Participatory design of agroforestry systems: developing farmer participatory research methods in Mexico

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Agroforestry systems can take an almost infinite number of different forms, as they have the potential to include any of the crop, animal, and tree species used in agriculture and forestry. This tremendous potential variability allows agroforestry systems to meet the needs of farmers under almost any set of environmental, economic, and social conditions. At the same time, this great plasticity and adaptability of agroforestry makes designing and evaluating agroforestry systems complex (Scherr 1991). Traditional experimentation–validation–dissemination approaches are largely inappropriate for natural resource management innovations such as agroforestry (Rocheleau 1991) because of the long-term nature of tree-based systems and the possibility of multiple solutions. It is not usually appropriate to develop a single production technology for all farmers to apply; rather, it is expected that each farmer will modify any given production technology. Thus a different strategy needs to be developed, incorporating farmers into the research and development process.

Furthermore, rather than trying to homogenise management and treatments, any strategy should exploit the plasticity of agroforestry, by learning from the variations in the way farmers manage agroforestry. Participatory research methods hold the greatest potential for integrating farmers into the process of designing agroforestry systems. On-farm is where the ecological, social, and economic influences that determine the viability of an agroforestry system meet and integrate. Moreover, we believe that farmers are probably the best integrators of these factors.

Opportunities for agroforestry in the Yucatán Peninsula

Although in legal terms, landholding in both indigenous and immigrant communities (*ejidos*) in the southern Yucatán Peninsula is communal, in effect most farmers maintain usufruct rights to between 20 and 100 hectares (ha). The region is primarily covered in secondary semi-evergreen forest, and it receives between 1000 and 1500 millimetres (mm) of rain per year. The soils, derived from limestone, vary greatly depending on topographic position; they include lithosols, rendzinas, luvisols, and vertisols. Farming is based upon shifting cultivation practices that give extremely low yields (0.5–1.0 tonne/ha of maize) plus backyard small-animal production. Crops are supplemented by extracting forest products including timber, *chicle,* honey, and allspice, which may contribute up to half of the household income. Surveys with farmers show their concern to increase the productivity of traditional maize production and diversify production through the planting of fruit and timber trees.

An evaluation of a previous agroforestry project in the region demonstrated farmers' considerable initial and continuing interest in engaging in agroforestry, but a high level of subsequent abandonment of plots by those who undertook it (Snook and Zapata 1998). This suggested that farmers recognised the potential of agroforestry but were experiencing serious problems in implementing it. The principal difficulties they cited were lack of technical support, poor-quality plants, and lack of immediate products. To diagnose the problems in implementing agroforestry, and to determine whether there might exist viable agroforestry systems for the region, we helped farmers to establish eight farmer participatory research groups.

Stages of participatory agroforestry system design

Establishing farmer groups

Farmer research groups were established in two regions of the southern Yucatán Peninsula (see Table 1): Calakmul in the State of Campeche (predominantly mixed-race immigrants from other southern Mexico states), and Zona Maya in the State of Quintana Roo (predominantly indigenous Maya). Only in Campeche were there women members, as in Zona Maya women do not take part in agriculture outside the home garden. In four of the fruit-and-timber groups, farmers were already working with agroforestry. In the other two such groups and in the two improved-fallow groups, researchers suggested the systems and then the farmers opted to collaborate.

The groups varied in their formation: two were based on farmer groups that already existed, three were groups of farmers from a community that had no previous association, and three had no previous association and were composed of farmers from several communities. All participants were self-selecting. Although the research groups that were based on an existing form of association were the quickest to start, internal conflicts related to other activities later affected their functioning. Groups of farmers from the same community without any other formal association between themselves were more successful than groups of farmers from different communities, as there was greater interaction between them outside formal project events. On the other hand, the groups composed of farmers from different communities were able evaluate a technology across a wider range of socio-economic conditions, as was the case with the improved-fallow research groups. Immigrant communities readily adopted the idea of testing new crops and trees. They perceived their experience over the 20 years since they had arrived in the zone as being one of looking for new viable options in a new land – and the options tried had not yet been very successful. Indigenous Mayan communities were

Table 1: Summary of the eight farmer research groups established in southern Yucatán Peninsula, Mexico

State	Community	No. of farmers		Ethnic group	Production system	Research theme
		Men	Women			
Quintana Roo	Xpichil	8	0	Mayan	Timber and fruit	Associated crops
	Cuauhtemoc	9	0	Mayan and immigrant	Timber and fruit	Tree species trials
	Reforma	7	0	Immigrant	Timber and fruit	Tree species trials
	Zona Maya – four communities	8	0	Mayan	Improved fallows	Establishment methods
Campeche	Calakmul – five communities	8	1	Immigrant	Timber and fruit	Tree species trials
	Narciso Mendoza producers' society	8		Immigrant	Timber and fruit	Legume cover crops
	V. Gomez Farias women's cooperative	1	8	Immigrant	Timber and fruit	Legume cover crops
	Calakmul – three communities	6	3	Immigrant	Improved fallows	Establishment methods

much more reserved about trying new species. Their aims were more to rescue old farming practices in which the younger generation were not interested.

