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Agroforestry adoption in Mexico: using Keynes to better understand farmer decision-making

Abstract: *The objective of this paper is to empirically test the hypothesis that reducing uncertainty for farmers through investment in human capital increases the likelihood of participation in an agroforestry development program. A model based on Keynes's notion of profit expectations and "weight" is developed in order to gain some insight into agroforestry adoption behavior. Data was collected 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. Results support the hypothesis that human capital investment improves the likelihood of participation in an agroforestry development program.*

Key words: *agroforestry investment, human capital investment, Keynes, uncertainty.*

The adoption of sustainable activities, such as agroforestry, sustainable logging, and agropastoral production systems, can help to greatly reduce deforestation (Nair, 1990; Scherr, 1993). In spite of this, many individuals and firms do not practice sustainable activities, and many governments do not support these efforts by offering land stewardship incentives or implementing environmentally sound policies. There have been numer-

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ous studies on the adoption of sustainable practices in tropical regions, such as advanced farming systems (Adesina and Zinnah, 1993; Holden, 1993; Kebede et al., 1990), sustainable logging (Allen 1985; Kahn et al., 1997; Lovejoy, 1986; Lovejoy et al., 1986; McCormick, 1998), and agropastoral development (Dercon, 1998; Gryseels, 1988; Serrão and Toledo, 1992). In spite of this vast literature, there are still many unknowns in relation to why adoption rates are low (Mercer and Miller, 1998).

This paper offers a new theoretical explanation for low adoption rates using Keynes's model of investment determination to obtain insights on the relation between the level of human capital farmers possess and their willingness to participate in an agroforestry development program. The farmer who is more confident in interpreting information or who places more "weight" on a 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. Using farm-level data collected in southeastern Mexico from January through March of 1998, this paper empirically tests whether various forms of human capital enhance the likelihood of participating in an agroforestry development program.

Agroforestry in the tropics

Agroforestry is a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, seeks to diversify and sustain production for increased social, economic, and environmental benefits for land users at all levels. Simply put, agroforestry entails planting trees on farms. Compared to single output systems (monoculture), agroforestry systems have a number of advantages, as reported by landowners in certain areas.

Owners have reported financial and nonfinancial benefits (Cairnes and Garrity, 1999; Dakora and Keya, 1997). Some of the sources for the increased financial benefits are (1) more intensive use of the available land, (2) reduction in time between cash flows, and (3) sharing of costly resources, such as fertilizer and herbicides between multiple outputs. In addition to these financial benefits, agroforestry is also considered to be more compatible with society's ecological and environmental goals than monoculture agriculture (Cairnes and Garrity, 1999; Caviglia and Kahn, 2001; Dakora and Keya, 1997). Agroforestry, in this respect, may contribute to (1) increasing species diversity, (2) reforestation, (3) reducing the use of chemical agents on the farm, and (4) improving soil fertility and stability, hence making a claim to being more sustainable than traditional monoculture agricultural systems.

In Latin America, where the site studied in this paper is located, agroforestry is used to maintain crop production while replenishing and maintaining soils through the reduction of erosion and leaching. Even though the motivation for the adoption of agroforestry may differ between tropical environments, one commonality is that adoption rates are low, as is the case in Campeche, Mexico.

A majority of the farmers in Campeche use slash-and-burn agriculture. This agricultural method requires that large areas of forest are cut and burned to plant monocultured or mixed annual crops (such as rice, beans, corn, squash, and peppers). The burned vegetative matter introduces nutrients into the soil that can be used by future vegetation. However, the new plants and constant leaching by heavy tropical rains rapidly exhaust these nutrients. Tropical soils, by nature of their climate, contain few nutrients in the root zone. Instead, the nutrients are captured by leaves and absorbed by buttressed root systems and fungi. Trees, and the litter that they provide, play a prominent role in the nutrient cycle of tropical forests. As leaves, branches, and seeds fall to the forest floor, the matter is rapidly decomposed due to the high temperature and abundant moisture and reabsorbed by plants and trees. Slash-and-burn agriculture destroys the most intricate part of the tropical nutrient cycle—the trees.

Conversely, agroforestry incorporates trees in the farming system either in rows (by replanting trees or by clearing only small rows of forest) or scattered throughout the plot. This agricultural method is sustainable in tropical soils primarily because essential nutrients are kept from washing away with the rainfall.

