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Velvetbean (Mucuna spp.) in the Farming Systems of Atlantic Honduras[1]

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Introduction

In many parts of Central America traditional shifting cultivation practices are no longer feasible due to increasing land pressures. Fallow periods are typically short or non-existent and grassy weeds have replaced tree species in fallow fields. The deterioration of the bush-fallow system has resulted in declines in soil fertility, weed invasion and increased soil erosion in these farming systems (Sheng, 1992).

Collaborative research on this problem between the Honduran Secretariat of Natural Resources (SRN) and the International Maize and Wheat Improvement Center (CIMMYT) was initiated in 1982 with a diagnostic study of maize practices in the Department of Atlántida (PNIA-CIMMYT, 1983). At that time, researchers observed a small number of farmers planting the legume velvetbean (Mucuna spp.) in rotation with winter maize. By the late 1980s it became clear that the diffusion of velvetbean was an important regional development and a research priority for the Agricultural Directorate in Atlántida. A regional research program was subsequently developed by the Regional Maize Program for Central America and the Caribbean (PRM). This paper presents some of the

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results of research on velvetbean conducted in the area, focusing on the socio-economic factors influencing adoption of the technology.

The Study Area

The department of Atlántida is characterized by two agro-ecological zones, the coastal plain and the hillsides of the mountain range Nombre de Dios that runs parallel to the coastline (Figure 1). The climate is hot and humid, with bimodal rainfall between 2,000 and 3,300 mm per year and an average temperature of 28°C. The coastal plain is characterized by fertile alluvial soils while on the hillsides relatively undeveloped, thin soils derived from sedimentary materials are common. The hillside topography is broken, with slopes ranging from 10 per cent to more than 100 per cent.

The agricultural year is divided into two seasons, the summer planting in June (primera) and the winter planting in December (postrera). High annual rainfall and temperatures are conducive to a wide range of crops. Nevertheless, the coastal plain is mainly dedicated to plantation crops (bananas, pineapple and African palm), dual purpose cattle and some rice while the hillsides specialize in maize, beans and summer pastures. Small-scale production of manioc, rice, cocoa and coffee is also common on the hillsides. Traditionally, the summer was the most important maize season, although recently winter maize has become dominant on the hillsides due in part to the diffusion of velvetbean (see below).

While the original tall rainforests have been cut down, Atlantic Honduras is still an agricultural frontier in several respects. Many hillsides are covered with secondary forest species at various stages of growth and the grassy weeds characteristic of completely deforested areas are not dominant. Shifting cultivation is still practiced, typically followed by the establishment of poor quality pastures that quickly degenerate once again into secondary forest vegetation. Extensive areas are owned by ranchers who exploit only a portion of their landholdings at a time. Farmers rent uncultivated land for maize and bean cultivation at very low prices on the condition that they establish pastures after a few years. As a result of these conditions, farmers have relatively easy access to fallow land appropriate for shifting cultivation. The extensive character of land use patterns in Atlántida is reflected in the relatively large average farm size, 9.2 ha per family.

Velvetbean is planted by farmers in association with winter maize (Figure 2). It is established for the first time in a field as an intercrop 40 to 55 days after planting winter maize (mid- to late February). Two to three seeds per hill are planted every metre or so between each row of maize. Winter maize is harvested between March and April and velvetbean is allowed to develop as a sole crop throughout the summer season. Summer maize is planted in a separate field using the conventional technology of shifting cultivation. Meanwhile, the velvetbean develops into a thick mat of luxuriant growth some 1.5 m deep. The legume reaches the end of its vegetative period by late November when seed is formed. Farmers slash the vegetation and a few weeks later stick-plant winter maize into the mat of decomposing leaves and vines. Two thirds of the farmers interviewed rely exclusively on natural reseeding of the field while the remainder replant velvetbean in the winter maize field every year. Farmers indicated that it takes three years to establish a 'self-sustaining' velvetbean field that does not require reseeding and that provides maximum benefits to winter maize.

Methods

The data presented were derived from a 1992 survey of 128 families in 16 villages concentrated in the municipalities of Jutiapa and Tela, Atlántida (Buckles et al., 1992). Approximately 13,000 families live in the hillside communities between the municipalities of Jutiapa and Tela, the two extremes of the department of Atlántida. Villages were selected at random with the chance of selection in rough proportion to the estimated population of the village. In each village, heads of households were randomly selected for inclusion in the survey from the family census data of the Health Secretariat. An additional requirement for farmer selection was that the farmer had planted maize during the current winter cycle or the previous summer cycle. The survey questionnaire was tested and revised, enumerators were trained during a three day workshop, and each questionnaire was reviewed by the coordinators of the survey at the end of each day. The survey was completed within three weeks. The results reported here represent typical maize farming practices in hillside communities in the Department of Atlántida.

