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Evaluation of Technological Alternatives for Small Farmers in Central America

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Technology Development in Farming Systems Research

One of the most distinctive aspects of Farming Systems Research is its strategy for developing new technologies, which attempts to ensure on-farm applicability of technologies through an interaction of experiment station data and farm trial results. The first stages of technology development begin in the "characterization" phase of farming systems work, where farmers' problems, constraints and objectives are initially identified. Once alternative technologies have been identified a series of "validation" procedures are followed, either to verify their ultimate usefulness to farmers or to make necessary adjustments to the technology before making a generalized recommendation as to its use. Not all of these verification procedures are validation in a strict sense, but they occupy a homologous position in the research process (see Figure 1.1). Nor are these different validation procedures exclusive, but rather are complementary and usually sequential, to be applied according to the state of development of the alternative technology in question (Shaner et.al. 1982).

The focus of this paper is "technology evaluation"[1]. Technology evaluation is necessary when technologies have long production cycles which do not permit their installation and maturation within a project time frame. Projects which deal with perennial crops, forestry or animal production are the most likely to require this sort of analysis. The data presented here are taken from a technology evaluation of the CATIE-ROCAP Mixed Systems for Small Farmers Project[2], in Cariari, Costa Rica, and in Comayagua, Honduras[3]. The objective of the

Mixed Systems project was to develop technologies appropriate to the nearly universal "mixed" animal-crop production strategy practiced by small farmers in Central America. Although cattle and crops are complementary activities on small farms (see Muller 1982) they are usually treated separately in agricultural research (McDowell and Hildebrand 1980) with the result that grain crop production strategies are developed without reference to plant-animal interactions, and vice versa. The objective of the Mixed Systems project was to improve productivity per ha. for cattle and small animals by introducing improved dietary regimes, new forage crops, improved management practices, and at the same time improve the productivity of traditional crops[4]. The use of the technological alternatives required an increased use of capital and labor for their implementation, and it was hypothesized that there could be conflicting demands on these resources arising from the farmers' strategy for family and farm development and project technology requirements. The structure of farmers' goals was determined through the use of a methodology of "paired comparisons" (Harper and Eastman 1980), to analyze the changes in resource use implied by the adoption of the technological alternatives as outlined by project technicians.

Institutional Setting - Farming Systems Project Background at CATIE

In 1973, CATIE began with a broad project called the "Small Farmer Cropping Systems Project" (SFCS) in response to observations made with regard to agriculture in Central America. These observations are well summarized in a 1980 evaluation of the progress of the SFCS project;

> "... a survey of Central American agriculture ... had lead [researchers at CATIE] to the following conclusions: 1) most of the basic food staples, beans and corn in particular, were produced by small farmers whose average farm unit was less than 5 hectares; 2) most of the beans and corn produced were cultivated using multicropping rather than single cropping techniques; and 3) the agricultural technologies produced by international, regional or national research centers did not reach the small farmers who were using traditional, low-input technologies." (Hobgood et. al. 1980;2).

The SFCS project had addressed these problems, but the 1980 evaluation also found that the impact of the new research approach itself suffered from limitations. Although the cropping systems approach had investigated cropping strategies which were more immediately applicable to small farmers, it did not address questions of mixed crop-animal production strategies, despite the fact that this was a near universal production pattern. The "Mixed Systems for Small Farmers Project" began in 1981. This project was defined as a Farming Systems Research project, and while it built on the experience of the SFCS project in crops and the previous experience in other animal production projects (CATIE 1983, Novoa 1983a, 1983b, 1983c, 1984), it was directed toward a broader range of considerations.

Animals and crops are produced in a close symbiotic relationship on small farms; animals provide traction to plant or prepare land for cultivation. Animals consume crop residues, and successive crops are fertilized by animal wastes. In a managerial sense, capital, labor and land must be allocated for maintenance or production activities either for crops or for animals, so the relation between crops and animals is at the same time complementary and competitive. The importance of this relationship is demonstrated by the observation cited by Foster (1973;101), that farmers in Nepal rejected high yielding, dwarf grain varieties because they did not produce sufficient stalk residue to feed their animals. Cattle also serve an important financial function, in being a liquid store of capital; this function has been most elaborately described for tribal societies (see esp. Goldschmidt 1975 regarding African cattle keepers), but it is equally important in peasant farming societies (Muller 1982). The Mixed Systems project was designed to identify strategies which would permit improved animal and crop production through an analysis of complementary interactions for the design of production alternatives.

In 1983, the investigation described here was begun, with the objective of evaluating the acceptability of the technologies developed by the Mixed Systems project. On-farm implementations of technological alternatives were evaluated to permit a more realistic appreciation of their appropriateness through the observation of farmer reactions to and commentaries regarding on-farm trials. Although the focus of the Mixed Systems project was regional, at the time of the research reported here only the work at Cariari in Costa Rica, and Comayagua in Honduras was sufficiently advanced to permit an evaluation of the technologies in the field.