Farmers in Campeche primarily plant trees on previously harvested, degraded land or they may intercrop trees with annuals, such as corn, beans, and squash. The tree species of choice are mahogany and Spanish cedar, which are used primarily for building material in the short term, and potentially for sawtimber in the long term. These rows of hardwoods can also serve as live fences to demarcate property lines and provide shade and fodder for animals on the farm.

Conventional wisdom suggests that agroforestry systems, capable of providing substantial net economic and ecological benefits to households and communities, should be readily adopted by farmers. Studies by Dunn et al. (1990), Wannawong et al. (1991), Sullivan (1992), and Current et al. (1995) show higher net present values (NPVs) for agroforestry systems than for monoculture systems, yet farmers in developing countries show low rates of adoption. When adoption occurs, many farmers eventually abandon the new agroforestry system of production in favor of more traditional systems (slash and burn) with lower NPVs.

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? Mercer and Miller (1998) suggest that shortcomings in our understanding of the contribution of risk and uncertainty to agroforestry adoption may explain the low adoption rates.

Adopting an agroforestry system requires more than a simple calculation of internal rates 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, I develop a model of investment in agroforestry by farmers based on Keynes's theory of investment. In Keynes's view, when decision-makers are uncertain, they attach a low "weight" to their forecast. It is possible that farmers with greater amounts of human capital are better equipped to make the adjustments needed to successfully implement an agroforestry production system. If so, farmers with greater human capital are likely to place more "weight" on their forecast, so, for a given NPV, they are more likely to implement the agroforestry program.

Keynes's 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 (ibid.).

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 the "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 gives more "weight" to propositions derived with superior information (Keynes, 1971). In the *Treatise,* Keynes emphasizes how "weight" can drive behavior:

> 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. (ibid., pp. 293–294)

In Keynes's view, insufficient confidence results in the precarious nature of long-term expectations, and it is this precariousness that leads to insufficient investment. It is possible to use this result from macroeconomics to gain insight into a microbehavioral problem. In the case of agroforestry adoption, no matter the information presented to a farmer, if he is not in a position to understand or place any confidence in his own interpretation of the information, he will attach little "weight." Therefore, he will be less likely to invest in agroforestry.

Keynes and agroforestry

Using Keynes to understand agroforestry adoption

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 droughts, 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 possess 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, that is, 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).

A farmer considering agroforestry adoption is making an investment decision. Part of this decision is based on the information presented by the agroforestry practitioner. 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 of uncertainty about the decision to adopt. However, Schultz (1964) argued that farmers with greater human capital are better able to utilize new technology. According to Blaug, human capital improves 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. (1970, p. 47)

Thus, human capital can be used as an indirect measure of uncertainty. When human capital increases, the "weight" farmers attach to agroforestry information is expected to increase (uncertainty decreases) and the likelihood of program participation increases.

Model for adoption

Neoclassical economics asserts that a farmer is trying to maximize his utility subject to a relevant constraint. In the case of the subsistence farmer in the Yucatan, utility is a function of the consumption of products derived from agroforestry, A, and products produced by conventional agriculture, C. The constraint in the model is a time constraint, T, due to the relevant trade-off evaluated, which exists between the time one spends practicing conventional agriculture, t_c, and the amount of time allocated to agroforestry production, t_a. Leisure is ignored so that T becomes the total time available for producing consumable farm products, $T = t_a + t_c$. W is the "weight" attached by the farmer to the information presented by the agroforestry extension agent. This weight depends primarily on the accumulated stock of human capital of the farmer.

$$W = f\left[HC\right]. \tag{1}$$

The introduction of a new technology or system of production introduces uncertainty (Ellis, 1988; Low, 1974). In order for the farmer to allocate time to agroforestry, the benefits minus any disutility generated by the associated uncertainty must be greater than the net benefits derived from conventional agriculture, which is assumed to be the uncertainty minimizing position for the farmer.

Alternatively, the benefits of practicing agroforestry ($A(t_a)$) must be sufficiently greater than the returns from conventional farming to compensate for the increased uncertainty. Some farmers will be able to reduce the uncertainty associated with adopting agroforestry as a new production method because they have prior experience or have been previously exposed to information pertaining to the benefits of agroforestry through contact with an extension agent. If the farmer has more relevant information or more experience, then he can be more certain of the potential outcomes from choosing agroforestry as a production system. As W rises, the contribution of t_a to A rises, which increases the likelihood of investment in agroforestry. Returning to Keynes's notion of "weight" or confidence, it is easy to see how W acts as the "weight" in this argument. Therefore, investment in agroforestry will depend not only on the information presented by the extension agent/agroforestry practitioner, but will also be a function of the "weight" the farmer places on this information.

