PROPOSAL FOR THE SELECTION, ESTABLISHMENT, AND MAINTENANCE OF AGROFORESTRY RESEARCH/DEMONSTRATION PLOTS IN FIJI

John Beer
CATIE, Turrialba, Costa Rica
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CONTENTS

	Page
1. INTRODUCTION	1
2. PRIORITY AREAS AND RECOMMENDED AGROFORESTRY ACTIVITIES	4
2.1 Ginger, root-crop area	4
2.1.1 Alley-cropping	4
2.1.2 Line planting of fruit or timber trees	8
2.1.3 Recommendation for ginger, root-crop area	9
2.2 Sugar-cane area	9
2.2.1 Timber trees along boundary lines	10
2.2.2 Forage trees as a dry season supplement	10
2.2.3 Inclusion of fruit trees on sugar-cane farms	10
2.2.4 Fuelwood from boundary fence lines or wood lots	11
2.3 Shifting cultivation area	13
2.3.1 Improved fallow	13
2.3.2 Sustainable AF alternatives to shifting cultivation	14
2.4 Livestock-pasture area	14
2.4.1 Inclusion of cattle in existing pine plantations	14
2.4.2 Inclusion of trees on grazing lands	15
2.5 Cocoa area	15
2.5.1 Ministry of Primary Industries cocoa programme	15
2.5.2 Research/development needs for cocoa shade trials	16
2.5.3 Experimental design for cocoa-shade trial	17

Page

3. AGROFORESTRY WORKING PLAN 19

3.1 Permanent agroforestry working group 19

3.2 Agroforestry field staff 19

3.2.1 Selection of farmers and sites for AF trial or demonstration plots 20

3.2.2 Review of available information 21

3.2.3 Finalization of management details 21

3.2.4 Agreement farmer-project 21

3.2.5 Nursery and site preparation 22

3.2.6 Trial establishment 22

3.2.7 Trial maintenance 22

3.2.8 Plot marking and documentation 23

3.2.9 Evaluations 23

4. GENERAL CONCLUSIONS AND OBSERVATIONS 26

5. BIBLIOGRAPHY 28

ACKNOWLEDGEMENTS

The information in this report was provided by the Fijian technicians and farmers, and the task of the author was basically to collect and organize available knowledge as well as to suggest priorities for the potential agroforestry (AF) activities. Although this report expresses the views of the author, and not necessarily those of the Fijian Forestry or Agricultural Departments, the general conclusions were discussed with the AF Permanent Working Group and special thanks is due to the members of this group for their contributions and support to the AF programme in Fiji. The contributions of Mr. Osea Tuinivanua, Dr. Kees van Tuyll and Mr. Martin Homola, the staff of the Fiji-German Forestry Project, are gratefully acknowledged. It is hoped that their support, not just for this consultancy but generally for the promotion of AF in Fiji, bears "fruit" (and other AF products!).

1. INTRODUCTION

The need for sustainable land-use systems for Fiji, as an alternative to the mono-cultures which suffer high erosion rates (amongst other disadvantages), has long been recognized (Ward, 1985). As a consequence, the Fiji German Forestry Extension Project has proposed a programme to evaluate the potential of agroforestry (AF) systems and techniques in comparison to other potential land uses. The conclusion of initial reviews (Von Maydell, 1987;De Haen, 1987), which involved consultants and national staff from both the forestry and agricultural sectors, was highly positive and the latter study (De Haen, 1987) lead to the formation of an interdisciplinary AF committee which includes the top decision makers from both the Departments of Agriculture and Forestry. Provisional priorities for the land use systems that need to be improved, and for the AF systems with a potential to alleviate the critical problems identified in these systems, were also suggested (De Haen, 1987). These priorities were principally for the main cash cropping systems which are already widely used, or are presently being promoted in Fiji: i.e. sugar-cane, ginger, cattle ranching, cocoa.

The potential of traditional Fijian AF systems, as a source of food and most materials needed for subsistence, has also been emphasized by the University of the South Pacific (Thaman). However, the opinion of the author of this report (and apparently that of previous consultants) is that, within the context of the present project, research and development resources which are available should be firstly directed towards improving the above four cash orientated systems. The main justification for this point of view is that it follows the expressed preferences of the farmers*. Moreover, the potential impact (benefit) for both farmer and society will be greater and more immediate if the cash crop monocultures can be converted into sustainable polycultures, rather than trying to improve the already complex traditional polycultures. A final reason is that a methodology for planting replicated plots of the traditional polycultural systems, from which to obtain quantifiable data which could be used in an extension programme, has yet to be developed. In contrast, the simpler approach of testing a limited number of tree species within monocultures has been implemented in many countries (See journals: Nitrogen Fixing Tree Research Reports; Agroforestry Systems).

The present consultancy is a logical follow up to the previous work (see T.O.R. below), and it was not considered necessary to again justify AF in general terms. Rather the need was for detailed discussions and proposals in order to facilitate the rapid implementation of an AF development and extension programme, under the guidance of the AF committee and with the assistance of the Fiji-German Forestry Extension project. Thus each of the 5 proposed areas (T.O.R.) were visited, and the present as well as potential land-use discussed, in order to judge the real potential for AF in each, and to try to make suggestions for trial plots. Inevitably this work brought to light limitations which will affect the potential of AF

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* This initial, and possibly superficial impression, will be checked through a series of interviews of farmers (see section 3.2.1). Until contrary information is given by the farmers it is not acceptable for technicians to assume that the farmers are misguided and to impose their own opinions about what the farmers should request.

in each area, and consequently affects the relative priorities. Some of the general criteria used to judge the AF potential in all proposed areas were: acceptance of AF proposals by farmers (and at a second level by technicians); probable ease of establishing a new AF system; importance of the problem or objectives that AF was to address (crop diversification and maintenance of soil fertility were each given equal weight with the previously emphasized objective of controlling soil erosion).

Terms of Reference (T.O.R.) for the Agroforestry Consultant

1. Identify suitable sites for demonstration plots in the following areas:

   A. Cash crop (ginger, root crops) on the wet side (East) of Viti Levu.

   B. Sugar-cane area on the dry side (West) of Viti Levu

   C. Shifting cultivation area.

   D. Livestock/pasture area.

   E. Cocoa plantations.

2. Propose designs for AF plots for these areas.

3. Layout of a working plan for the establishment and maintenance of these plots.

4. Conduct a seminar, for forestry and agricultural extension staff, on the proposals for the above 3 items.

The details of how these general criteria were applied should be apparent in the following discussions for each of the five previously identified problem areas. When possible a simple trial plot design is proposed. The outline for the work plan for the AF programme is also given. After gaining experience, modifications to these proposals are probable but it is obviously necessary to make a start during which the project team overcomes the inevitable setbacks during plot establishment, and proves that such AF systems are practical. In view of the agronomic difficulties of working with new systems, and sometimes new species, it is advised that the most propitious on-farm plots are selected at first. This implies selecting the best farmers within a given target group and initially avoiding the most difficult site conditions. For this reason, a lot of emphasis is given to the selection of the plot, or rather of the farmer, who will collaborate with on-farm trials. Once the agronomic difficulties (and some of the socio-economic limitations) are overcome, it will be time to face the remaining socio-economic problems that occur when testing or introducing an improved (from the present methods) or new AF technology on all farms in a given area.

Taking into account the characteristics of the Fiji-German Forestry Extension project, the main proposer of the AF programme presently being discussed, it is apparent that research is only justifiable when it immediately serves an urgent need of the national extension programmes (Forestry or

Agricultural). The emphasis must be on demonstration plots, and when research plots are needed because of a complete lack of information under Fijian conditions, then they should be simple and practically orientated. Moreover, experiments should be on-farms and be designed in such a way that they have the maximum demonstration value possible. There is no doubting the need for basic research (including erosion measurements) to understand the interactions in AF systems in Fiji, but it does not fit within the existing project, or to other immediately available resources. For this same reason, although there is a need for surveys of existing farming systems within the proposed target areas, and for the application of a diagnosis and design methodology (ICRAF, 1983a, b, 1987) or other methodology for objectively identifying problems, potentials, priorities and possible AF solutions (Mercer, 1985; GTZ, 1987 a, b, c, d), such activities are not discussed within this report. Once the AF programme has gained experience through field activities, it would be worthwhile to reevaluate the programme using one of these methodologies. This approach, which could be validily criticized as being an illogical sequence, is justified by the need to first gain experience and to convince both the technical staff and the farmers of the potential of AF systems in Fiji. This will best be done by rapidly establishing practical functioning examples rather than by embarking on surveys and detailed diagnoses of the situation. If it subsequently turns out that the recommendations of the 3 AF consultancies (including this one) are totally incorrect then GTZ needs to drastically assess its use of short-term "experts" for the initiation of such programmes!

2. PRIORITY AREAS AND RECOMMENDED AGROFORESTRY ACTIVITIES

2.1 Ginger, root-crop area

Although ginger is a relatively new export crop in Fiji, and the number of producers is still small, it has justifiably been given priority in agricultural research and development proposals (Nelson, 1987; De Haen 1987; M.P.I., 1987), for the following reasons:

1) Growing significant contribution to foreign currency earnings

2) Ginger cultivation areas provide one of the worst examples of erosion in Fiji

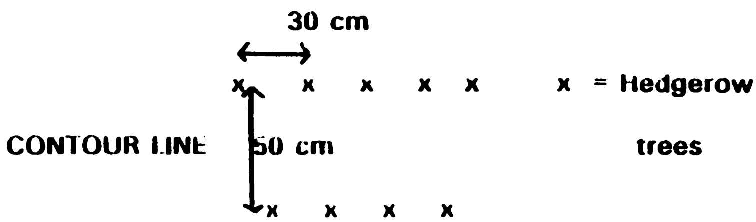
3) Root crops grown in rotation with ginger are basic for the Fijian diet (and culture).

The main producing areas for immature (green) and mature (dry) ginger are in the wet zone of Viti Levu, relatively close to the capital city Suva. In order to produce export quality, particularly of mature ginger, the crop is grown on recently cleared forest land on slopes (good drainage is essential) which have to be well tilled and are clean weeded. Given that rainfall in this area is 2,500 mm/year or more, serious erosion is not just a danger but rather a certainty, unless special techniques are used. The first of these must be the application of land use planning (Nelson, 1987), i.e. the prohibition of ginger cultivation on the steepest slopes where no AF or other agricultural system is going to reduce soil losses to acceptable (sustainable) levels. A second possibility, which is discussed below, would be the introduction of the AF system known as alley-cropping (Appendix 1) onto the moderate slopes (M.P.I., 1987) where ginger is grown in rotation with the root crops dalo (Colocasia esculenta) and tapioka (Manihot esculenta). The definition of the maximum permissable slope for ginger cultivation, within an alley-cropping system, will have to be determined from experience.

2.1.1 Alley-cropping

If the main objective of introducing alley-cropping to the ginger area is to reduce soil losses, then close planting of tree hedgerows along the contour will be required, between the stips of land which will be used for root-crop production. If the main objective were changed to, for example, forage or firewood production from hedgerow trees, then the tree management would have to change (e.g. spacing; pruning regime). For erosion control each hedgerow should contain at least two lines of trees, spaced at about 30 cm in the line (depends upon the species and planting material used), with planting positions staggered between lines.

For example:



Pruning of the trees must be timed to favour crop growth (see Appendix 1 for details) and pruned material is thrown onto the soil in the alleys to provide a mulch and as an organic fertilizer. At least initially, larger pruned branches should be piled along the uphill side of each hedgerow to provide a physical barrier to run-off and hence trap eroded soil. Once hedgerow barriers are established, and terraces begin to form, it may be possible to harvest poles and firewood from some hedgerow trees but the high density planting will not favour such production.