Project Area Background

The Central American Isthmus is divided into seven countries, Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama. Its total population was more than 22 million in 1984, on a land area of some 516,000 km².

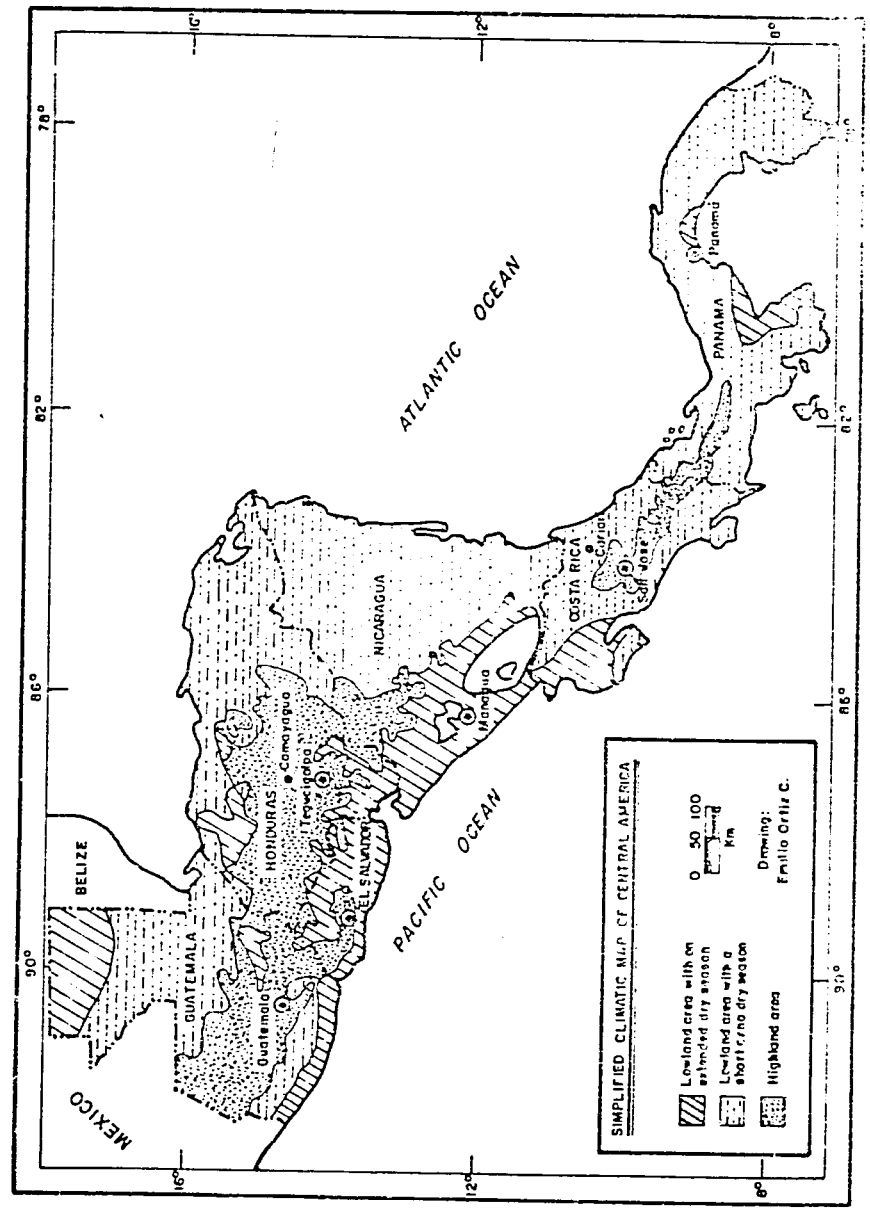
The area can be divided into three general climatic zones (see map). The most extensive climate area is that of lowland humid forest on the Atlantic side of the Isthmus, covered by dense broadleaf forest, and in some areas, open pine savannah. In general, precipitation ranges from 2,000 to 6,000 mm, with a short or no dry season. The area is low, generally below 600 m elevation with average annual temperatures greater than 20 C.

A second climatic zone is the highland area of the central mountain range which runs through most of the Isthmus. It is characterized in general by a relatively heavy rainfall, but with lower temperatures than in the Atlantic zone. Two major highland areas can be identified. A northern highlands area stretches from Mexico, through Guatemala, El Salvador and Honduras, and ends in northern Nicaragua. A southern highlands area runs from the north of Costa Rica to central Panama. Generally speaking, the northern highlands are drier than comparable areas in the south and have a longer dry season. They are characterized by pine forests alternated with smaller areas of broadleaf forest, while the southern highlands have only broadleaf forests.

A third zone, with a relatively extended dry season, is found on the Pacific side of the Isthmus, from the north of Costa Rica to the Guatemala-Mexico border. Smaller areas with similar climates can be found in the northeast of Guatemala, the north of Honduras and in parts of the Pacific coast of Panama. The marked dry season in these areas lasts three to eight months, with annual average precipitations usually between 1,000 and 1,500 mm. In terms of altitude and temperature, this zone is similar to the rainy Atlantic zone, although maximum temperatures may be higher.