Therefore, the farmer's utility maximization problem can be expressed as

$$Farmer: \text{Max} U\left[A\left(t_a; w\right), C\left(t_c\right)\right] \tag{2}$$

$$s.t. T - t_c - t_a = 0 \tag{3}$$

$$\partial A / \partial Ta > 0 : W \tag{4a}$$

$$\left(\partial A / \partial Ta\right)\left(\partial Ta / \partial W\right) > 0. \tag{4b}$$

As W increases, the impact of Ta on A also increases, and the farmer will allocate more time to agroforestry, t_a, when he expects his utility to be greater with than without agroforestry and this decision is contingent upon the level of W.

$$U\left[A\left(t_a; w\right), C\left(tc\right)\right] > U\left[0, C\left(t_c\right)\right]. \tag{5}$$

Empirical procedures

Data

The data for this research were collected in the State of Campeche, in the southeastern corner of Mexico near 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 past 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.

Table 1 lists each of the communities surveyed, the total population in each community, and the number of people interviewed.

Individual farmers were interviewed during the January 1998 through March 1998 period. 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. Of these 175 farmers, 57 are currently using agroforestry on their farms.

Model specification

Keynes's theory of investment predicts that farmers with more human capital attach greater weight to the profit forecast associated with agroforestry. In order to test the hypothesis that farmers with greater human capital are more likely to adopt agroforestry, we estimate the following model of agroforestry adoption.

$$Y_{1,0} = \alpha + \beta_1 H_i + \beta_2 S_i + \beta_3 R + \varepsilon. \qquad (6)$$

Two versions of the equation are estimated. For those farmers saying they are interested in agroforestry (the stated preference model, *SP*), the dependent variable, *Y*, is equal to one if the farmer says yes he will

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

participate and zero if he says he is not interested. For the revealed preferences of farmers (the *RP* model), the dependent variable, *Y*, is equal to one if the farmer is currently using agroforestry and zero otherwise.

Hi is the vector of human capital investment expected to influence the weight that farmers attach to information about agroforestry. *Hi* includes variables to measure the amount of formal education, *ED*, the level of forestry-related experience, *EXP*, the number of hectares currently cultivated in trees, *TREES*, whether the farmer thinks he has been successful in previous attempts to cultivate trees, *SURV*, and to identify those who have been exposed to agroforestry through formal forestry-related development programs, *EXPOSE*.

The vector *Si* contains socioeconomic characteristics of the farmers. *Si* includes variables to measure income, *INC*, the size of the farm, *FARM*, the number of years the farmer has been at the present location, *YEARS*, whether or not there is an adequate natural seed source available to the farmer, *SEEDS*, family size, *FAMILY*, area in crop production, *CROP*, and the distance from the household to the agricultural fields, *DIST*. *R* is a dummy variable that identifies communities in the southeast area, which receive more rainfall than other areas.

The logistic functional form is chosen due to the discrete nature of the dependent variable and the compatibility of the logistic function and utility maximization (Haneman, 1984). Table 2 contains a description of

Table 2
Variables included in model specifications

Variable name and description	Mean	Standard deviation	Minimum	Maximum
HAAF: The number of hectares currently planted in an agroforestry system.	0.38	0.65	0	3
ED: A categorical variable to differentiate between farmers who have not completed primary school and those who have completed primary school.	0.51	—	0	1
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.	0.31	—	0	1
EXP: Farmers who had agricultural experience before coming to Calakmul and have since obtained some forestry experience received a one, and all others a zero.	0.17	—	0	1
EXPOSE: If a farmer has been exposed to an extension agent, he receives a one, and all others zero.	0.46	—	0	1
INC: Total income from the sale of agricultural and forestry-related products (in pesos).	11,363	12,269	0	63,600
STRAT: Dummy variable differentiating the northwest zone and southeast zone.	0.39	—	0	1
FARM: Size of the farm, including agricultural land, forestland, the homesite, and so on.	49.1	25.1	0	120
YEARS: The number of years the farmer has been living at the present location.	11	6.4	0.3	36
SEEDS: Dummy variable indicating whether or not the farmer thinks the local forest is a good source for seeds and seedlings. One if yes, zero if no.	0.53	—	0	1
DIST: The distance the farmer actually has to travel to get to his fields.	2.9	2.3	0	10
BOYS: The number of male children living at home.	2	1.8	0	8
CROP: Hectares of cropland.	3	2.1	0	18
HARV: One if the household harvests timber, zero otherwise.	0.16	0.37	0	1
BURN: Hectares burned for agricultural use.	17	13	0	95
AGE: Age of the household head.	38	13	16	74
FAM: Total number of people living in the household.	6	4	0	14

how each variable in the model is measured along with means and standard deviations. The dependent variable is equal to one if the farmer says yes he will participate and zero if he says he is not interested.