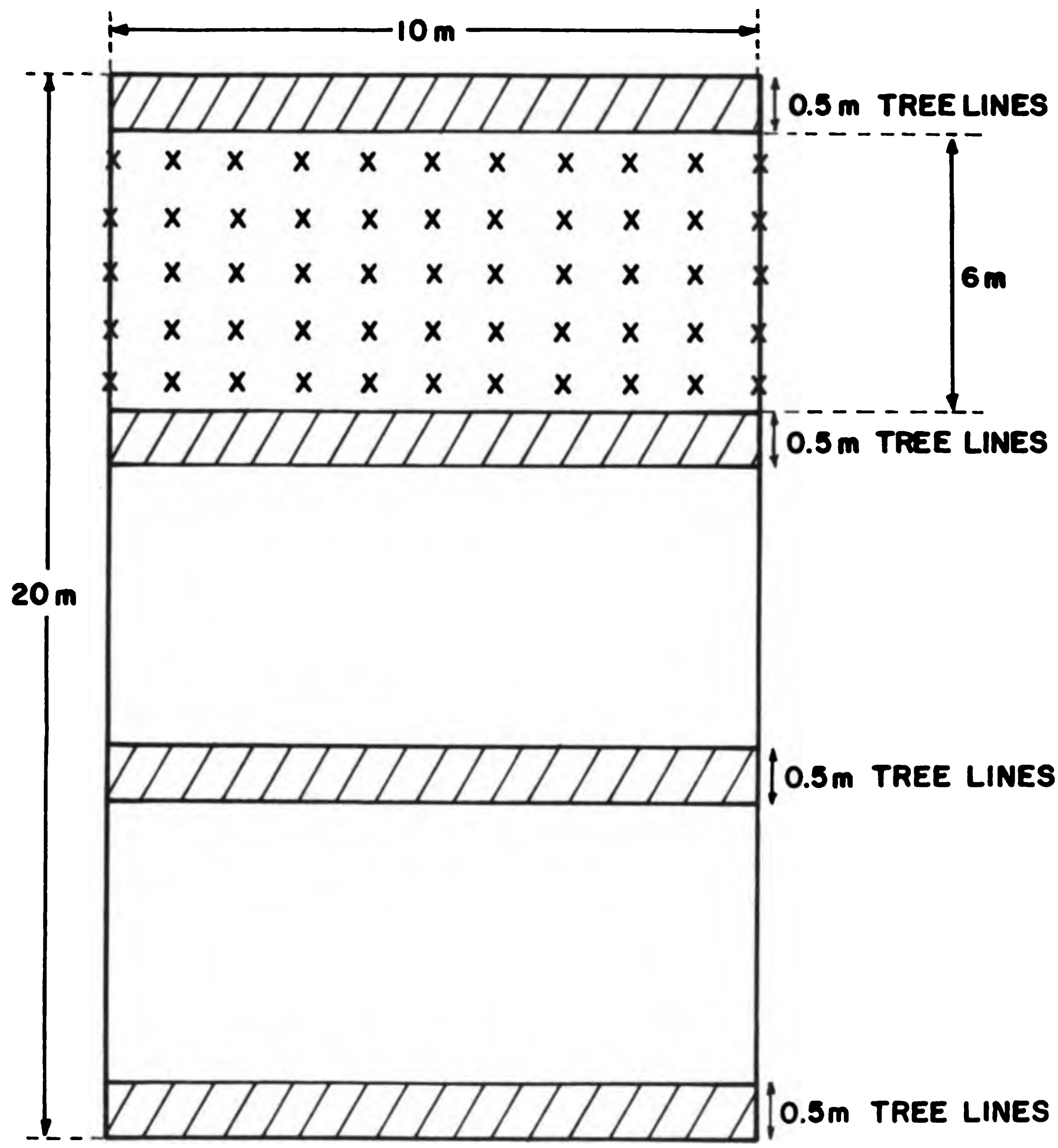
The main limitation to the introduction of this system should not be technical, since it has been thoroughly researched and tested in other countries (see Watson and Laquihon, 1982, Appendix 1 and articles by Beer and Heuveldop, as well as by Kass In Beer, Fassbender and Heuveldop, 1987). Rather it will probably be the problem of convincing farmers to plant and care for trees which give no direct product. However, as a consequence of the recent drastic increase in fertilizer prices, due to the elimination of subsidies, farmers may be convinced by the arguement that the trees produce a fertilizer. Although these organic fertilizers may not completely substitute the inorganic ones, demonstration of their beneficial influence on crop production should persuade the farmers that the trees do provide a valuable product. With few exceptions, farmers are not going to be convinced that erosion control justifies the extra work involved in the alley-cropping system.

Taking the above arguements into account, as well as the local technical and logistical limitations, the proposed work emphasizes demonstration rather than research. It is essential that the responsible technicians first learn how to manage the alley-cropping system under local conditions, by establishing a few examples together with cooperating farmers. The multitude of management details (spacing of crops, fertilizer applications, weed control, etc.), required for the successful promotion of an alley-cropping system, which involves the crop rotation ginger-dalo-tapioka (fallow?), can only be learnt by experience and no recipe is offered here. The proposal below (Fig. 1) is a first approximation of what should be tried.

Since the farmer's main objective (organic fertilizer to counter-act nutrient depletion by cropping) has to be given equal weight to the technician's main objective (erosion control) it could be justifiable to establish some demonstration plots on flat land. Obviously the ideal is to satisfy both objectives with this system, and most demonstration plots should therefore be on moderate slopes. Spacing between hedgerows will depend upon the degree of slope, shade tolerance of the associated crops and the required biomass production levels (i.e. organic fertilizer) of the trees. Initially a 6 m inter-hedgerow spacing is proposed.

Pruning of the hedgerow trees can not begin until they are well established. Depending upon species and site conditions, this implies no pruning during the

Figure 1 Experimental design for alley cropping plots with dalo, tapioka and ginger



X = DALO AT 1 x 0.5 m

1 TREE SPECIES PER FARM

TEST: CALLIANDRA CALOTHYRSUS
GLIRICIDIA SEPIUM
ERYTHRINA SP.
CONTROL PLOT (NO TREE LINES, 10 x 20 m)

first year and hence shading of any companion crop will be greater than in subsequent years. Since the production of mature export ginger requires full sun to achieve the acceptable rhizome size, its inclusion during the first alley-cropping year is therefore not recommendable. For this reason the suggested rotation for the demonstration plots is: Year 1 – establish hedgerows and cultivate dalo; Year 2 – interplant ginger between hedgerows; Year 3 – interplant tapioka ; Year 4 fallow or start rotation again with dalo*. Although many farmers would normally plant ginger directly after forest clearing, there are some less well off farmers who first plant dalo in order to prepare the soil for ginger production (tillage is better in previously worked soil and less tree stumps remain). Intensive frequent pruning of the hedgerow trees, during the ginger cropping period, should eliminate the problem of shade. If the recently established trees can not withstand the required pruning regime, during the first crop rotation, then the first ginger harvest should be for green ginger which requires a much shorter cropping period. The ability of potential hedgerow trees, such as Gliricidia sepium, to withstand pollarding every 6–10 weeks (Appendix 1), has to be checked under local conditions. Pollarding height should be low (less than 1 m). The pollarding height choosen depends upon the vigour of the trees, i.e. a more vigorous tree can withstand lower pollarding heights and indeed this would be necessary to reduce possible shading effects.

Apart from G. sepium, potential hedgerow trees for alley-cropping in the wet zone of Viti Levu (low elevations) would be Calliandra calothyrsus, and an Erythrina spp. The success of the system will depend upon fast tree growth and high biomass production rates under a heavy pruning regime. Any objection to Erythrina spp., such as Dadap (E. subumbrans syn. E. lithosperma), based on the idea that they grow too quickly, is therefore not valid in this context. If the trees are not frequently pruned, then alley-cropping will fail with any species! Other criteria for the selection of possible hedgerow species are given by IITA (Appendix 1).

The districts to be considered, for the establishment of AF demonstration plots involving ginger, are clearly defined by the present limited production areas of this crop. However, the Lomaivuna project area and the Waibau ginger area are specifically recommended because of the existing extension infra-structure (Department of Agriculture) in or near to these areas, and the actual or potential problems of site degradation (erosion and/or nutrient depletion). Moreover, the priority given by the Fijian government, for the introduction of alley-cropping onto ginger farms in these areas, is clearly shown by a proposal already prepared by the Department of Agriculture (M.P.I., 1987; see also Nelson, 1987). Obviously this proposal, and any subsequently funded project, is central to the ideas being discussed in the present report. Indeed such a project would provide an excellent national counterpart (personnel and resources) to any internationally funded AF project in Fiji**.

In order to gain experience, without over-emphasizing research, it is proposed that each demonstration (trial) consists of one alley-cropping plot

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* Depends upon the ability of the hedgerow trees to maintain soil fertility. Moreover, if the trees are intensively pruned for 1–3 years, a one year resting period may be necessary.

** Personal communication Mr. L. Ratuvuki and Dr. P. Sivan (Minutes of meeting of Agroforestry Permanent Working Group, 31.08.88).

including only one tree species, alongside a control plot managed in the traditional (existing) way without any woody species involved (Fig. 1). There should be only one trial per selected farm (i.e. one tree species) and therefore three farms are needed in each target area to try out the above mentioned three species. The facilities of the Lomaivuna project, as well as the characteristics of the farmers there (Brookfield, 1985?; Overton, 1986), provide for a much higher chance for the initial success of this activity than in the Waibau area. It is therefore strongly recommended that the first three trials be established in Lomaivuna and that the more difficult Waibau area be tackled later. Moreover, although the problems in Waibau may be more obvious at present, it should be recognized that they are soon going to be serious in Lomaivuna as well, where most farmers are presently cutting the last piece of remaining forest on their leased land. Unless they move to new sites they have reached the limits of "horizontal expansion" (De Haen, 1988) and urgently need sustainable crop rotation systems.

2.1.2 Line planting of fruit or timber trees

Returning to a previously mentioned limitation, that the proposed species do not provide a direct product (if the organic fertilizer is not considered as such), then alternatives to alley-cropping need to be considered. Two similar possibilities would be to plant fruit trees or timber trees in single monospecific lines along the contour (could involve different species in different lines). Complex mixtures of trees within a line would complicate management (e.g. the slower growing might be shaded out and give no return) and from an experimental point of view would be disadvantageous since no one plot could replicate another and statistics for extension (such as confidence limits on predicted mean production levels of any one species) would not be obtained. Moreover, successful demonstrations are more likely if we start with the simpler systems.

On the other hand, in the case of the ginger area, these systems which produce fruits and/or timber, should not be given priority since the goal of direct production would compromise the goal of sustainability (erosion control and nutrient availability). For the first goal, the size of the trees and their management requirements dictate wide spacings and infrequent selective pruning, if any. For the second goal, maximum benefits are obtained by dense strip planting and intensive frequent pruning. The decision as to which option is most acceptable to the farmers is also affected by the species of the associated crop, i.e. its ecological demands such as for light. For example, a shade tolerant crop such as cocoa might be successfully associated with fruit trees, whilst a shade intolerant crop such as ginger for export would not be. Thus if there are strong justifications for introducing fruit or timber trees into ginger growing areas, then the farmers have to be persuaded to produce different associated crops The way to achieve such a major change would have to be through a gradual replacement and change of practices on the most susceptible sites. An example would be to plant rows of coconuts along the contour lines of the steeper ginger fields, followed by cocoa, which would replace the ginger once established. If the actual profit margins from ginger continue, then the introduction of this new practice would depend upon each farmer still having suitable land available for this export root-crop as well as for his subsistence root-crops (dalo, tapioka). This again illustrates the need for land use planning (at a farm level) at the same time as the promotion of sustainable land use systems such as AF. The two approaches should not be separated!

2.1.3 Recommendation for ginger, root-crop area

Finally it can not be over-empasized that the extension success of any of the AF proposals in this report will depend upon the ability of the technicians to establish productive examples on private land* (see also Nelson, 1987). If technical support is lacking, yields are poor, disease incidence high, etc. then the collaborating farmers will rapidly eliminate or abandon the demonstration plots and return to their previous methods.

In view of the present resources, local conditions and priorities in Fiji, the best possibility for an early success of the AF programme, appears to be with the above described alley-cropping system. For this reason, it has been given most emphasis in this report and it should have the top priority when the AF programme begins.

2.2. Sugar-cane area (West side of Viti Levu).

The farmers are facing two principal problems: erosion and dependence upon a single export crop. Possible solutions to the erosion problem are already known. Firstly, land use planning has been done and was previously respected (Clarke and Morrison). Secondly there are some management options, such as contour line planting, the planting of Vetiver (Vetiveria zizanioides) grass strips and the use of cover crops, which have been used but are not generally implemented at present. The reasons for these retrogressive steps are: i) the Fiji Sugar Corporation (F.S.C.) is encouraging increased production without sufficient control of how this is achieved; ii) the complex land tenure arrangements (generally leases) of the predominantly Fijian-Indian sugar-cane farmers, who lack security; iii) the lack of agreement between the national institutions (Native Land Trust Board, F.S.C. and the Ministry of Primary Industries) about who is responsible for enforcing land use regulations; iv) the inadequate resources for the F.S.C. extension service (each farm advisor should attend approximately 400 farmers); v) the purely commercial orientation of some farmers ("get-rich-quick"); vi) the socio-economic changes amongst the farmers such as a reliance on purchased materials like tin roofing rather than using Vetiver grass for a thatch roof; vii) the changes in farm practices (Vetiver grass strips interfere with trucks taking harvested cane down-slope and also complicate tractor ploughing up-slope, when compared to the traditional methods which involved farm animals). It was also mentioned that the Vetiver grass strips gradually disappear if they are not maintained and contradictorily that they spread by vegetative reproduction, occupying more land than the farmer can accept. An additional disadvantage of belts of trees or shrubs would be that root spread would interfere with ploughing whilst on the other hand ploughing would annually damage tree roots possibly resulting in fungus/disease attack and tree mortality.