Adoption Patterns over Time and Space

Interviews in the region indicate that velvetbean and the knowledge of its uses was introduced to Atlántida in the early 1970s by farmers migrating from the coastal region of Guatemala and neighbouring Honduran departments. The technology spread slowly in the first 10 years following its introduction to the region and explosively in the subsequent 10 years (Figure 3). Adoption of the technology increased at a rate of approximately 5 per cent per year, peaking at almost two thirds of all hillside farmers in the early 1990s. Adoption has leveled off in recent years.

While 34 per cent of the farmers surveyed reported that none of their current winter maize was planted in velvetbean fields, half of these farmers had planted winter maize with velvet bean at some point in the recent past. Thus, an estimated 83 per cent of farmers in the study area, totaling over 10,000 hillside farmers, have direct experience with the technology. Farmers' reasons for discontinuing use of velvetbean are mainly associated with insecurity of access to land, an issue examined below.

The proportion of farmers' fields dedicated to the technology is very high. Approximately 78 per cent of farmers with velvetbean fields cultivate more than half of their winter maize in this association while some 55 per cent cultivate all of their winter maize in this manner. For these farmers, the technology has virtually displaced traditional forms of winter maize cultivation.

While individual farmer decisions to plant a velvetbean field may take some time, once the decision is made conversion to the system is immediate and relatively complete. Farmers do not seem to pass through a period of small-scale experimentation with the technology as is normally expected with new practices. Regression analysis with the survey data indicates that recent adopters plant just as much of their winter maize with velvetbean as farmers with many more years of experience.

Changes in the Farming System

Adoption of the velvetbean-maize association has thoroughly transformed cropping patterns and other key aspects of the regional farming system. During the last 10 years, winter maize has overtaken summer maize as a proportion of total maize production in the region, currently accounting for 65 per cent of aggregate winter maize production.

Increases in land area under winter maize established with velvetbean reflect significant advantages of the system over conventional shifting cultivation. Maize yields in velvetbean associations reported by farmers average approximately 3 t/ha, some 35 per cent higher than yields reported in the survey for the conventional fallow system (Buckles et al., 1992). These findings are consistent with yield advantages determined in on-farm experiments under similar conditions (Durón, 1989; Avila Najera and López, 1990; Chávez, 1993).

System productivity is also greater over time. During the seven year cycle typical of a maize-bush fallow rotation, only three maize crops are produced. In contrast, velvetbean-maize associations produce one crop of maize per year in a continuous rotation. Farmers in Atlántida report continuous annual rotations of over 10 years.

Savings in labour time during land preparations also favour the use of velvetbean. The aggressive legume smothers competing vegetation and is much easier to cut than tough grassy weeds and other secondary vegetation. Farmers indicate that labour dedicated to land preparations in the rotation is reduced by about two thirds compared to a four year bush-fallow. Farmers cultivating maize with velvetbean are consequently able to clear more land in the same amount of time as farmers clearing land in the conventional manner.

Adopters of velvetbean rotations cultivate on average 40 per cent more winter maize than farmers who do not use the technology. Much of the increased farm area is on steeper slopes. Velvetbean fields have an average of 57 per cent slope compared to an average slope of 45 per cent on fields cleared from bush-fallow. This finding raises an important quandary. Are adopters of the technology cultivating land that would normally be cleared from forest for conventional cultivation or are they extending the agricultural frontier onto increasingly marginal forest land? The survey data are inconclusive, although preliminary analysis suggests that most velvetbean fields are established on previously cultivated land, not directly from forest.

While velvetbean fields offer considerable soil protection during the heavy rains of summer, the cultivation of steep slopes may present serious problems of landslides. Farmers and field observations indicate that the thick, shallow-rooting cover created by velvetbean destroys deeper rooting vegetation and loosens the soil, occasionally provoking landslides during heavy rainfall. The risk of landslides needs further investigation before conclusions can be reached regarding the suitability of velvetbean on very steep slopes.

Farmer Evaluation

Honduran farmers are keenly aware of the advantages and disadvantages of the velvetbean-maize association. They consider the fertilizer effects of velvetbean the most important reason for using the technology but recognize several other benefits as well including labour savings, soil moisture conservation and erosion control (Table 1). Ease of land preparations was rated by farmers as the second most important advantage over the conventional cropping system. Interviews in the region suggest that 15 years ago when fertile land was more abundant in Atlántida, ease of land preparation was the main impulse behind the diffusion of the technology. The high rating given to savings in labour time underlines the centrality of labour considerations in farmers' decisions regarding technological options. Resource poor farmers in Atlántida clearly value technologies that offer significant labour savings and give considerable weight to this consideration. Thus, when considering natural resource conservation technologies for resource poor farmers one cannot assume that labour-intensive technologies will be well received.