The population of Central America is concentrated mainly in the highland areas of Guatemala, Honduras and Costa Rica, and in the pacific Lowlands of all countries. Agriculture as well is concentrated in the highland regions, and in the relatively dry Pacific regions. Except in ports and major banana-producing areas (which in most cases are contiguous), the humid Atlantic coast is sparsely populated.

The two project implementation areas discussed here are located in contrasting climate zones, although both are typically



tropical with high temperatures but contrast in their average rainfalls. Cariari is located in the humid Atlantic zone; rainfall averages 4,261 mm annually, with no dry season (even the dryest months have more than 100 mm of rainfall). The area is located at approximately 300 m above sea level on the Atlantic coastal plain, at the base of the foothills of the Costa Rican Central Plateau. Following the Holdridge classification of life zones (Holdridge 1979) the area falls in the Humid Tropical Forest life zone. Comayagua is a valley in the western central mountains of Honduras; the valley floor lies at approximately 1000 m but the surrounding mountains rise to nearly 3000 m. Although the valley falls within the mountainous area of Central America, its climate is typical of the dry Pacific zone; average annual rainfall is 1,035 mm, with a six month dry season. According to the Holdridge classification, the life zone is Dry Subtropical Forest.

Another major contrast between the two project areas is in land tenure. Comayagua is one of the oldest agricultural areas of Honduras and has undergone a long process of development and land consolidation. Cariari is in the Costa Rican Atlantic zone, which has been relatively recently colonized; Cariari itself was established in the 1960's (see Jones 1985a). In Comayagua only 32.6% of the farms are owned by their operators, while in the Costa Rican Atlantic zone this figure is 93%. Farms tend to be much larger in Cariari, with an average size of 46.2 hectares, while in Comayagua average farm size is 10.9 ha.

The Validation Process

The ultimate objective of the validation process in FSR is the observation of new technologies on farms, under farmer management practices with minimal intervention from technical personnel, except in the form of advice. This process is meant to replicate the real conditions of agricultural production, with normal capital restrictions, and with principally verbal technical assistance.

The validation approach consciously avoids the tendency to turn on-farm trials into "Model Farm" experiments, where technical assistance is constant and active, capital is not a limiting factor since it is provided by project funds, and where most management decisions are effectively made by agricultural technicians rather than by the farmers. The pitfall of the "Model Farm" approach should be obvious: a few hundred dollars injected into a poor farm can completely change the income

horizon for the farmer, to the extent that new income maximization strategies involving project manipulation are a major factor in on-farm decision making: or, the farm can be run as an experiment station, with a level of investment of capital, technical assistance and other resources which are not normally available on farms. In both cases, it is possible to produce very good agronomic results which have little relation to local socio-economic conditions. It is likely that the "Model Farm" phenomenon is the cause for the disappearance of apparently successful agricultural technologies when project funds are removed.

The validation of technology requires several complete reproductive cycles. Once a technological alternative is developed it is introduced to farmers for management on their own farms. At this stage, farmers may receive project funds to ensure that they have sufficient resources to properly implement the alternative. It is assumed that the technology has been sufficiently tested in experiment station trials for there to be little doubt as to its technical efficacy, and that in the initial year of use there will be a substantial income improvement which will provide funds for the coming season. After a period of instruction, farmers are "separated" from the project in the sense that they cease to receive whatever support or subsidies were necessary for the initial period of demonstration. An "index of acceptability" (Hildebrand 1979) can be calculated on the basis of the number of farmers who continue to use the technology once project financial support is removed, since this should indicate the percentage of farmers who, knowing how to use a technology, find it worthwhile.

Validation exemplifies the interactive character of FSR, in that it is designed to allow farmers to concretely demonstrate the viability or problems of technological alternatives under normal socio-economic conditions. Observations by both agricultural technicians and the farmers are reincorporated into the technology design process. Of particular interest are spontaneous adjustments farmers make to the proposed technology during the validation period in response to problems encountered in the field.

In certain cases, it may be desirable to carry out on-farm trials even though the alternative technology is not entirely ready for validation. This occurs when a complex or slowly reproducing system is implemented. For the Mixed Systems technological alternatives several seasons are necessary to establish fodder crops, reproduce animals and make necessary installations of the farms. The efficiency of these systems depends on the interaction between different components, which can only be appreciated once the entire system is established

and functioning. In such cases, the technology must be "evaluated", rather than "validated" using methods which try to gauge technological utility and compatibility on the basis of indirect measures, e.g. comments by farmers, or observations of their on farm resources and estimations of farmer capabilities.

Procedures for Technology Evaluation

Technology evaluation faces a special set of problems since results must be projected onto a larger population on the basis of interviews and observation of farm activities on few farms. For the purposes of evaluation, it is imperative that farmers critically analyze and comment on the new technologies from the perspective of their applicability under **their own** farm conditions, as a simulation of actual validation.