Thus the solutions to the erosion problem in sugar-cane areas, are political, cultural, economic and logistical. Technical solutions are not lacking and there is no justification (nor potential for success) for proposing research/demonstration AF plots as a possible solution for erosion control. Nevertheless, if the second problem identified is to be given priority, then there are many potential AF systems

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* Obviously socio-economic considerations, such as markets and the familiarity of new technology, are also critical.

which might reduce the economic vulnerability of farmers presently depending upon a sugar-cane monoculture. Definite proposals can not be made without a more complete study of a representative group of farmers*. Possible AF systems or techniques are:

2.2.1 Timber trees along boundary lines. In fire prone areas, the trees have to be in protected blocks and not along exposed boundaries. Thus, this system would be more suitable for the more intensively farmed areas on rolling hills such as the Lautoka/Legalega sectors and not for outer hill areas. Possible species which are already known in this area are teak (Tectona grandis), Eucalyptus deglupta for more fertile humid sites, E. citriadora for drier sites or P. caribaea. The latter has a low priority but is justifiable in accessible areas because of the new wood chip project. Others should be identified, including if possible some native (preferably fire tolerant) species.

2.2.2 Forage trees as a dry season supplement. Farmers have to look for naturally occurring supplements, at the end of the dry season, in order to feed their animals. Some lop tree branches of leguminous trees, e.g. "Vaivai". Leucaena leucocephala is one example but it was not possible to identify other species and at least 10 Mimosaseae are known by the common name "Vaivai". Raintree (Pithecolobium saman) is obviously well adapted to the area since it is frequently the only surviving tree in the cane areas, but its potential as a forage source is limited. Forage trees could be planted in fence lines (for example the Gliricidia sepium fenceposts on the West side of Sikatoka) or in "protein banks" (M.P.I., 1988) on small steeply sloped areas which are judged highly susceptible to erosion. The latter would be an intensively managed area with trees at close spacing such as 2 x 2 m, pruned twice a year or more, to try to ensure green sprouts during the dry season. The farmers' motivation, to provide better dry season feed for animals, needs to be checked before starting agronomic trials.

2.2.3 Inclusion of fruit trees on sugar-cane farms. Until a market is identified it is not correct to promote large scale planting of fruit trees on small-medium private farms. Indeed few farmers would accept the idea, if they had to invest their own funds, unless there was some sort of guarantee of a sales outlet. Thus at present, the only potentially acceptable way of promoting fruit trees would be with home use as the main objective and sales only of the occasional excess. This involves the home garden (kitchen garden, etc.) concept. Since home gardens are genetically and structurally very complex, the problems of establishing research plots would be great. The best method to promote such AF systems is to let the farmers decide for themselves what they want to plant and where. A

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* The five sugar-cane farmers interviewed during this consultancy were well choosen to represent small/medium and large farms, including both Indian and Fijian farmers, but they probably represented the more progressive or innovative farmers. A study of farmers interests should cover a representative cross section of all farmers attitudes even if those choosen for the research/demonstration plots are from the advanced/innovative/more successful group.

project can best support the farmers by providing a reliable (and hopefully cheap) source of planting material - e.g. by means of community nurseries. Ideally these nurseries should be established and run by cooperating farmers who possibly divide the out-put according to the number of hours each has worked. The project initially provides seed, agrochemicals and technical advise to the nursery groups*. The formation of a group also facilitates extension activities and in the future marketing, since the combined production of many should be more attractive to a buyer. Ideally the project or other extension service, also provides some technical on-farm advise but in the near future this may not be possible. The feasibility of this proposal (communal nurseries) needs to be carefully analysed after studying existing community organization and discussing the proposal with groups of farmers.

2.2.4. Fuelwood from boundary fence lines or wood lots. The former is for small farms, whilst the latter would be for medium-size farms. Fuelwood is not only scarce for many families but there is also a potential market at the sugar-cane mill for those farmers living close by. This is probably one of the easier systems to implement on a small scale whilst more information is gathered on the real on-farm needs, off-farm markets and preferences for certain fuelwood species. Management of naturally regenerated shrubs should be considered for wood lots (P. saman), since it is unlikely that plantations for fuelwood alone will be attractive (certainly not economic). Where the trees provide other products (e.g. thinnings for fuelwood; final crop gives timber) or services (boundary markers; dry season forage) acceptance should be greater.

A simple on-farm experiment, to both test and demonstrate potential fuelwood trees which could be managed along the boundary lines of sugar-cane farms, is presented below (Fig. 2).

This random block design should have a minimum of 3 replications of 3 different species. More replications and/or species are desirable from a statistical point of view, but the length of the line plots makes it difficult to find suitable sites, even with only 9 plots. Since a plot is a single line of 20 or more trees of the same species, and the experiment is to be planted along a boundary, it is inevitable that blocks are long and thin rather than compact. Therefore the risk of intra-block site variation is increased, and consequently it is especially important to locate homogeneous sites for this kind of trial. For the sake of comparability, it would be better to establish all species by planting seedlings, but it is of course possible to establish some (like Gliricidia sepium), by vegetative reproduction of 1-2 long stakes. A similar design to test fruit trees would not be suitable because of the much wider spacing that would be needed. For the firewood trial, a one meter spacing within the line is proposed for the initial comparison of species. It would however be useful to include one extra plot of a potentially valuable fruit tree, such as a grafted mango (Mangifera indica), as a demonstration. The number of fruit trees in this plot would be determined by the available site.

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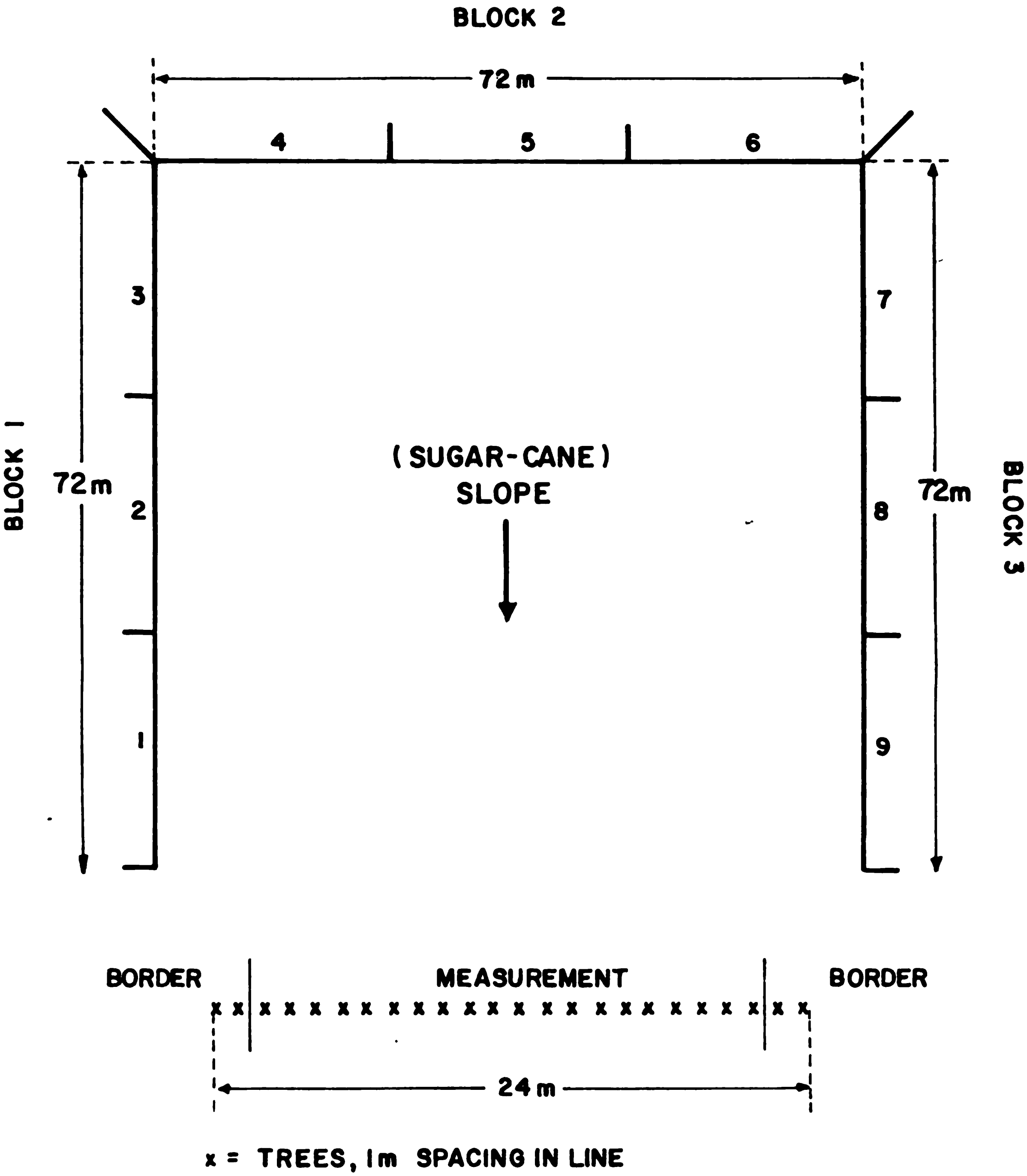
* See Appendix 2 for guidelines on how to select nursery sites and how to organize supervision.

Figure 2 Experimental design for firewood species trial in the sugar-cane area



Potential species for inclusion in a firewood trial would be: Gliricidia sepium, Eucalyptus camaldulensis, Pithecolobium saman. Desirable characteristics for firewood species to be tested would include: coppicing ability, and tolerance of frequent pruning; fire tolerance (e.g. G. sepium and E. camaldulensis will often sprout back after being burnt down); high biomass production; forage value; ability to be propagated vegetatively; absence of natural regeneration; absence of root suckers; deep rooting; and obviously suitability for this seasonally dry ecological zone.

In all cases a proposed system has to fit within the farmers management scheme and interests. Changes can only be implemented step-by-step. Diversification of sugar-cane farms, with AF techniques, is a possibility but erosion control with such techniques can only be a long term goal, if it is indeed the most logical solution. Erosion will continue, and probably increase on the sugar-cane farms on the slopes, until the political/legal/administrative system is changed. At present, technical proposals have no chance of changing this situation.

2.3 Shifting cultivation area

There are two principal agricultural methods which could alleviate the problem of forest destruction by shifting cultivation:

1) Establish improved fallow systems, by deliberately encouraging or planting tree species which regenerate the soil more rapidly than the natural pioneer vegetation, and/or which may provide useable or saleable products. Thus fallow periods may be shortened and/or site productivity increased, which eventually enables the farmer to continue working on already cleared plots without the need to deforest more land.

2) Stabilize the farmers on one piece of land by offering them a sustainable agricultural or AF system, which provides at least as much income and products for family use (food, wood, etc.) as they could obtain from continuing with traditional shifting cultivation.

2.3.1 Improved fallow

The former method will be difficult to promote at the initiation of an AF programme in Fiji, because in the case of soil improving species, it will be a problem to convince farmers to establish plants/trees from which they see no direct benefits. Moreover, although the inclusion of the tree species which do give direct products (fruits, timber, etc.), might be attractive to farmers, the techniques for managing them in fallow vegetation are only known from some traditional subsistence systems (e.g. Vergara and Nair, 1985). The establishment of timber species in secondary vegetation is a well developed method in Fiji (e.g. mahogony line planting), but then the limitations would be: the long rotation needed for timber production before the plot could be cleared and used again; the land tenure problem (von Maydell, 1987).

2.3.2 Sustainable AF alternatives to shifting cultivation

When the latter mentioned method (stabilize the farmers) is considered , any productive agricultural or AF system is an alternative, and therefore all the other systems discussed in this report are possibilities. For this reason it does not seem logical to try to identify sites and systems for AF development in any one "shifting cultivation" zone out of the many Fijian zones where it is common. Rather efforts should be devoted to providing the Fijian technicians and farmers with a few successful demonstrations of AF alternatives (see 2.1, 2.2 and 2.5), and once the programme has proved itself, it should be promoted in as many areas as is possible given logistical and ecological limitations. Moreover, it is especially hard to differentiate between the root-crop area (2.1) and the shifting cultivation area in the wet zone of Viti Levu, since the main difference is only one of intensity of land use (i.e. length of fallow period). Therefore, the activities proposed in section 2.1 also cover one main shifting cultivation area and no additional activities are proposed for the initial phase of the AF programme.