Diagnosis of the potential of agroforestry

Interviews were conducted with all farmers using an open-question semi-structured format based on principal themes. The farmers were asked to present their objectives in working with agroforestry, the problems they had experienced, the solutions they proposed, their future plans in agroforestry, and the limitations they perceived in trying to implement them. This kind of interview, compared with a normal questionnaire, reduced the risk of excluding a key response that concerned the farmers.

Next, the researchers and farmers jointly formulated an agenda of activities during a workshop with each group. First, the results of the diagnosis were presented and reviewed with the farmers. Then researchers and farmers jointly agreed upon the objectives where they had a common interest and the capacity to address. Based on this, both sides proposed actions to resolve the production needs or limitations

Table 2: Farmers' objectives, options tested, problems, and solutions for the Calakmul farmer research group

Farmers' objective	Options in order of preference	Problem	Solution and activity
Produce for home consumption and sale	• Plant staple crops: maize and bean	• Too many weeds	• Test cover crops, researchers provide seed
	• Try new fruit trees: mango, breadfruit, cinnamon, or mamey	• Lack of planting material	• Researchers provide two priority fruit trees
		• Poor growth	• Apply fertiliser
Invest in products for the future	• Plant Spanish cedar and mahogany	• Pests, stem borer that causes poor form	• Training in pest control
Diversify	• Test cash crops: habanero chile, papaya, roselle, or annatto	• Lack of plants/seeds	• Researchers provide seeds for tests
		• Lack of labour	• Community organisation requests financial support from government

identified. These proposals were reviewed and all participants set the priorities. From this an agenda involving activities for research, implementation, and training was developed. Usually both farmers and researchers suggested the activities (see Table 2).

Design and implementation of agroforestry trials

Based on the agenda that emerged from the workshop, one or more trials were developed. Depending on the original objectives, these usually maintained some comparative structure. If the objective was to test different cover legumes for weed control in a fruit-and-timber agroforestry system, then at least one of the treatments would be a control, usually the traditional practice of maize cultivation. In such cases, it was preferable to have some replication, either within or between farms. Nevertheless, the number of replications of any one treatment often varied and reflected the level of interest of the farmers in that option. Where the objective was to test new fruit or crop species, formal controls and comparisons were not thought to be necessary, although any new species was tried by at least two or three farmers.

The farmers implemented the trials on their own and did not receive financial assistance for their labour in establishing and managing them. Researchers covered expenses that implied cash outlay (plants, seeds, agrochemicals), as it was not realistic to expect farmers to make such a high-risk investment. Such inputs, however, were kept to a minimum – that is, they would be within the ability of the farmer to provide if the technology proved successful. Researchers provided the farmers with technical advice both on the management of the experiment and on the crops and trees. The farmers, however, made their own decisions on how to manage the system.

Evaluation of agroforestry trials

Evaluation included criteria that were important to farmers as well as those which concerned the researchers. Farmers and researchers made the field evaluations jointly, and the researchers presented all of the data collected to the farmers. Many of the criteria the farmers evaluated, such as taste of product, were not readily quantifiable but were critical to the acceptability of an option. Workshops were conducted in which farmers ranked or scored different options as a group (Ashby 1990). Farmer groups evaluated component species for agroforestry systems and then noted any factors (modifiers) that might limit the potential of the species (see Table 3).

Table 3: Priority of components for an agroforestry system by the farmers of the Cuauhtemoc research group, by scoring relative importance of the different components (1 = very important, 2 = moderately important, 3 = of lesser importance) and overall farmer preference (1 is most preferred)

	Scoring of importance			
	Home consumption	Sale	Modifying comments	Score on overall farmer preference
Annual crops				
Jamaica	3	1		1
Sesame	3	2		2
Maize	1	3		3
Beans	1	3		3
Perennial crops				
Plantain	1	1	Only deep soil	1
Annatto	3	2		2
Pineapple	3	2	Only deep soil	3
Cassava	2	3	Only deep soil	4
Fruit trees				
Avocado	1	2		1
Mamey	1	2		1
Mango	1	2		1
Sapotillo	1	2		1
Star apple	2	3		2
Soursop	2	1	Fruit rot	2
Tamarind	1	3		2
Sweetsop	2	3		3
Nance	3	2		3
Custard apple	2	3		4
Cashew	3	3		5
Timber trees				
Spanish cedar		1	Fastest growth	1
Mahogany		1		2
Ciricote		2		3

