative premise behind the biosphere reserve is to link conservation with human activities and rural development.

The majority of people in Calakmul practice slash-and-burn agriculture and all are basically poor, subsistence-type farmers. Poverty rates have continued to increase in the region over the last ten years due to migration from other areas of Mexico and the general lack of agricultural knowledge inherently found in urban migrants. In addition, the natural resource base has been degraded with the increase in population and more intensive use of the land.

The total population for sampling consisted of all the communities participating in CONSEJO, which is the regional council for development in Calakmul. At the time, there were 60 communities participating in CONSEJO. The decision to conduct a stratified random sample of the entire region was predicated on two factors. First, the amount of rainfall in the southeast zone is substantially higher than in the northwest. These zones were chosen based upon several conversations with local forestry and agricultural extension workers and their impressions of rainfall patterns in the region. We were not able to obtain actual rainfall data and the dummy variable approach is used as a next best alternative. And secondly, a decision on behalf of the entire research team to interview a minimum of 20% of the total communities in Calakmul and to interview a minimum of 20% of the individuals in each community. The following table lists each of the communities surveyed, the total population in each community and the number of people interviewed.

Table 1. Ejidos surveyed

EJIDO	Population	Number surveyed	Percentage surveyed
Ley de Fomento	44	15	34
Felipe Angeles	24	10	41
11 de Mayo	57	17	30
La Guadelupe	84	22	26
Josefa Ortiz	34	13	38
El Refugio	30	12	40
Carmen II	58	16	28
Castellot	20	13	65
Heriberto Jara	54	9	17
Centauro del Norte	60	10	17
20 de Junio	57	11	19
Nueva Vida	40	10	25
16 de Septiembre	14	8	57
Alvero Obregon	NA	5	NA
Narcisso Mendoza	NA	4	NA
Total		**175**	**NA**

Individual farmers were interviewed during the period, January 1998 through March 1998. Farmers were asked about their current farming methods, experience with tree harvesting and their interest in participating in an agroforestry development program. A total of 175 farmers were interviewed in 15 different communities. Of the 175 farmers, 142 expressed interest in agroforestry as a potential production strategy for, at least, part of their farm.

V. MODEL SPECIFICATION

The probability of investing in agroforestry is estimated using a Logit model. The logistic functional form is chosen due to the discrete nature of the dependent vasriable and the compatibility of the logistic function and random utility theory. The dependent variable is equal to 1 if the farmer says yes he will participate and 0 if he says he is not interested and the decision to participate is modeled in a utility maximization framework.

In addition to the human capital variables, included are the following socioeconomic variables: age, size of family, income, hectares in cultivation, forested area and total hectares available, distance from home to the fields, years in the present location, and a variable to identify farmers who said they are happy with the progress of their current tree plantation. Also included in the model is a dummy variable to differentiate between farmers who live in a higher rainfall zone (Southeast) and other farmers (Northwest). Table two describes all of the variables included in the final estimation.

Table. 2: Final Variables Included in Model Specification

ED: A categorical variable to differentiate between farmers who have not completed primary school, those who have completed primary, those who have completed secondary, and those with more than secondary school.
EXP: Farmers who had agricultural experience before coming to Calakmul and have since obtained some forestry experience receive a 1 and all others a 0.
TREES: The number of hectares currently planted in an agroforestry system.
PART: If a farmer has participated in any forestry-related program he receives a 1, and all others 0.
INC: Total income from the sale of agricultural and forestry related products.
FARM: Size of the farm, including agricultural land, forestland, the homesite, etc.
AGE: Age of the head of household.
KIDS: Number of children currently living at home.
FOR: Number of hectares in primary forest.
SURV: Farmers who say they are happy with their current plantation receive a one and those who are not pleased with their current plantation receive a zero.
STRAT: Dummy variable differentiating the NW zone and SE zone.

Again, the dependent variable (Y) represents the decision to participate in an agroforestry program (1) or not (0) and the independent variables are the vector of socioeconomic characteristics of the farmer (Si), the human capital variables (Hi), and the rainfall dummy (R). Therefore, the following equation is estimated. $\mathbf{Y = \alpha + \beta Si + \beta Hi + \beta R + \varepsilon}$

VI. RESULTS

Table 3, below, summarizes the main characteristics of farmers in Calakmul and compares those interested with those not interested in agroforestry.