2.4 Livestock-pasture area

Within the livestock-pasture areas, the only AF system which has a good possibility of being accepted by farmers, and which is sufficiently developed to be implemented, is that of grazing cattle under trees*. In particular the cattle-pine system could be of interest to two groups:

1) Owners of pine plantations

2) Owners of rough grazing land, with poor soils (Talasiga areas)

2.4.1 Inclusion of cattle in existing pine plantations

Techniques for using animals to prepare pine planting sites (to clear weeds) and to reduce burnable ground storey material within existing pine stands, have been developed by the Fiji Pine Corporation (F.P.C). However, the application of these techniques seems to have been limited by various problems which include: economic (e.g. fencing costs; some animals lost weight); social (e.g. theft of animals) and managerial (e.g. a wider pine spacing is required for a silvo-pastoral system than has been established for pulp-wood plantations).* Large pine estates (F.P.C or government plantations) are outside of the target group (small-medium private farms) for the AF activities, and the potential as well as the interest in running cattle under the small pine stands (less than 1 ha) found on many small farms, is very limited.

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* Other AF systems which have been suggested (von Maydell, 1987) would have less immediate impact because of the limited areas which would be involved, site specific limitations (socio-economic and agricultural), lack of markets and unfamiliarity as well as lack of acceptance by farmers.

2.4.2 Inclusion of trees on grazing lands

Justifications for the AF programme setting up research or demonstration plots of a silvo-pastoral system, have to be based on a genuine interest from the second group, i.e. private cattle ranchers who want to combine trees (generally pine) with pasture on part of their farm. Before any further work is done with this system it is necessary to firstly review all previous experiences* and determine why adoption has not yet occurred, and secondly to carefully evaluate the interest of the cattle ranchers as well as the real potential of their land for such an AF system. It may be that the areas proposed for including pines, are only suitable for pure forestry use and there is little possibility for grazing animals under the trees, i.e. spatially separate the two types of land use. If the conclusion of this review of local information is that pine silvo-pastoral systems are both technically and economically feasible, then a new management regime of the pines, which favours pasture growth more than the present system, will have to be developed. Improvement of pasture productivity, through the introduction of leguminous cover crops or fodder trees, will be necessary in some areas to compensate the farmer for reduced fodder production in the afforestation areas.

It is not worthwhile developing more detailed proposals, for demonstration plots (research?) and extension work until the real potential of the cattle-pine system is known.

2.5. Cocoa area.

This crop was not included, with the above four topics, in the list of farming systems where monitoring, research and extension should begin (pp 26-27; De Haen, 1987). However, the same author did present the case of cocoa plantations as one where AF should have priority (pp 19-20). A possible reason for the lower priority given to cocoa is that erosion in existing plantations is not serious, although areas of bare soil on the steepest slopes (the litter layer has presumably been washed away by superficial run-off) indicate that it does occur. If the other justifications for promoting AF are taken into account (diversification; maintenance of soil fertility) then the priority given to the cocoa should be increased, as indeed was done when it was included in the T.O.R. for this mission. Another reason for giving cocoa a high priority in the AF programme is that the Ministry of Primary Industries (M.P.I.) is now giving priority to this cash export crop**, and the plantation area is presently expanding (target 100-150 ha/year). Heavy investments are presently being made in infrastructure for cocoa development areas (E.E.C. scheme, Tailevu province).

2.5.1 Ministry of Primary Industries cocoa programme

The original extension programme to promote cocoa planting on private land, was implemented 20-25 years ago. This extension programme was certainly influenced by the concurrent world-wide development of unshaded cocoa management, and close planting (6' x 6') was recommended together with the

* See letter P. Drysdale, F.P.C. to Director of Agriculture, 30 January 1987, [Appendix XI/5a in von Maydell, 1987]

** Personal communication Luke Ratavoki, Director Agricultural Extension, M.P.I.

gradual complete removal of shade trees. A reason for the persistence of this idea may have been the M.P.I. experiment in which Terminalia ivorensis shade was compared with a temporary shade of dalo (Colocasia esculenta) or tapioka (Manihot esculenta) or bananas, for the establishment of hybrid cocoa. The average cocoa yields, over the initial 6 bearing years, were not significantly different between the Terminalia plots and plots which had had dalo or tapioka shade but were approximately 40% higher for the plots which had had banana shade. (Martin et al. 1982). All plots yielded over 1000 kg/ha/yr. compared with the national average yield of about 300 kg/ha/yr. Weed control and protection of the juvenile cocoa from wind damage were considered important advantages of temporary shade. Interestingly, the variable amount of shade between plots (tree and/or cocoa self-shading which varied due to the different cocoa growth rates) had no correlation with the incidence of black pod disease (Phytophthora palmivora). This apparently contradicts one of the common justifications for removing shade ("reduce black pod"). However, maybe this just illustrates the dangers of generalizing conclusions from specific circumstances, since the correlation of black pod with the degree of shading may be clear when heavy forest cover is gradually reduced, but may not exist when different kinds of light (i.e. partial) shading are compared with no shade!

Likewise the results of the above experiment should not be extrapolated to established cocoa plantations, since it is well known that shade requirements of juvenile cocoa are different to those of the bearing crop (for review see Beer, 1985 b). Moreover, in the early years of this experiment, the Terminalia shade may have been insufficient for juvenile cocoa, when compared to the more densely planted temporary shade species. In other words, although the greater yields in the unshaded plots, which had initially included temporary banana shade, could be interpreted as a justification for eliminating shade, in reality the insufficient initial shade from the Terminalia may have been a major causative factor for the difference. In conclusion, there is an urgent need for an experiment to compare different permanent shade trees in established cocoa plantations.

The actual recommendations for cocoa planting are for a slightly wider spacing (8' x 8'), and that farmers leave approximately 25% shade after gradual removal of some of the original forest trees which remained after site preparation. Since most cocoa is presently planted on land which had previously been under natural forest cover, the practice of planting shade trees is hardly known. Moreover, it appears that many farmers eliminate far too many of the existing shade trees, and completely unshaded plantations are not unusual (both old and young plantations). The common occurrence of die-back of cocoa shoots in these plantations, is a clear indication of the detrimental consequences of growing unshaded cocoa without intensive management and/or very fertile soils (Beer, 1985 b). This presumably is the main reason why the extension service has modified its recommendations, but unfortunately the new message has not yet been accepted by many farmers.

2.5.2 Research/development needs for cocoa shade trials

The cocoa extension officers of the M.P.I., and at least the farmers contacted during this mission (Appendix 9), were in favour of testing useful shade trees for cocoa. However, it was frequently stressed that if the shade tree did not produce some kind of useful product, then acceptance by farmers (particularly post-planting management) would be very poor. For this reason, at present it would not be recommendable to test, and therefore promote, the use of intensively managed (e.g. pollarding, pruning) leguminous shade trees, like Erythrina poeppigiana, since they produce no directly useable product. However, the advantages of such trees for soil improvement, and hence increased cocoa yields, should not be forgotten when planning future research/development activities of the cocoa AF programme. At present, shade trees to be planted in trials should provide either wood products (timber, firewood, poles, etc.) or fruits, for home use and/or sale. Other desirable characteristics for cocoa shade trees are given in Appendix 3. Possible species to be tested are: Inga spp.; Cordia alliodora; Terminalia ivorensis; and hopefully a native species with similar characteristics to the leguminous Inga, which has a low open crown and produces fruits as well as excellent firewood, or like the timber producing Cordia alliodora, which has a narrow crown and rapid apical growth even in an open grown environment. Wind resistance is an especially important characteristic in Fiji. Dadap (Erythrina lithosperma) is not included due to the damage it causes to the cocoa, as a result of breakage and uprooting during cyclones.

2.5.3 Experimental design for cocoa-shade trial

The same simple random block design, described above for fuelwood trials, is again proposed for testing a minimum of 3 shade species with 3 replications (Fig. 3). However, this absolute minimum number of plots (9) requires nearly 2 hectares, and the possibility of establishing such an experiment on a homogeneous site on a farm, must be very low. The options are to establish the experiment(s) on government land (experiment station) or to split the blocks between adjacent farms, or between nearby sites on a large cooperative farm. A minimum of two experiments, established in two different areas, should be planned but logistical limitations (costs) will be great.

The problems of setting up experiments with different cocoa shade species, are even greater when shade tree production measurements are required. The present proposal provides for 5 by 5 shade trees (6 x 6 m) within the central (measurement) plot, allowing for 1 border row only, before thinning is carried out. However, after the final spacing is achieved (12 x 12 m) there would be only 4 shade trees in the central plot, hardly sufficient for any statistical analysis given the typical genetic variability of such unimproved tree species. Thus, this design is only justifiable for the objective of studying the cocoa production, disease incidence, etc., under different shade species*. Studies of the shade trees themselves, at these spacings, would require a different methodology. For the moment, the proposal is therefore limited to cocoa measurements, for this comparison of different shade species.

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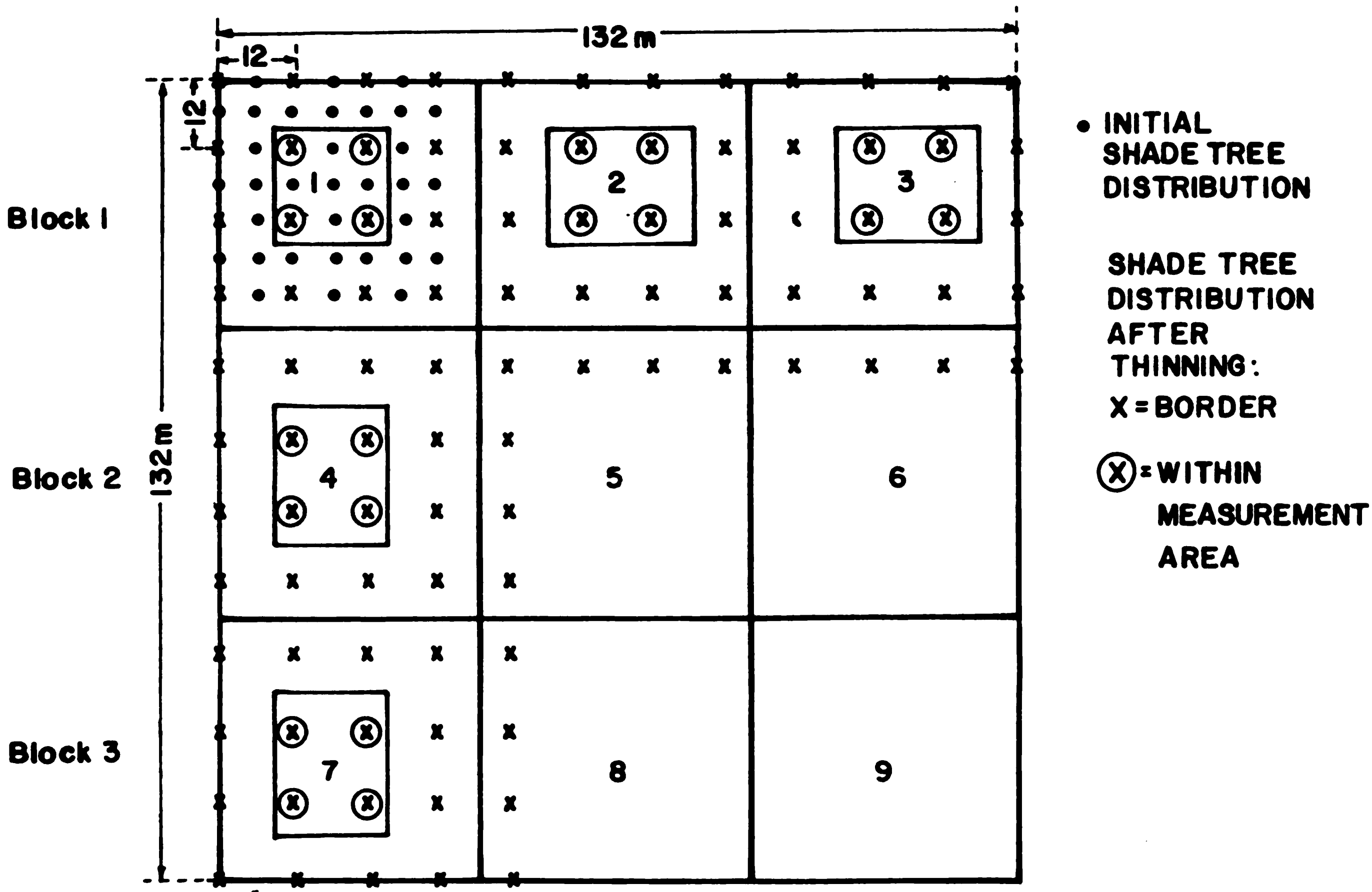
* Leaving 3 cocoa border rows, there would still be 49 cocoa trees in the central plot.