A first problem in the evaluation is to establish that farmers understand the technology being presented. Since the use of a technology implies the commitment of resources, possible conflicts with other activities on the farm, and changes in production procedures, the farmer cannot evaluate its applicability without a thorough understanding of what the new technology entails.

A second problem is; how to ensure that farmers really express their critical observation of technologies? It is common for farmers to see experiments in much the same way as they see their own farms, as extensions of their personalities, work capacity, responsibility, intelligence and management ability. A strong sense of etiquette is implied in any observation of another's agricultural activity, and the first reaction of the farmer is most likely to be one of polite reserve; you would no more criticize an acquaintance's farming than you would criticize their clothes, in "proper" daily interactions.

Finally, an understanding of the farmers' motivational framework must be developed to permit a comparison of the farmers' aspirations and the requirements for the implementation of the technology.

These problems were resolved through the use of interviews with farmers carried out in multiple visits to their farms. In an initial visit, the purpose of the project and evaluation exercise were explained, and farmer's goals for their family development were established. In a second visit, farm development goals were established, and their participation in a visit to the demonstration farm was confirmed. The visit to the demonstration farm was followed by still another interview, to

collect farmer's observations with regard to the applicability of the alternative technology on their own farms.

A more complete understanding of the alternative technology was thus promoted in several ways. During the initial interviews, the problems addressed by the alternative technology were discussed with the farmers, and the solutions proposed by the alternative technology were presented verbally. The strategy was to focus the farmer's attention on the technology, if it was not already. and to let him contemplate strategic alternatives during the period between interviews, so that during the visit to the demonstration farm he would be more prepared to critically observe. In the preliminary talks, questions were deliberately posed and left open, to be resolved in the visit to the demonstration farm.

The visit to the demonstration farm involved an inspection of the entire farm, a guided tour with the owner as guide. Technicians accompanied the group, but only responded to direct questions which were posed to them by group members; it was to be clear that the farmer was in charge. The farm tour was loose and unstructured, with a continual question and answer process. At the end of the visit, a final group discussion was held for clarifying final questions; at this point the technicians made a brief presentation as to how and why they thought the system should operate. It was felt this was necessary, because of misconceptions which may have been exchanged among the farmers during the visit. Since the project was still in progress, the educational element was felt to be important.

Several elements were included in the evaluation process to ensure that farmers would be able and disposed to make critical evaluations of the alternative technology. First, during the initial interviews an attempt was made to establish who besides the farmer was involved in farm decision making. In many cases it was the wife, although in some it was a brother, son or friend; the farmer was encouraged to attend the demonstration with that person. The final observations by the farmer on the alternative technology were recorded at his own farm, several days to a week after the visit to the demonstration farm. This allowed time for the alternative to be discussed, and also ensured that the farmer was not put in the ungracious position of being asked to "criticize" his "host's" farm during what was for many a social visit. In addition, an attempt was made to discuss the application of the technology in the context of the stated goals from the earlier interviews, and determine if these goals would be more easily achieved through its use. During all the interviews, it was stressed that we, as project technicians, were involved in an experiment, and that we honestly did not know enough of the details of farming

in the area to completely evaluate the applicability of the technology.

Due to the intensiveness of the multi-visit strategy, a limited number of farmers could be included in the evaluation process. In Cariari, 12 farmers were included, and in Comayagua there were 18 (more were interviewed, but some had incomplete information due to time constraints). These samples constituted 3-4% of the population. Since this was felt to be a sufficiently large sample statistically, extra effort was dedicated to guaranteeing the quality of the information gathered.

Since interview time was to be used in the collection of attitudinal data, families included in the samples were limited to those for which up-to-date socio-economic information was available. This placed obvious constraints on sample selection. However, in both Cariari and Comayagua sufficient data had been previously collected for some 80 randomly selected farms (in each area), and it was possible to select subsamples which were structurally similar to the target populations in terms of land and animal possession.

Comparison of Farming Systems

Farming Systems of the two project areas are quite different. Comayagua agriculture is focused around production of corn and sorghum on unirrigated lands and vegetable production on irrigated land. Cariari farms focus on the production of corn and tubers. Both areas share a general small farm orientation toward the management of increasing numbers of cattle, which serve a "banking" function; the value of the animals purchased grows with a minimum of attention, and they can be quickly turned into cash when necessary, or used as collateral for loans.

In Comayagua, farms are developed through the progressive purchase of small parcels. Young families first establish themselves on a houselot in a village or town, and begin farming inherited or rented parcels. If land is irrigated, high value vegetable crops can be grown, such as watermelon, tomato, green peppers, etc. For capital poor farmers, cash inputs can be "financed" through sharecropping arrangements, since wealthier individuals in some cases prefer letting others manage these labor intensive crops[5]. A typical small farm will have 3 to 7 parcels averaging 1 ha. in size, some irrigated and some not irrigated. Income is derived primarily from vegetable sales, and additionally from subsistence grains when there is surplus production. In good years, farmers purchase cattle with their

profits, and these are rotated along with the oxen to different parcels to feed on crop residues.