Empirical results

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

Farmers interested in agroforestry (1) have planted more trees in the past, (2) have obtained more formal education, (3) are happier with the survival rate of current plantations, (4) have more agricultural and forestry experience, (5) are more likely to have participated in a forestry development program in the past, (6) have lower incomes, (7) have slightly larger farms, (8) are younger, (9) have fewer children, and (10) have a higher percentage of their farms in forest cover.

Table 4 provides the results from the stated preference, *SP*, and revealed preference, *RP*, equations. Signs of all variables are as theory predicts, except for income. Traditional economic theory predicts that per capita income will play a positive role in the adoption of new technologies. Results from Dercon (1998) and Rosenzweig and Binswanger (1993) support this theory. However, there is also contradictory empirical evidence. Caviglia and Kahn (2001) show that information and education are the important factors in the adoption decision. Shakya and Flinn (1985) find similar results, and I find the same. The results show that income is not significantly different from zero.

Of the 175 farmers interviewed, 57 are currently using agroforestry. This accounts for 32 percent of the sampled population. The equation relating the actual adoption of agroforestry (*RP*) to various factors is well specified. A chi-square of 25.86 with 9 degrees of freedom is significant at the 0.002 level, implying the right-hand side variables, taken collectively, do influence the decision to adopt agroforestry. Moreover, a pseudo *r*-square of 0.118, with 72.16 percent of the responses predicted correctly, suggests the model is well specified. There are three significant variables, all of which are positively correlated with the adoption decision. They are exposure to agroforestry through an extension agent, *EXPOSE*, level of education, *ED*, and amount of cropland in cultivation, *CROP*. *ED* and *CROP* are significant at the 0.05 level and *EXP* at the 0.01 level. The acquisition of information from an extension agent and educational attainment are two factors that reduce the uncertainty of adopting agroforestry.

Table 3
Study sample characteristics

Characteristic	Total $N = 175$	Yes $N = 142$	No $N = 33$
Agroforestry (hectares)	0.38	0.43	0.13
Education	0.506	0.552	0.303
Survival	0.31	0.35	0.15
Experience	0.17	0.19	0.09
Exposure	0.46	0.50	0.31
Income (pesos)	11,363	10,787	13,859
Total farm area (hectares)	49	49.8	46
Years	10.9	10.9	10.9
Seeds	0.53	0.55	0.39
Distance	2.9	2.9	2.9
Age	38	37.7	40.7
Kids	4	3.9	4.5
Forested area (hectares)	28.0	28.7	25.4
Crops (hectares)	4.8	4.8	4.9

Table 4
Results of logistic regression

Stated preference			Revealed preference		
Number of obs = 175			Number of obs = 175		
$\chi^2(15) = 29.95$			$\chi^2(9) = 25.86$		
Prob > χ^2 = 0.0121			Prob > χ^2 = 0.0021		
Log likelihood = –68.272			Log likelihood = –97.153		
Pseudo R^2 = 0.1799			Pseudo R^2 = 0.1175		
82.86% correct			72.16% correct		
Adopt	Coefficient	Standard error	Adopt	Coefficient	Standard error
HAAF	2.77**	1.407	*CROP*	0.279**	0.121
ED	0.729**	0.384	*ED*	0.629**	0.295
SURV	1.15**	0.584	*EXPOSE*	1.207***	0.366
EXP	1.44*	0.855	*BURN*	–0.527	0.793
EXPOSE	0.364	0.495	*FARM*	–0.006	0.007
INC	–0.00002	0.000018	*YEARS*	–0.009	0.030
STRAT	0.531	0.507	*AGE*	0.017	0.014
FARM	0.014	0.009	*FAM*	–0.074	0.068
YEARS	0.029	0.038	*INC*	–0.00002	0.0001
SEEDS	0.413	0.496	_cons	–0.362	0.996
DIST	–0.031	0.106			
BOYS	–0.040	0.126			
CROP	–0.069	0.103			
HARV	–0.573	0.798			
_cons	–0.225	0.844			

Notes: * is significant at the 0.1 level; ** is significant at the 0.05 level; *** is significant at the 0.01 level.