Figure 3 Experimental design for cocoa shade tree species trial



DENSITY COCOA 3 x 3 m

INITIAL DENSITY SHADE 6 x 6m

LATTER THIN SHADE TO 12 x 12m

SPLIT BLOCKS BETWEEN FARMS ?

3. AGROFORESTRY WORKING PLAN

3.1. Permanent agroforestry working group

The following section is only an outline of a work plan, which lacks many details that could not be obtained during a short consultancy. On the other hand, an annual work plan can not be prepared until some preliminary decisions are made by the agroforestry working group, i.e. selection of priority zones, selection of priority AF systems; approval of guidelines for selecting collaborating farmers and farms; and approval of selected farms (following initial farm visits by field personnel). This report pretends to synthesize available information and criteria, in order to assist the working group to make these decisions. The responsibilities of the AF working group would then continue with: approval of annual AF work plans; approval of annual AF reports; and briefing their own departments on the AF activities. They also should be involved in the identification of resources for the AF programme and they should directly support this AF programme by providing staff and resources from their own departments, whenever possible. At a later date they have a responsibility to ensure that the results from the AF programme are incorporated into their own extension programmes (forestry and agriculture). If any of the above points are ignored, then the impact of the AF programme will be minimal.

The implementation of the above steps depends upon the existance of field personnel who collect basic information, prepare the details for annual work plans, prepare annual reports and who carry out the field work. The following discussion of the work plan refers to the activities of these persons. Obviously another condition for the promotion of AF in Fiji is that resources are found and a team ("project") is formed (see for example De Haen, 1987). The necessary work can not possibly be done using only the available time of existing personnel in the Fiji German Forestry Extension project, or M.P.I. personnel. If the necessary "minimum critical mass" of resources can not be made available (i.e. at least one full time qualified agronomist who has his own 4 wheel drive vehicle and independant operational funds for labour and material costs), then it would be better not to initiate an AF research/extension programme. It must be recognized that any AF system is complex, and normally requires a higher level of management than is seen in most silvicultural systems. Therefore, not only does the AF programme need a minimal critical mass, but also it should concentrate on one activity until success has been achieved, or more resources become available.

3.2. Agroforestry field staff

Some of the above mentioned responsibilities of the AF field staff need no further elaboration (preparation of annual work plans and of annual reports). However, the selection of the collaborating farmers is a critical step.

3.2.1 Selection of farmers and sites for agroforestry trial or demonstration plots

The secret for success with on-farm demonstration plots depends upon the correct selection of farms* and especially cooperating farmers. This implies the use of a set of selection criteria, rather than just relying upon the recommendations of local field staff or worse, just taking the most convenient farms. Since the establishment of AF demonstration plots on Fijian private farms is a new activity, there are many biological as well as socio-economic unknowns to resolve, and problems to overcome. Thus it is recommended that initially the "best" farmers, within a given target group, are choosen. This at least provides for the possibility of a successful demonstration, while the selection of a "bad" farmer guarantees failure. The criteria suggested in Appendix 4A and 4B have been derived from experiences in other countries (Central America and Philippines), and have been modified for Fijian conditions following discussions with Fijian foresters and agronomists. They certainly are not definitive and should be further modified after field testing.

It is obviously unlikely that any one farmer will fulfill all criteria and these lists are a guide to help project coordinators select the most promising farmers. The correct selection of a pilot zone (e.g. a resettlement scheme like Lomaivuna) will mean that some criteria are already fulfilled Furthermore, there are other criteria in the lists which refer to the correct selection of the plot site within a farm. The remaining criteria, which will most influence the selection of farmers in any given area, are not very different to the selection presently applied within the Lomaivuna scheme (Appendix 4C).

The lists of proposed criteria (Appendix 4A and B) have been generalized in the hope that they can be consistently used, by the AF programme, in all parts of Fiji. Nevertheless some local modification is not only inevitable but desirable. Although some of these criteria may seem obvious their inclusion is justified for the guidance of field staff. It should be noted that both the proposed criteria and those actually used in Lomaivuna, initially place more emphasis on the selection of the farmer than on the selection of the site. For example, in the CATIE-GTZ AF project in Central America, having selected the most promising farmers, a return visit is made to the farms to decide which has the most appropriate site for the proposed trial. Many other projects first select appropriate sites and then look for the farmer to ascertain his interest. This latter attitude is <u>not</u> a promising start for a collaborative (i.e. farmer and project) trial and it must be stressed that land lent to the project is <u>not</u> what is required. The farmers involvement is necessary to adapt the proposed technologies to his socio-economic circumstances and it will promote acceptance by other farmers during the follow-up extension phase.

This objective method for selecting collaborating farmers necessitates that all candidates are interviewed using a standard set of questions and observations to be made by the interviewer. An example from Costa Rica (Segleau, 1988) is given in Appendix 5. Previous knowledge of the farmers, obtainable from local field staff, is <u>not</u> sufficient but ideally they, or graduates from the local high school, should be trained to <u>objectively</u> interview farmers in order to collect this information and subsequently discuss it with a supervisor. This is the moment when the selection criteria should be reviewed in order to make provisional

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* It is assumed here that the farm is the land managed by one family. It may consist of widely separate plots (gardens) as in shifting cultivation systems.

decisions as to promising candidates. It is neither practical nor desirable that field staff try to apply the criteria during an interview, although obviously they have to understand the methodology if adequate information is to be recorded. Note that these interviews are not part of a survey. The open ended questions can be discussed in any way which is convenient for interviewer and farmer. However many of the considerations for the correct field implementation of surveys apply to these interviews as well.

3.2.2. Review of available information

Once the priority zones and systems have been decided, and the selection of collaborating farmers is well advanced, it is necessary to work out the management details for each proposed AF system. This implies reviewing published and unpublished information (for the latter make study trips or bring in national/international consultants). Since the main support for AF in Fiji has come from the forestry sector, it is especially important to consult the experienced M.P.I. agronomists who can advise as to the potentials, requirements and limitations of each agricultural crop (e.g. ginger specialists; field officers). These M.P.I. staff are also essential sources of information on how to work with the farmers who have their own specific interests, beliefs, potentials and limitations. Off-farm information such as market possibilities should not be ignored at this stage.

3.2.3. Finalization of management details

Some provisional proposals are given in section 2, but the final details must be decided together with the collaborating farmers, and therefore after farm conditions are known from the initial interviews. The information collected in the previous step (3.2.2.) is combined with information on local site conditions (farmers and M.P.I. field officers) to make proposals for plot management (e.g. crop spacing; timing of agricultural activities; land preparation technique; weed control methods). Since the farmer should be responsible for at least some of these management activities, he must not only be consulted but also be in agreement with the proposed methods. A good collaborating farmer will constructively criticize and discuss the technician's proposals.

3.2.4. Agreement farmer-project

A signed legal agreement with a collaborating farmer has little value for an agricultural demonstration plot, since if the farmer losses interest, plot management will be such that the demonstration value is lost (i.e. the plot becomes semi-abandonned or the project has to take over all activities and the plot is therefore no longer representative). Moreover, the legal process is too slow, and such a contractal agreement may provoke negative feelings towards the project. Successful on-farm demonstration plots depend upon motivated farmers, with whom legal contracts are not necessary. However, to reduce the risk of mis-understandings between the collaborating project and farmer, and to ensure continuity in the terms of a verbal agreement should one of the participants change, it is recommendable to at least write down the terms of the agreement (Appendix 6). These terms usually cover: the division of responsibilities to provide labour and/or materials; the project's rights of access, measurement and sampling; that all production from the plot belongs to the farmer. It is also often necessary to specify the time scale of the agreement with allowance for extensions to be discussed at a later date.

3.2.5. Nursery and site preparation

Although quantitative data from research/demonstration plots is needed, the importance of also recording observations should never be forgotten. This begins before land preparation when the actual state of the site is described, and the site history is also obtained from any informed persons (farmer, neighboring farmer, M.P.I., field officer, etc.). Land preparation is normally the responsibility of the farmer but it is good policy for project staff to participate in order to demonstrate their determination to implement the plans, and thus to motivate the farmer. Once a decision to work on any one site is made, it should be implemented together as rapidly as possible.

Tree seedlings need a long lead time before they are ready for out-planting (3 months or more), especially when seed has to be imported. Therefore tree nursery work should begin as soon as the necessary decisions have been made (quantities and species selection), and long before site preparation is initiated. However, there are some qualifications to this general statement:

1. Depending upon the ecological zone, tree planting may be restricted to certain months (rainy) of the year.

2. If site preparation involves tree felling, this should be done as soon as posible (best to avoid plots where this is necessary).

3.2.6. Trial establishment

It is essential that this is carried out together with the farmer and that once again it is emphasized that the plot is his and not that he is lending land to the project. Plot marking might be carried out by project personnel alone but all activities related to planting should be a joint effort. Some activities, such as fencing can be left to the farmer alone, provided that he previously agreed to take this responsibility. For the kind of research/demonstration plots proposed in this report (seccion 2), it is normal for the project to provide all materials which can not be obtained from the farm (e.g. the wire for the fence). For the subsequent stage of an extension project, the farmer would be required to provide more.

A provisional soil study, using a soil auger to visually evaluate physical changes, in at least the top 50 cm, should precede plot marking. Changes in soil texture or drainage, within a trial, should be avoided. A detailed soil characterization, including chemical analyses, is often not feasible prior to trial establishment but should be completed later.

All original plot data sheets, maps and any other field forms should be kept in the experimental files, together with any copied data sheets.

3.2.7. Trial maintenance

Although it is desirable that the farmer does most of the maintenance, some activities require at least the supervision of the technicians (e.g. herbicide applications -see agreement Appendix 6). Regular supervision visits by project personnel are necessary not only to document the developments in the trial and to control the management, but also as a psychological reinforcement to the farmer. He should be quite capable of providing the desired management, but without regular contacts he may lose the will to do so. Since the regular supervision visits will probably be made by field staff rather than by the agronomist who is responsible for the AF programme, a standard evaluation form is useful to ensure some consistency in observations and that all potential problems are always checked in each plot. An example of such a form has been prepared for the ginger-alley cropping trials proposed in section 2.1. (Appendix 7).

3.2.8. Plot marking and documentation

The standard procedures used in permanent forest sample plots can be adapted for use in AF plots (Synnott, 1979; CATIE 1984). Since demonstration is one of the main objectives of the AF programme, a simple easily readable signpost is needed at each site. The collaborating farmer's name should be included on this.

An individual file should be opened for each trial. In addition to the site descriptions, original field data sheets, maps and monthly evaluation forms, an experiment or plot description form should be completed This includes as a minimum: 1. Photocopy of a published map (1:50,000) of the region with the farm site marked; 2. Drawing of the farm with the trial site marked; 3. Drawing of the plot(s) showing spacings and lay out; 4. Reasons (background) for the establishment of this kind of trial; 5. Objectives of the trial; 6. Written description of the trial location and general site characteristics (climate, soil type, elevation, etc.); 7. Explanation of the design used; 8. Initial and future treatments (management details) required; 9. Plot, and when appropriate tree, marking methods, 10. Future measurements required and the probable measurement dates; 11. Proposed analysis and presentation of results. An example is given in Appendix 8.

In general, the trial description form should provide enough information for a new technician to locate, maintain, measure and analyse a trial, even if he does not have the opportunity to discuss it with the initiator. It is especially important to include all observations and the reasons for starting a trial-two aspects which are frequently neglected but which are very important for future interpretation of the results.

3.2.9. Evaluations

The most important information to be taken from any AF research/demonstration trial will be production data. This implies biomass measurements of firstly the saleable or directly utilizable products which may be wood, fruits, rhizomes, etc. A lower priority would be given to standing or total biomass measurements of one or more components in an AF system.

This second group of measurements may be very useful from the scientific point of view but rarely will impress the farmers. The exception would be the measurement of organic fertilizer production by alley-cropping trees. This biomass measurement should also receive a high priority. Biomass measurements of either kind will normally require sub-sampling for dry weight determinations, which means that access to drying ovens will be needed. This is an obvious case where cooperation with the University of the South Pacific (U.S.P.) would be valuable and indeed might be an opportunity for a student thesis under the combined direction of U.S.P. and the AF programme.