The critical aspect of the farming operation is the maintenance of the farmers' "capital", the cattle, through the dry season. Farmers try to sow sufficient forage for their animals, either in the form of the stalks of corn and sorghum planted for grain, or through the high density planting of sorghum, exclusively for animal feed. Cattle can also be maintained in public lands, although this is an unpredictable resource of generally poor quality. The length of the dry season varies, and in years where the dry season is longer than expected, farmers must resort to renting pastures, buying feed or selling animals. Some farmers purchase infertile, sloping land in or near the valley as a dry season pasturage for their animals. The difficult management decision in this case is how much land, labor and capital to invest in forage production, at the cost of cash crop production.

Cariari is much more heterogeneous in the farming systems observed. In terms of size, farms tend to be more homogeneous than in Comayagua; approximately half of the farms are still in the hands of the original land reform beneficiaries, and the rest have generally changed hands as the whole 20 ha blocks initially distributed to each farmer, rather than be subdivided. Corn and cattle production are the major sources of cash income, but a great number of additional crops of less importance, or which are in the experimentation stage, are also grown. Cassava is an important cash crop in the area, but this depends on variable international markets. New specialty crops such as ginger, curry, black pepper, palm heart, tropical fruits, etc. are found on many farms, but they are not uniformly distributed and are not yet considered a permanent part of most farms.

A general pattern for farm development in Cariari is a focus on high return, labor intensive and risky activities in order to establish working capital on the farm. These crops are most commonly cassava and corn; commercial pig production also falls into this category but to a lesser degree, as do some of the specialty crops mentioned above. As a farmer builds up capital he buys cattle, but with more of a "production" (as opposed to "banking") emphasis than in Honduras. Since farms are relatively large, farmers can expect to earn a reasonable living from cattle reproduction, although they may focus on the sale of calves to larger farms for fattening. Nevertheless, cattle production requires a relatively large farm to allow a farmer to generate an attractive income, so the cattle option requires the purchase of additional farmland to become a long-term option for farmers.

In the farming systems of both areas, the use of extensive

cattle grazing was an integral part of the farmers' personal development strategy. The objective set for the Mixed Systems Project was the introduction of cattle management techniques to permit improved income through the use of cultivated pastures and forages, which would result in better animal health without resorting to land extensive grazing, lower mortality rates and shorter periods between births. These activities were directed especially at the non-irrigated lands in Comayagua, since these were those most misused and least productive lands in the area. In Cariari, project activities were oriented toward increasing the protein content of animal feeds, since in high rainfall areas animals tend to be undernourished due to the intake of low quality feeds. In both Comayagua and Cariari, the project proposed to work with animals which are genetically "superior" to those commonly used by the farmers (milk cows in both areas, and pigs and cows in Cariari).

Briefly described, the technical improvements for Comayagua were;

1. the plantation of sugarcane for use as feed during the dry season.
2. the plantation of **Leucaena** spp. as a protein source, and as a method to overcome food shortage in dry months, since its deep tap root would reach deeper water supplies than grasses or annual crops.
3. changes in fertilization and plant spacing in corn production, to permit a maintenance of maize production on a reduced land area.
4. the use of Zebu cattle stock with slight mixtures of Holstein or Brown Swiss to improve milk production capacity.
5. the use of the forage chopping machine to permit the proper mixtures of feeds, and the use of otherwise unpalatable food sources.

For Cariari, the improvements proposed were;

1. the introduction of a leguminous cover crop, which would improve soil quality, and produce high protein feed for cows and pigs.
2. the use of cassava residues to improve cattle feed.
3. the plantation of King Grass (**Pennisetum** sp.) as a mainstay for the milk cows' diet, to reduce the need for pasture area.
4. the use of a machine to chop forages and allow the feeding of a proper mixture of different feeds to cattle.
5. introduction of Jersey cattle, to minimize food and especially protein needs.
6. increased use native **criollo** pigs, rather than crosses with foreign pigs, to reduce protein requirements.

Determination of Farmer Goal Preferences

Lists of alternative goals were developed with reference to the farm family and to the farm as a production unit. The lists were deliberately kept short to avoid confusion in the collection of data (See Urquhart and Eastman 1978).

Alternative goals for family development were:

1. Self sufficiency in food production.
2. Improvements in the quality of life through the acquisition of material possessions.
3. Prestige within the community (respect of neighbors).
4. Children's education.
5. The assembly of a material inheritance for children (land, houses, money, etc.).
6. Leisure (activities not directly related to farm production).

Alternatives for farm development were:

1. Acquire more land.
2. Acquire more on-farm capital.
3. Increase income.
4. Assure a constant income.
5. Avoid risk (especially bank loans requiring a farm mortgage).
6. Diversify production.
7. Avoid hiring off-farm laborers.