Of the 175 farmers interviewed, 142 said they were interested in agroforestry as a production strategy. The *SP* model, with a chi-square of 29.95 with 15 degrees of freedom, is significant at 0.01 percent, implying the independent variables, taken collectively, influence being interested in participating in an agroforestry program. Accordingly, the model predicts 82.9 percent of the responses correctly and has a pseudo *r*-square of 0.179.

Each of the human capital variables is positively correlated with the decision to adopt. The variable *HAAF* is significant at the 0.05 level as are education level, *ED*, and the subjective measure of tree planting success, *SURV*. Forestry experience, *EXP*, is also positively related to the decision to adopt and is significant at the 0.10 level.

The variables *HAAF* and *EXP* can be interpreted as measures of informal specific on-the-job training. We can compare this to *EXPOSE*, which is a measure of formal general training, and see that exposure matters in the *RP* model, but not in the *SP* model. This has important implications for "weight." Those farmers who are actually using agroforestry had been formally exposed through contact with an extension agent, and this influenced the decision to adopt. Conversely, farmers with more informal on-the-job training are more likely to state interest in agroforestry, and it may be possible to identify and use these farmers to informally teach others about tree planting. This should enhance the likelihood of adoption by other farmers. Moreover, *ED*, the level of education, supports the theory that those with more education are more likely to be interested, as they can more readily handle uncertainty.

To place this in the context of the theoretical model, the farmer with no tree planting experience, minimal education, and no exposure to an extension agent is very unlikely to place much "weight" on the evidence presented as to the benefits of agroforestry. This evidence, in total, confirms our initial hypothesis that investment in human capital allows the farmer to place more "weight" on the evidence presented by agroforestry practitioners.

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. Second, the farmer must have confidence in his or her own skills and experiences in order to handle the planting, caring of, and eventual harvesting of the trees. Therefore, farmers with higher levels of education, more tree planting experience, and more perceived success with planting trees will be more confident in their own ability to profit from agroforestry and be more likely to invest.

Conclusion

This paper offers evidence on the relationship between uncertainty and investment in agroforestry. The primary question is whether or not farmers with more human capital are more likely to be interested in agroforestry. The empirical results lead to the conclusion that investment in human capital, by subsistence farmers in southeastern Mexico, does lead to a higher probability of adoption/investment in agroforestry. Specifically, (1) informal specific on-the-job training, (2) formal training, and (3) formal education improve the likelihood of adopting agroforestry.

Certainly, Keynes's animal spirits are alive and well in the Yucatan. That is, long-term expectations and investment as a function of those expectations are extremely precarious. I have shown for farmers in the Yucatan, as did Anderson and Goldsmith (1997) for managers in North America, that the likelihood of investment rises when the investor is able to place more "weight" on the profit forecast. The investment in agroforestry is, at least, partially explained by the confidence farmers have in the available evidence. We should expect future investment in agroforestry will be as precarious as it has been in the past, unless we investigate the farmer's current level of human capital or some other measure to predict his ability to cope with the uncertainties of adopting new production methods.

These findings, supported both by the revealed behavior and stated interest, also suggest that low rates of adoption can be improved through the use of public policies affecting access to education, exposure to information about agroforestry from other farmers, and the careful implementation of initial rural development programs. This is an extremely important point. The evidence provided by the variables *HAAF, ED, EXP, EXPOSE,* and *SURV* suggests that farmers who have more education, more training, and previous successes are more likely to invest. Of course, this makes sense, but it also highlights the effect of previous development programs on the implementation of new or current programs. We may have new information pertaining to the benefits of agroforestry, but we may also have to overcome failed efforts in the past in order to implement new strategies. Therefore, working closely with farmers in order to improve their comfort level/confidence with new systems being offered, or analogously, reducing the uncertainty of investing in a new system of production is an important component of the development process.

Agroforestry practitioners can improve the odds of successfully implementing agroforestry by providing continuing education and training to farmers. Perhaps most important is the role to be played by farmers who have already successfully implemented agroforestry systems. These farmers need to be identified and allowed to participate actively in the dissemination of information and the on-the-job training of new adopters of agroforestry technologies.

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.

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