Among the problems with velvetbean-maize associations cited by farmers, increased incidence of rats and landslides are the most important (Table 2). The closed-cover created by velvetbean is a protected environment attractive to rats, although cyclical fluctuations in local rat populations are probably the most important factor affecting the intensity of this problem. Many farmers can identify communities where small landslides have been provoked by velvetbean fields. The risks associated with these problems are considered by farmers less important, however, than the significant benefits to be gained from using velvetbean.

Technical and farmer evaluation indicate that velvetbean-maize associations are consistent with the traditional model of soil, weed and water management in shifting cultivation. In both systems, depleted soils regain fertility under rotation, weeds are reduced and water is conserved through mulching. Velvetbean management builds on farmer knowledge of land degradation and restoration processes under shifting cultivation, an important factor behind rapid and widespread adoption. This finding suggests that the development and diffusion of new technologies in the region would benefit from an understanding of the strengths and weaknesses of the farmer knowledge base.

Property Rights

The most important farm level factor limiting further diffusion of the technology in Atlántida is access to land. The survey data indicate that land owners are much more likely to adopt velvetbean than farmers dependent upon rented land. Land rental arrangements are typically too insecure to justify the establishment of velvetbean fields by landless farmers. This does not mean, however, that long term security of land ownership is a necessary condition for the adoption of the technology. Survey data from 1990 (Buckles et al. 1991) indicate that farmers with squatters' rights and official land titles are equally disposed to adopt velvetbean. Interviews in the region and economic analysis of the system indicate that a planning horizon of two years more than compensates for the initial investment in the establishment of the velvetbean rotation system (Sain, Ponce and Borbón, 1992; Flores, 1993).

The rotation of velvetbean and maize, while more land intensive than the conventional bush fallow system, depends in part on farmer access to additional land for the cultivation of summer maize and other crops. The survey data indicate that adoption increases among farmers with larger farms. Nevertheless, the minimum farm size for adoption of the technology in Atlántida is quite low, as little as 1.6 ha according to the survey data. Furthermore, adoption rates are still relatively high (56 per cent) among farmers with less than 2 ha (Table 3).

These findings suggest that farm size is not an absolute limit on adoption of velvetbean management practices. One must take into consideration, however, the relative abundance of fallow land in Atlántida and the well-developed land rental market. The landless and farmers with very small farms can rent land under bush-fallow, especially for summer maize, at low cost from ranchers interested in converting fallow land into pasture. They are consequently free to dedicate their own small parcels to the velvetbean-maize rotation. Furthermore, a rental market for velvetbean fields has developed in some parts of Atlántida, with these fields fetching roughly 70 per cent more than a field under secondary forest growth. In short, it is the broader socio-economic system affecting access to land, and not individual farm size or land tenure arrangements, that is likely to be a determining factor in the diffusion of the technology.

Conclusions

A resource conserving, productivity enhancing green manure technology has been widely adopted in Atlantic Honduras, mainly as a result of farmer to farmer diffusion. Widespread use has in turn transformed key features of the farming system such as cropping patterns, yields and labour requirements. Specific features of the technology such as its ability to respond to multiple objectives and compatibility with the traditional model of land management are important economic and cultural factors facilitating adoption. Nevertheless, broader forces such as land rental markets favourable to this relatively land extensive system are also important conditions for adoption. As land use intensity increases in the region, new management practices will be needed to sustain agricultural productivity and conserve the natural resource base. Perhaps the greatest lesson to be learned from the use and diffusion of velvetbean in Atlántida is that green manures can be effective and adoptable components in hillside farming systems.

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Table 1
Advantages of velvetbean

Characteristic	First selection N	First selection %	Second selection N	Second selection %
Fertilizer effect	32	40	14	18
Ease of land preparation	18	23	21	27
Weed control	7	8	18	24
Moisture conservation	17	21	20	26
Erosion control	6	8	3	4
Total	**80**	**100**	**76**	**100**

Table 2
Risks associated with velvetbean

Characteristic	First selection N	First selection %	Second selection N	Second selection %
Pests (rats, snakes)	37	46	10	12
Landslides	23	28	9	11
Loss of summer crop	9	11	12	15
Not important	12	15	50	62
Total	**81**	**100**	**81**	**100**

Table 3
Adoption by farm size classes, land owners only

Farm size	With velevetbean rotation		Without velvetbean rotation		Total	
	N	%	N	%	N	%
0 - 2	5	55.6	4	44.4	9	100
2 - 5	19	76.0	6	24.0	26	100
5 -10	17	70.8	7	29.2	24	100
> 10	31	86.1	5	13.9	36	100