All components tested by some or all of the farmers

Fundamental to the joint farmer–researcher evaluation was an integrated evaluation of the trials themselves. Different quantitative and qualitative evaluations were integrated by forming a matrix of the ranked qualifications. For example, the Narciso Mendoza group ranked the cover legumes that were tested in a fruit-timber agroforestry system according to the services provided (weed control and mulch production), yield, and quality of product (see Table 4). Rather than look for a single 'best result', these qualifications were used to identify different production strategies that would be adapted to the different objectives of the farmers. In this case, the best options for food production were varieties of cowpea, while the best for weed control was canavalia or mucuna (Haggar and Uc Reyes 2000).

Adaptation of participatory methods to different circumstances

Most of the farmers participating in testing fruit-timber tree agroforestry systems had some prior experience with this system, so it was

Table 4: Farmers' evaluation of cover legumes in a fruit–timber agroforestry system by the Narciso Mendoza farmer group (5 is high, 1 is low)						
	Services*		Yield†		Quality of product‡	
	Rank in group	Rank of best of each group	Rank in group	Rank of best of each group	Rank in group	Rank of best of each group
Bush bean		2		1		3
Cowpea (var. Xpelon)	5		4		5	
Cowpea (var. Andalon)	5		5		3	
Black bean (var. Jamapa)	3		3		4	
Red bean (var. Michigan)	1		1		1	
Red bean (var. Flor de Mayo)	1		1		1	
Cover legumes		3		3		1
Mucuna	3		2		3	
Canavalia	3		3		2	
Lima bean	1		1		1	
Other legumes		1		2		2
Soya	1		2		5	
Peanut	3		4		3	
Cowpea (var. Lentejito)	4		5		4	
Pigeon pea	5		4		2	
Clitoria	2		1		1	

* Services of weed control, mulch production, with modifying comments on disease susceptibility and competition with trees
† Yield based on data taken by the farmers
‡ Quality of product for human or animal consumption

possible for them to diagnose their problems. But improved fallows were a totally new concept, and farmers were unfamiliar with cultivating the species – *mucuna* and *leucaena*. It was therefore necessary for researchers to design the initial trial with those farmers who were interested in these fallows in a way that farmers could later modify as they gained experience with the plants and the system. To initiate the process and demonstrate the idea, they presented the farmers with two highly contrasting improved fallows. One improved fallow was planted with *leucaena*, a shrub, and the other with *mucuna*, an herbaceous leguminous climber. After two years of establishing improved fallows with these species, farmers identified a technique for each. To establish *leucaena*, they preferred to broadcast large quantities of seed before burning the plot. Rather than sowing *mucuna* for an improved fallow, they preferred to use it in the traditional method as a green manure within or between maize crops. Thus, after gaining experience with the system these farmers could redesign and adapt the original system to meet their own conditions and needs.

Impact of participatory research and the empowerment of farmers

There has been some concern that participatory research methods may create only local solutions for local problems. Obviously, it is not possible to assist every community to have its own participatory research group. To ensure that participatory research provides solutions for more than just those individuals who directly take part in it, both the communities and the participants within the communities should be selected to represent the range of ecological, social, and economic conditions over which an impact is expected. It must be recognised, however, that investing in research may be beyond the capacity of the poorest farmers.

Aside from the technological recommendations *per se*, the greatest impact of participatory research arises from its emphasis on empowering farmers to act in the research and development process. Farmers' trials were used as demonstration plots to disseminate the results of the research to other farmers and to other communities. Farmer experimenters themselves promoted the results of their experience.

In the future it is hoped that the farmer research groups will develop greater independence with more limited external facilitation of their activities, similar to the local agricultural research councils (CIALs) widely implemented in Central and South America (Ashby and Sperling 1995). However, because of the complexity of agroforestry systems and the long-term investment necessary to produce trees, a longer-term partnership between researchers and farmers than is normally undertaken may be desirable, to establish a CIAL. All the communities we work with belong to a community organisation, either the Xpujil Regional Council (CRASX) or the Zona Maya Organisation of Forest Producers (OEPFZM). These provide a forum where the farmers present the results of their research to the leaders of the organisations. They are using the results of participatory research to adapt government development projects to better meet the needs of their members. One OEPFZM now has a fruit-and-timber agroforestry project that is working with 200 farmers. Government development projects in both Quintana Roo and Campeche are using both the fruit-and-timber and the improved-fallow work of the farmers to teach extension workers how to provide farmers with alternatives to slash-and-burn agriculture.

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