The standard methods for evaluating the production of agricultural, forestry or animal husbandry trials will be used for an AF trial. To cover the details of all the possible methods, which may be used in AF trials in Fiji, is not feasible in this report. The details will have to be decided after consulting standard texts (e.g. Synott, 1979; Pearce, 1976; Huxley, P; Shaw and Bryan, 1976) and qualified scientists (U.S.P./Research Division M.P.I./International contacts).

Production data that should always be taken includes survival rates of both trees and crops at, for example, one month, 6 months and 12 months after planting (number of measurements and date of last measurement vary depending upon crop and tree species involved). During the first two years, tree heights are normally measured immediately before and after the dry season, or at 6 month intervals in areas without a dry season. Subsequently, height measurements would be made at yearly intervals during the dry season. Tree stem diameters (normally only breast height) will only be required if the calculation of stem volume data (timber production) or fruit production (from previously developed repression models) is involved.

It does not seem worthwhile at the moment to try to set up erosion (run-off) plots in the AF trials due to the high technical and financial investment which would be needed. However, once an AF system has been successfully demonstrated such soil loss studies may be justifiable and feasible. Bearing this in mind, the site selection for the AF demonstration plots should allow for the future possible establishment of run-off plots (minimum size 10 x 10 m on a constant slope; an intra-site comparison of plots under different management necessitates that all have the same slope). Once again this could be the topic for a student's research project and in any case the involvement of the U.S.P. is desirable. Other simpler methods for determining soil losses in agricultural areas (i.e. where people are frequently present), such as the use of 'pins', are of very dubious value and unlikely to provide useful data.

Economic studies of the AF systems are highly desirable but not justifiable at the initiation of the AF programme, because the results from small research/demonstration plots are totally non-representative. For example, labour input is highly exaggerated compared to a commercial use of the same AF system. Moreover, when at a later date such analyses are attempted on more representative areas, there is a problem to obtain accurate data unless a lot of resources are devoted to such work. For example, labour inputs in AF systems are frequently provided by the farmer's wife and children, as one of their many activities during a day, and it is difficult to estimate the total time really invested in the plot as well as to put a cost on this. (See Hoekstra in Beer, Fassbender and Heuveldop, 1987; and De Haen, 1987, for comments on the difficulties of putting a value to the farmer's time).

The importance of noting all observations, made by both the farmer and the technicians, has already been emphasized. Ecological observations of phenology, pest outbreaks and rooting patterns should obviously be recorded (e.g. Appendix 7) but equally valuable information on social or cultural limitations may also be taken into account if the day-by-day comments and observations are adequately documented. This is in addition to a complete record of management activities. However, these social/cultural limitations may be difficult to detect and understand. Therefore, it is advisable to employ a qualified consultant to help design a methodology to ensure that the suggestions and criticisms from the cooperating farmers are obtained, analysed and incorporated into future planning. Given the importance and possible delicacy of this task, it is not recommended that it be given to a student.

If an appropriate selection of field personnel has been made*, then they should be capable of recording all the required biological, social and economic information under appropriate guidance as described above. However, they will obviously also need qualified advise before making any evaluation of the results. The U.S.P. as well as the M.P.I., F.S.C. and F.P.C. could play a role here.

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* The cultural, linguistic and educational background of field staff should be such that they have no difficulty in both relating to, as well as talking to the cooperating farmers. Ideally they should originate from the target group and the target area.

4. GENERAL CONCLUSIONS AND OBSERVATIONS

4.1. Although there are arguments against only promoting cash crops, the factor which at present most motivates farmers in Fiji to change their land use practices, is one of immediate guaranteed financial gain. The present economic success of the F.S.C. marketing system is an interesting example for any agroforestry project, in that 95% of the crop is grown by small holders under contract to the company. Any project which can organize a similar stable market outlet for the products from AF systems, should have a very high probability of acceptance and that AF system will rapidly spread until the market is saturated.

4.2. The common rural development method in Fiji, of indebting farmers through the provision of outside services and/or materials to be paid back from future harvests, should be used with extreme caution. Exaggerated production estimates, inadequate resources to maintain an extension programme and an omission to consider socio-economic limitations have lead to some farmers failing to reach targets and consecuently to repay their debts. Apart from meaning a setback in rural development, this results in a loss of confidence between the rural population and the technicians who are supposed to serve them. The promotion of gradual rather than drastic change, relying as much as possible upon local materials and services, is advisable. Moreover, the technicians have to be confident of their production estimates, which is one of the main justifications for the on-farm demonstration plots proposed in this report (see 4.7).

4.3. Erosion control should not be seen as the only or even as the main benefit from promoting AF systems in Fiji. Maintenance of site productivity and risk avoidance (diversification) can be equally important reasons that justify promoting AF on flat high quality agricultural land as well as on marginal hillsides.

4.4. The importance of the participation of the farmers in the selection, establishment management and evaluation of AF demonstration plots has to be continuously emphasized. Thus the selection of these collaborating farmers is a critical step. It may first be necessary to convince some extension staff that they do not know everything about the farmer's wishes, limitations, etc., and that objective on-farm interviews are needed.

4.5. At the initiation of an AF research/development programme, it is important to establish a limited number of simple but well managed demonstration plots or experiments. AF systems are complex, usually site specific and "recipes" are not available. Methods will have to be tested and proven under different Fijian conditions before attempting to convince farmers to adopt any AF recommendation. Thus resources should be concentrated on a few activities until the technicians are experienced. This may be the only way to convince many M.P.I. agronomists of the potential of AF, and to change their actual commodity orientated approach.

4.6. The first priority for the proposed AF programme should be the establishment of alley-cropping demonstrations in ginger, root-crop areas, specifically on moderate slopes on farms in Lomaivuna and Waibau. The second priority is for the comparison of permanent shade trees for cocoa, by means of two experiments on private or government farms. A lower priority is suggested for the demonstration of fuelwood production from boundary line trees of sugar-cane farms, and for the promotion of tree planting on marginal grazing lands.

4.7. The suggested programme emphasizes, on-farm demonstration plots. Apart from the obvious justification for an extension project, these plots have to provide realistic production data, and to facilitate socio-economic evaluations that take into account the cultural characteristics of the farmers.

4.8. When considering the resources needed to implement an AF programme, it must be recognized that a "minimum critical mass" is needed to achieve any worthwhile results. This implies that funding has to be provided for a full time agronomist, a 4 wheel drive vehicle and for operational funds (including field laborer costs). Once the priorities and work plan have been agreed, and the resources found to implement an AF programme, then local experts should be identified to support each activity (i.e. AF association). Expertise is especially needed to evaluate socio-economic limitations, which have been the cause of the failure of many previous agricultural development efforts.

4.9. This report contains no information on the women's point of view with respect to AF development in Fiji, since all meetings and interviews were with male farmers and technicians. It is highly recommended that at least one woman is included in the team of technicians who cooperate on the AF programme, to avoid such a future bias. Moreover, although the topic is sensitive, the racial characteristics of technicians and farmers should be matched. It is highly unlikely that the communication and understanding between a Indian-Fijian technician and a native Fijian farmer will be as productive as that between two native Fijians (because of linguistic and cultural backgrounds). Thus for the same reasons native Fijian technicians are not the best choice for a target group where Indian-Fijians predominate (e.g. sugar-cane area).

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APPENDICES

1. IITA. Alley-cropping*
2. Beer. Promotion of tree planting on small farms in the area of Acosta-Puriscal, Costa Rica
3. Desirable characteristics for perennial crop shade trees
4. Selection criteria of Fijian farmers for agroforestry demonstration plots
5. Interview form for selection of farmers
6. Letter of understanding between agroforestry project and farmer
7. Inspection register
8. Experimental description form
9. Contact persons

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* Reprint sent separately.

Pan American Development Foundation

1889 F Street N.W. • Washington, D.C. 20006 • U.S.A.
Phone: (202) 458-3969 • Cable: FUPAD • Telex: 64128 • FAX (202) 458-6316

APPENDIX 2

PLANTING TREES WITH SMALL FARMERS

A PLANNING WORKSHOP

PAPERS AND PROCEEDINGS OF AN

INTERNATIONAL PROJECT PLANNING WORKSHOP

SPONSORED BY PADF AND CODEPLA
IN PORT-AU-PRINCE, HAITI
AUGUST 5-9, 1985

GLENN R. SMUCKER, EDITOR

With the support of the
United Nations Tree Project

PROMOTION OF TREE PLANTING ON SMALL FARMS IN THE AREA OF ACOSTA — PURISCAL, COSTA RICA

JOHN BEER
CATIE, TURRIALBA, COSTA RICA

1. INTRODUCTION

During 1984 and 1985 an agroforestry project of the Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE) funded by the Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) established 8-10 tree nurseries on small coffee farms in the area of Acosta-Puriscal, Costa Rica. The farm owners managed these nurseries under supervision by project assistants, who were in turn directed by a Peace Corps Volunteer and the Direccion General Forestal (DGF) project counterpart. Specific details on the species, nursery inputs, cost etc. are given in a report prepared by the latter.* This activity of the CATIE-GTZ project was a direct consequence of a field day held at CATIE in October 1982, for 60 farmers who had cooperated with the project. After seeing the CATIE germplasm collection and forestry seedbank, many of the farmers requested seed of varieties of known crops, and of new tree and crop species.

Subsequently, project assistants visited all the farmers to note preferred species and project staff included some others such as potential cash crop alternatives to coffee (e.g., Bixa orellana). Based on previous contact with this group of 60 farmers, a number of strategically located farms, whose owners were known to be responsible and motivated, were invited to form the nuclei of communal groups for each village nursery. In fact only the owners of the nursery sites continued to look after the nurseries. The activity was originally organized as a service for the farmers who had helped the CATIE-GTZ Project, and it was not forseen as a research or development study. Thus it was principally directed by the farmers wishes. Whatever success it had must in large part be due to this background. This also explains how we came to be involved in the propagation of fruit trees like Citrus spp. which require relatively sophisticated techniques like grafting.

*Jimenez, R. Viveros familiares: produccion de arboles para pequenos finqueros. Turrialba, Costa Rica. CATIE. (In preparation.)

The research area is in one of the most densely populated agricultural regions of Costa Rica where nearly all farms are privately owned. Altitudes range from 800-1200 metres above sea level with life zones of tropical moist forest-premontane belt transition and premontane wet forest.* Annual total rainfall varies between 1300-3500mm/year with a distinct very dry season from December to May. Mean monthly temperatures range between 19.5 and 22.5 C. There is little flat land, and slopes vary between 30 and 80 percent. The area was chosen after being declared a national emergency zone due to the excessive erosion which occurs principally in pasture land.

For logistical reasons, only 10 sites were chosen, distributed over the project area of 23,000 ha. Apart from the location of suitable farmers, selection criteria included availability of water and central locality for a group of farmers who had requested plants. A secure water supply was critical since the nursery stage was planned for the dry season (December-April), in order to have planting stock ready for the beginning of the wet season (May-June). An aspect we did not check adequately was the availability of sufficient suitable sites for out-planting of the trees, and on the possible labor limitations caused by conflicting work needs for existing crops. Thus a few farmers produced an excess of seedlings of some species. There were also delays in out-planting of certain species which were not ready until September-October, when the coffee harvest had already begun. One farmer produced far too many plants in the hope of making a commercial gain from his nursery. Although the project attempted to stop such exploitation, it is not necessarily undesirable to promote the establishment of decentralized commercial nurseries. It has not, as yet, been possible to organize communal groups, and nearly all seedlings were planted on the same farm where they were produced.

The area still has many trees but nearly all are in agroforestry combinations. Only 2% of the primary forest remains, with secondary forest and woody regeneration covering approximately 11% of the area. National awareness of the need for tree planting is relatively high but the small farmers of the zone (i.e. those with less than 4 ha.) can not afford to reforest significant proportions of their farms. Thus most tree seedlings were established in combination with crops or pasture, and not in pure stands.

The following notes are suggestions of criteria and factors that need to be considered when promoting decentralized tree nurseries and tree planting on small tropical farms. These notes are certainly not complete and readers should also consult available literature (Annex 1) before attempting such a program.

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*HOLDRIDGE, L.R. Life zone ecology. San Jose, Costa Rica. Tropical Science 1976. 207 p.