Each of the lists of goals were presented in the course of an entire interview (two interviews were required). At least one hour was spent discussing the definitions of goals before actually ranking them. For example, the farmer was asked what was the level of education to which he aspired for his children, where they would have to go to receive it, etc. as a prelude to ranking the "education" goal with the other alternative.

The ranking of alternative goals was done through a method of paired comparisons (Harper and Eastman 1980; Urquhart and Eastman 1978). This method was chosen because it permitted ambiguity in the ranking[6]. During the course of

the interviews the advantages of the method were apparent. Farmers frequently commented that they found the comparisons and rankings of preferences difficult, because they in fact tried to structure their lives so as to avoid the necessity of choosing. They commented in some instances that there was no real need for them to choose between certain goal alternatives, for example, "because school board meetings (education goal) are scheduled on other days than other community meetings (prestige goal)". It seems likely that on a collective level an effort was made to avoid these conflicts. In all cases the interviewer initially insisted on a clear statement of priority, although a tie was recorded if the farmer would not state a preference.

It was especially important to do this type of interview with a minimum of peer interference. While the presence of children did not affect interview results, the appearance of neighbors visibly altered the interview situation, by distracting the farmers' attention, on the one hand, and due to the opinions and suggestions offered by the neighbor in the course of the interview.

Presentation of Technological Requirements for Technological Alternatives

The presentation of the technological requirements of the technological alternatives involved considerations of labor inputs, costs, profitability, and general desirability of the proposed activity. The comparison of farmer goals and technological requirements was carried out in the final interview after the visit to the demonstration farm. To prepare the interview, the technological alternatives were considered from the point of view of required inputs, and the difficulty of acquiring them, and questions were directed toward these areas.

During the interview, specific questions were addressed to the scale of operations, labor requirements and the need for on farm labor reallocation. While these questions were presented in a standard format, interviewees were encouraged to expand on each of these topics, and especially on aspects which they found especially appealing, or especially dubious with regard to their applicability.

With regard to costs, the discussion was focused through the use of a simplified cost-income chart which demonstrated project estimations and assumptions.

Analysis of Paired Comparisons

The same set of goals was tested in both Cariari and Comayagua, with the adjustment of terminology in the field. The samples were broken down into two classes in each study area, since cattle are used as liquid capital investments, their number was operationalized as an indication of wealth. Farm development goals and family development goals were analyzed for each "wealth" class, "wealthy" individuals being those with more than 20 adult animals.

The preference ordering for family development goals showed a great homogeneity, and was virtually identical for both wealth classes in both areas. The education of children was universally cited as the most important family goal, while leisure time was the least important goal. In Cariari, the ordering was not differentiated by strong preferences; in Comayagua, preferences were more differentiated (See Table 9.1) with education singled out as a unique, significantly preferred goal. Even when the significance level of the LSD test is reduced to a probability of less than .20, Cariari farmers do not show the degree of preference for education seen in Comayagua.

In the preference orderings for farm development goals, there is less homogeneity than in family development goals. In each of the study areas, both classes of farms agreed on the least important goals; in Cariari, land acquisition was felt to be the least important goal in agricultural production, while in Honduras, the avoidance of contracting outside laborers was felt to be the least important goal. The avoidance of risk was a more important goal for the wealthier farmers in both Comayagua and in Cariari, although only in Comayagua does it reach a point of statistical differentiation from the other goals at a .10 level (See Table 9.2).

Interpretation of Paired Comparison Data

Family development goals for Cariari and Comayagua are differentiated by the strong preference for education as a goal for Honduras and a relatively weak preference in Cariari. The differences in the degree of preference for the goal of education of children reflects the educational situation in the two countries. Costa Rica has an extremely effective national education program, and high degree of literacy, when compared to Honduras. Nearly all Costa Ricans finish the first 6 years of instruction, and it is not uncommon for a full 12 years to be

Table 9.1
Family development goals in Cariari, Costa Rica and Comayagua, Honduras

Cariari - Family Development Goals by Number of Cattle

LSD P LT* .05 = 12.70
LSD P LT .10 = 10.96
LSD P LT .20 = 8.31

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LSD P LT .10 = 10.96
LSD P LT .05 = 8.31

Goal/	0 - 20 Animals	Goal/	20 - 80 Animals
Education	19	Education	20
Self Sufficiency	15	Self Sufficiency	20
Inheritance	15	Inhertance	15
Quality of Life	13	Quality of Life	12
Prestige	13	Prestige	11
Leisure	9	Leisure	3

Comayagua - Family Development Goals by Number of Cattle

LSD P LT .05 = 17.20
LSD P LT .10 = 14.43
LSD P LT .20 = 10.36

LSD P LT .05 = 17.20
LSD P LT .10 = 14.43
LSD P LT .20 = 10.36

Goal/	0 - 20 Animals	Goal/	20 - 80 Animals
Education	41	Education	48
Self Sufficiency	40	Inheritance	35
Quality of Life	29	Self Sufficiency	24
Inheritance	31	Quality of Life	21
Prestige	18	Prestige	18
Leisure	5	Leisure	18