Table 3. Study Sample Characteristics

Characteristic	Total N=175	Yes N=142	No N=33
Age	38	37.7	40.7
Kids	4	3.9	4.5
Education	.506	.552	.303
Total farm area (hectares)	49	49.8	46
Income (pesos)	11363	**10787**	**13859**
Agroforestry (hectares)	0.38	**.43**	**.13**
Experience	.17	**.19**	**.09**
Forested area (hectares)	28.0	28.7	25.4
Crops (hectares)	4.8	4.8	4.9
Participation	.46	**.50**	**.31**

In general, farmers interested in agroforestry are younger, have fewer children, have obtained more formal education, have bigger farms, lower incomes, more agriculturaland forestry experience, have more forest area, currently have a larger area in agroforestry, and are more likely to have participated in a forestry development program in the past.

Table 4 provides the results from the estimation equation.

Table 4. LOGIT MODEL: participation (1) or not (0)

Variables	Coefficient	T – stat
TREES	**1.29**	**2.08****
ED	**.634**	**1.81***
EXP	1.26	1.6
PART	.378	0.82
INC	-.000029	1.9*
STRAT	.661	1.43
FARM	.011	1.21
SURV	.988	1.76*
Constant	.104	.15
Psuedo R2 = 0.156	**Chi2 (8) = 25.98**	**N = 175**

- * significant at .1 **Correctly Classified 84.00%**
- ** significant at .05

Signs of all variables are as theory would predict, except for income.[1] The variables for age and other socioeconomic characteristics, included in the initial empirical model are dropped from the final equation due to extremely poor performance in the estimated equation.[2] A Chi-square of 25.98 with 8 degrees of freedom is significant at < 1% implying the independent variables, taken collectively, influence the decision to participate in an agroforestry program. Accordingly, our model predicts 84% of the responses correctly.

These regression results confirm our initial hypothesis. Farmers with more human capital are more likely to be interested in agroforestry. Factors including education, farming and forestry experience, past participation in forestry development programs, and familiarity with tree planting on the farm are all positively correlated with interest in agroforestry. As expected, the most important variable is previous tree planting experience.

Investment in human capital allows the farmer to place more "weight" on the evidence presented by the agroforestry practitioner. Again, the farmer with no tree planting experience and minimal education is very unlikely to place much "weight" on the evidence presented as to the benefits of agroforestry.

There are two good reasons to believe this is the case. First, the farmer must have a minimal understanding in order to interpret the information presented by the agroforestry practitioner or extension agent. Secondly, the farmer must have confidence in his own skills and experiences in order to handle tree planting, caring for the trees, and the eventual harvest of the trees. Therefore, the farmer with more education, more experience with trees, more overall farming experience and more familiarity with development programs is more confident in his own ability to profit from agroforestry and is more likely to invest.

VII. DISCUSSION & CONCLUSIONS

The primary question of this research is whether or not farmers who invest in human capital are more likely to be interested in agroforestry. Results lead to the conclusion that investment in human capital, by subsistence farmers in SE Mexico, does, in fact, lead to a

[1] Income in Calakmul is highly correlated with planting peppers and farmers who grow peppers have already invested large amounts of time and resources in pepper production and are receiving a consistent cash flow. Therefore, they are less likely to invest in agroforestry due to the high opportunity cost associated with their current investment in pepper production.

[2] The poor performance of these variables may be explained by the extreme diversity of the population in Calakmul or that they are not very important in the investment decision.

higher probability of adoption. If we accept that some of the limits to adoption are, as pointed out by Hamilton & Bliss (1998), lack of resources and lack of information, it follows that farmers with more education, more overall farming experience, familiarity with tree planting and forestry training, will be more inclined to participate in any given agroforestry development project due to the increase in their relevant information.

Interestingly enough, the two variables most often used to predict the adoption of new technologies, income and total farm size are not as important as our variables of human capital investment. The traditional argument being farmers with higher incomes and/or access to more land are more able to deal with the "risks" involved in changing or adopting new methods of production.

Agroforestry has been presented as a sustainable alternative to current methods of production in the tropics. If it is to succeed, the accompanying investments in the human capital of farmers through extension programs and on-farm training must be a part of the overall implementation strategy for agroforestry practitioners. In addition, agroforestry projects must be targeted toward those farmers that are most likely to be successful.

From the agroforestry practitioners' perspective, what does this say about uncertainty and agroforestry? First, working with the farmers to improve their confidence in the system being offered or analogously, to reduce the uncertainty of investing in a new system of production is an important component of the development process. Farmers do this on their own through education, farming experience and previous participation and agroforestry practitioners can improve the odds of successfully implementing agroforestry by providing education and training to farmers.

The immortal words of T.W. Schultz ring true today for agroforestry development, "The knowledge that makes transformation possible is a form of capital, which entails investment – investment not only in material inputs in which a part of this knowledge is embedded but importantly also investment in farm people."

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