2. Selection of nursery sites and farmers

i) The motivation should come from the farmer. One way to achieve this is to take a group of potential cooperators to an experimental station where they can see alternative crops and trees, and a functioning nursery. Subsequently, fix a day when farmers can come to the nursery to be trained on basic techniques such as soil sterilization. This will help indicate which farmers have sufficient motivation to carry through a 3-6 month nursery programme.

ii) Select farmers in central locations, from which they can supply neighbors.

iii) Limit the number of nurseries to ensure that weekly supervision visits are possible.

3. Choice of species

i) Identification of objectives of the farmers in order to select, with them, species. For example, initially it is not good to promote fodder trees if the farmers do not see this as a present need.

ii) Request farmers' opinion on preferred species and consider native species.

iii) Select several rather than one species to reduce the risk factor from disease, etc.

iv) Select species already tested in the region, which have a good growth rate and which are tolerant of the site conditions.

v) Include fruit trees. However this may complicate supervision due to the need to teach complex techniques, such as grafting, for some species. With highly motivated farmers this is an advantage as their gain from learning new techniques will increase their interest to care for their nursery. But it implies a longer term commitment (12 months or more).

vi) Use natural regeneration (e.g., *Cedrela odorata*/*Cordia alliodora*/*Psidium guajava*). In these cases we need to promote simple management techniques that will increase productivity of the tree component, without reducing productivity of any associated crops, e.g., thinning and transplanting to get even tree distributions in combined systems such as shaded coffee or cacao plantations.

vii) If timber production is desired, the species should be capable of naturally producing straight stems, with little forking, in open grown conditions (without silviculture). Species which require future silviculture such as pruning (e.g. Cedrela odorata) are not ideal, unless a long term extension program can be guaranteed.

viii) Use species which root from large stakes. The advantages can be numerous but a main one is the avoidance of browsing by cattle and herbicide damage. The technique is easy to promote for fence lines, which are the most underutilized area on Acosta-Puriscal farms (e.g. Gliricidia sepium, Spondias purpurea).

ix) Forage trees are justifiable as a dry season fodder reserve (given pre-dry season pruning to avoid deciduousness of sprouts). They are not an alternative to pastures for annual biomass production, but rather a high quality forage supplement (Gliricidia sepium, Calliandra calothyrsus, Erythrina poeppigiana).

x) Check with local extension service to avoid a clash of recommendations.

4. Choice of planting areas

i) Check the area of suitable sites on the farm where the seedlings will be planted. In Acosta-Puriscal few farmers expressed interest in pure plantations and nearly all seedlings were outplanted in combination with crops or pastures. Planting in fence lines was the most common method due to the availability of space. Thus emphasis should be given to multi-purpose species (e.g. those that give fruits as well as wood) rather than species more suitable for pure plantations (e.g., conifers).

ii) The establishment of a few trees in pastures is not generally recommendable. Problems frequently include poor tree growth due to soil compaction and physical damage of trees by animals. Establishment of such combinations, on land presently dedicated to grazing only, generally implies high initial protection costs. Exceptions such as pine with grazing are known, but this situation is totally different since the main land use is as a forestry plantation with low animal carrying rates.

iii) On small farms tree fertilization may be justifiable when planting. Advantages include reduction of weeding and protection costs during the susceptible establishment phase.

5. Supervision

i) Arrange weekly visits.

ii) A fixed timetable is advisable so that the farmer has a routine and is confident of continued support.

iii) In general, for any demonstration unit or nursery a few good examples are better than many which have a low level of supervision.

iv) Get the farmers together during the course of the nursery period, to exchange experiences.

v) A general goal of the project should always be to get the farmers to do "extension" by example. Thus in this sense several decentralized small nurseries are more effective than one central unit, even if this is also managed by farmers. But one has to balance this advantage against the costs of supervising many nurseries.

vi) The use of educational material is advisable, but may have little influence. Demonstration and involvement of farmers is the main teaching technique.

vii) Two kinds of forms are useful for the quantification of results and for control of nurseries (see Annex 2). Form 1 is an example of how to control assistants who have the responsibility to make weekly supervision visits. By insisting that this form is always completed, the "quality" of supervision can be improved, but this form has to be reviewed immediately by the project organizer if it is to have the required effect.

viii) Quantification to determine costs is misleading since such experimental nurseries will inevitably have higher costs than purely commercial nurseries. However, it is worthwhile determining the relative costs of the different nurseries in a program, in order to determine what factors increase costs.

ix) Seed and materials should be initially provided by the organizing project and all labor by the farm owner. However, the objective is that the farmers gradually take over all costs (years 2 and 3), once they know how to obtain and use the necessary inputs (seed, agrochemicals etc.).

ANNEX 1

RECOMMENDED LITERATURE FOR PLANNING TREE PLANTING PROJECTS WITH SMALL FARMERS

1. AGPAOA, A. el al Manual of Reforestation and Erosion Control for the Philippines, Eschborn, Fed. Rep. of Germany, German Agency for Technical Cooperation, 1975. 569 p.

2. FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS. Forestry for local Community Development. Rome. FAO. 1978. 144 p. (FAO Forestry Paper No. 7).

3. GALLOWAY, G y BORGO, G. Manual de viveros forestales en la sierra Peruana. Lima, INFOR/FAO. 1983. 123 p.

4. ______________________. Guia para el establecimiento de plantaciones forestales en la sierra Peruana, Lima, Peru, INFOR/FAO, 1984, 144 p.

5. LEMCKERT, J.D. Instalacion y manejo de viveros forestales. San Jose, Costa Rica. UNED. 1979. 105 p.

6. TSCHINKEL, H. Tree planting by small farmers in upland watersheds: experience in Central America, 1985, 14 p. (Presented at the IXth World Forestry Congress, July 1-10, 1985. Mexico).

CATIE/GTZ AGROFORESTRY PROJECT
NURSERY INSPECTION REGISTER

Name of Farmer: ____________________ Farm code __________ Date __________

Site: ____________________ Assistant(s) ____________________

A. SPECIES	ACTUAL NUMBER	AVERAGE HEIGHT	NUMBER LAST VISIT	MORTALITY

B. ACTIVITIES CARRIED OUT SINCE LAST VISIT:

C. PROBLEMS/OBSERVATIONS

DISEASE ____________________

Shade (Insufficient or excessive) ____________________

INSECTS ____________________

Nutrient Deficiency ____________________

FAILURE TO WATER ____________________

Others ____________________

ANIMAL DAMAGE ____________________

(Take a sample; preferably an entire seedling).

D. RECOMMENDATIONS:

CATIE/GTZ AGROFORESTRY PROJECT

NURSERY REGISTER

NAME OF FARMER: ____________________ FARM CODE: __________ DATE: __________

SITE: ____________________ ASSISTANT (S): __________

ACTIVITY	AMOUNT	HOURS	PRODUC-TIVITY	COST/ SEEDLING	INPUT			TOTAL COST/ SEEDLING	OBSERVATIONS
					TYPE	AMOUNT	COST		

SEED:

AMOUNT/SPECIES

PROVENANCE

LOT

PLANTING METHOD/SPECIES | AMOUNT | SOWING DATE | GERMINATION DATE | TRANSPLANTING DATE

DIRECT

BEDS

BAGS

APPENDIX 3

Desirable characteristics for perennial crop shade trees

(1) Compatibility with the crop, which means minimal competition for water, nutrients and growing space, e.g. does not produce suckers; the crown branches above the crop; deep rooting; minimum overlapping of understory and overstory species root zones.
(2) Strong rooting systems (not susceptible to wind throw). Shade trees are more exposed to adverse climatic conditions than are trees in a forest or a plantation and should be capable of adaptation to open-grown conditions.
(3) Rooting ability of stakes to permit rapid shade establishment by vegetative propagation.
(4) Ability to extract soil nutrients which are not trapped by the crop[3].
(5) Ability to fix nitrogen.
(6) A light crown that provides a regular mottled shade pattern rather than uniform shadow of photosynthetically poor quality light.
(7) In the case of objective "2" (timber producing species). A small diameter light crown to: a) reduce the wind resistance of the foliage and hence the risk of wind throw, b) permit relatively high shade tree densities without reducing light levels below critical values for the crop; and c) minimize crop damage when individual trees (continuous timber yield system) are harvested.
(8) Non-brittle branches and stem.
(9) Thornless stem and branches to facilitate management.
(10) Rapid apical growth
(11) Self-pruning and the ability to form a straight unforked stem in open-grown conditions
(12) Tolerance of repeated heavy pruning or pollarding
(13) High biomass productivity of material that is recycled, through leaf-fall and/or pruning. Readily decomposed leaves and woody material.
(14) If deciduous, rapid flushing of new leaves to regenerate the shade cover.
(15) Absence of major disease or insect susceptibility which could lead to sudden defoliation.
(16) Small leaves to minimize rain drop coalescence and subsequent drip damage.
(17) No allelopathic properties.
(18) Smooth bark that does not harbour epiphytes.
(19) Valuable wood, fruit or other product, e.g. rubber from Hevea spp.
(20) Not an alternative host for insects and pathogens which are major enemies of the crop.
(21) Shade tree species should not have the capacity to become a weed e.g. Ricinus communis and Leucaena leucocephala (certain areas).

APPENDIX 4

SELECTION CRITERIA OF FIJIAN FARMERS FOR

AGROFORESTRY DEMONSTRATION PLOTS*

5A. Criteria for selecting cooperating farmers

1. Age: neither too young nor too old (maybe 35-45 is optimal).

2. Resident farmer: working with an absentee farmer is not desirable (see also Overton, 1988)

3. Prefer farmers who are already recognized leaders in their community: sector chairman, chief, Turaga-Ni-Koro**. (But be careful not to alienate the majority because of excessive backing of an elite group).

4. Reputation: is he respected by his neighbours as a successful farmer?

5. Recommendations: seek advise from local officials (e.g. M.P.I. locality field officers), reverands, retired teachers, etc.

6. Within the context of local land use, how well managed is the farm? Pick the best farmers from the target group.

7. In initial interview(s) how does he respond to the idea of a trial? Does he make suggestions? Avoid unresponsive farmers. (This assumes that the project has been adequately explained so that he understands the proposals).

8. Does the farmer (may include family but the farmer should personally participate) have the time to participate in a cooperative trial or does he show concern about the commitment required? (A responsible farmer would check what is required. However, avoid anyone who indicates he might not be available - collaborative trials are required, not land lent to the project).

9. Check his interest in the specific technology proposed for testing on his farm. He may be interested in only one of the project's activities.

10. Personality of the farmer: changeable or stable? Has he tried many new crops/technologies only to abandon the innovation before it was fully tested?

---

* It is highly unlikely that any one farmer will fulfill all criteria. This list is a guide to criteria that should be considered on a person-by-person basis, and it is intended to select the farmers with whom there is a high probability of establishing successful demonstration plots, who are not necessarily representative of the "average" farmer.

** In Fiji it may be preferable that the local political leaders are involved as informal assistants, reinforcing the suggestions from project staff, rather than as recipients, i.e. collaborating farmers.

11. Avoid farmers who also have outside incomes/jobs as being non-representative.

12. A farmer nominated by his group/mataqali/village is to be preferred if this does not compromise the criteria given in lists 'A' and 'B'. However, to avoid an awkward decision (when this is not so) it is better that the project makes the first choice, rather than to suggest that the farmers propose candidates.

5B. Criteria for selecting suitable sites

1. Proximity to established extension infrastructure: there would be a logistical advantage in working in a resettlement scheme, like Lomaivuna, where access to farmers is facilitated by roads, project office and technicians with considerable experience in the area

2. Proximity to other trial sites for logistical efficiency of project.

3. Central location with respect to other farmers who might be recipients of extension programme. Plot should be visible near a road, communal nursery or other meeting point.

4 Accessability: not more than 30 minutes from vehicle during rainy season (but not all along the main road!).

5. Secure land tenure: sufficient to guarantee that he or his family can harvest any tree products which may require a long rotation. Evidence of permanence on site (e.g. has he built a permanent home?).

6. Representative soil: the soil of a choosen site should be representative of one of the main soil types in the study area.

7 Site homogeneity: choose flat land or a constant slope; avoid plots with internal changes in soil fertility or spatially variable land - use history.

8. Drainage: should be good or easily provided; avoid areas subject to occasional inundation (unless a system is being proposed for areas which suffer this specific problem).

9. Wind susceptibility: avoid the most exposed, susceptible areas (subject to the condition noted in "8" above).

10.Existing tree cover: avoid areas with heavy forest cover in view of the negative demonstration effect of clear-felling and logistical problems of laying out a plot where tree stumps interfere. Avoid plots with large trees at less than 20 m from the border, due to early morning or late afternoon lateral shade.

11.Only one trial per farmer unless a demonstration farm is programmed. Spread the benefits and risks (for both parties) of collaborative demonstration plots.