All Farms - Family Development Goal Structure

Cariari		Comayagua	
LSD P LT .05 = 17.96		LSD P LT .05 = 24.32	
LSD P LT .10 = 15.08		LSD P LT .10 = 20.41	
LSD P LT .20 = 11.75		LSD P LT .20 = 15.91	
Education	39	Education	89
Self Sufficiency	35	Inheritance	64
Inheritance	30	Self Sufficiency	64
Quality of life	25	Quality of Life	52
Prestige	24	Prestige	36
Leisure	12	Leisure	23

* "Probability Less Than ...". LSD is the "Least Significant Difference" between two scores at a given level of significance. The vertical lines group variables which are not significantly differentiated at the .05 level.

Table 9.2
Farm Development Goals in Cariari, Costa Rica and Comayagua, Honduras

Cariari - Farm Development Goals by Number of Cattle

LSD P LT .05 = 14.67
LSD P LT .10 = 12.31
LSD P LT .20 = 9.59

LSD P LT .05 = 14.67
LSD P LT .10 = 12.31
LSD P LT .20 = 9.59

Goal/	0 - 20 Animals	Goal/	20 - 80 Animals
Constant Income	27	Avoid Risk	28
Increase Income	22	Constant Income	27
Avoid Risk	21	Increase Income	21
Diversify Farm	18	Avoid Laborers	19
Increase Farm Capital	15	Increase Capital	17
Avoid Hiring Laborers	13	Diversify Farm	17
Increase Farm Size	11	Increase Farm Size	6

Comayagua - Farm Development Goals by Number of Cattle

LSD P LT .05 = 15.84
LSD P LT .10 = 13.30
LSD P LT .20 = 10.36

LSD P LT .05 = 18.94
LSD P LT .10 = 15.89
LSD P LT .20 = 12.39

Goal/	0 - 20 Animals	Goal/	20 - 80 Animals
Increase Income	26	Avoid Risk	51
Diversify Farm	25	Constant Income	34
Constant Income	24	Increase Farm Capital	33
Avoid Risk	23	Increase Income	33
Increase Farm Size	22	Diversify Farm	32
Increase Farm Capital	21	Increase Farm Size	17
Avoid Hiring Laborers	6	Avoid Hiring Laborers	5

All Farms - Farm Development Goal Structure

Cariari		Comayagua	
LSD P LT .05 = 20.74		LSD P LT .05 = 24.69	
LSD P LT .10 = 17.41		LSD P LT .10 = 20.72	
LSD P LT .20 = 13.57		LSD P LT .20 = 16.15	
Constant Income	54	Avoid Risk	74
Avoid Risk	49	Increase Income	59
Increase Income	43	Constant Income	58
Diversify Farm	35	Diversify Farm	57
Increase Capital	32	Increase Capital	54
Avoid Laborers	32	Increase Size	39
Increase Size	17	Avoid Laborers	11

completed. Agricultural "colleges" (agriculturally oriented secondary schools) are highly dispersed in rural communities. In contrast, the educational level in Honduras is much lower; many children do not attend school, and illiteracy is high. Conversely, the perception of job opportunities and improved income through educational achievements is much higher in Honduras, probably accurately reflecting the unfilled demand for educated workers. In Costa Rica, the phenomenon of unemployed professionals has grown; several farmers made the observation that they personally knew of unemployed, relatively highly educated individuals, and concluded that their children may well have better opportunities in agriculture.

Another important factor is the observable quality of life in the agricultural sector. Cariari is a government sponsored colonization project which enjoys a high degree of government support in the form of technical assistance, bank credits, and infrastructural development. Comayagua farmers, on the other hand, generally do not receive as much government support, and the agricultural opportunities are visibly reduced due to problems of climate and the lack of infrastructure. Costa Rica traditionally has been a country which depends in large degree on the production of small farmers, even for export production (especially coffee), and this is reflected in the quality of government support which smaller farmers receive. A small farmer in Cariari seems much more likely to achieve an acceptable quality of life than his homologue in Comayagua, so the Honduran farmers tend to look outside the agricultural sector in their plans for their family.

Farm development goals show more consistency for wealth classes than for their location. There is a marked economic conservatism among the wealthier farmers of both areas, while the poorer farmers seem more disposed to risk or select otherwise undesirable alternatives in hopes of increasing income. In Cariari, it was universally observed that the contracting of laborers was difficult and unpleasant, due to the scarcity of labor and the procedures for satisfying labor laws (especially paying insurance, retirement and disability allowances). Nevertheless, poorer farmers are less averse to contracting labor in order to increase income or farm capital (P less than .10). In Comayagua, wealthier farmers are much more averse to risk (in the form of bank loans) than are poorer farmers (P less than .10), and were not disposed to borrow money for any purpose, while poorer farmers were not so categorically averse to loans for farm or income improvements.

Due to the relatively small sample sizes for the two areas (12 farms in Cariari - approximately 4% of the target population - 18 farms in Comayagua - 3.5% of the target

population) the preference structures of the farmers were not highly differentiated at the P less than .05 level, and the P less than .10 level was used as a basis for comparison. The interpretations based on these analyses are presented because they largely corroborate more intuitive observations made by investigators in the area. Obviously, a definitive study would require larger samples and more stringent decision criteria, but for the purposes of the Mixed Systems Project (and obviously, within the limits imposed by time and budget) it was felt that these data were sufficiently clear to make project recommendations.

Conclusions and Recommendations

Two basic conclusions, and recommendations, were derived from the analyses of farmer goals. First, poorer farmers were seen to be more receptive to changes which required sacrifices on their part. This conclusion in some degree contradicted the working assumptions of the project, since it was assumed that due to their poverty, poorer farmers would have less capital and time to invest in new activities which did not contribute primarily to food production. However, the results indicate that wealthier farmers are less willing to risk their accumulated capital, or to involve themselves in undesirable activities (such as labor contracting to make up for family labor deficits in intensified cultivation regimes) in hopes of achieving higher incomes. It was recommended that project activities give more attention to poorer farmers, and that stepwise implementation techniques for the alternative technologies be investigated to make them more accessible to capital poor farmers.

Second, the ultimate objective of the Mixed Systems Project was the formulation of technical packages whose increased capital intensity could be offset by increased profits and financing by local banks. As observed above, bank loans were not well received by farmers in general, although some indicated a willingness to use these funds in relatively risk-free activities. However, in Honduras this strategy was clearly not feasible; farmers' determination to educate children resulted in many cases in a decapitalization of the farm to pay educational expenses. The clear preference for education of children, and the determination that children should not work in the agricultural sector meant that capital investment in farms, even if it increased the sale value of the farms (and presumably the value of the inheritance for children) was not a desirable alternative. As a result, it was recommended that efforts be

made to decrease the need for investment in equipment in the Honduran technological alternatives.

As a methodological conclusion, it should be clear that paired comparisons can be applied to ranking of preferences other than the goals selected for the Mixed Systems evaluation. The selection of goal alternatives to be ranked will depend on the formulation of hypotheses to "explain" potential non-acceptance. For the evaluation described here, the hypotheses were that labor and capital requirements of the alternative technology could conflict with farmers' goals. Specific hypotheses must be developed for each study on the basis of existing conditions and problems encountered with the technology to be evaluated.

Data collection and analysis reflects the multidisciplinary exigencies of FSR field work. A conscious attempt was made to merge qualitative anthropological field investigation techniques and more quantitative statistical analysis. Interviews were lengthened, and the form of the questions was altered to permit a more "ethnographic" data collection procedure, which would avoid the problems associated with the rapid application of standardized interview schedules. The "paired comparison" technique provided a degree of statistical proof which helped biological scientists understand how conclusions were derived.

In the process of technology evaluation, special emphasis must be placed on ensuring that the farmer understands the motivations for proposing the technological alternative, and the framework within which he is being consulted. Reasons of courtesy, timidity, or insufficient understanding of the evaluation can contribute to the farmers being reticent to express their observations with regard to the technologies in question. Since the effectiveness of the evaluation depends on success in enlisting the farmers' intelligent participation in the process, it is justifiable to dedicate more time and effort to guaranteeing their understanding of the project.

Notes

1. Some parts of this paper were presented in the Short Course **Agroforestry for the Humid Tropics**, CATIE, Turrialba, Costa Rica, April 24 - May 4 1984.
2. ROCAP is the Regional Office for Central American Programs of the US Agency for International Development. CATIE is the Centro Agronomico Tropical de Investigacion y Ensenanza, based in Turrialba, Costa Rica.
3. Data are the product of 2 months of field work. Arturo Vargas assisted in data collection in Cariari, as did Edwin Cruz in Comayagua. Marcelino Avila, Carlos Burgos and Marco Esnaola were constant sources of support and ideas in this activity at CATIE in Turrialba, Costa Rica. Medardo Lazo, Enrique La Hoz and Roger Meneses directed field activities for the project in the field, and were extremely helpful in identifying potential goal and resource conflicts to be investigated.
4. The technologies are more completely described in Jones 1983a, and Jones 1983b.
5. Sharecropping as a form of financing for expensive crops is discussed in more detail for Bolivian potato farmers in Jones (1985b).
6. The analysis of the paired comparisons is carried out by summing the number of times a goal is preferred to other goals. The totals are summed for all cases for each goal. The numerical difference between these scores are then compared by means of a calculation of the "Least Significant Difference" (LSD), which is calculated as: LSD $= 1.96\ [B(t)(t+1)/6]^{\frac{1}{2}}$, where "B" is the number of interviews and "t" is the number of objectives which are included in the analysis.

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