12.Ecological suitability of site for proposed system: e.g. black pepper on living support trees needs well drained sloping land rather than flat, valley-bottom sites.

13.Plot security: what is the risk of damage by animals (e.g. proximity to goat herds is a disadvantage) or by people (e.g. proximity to collaborating farmer's house is an advantage).

14.Existance of farm statistics: it is an advantage if the M.P.I., or other organization (F.S.C.), can provide production statistics from previous years (e.g. farmers working on the ginger quota system).

5C. Specific criteria used by the M.P.I. to select farmers for ginger demonstration plots* in the Lomaivuna Project

1. Ginger production levels in previous years.

2. Has the farmer fulfilled his obligation to sell to a designated buyer in earlier years?

3. Has he followed recommendations in previous years?

4. Attitude to proposed management.

5. Quality of site preparation by farmer.

6. Evidence of initiative in carrying out improvements (e.g. finding alternative sources of artificial or natural fertilizers).

7. Availability of seed material which the farmer must provide.

8. Personal relationship farmer-extension agent.

---

* Personal communication Mr. Misieli Naivalu, Senior Agricultural Officer, Lomaivuna Project, Viti Levu, Fiji.

APPENDIX 5

INTERVIEW FORM FOR SELECTION OF FARMERS

PART I*

Farmer's name ________________________________ Estimated age __________

Date ______________________ Place ____________________________________

Interviewer's name ____

1. To which crops do you devote most time at present?

2. Would you be interested in planting timber trees on the land you cultivate? (which species?)**

3. Would you be interested in planting cocoa on the land you cultivate?**

4. Would you be interested in planting vanilla on the land you cultivate?**

5. Is there any natural forest remaining on the land you control?

6. Have you observed soil losses on any of the land you cultivate? (with which crop?)

7. Would you be interested in planting trees or shrubs to stop soil losses on slopes?**

8. Do you have any problem to obtain firewood?

9. Would you be interested in planting timber trees, fruit trees or something else along the boundaries of the land you cultivate?**

   If so what and where?

10. Can you suggest any other desirable way of planting trees on the land you cultivate (i.e. he would like to try it?)

11. Are you interested in establishing a demonstration plot or experiment on the land you cultivate (Note explain what they are again)?

    What kind of plot would you like to try?

12. What are your principal problems for agricultural or forestry production?

---

* To be completed with information given by the farmer.

** Note that these leading questions are included to prompt the farmer to discuss the topics of interest to the project. This is not a survey and the results should not be used as a statistic that "x"% of farmers are interested in any particular activity since the value will be artificially high.

PART II*

Farmer's name ______________________________

Date ____________ Place ______________________________

Interviewer's name ______________________________

(Instruction to interviewer –It is necessary to visit the farmer's land, in order to evaluate the management, before completing this section. Do not complete this section until after leaving the "farm". If it was not possible to see all the land managed by a farmer, or for other reasons it was not possible to respond to all the questions in this and the preceeding section, make appropriate indications, annotations, explaining the reasons when possible.)

1. Condition of any plants or trees which have been recently introduced onto the farm (e.g. cocoa, vanilla, fruit trees).

____

____

2. Quality of management of the land? (with respect to the average for the area).

____

____

3. Attitude of the farmer (does he look like a good candidate for a collaborating farmer)

____

____

4. Characteristics of potential sites for experiments (short description)

Homogeneous soil? ______________________________

Slope? ______________________________

Soil drainage ______________________________

Site irregularities ______________________________

____

---

* To be completed with the interviewer's observations after he leaves the farm.

Access to site ____

(Mark potential sites on the attached "farm" plan)

5. Does the farmer seem to be established in one place or is he likely to move on in the next 5 years?

PART III*

MAP OF LAND USE BY FARMER

Farmer's name ______________________________

Date ____________ Place ______________________________

Interviewer's name ______________________________

(Give very approximately the area and distribution of each main crop, pasture and forested land).

Note: Mark the farmer's house, access routes, and the approximate area of each plot (farmer's estimate).

Total area cultivated? ________ ha.

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* To be completed with information provided by the farmer whilst on the farm

APPENDIX 6

LETTER OF UNDERSTANDING BETWEEN AGROFORESTRY PROJECT AND FARMER*

Fiji - German Agroforestry Project:

Alley-cropping experiments with Dalo-Tapioka-Ginger.

This document is not a contract nor does

it have legal value

Based on discussions between the Fiji - German Agroforestry project and the Lomaivuna farmers, concerning the alley-cropping experiments with Dalo - Ginger- Tapioka, the attached table was prepared to remind both parties of their responsabilities, agreed verbally up to the date ______________ __________.

The project hopes that the collaborating farmers participate in all field activities, that they give their criticisms and suggestions with respect to all activities, and that they always regard the plot as their own and not as land lent to the project. Therefore it should be clear that all products from the plot belong to the farmer and apart from samples for quality control, the project makes no claim over these products.

The project will provide all necessary materials for this plot except for those that may be obtained on the farm (e.g. posts for fencing but see attached table for a complete list).

The principal responsibility of the farmer is to look after and protect the experiment against animals, weeds, fire and the entry of anyone who may cause damage. He agrees to not carry out any activity (e.g. fertilization, harvesting) without previous agreement with the project. The farmer also agrees to permit site visits of groups authorized by the project (e.g. Forestry or Agricultural Departments of the M.P.I.).

In the attached table, where the project only or the farmer only are marked, then the responsibility for that activity is 100% that of the indicated person(s). When both are marked then the responsibility should be equally shared between the two parties. Nevertheless, the project will try to participate in all the activities and it hopes that the farmer will always participate whenever project staff are present on his demonstration/trial plot.

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* Translated and adapted from the "Carta de Entendimiento" prepared by the CATIE-GTZ Agroforestry Project (Costa Rica)

DISTRIBUTION OF RESPONSIBILITIES

(Alley-cropping plots)

Activities	Responsible: Project	Responsible: Farmer
Plot measurement	x	
Clearing site		x
Staking	x	
Soil preparation (mounds etc.)		x
Planting holes		x
Planting tree lines	x	x
Planting crop	x	x
Weeding (manual)		x
Weeding (herbicide)	x	x
Tree pruning	x	x
Replanting trees and crop		x
Pesticide application	x	x
Fencing		x
Harvesting	x	x
Materials		
Equipment	x	x
Crop seed		x
Tree seed or seedlings	x	
Agrochemicals	x	
Fence wire	x	
Fence posts	x	x

APPENDIX 7

INSPECTION REGISTER*

Site: ____________________________________ Tipo de ensayo: ____________
Site No.: ________________________________
Experiment No.: __________________________
Date: ____________________________________
Name recorder: ___________________________

Species	Plot No.	Repetition	Insect attack	Disease attack	Wind damage	Animal damage	Fire damage	Observation
			1= little 2= moderate 3= strong					

Treatment applied? ________________________________ Date: ____________
Treatment applied? ________________________________ Date: ____________

Fence inspection: _________________________________ Repair date?: ____

Weed growth? _________ cm.

Tree Growth Cycles (Mark with x for phenological activity)

Species	Vegetative growth	Leaf fall	Flowering	Fruit or seed	Observation

Approval _________________________

* Translated and adapted from the "Registro de Inspecciones" prepared by the CATIE-GTZ Agroforestry Project (Costa Rica).

APPENDIX 8

Formulario No. 1

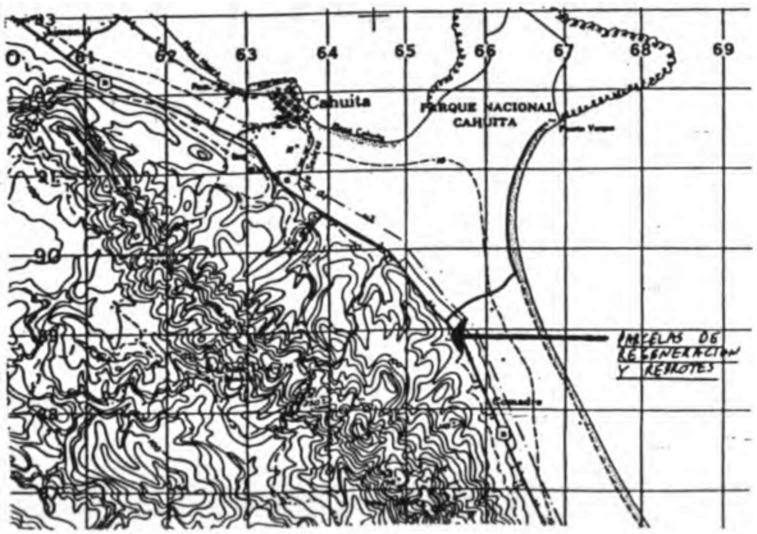
No. del Experimento 165-(79-16)

CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
Programa de Sistemas Agroforestales
Turrialba, Costa Rica

MAPA DE LOCALIDAD

Escala 1: 50000
1 cm. = 500 m

Publicado por el Instituto Geográfico de Costa Rica
San José, Costa Rica,
1: 50000 Hoja 3645-III ("Cahuita")
Ubicacion de parcelas 656 988



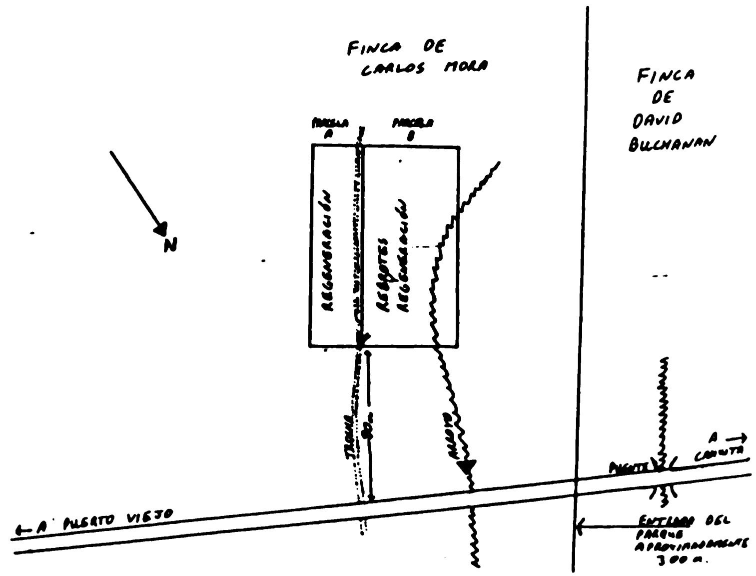
Formulario No. 2

No. del Experimento 165 (79-16)

CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
Programa de Sistemas Agroforestales
Turrialba, Costa Rica

MAPA DE LAS PARCELAS

Escala 1: 2000
1 cm. = 20 m



Formulario No. 3

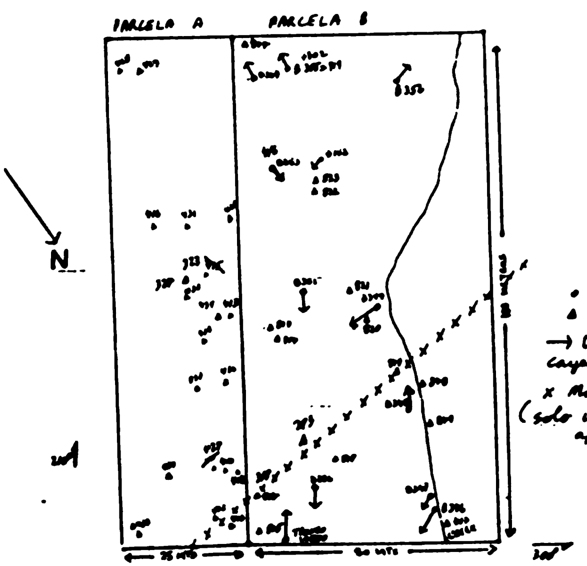
No. del Experimento 165-(79-16)

CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
Programa de Sistemas Agroforestales
Turrialba, Costa Rica

ESQUEMA DE LA PARCELA

Escala 1: 769
1 cm. = 7.69 m.

Ubicaciones estimadas



• Troncos
▲ Regeneración
→ Dirección en que cayeron los árboles
x Matas de cacao (solo una línea marcada, aproximadamente)

Formulario No. 4

No. del Experimento 165(79-16)

CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
Programa de Sistemas Agroforestales
Turrialba, Costa Rica

DESCRIPCION DEL EXPERIMENTO

1. NÚMERO Y NOMBRE DE LA LÍNEA DE TRABAJO:
Combinación simultánea de especies forestales con cultivos y pastos.

2. NÚMERO Y NOMBRE DEL PROYECTO: CATIE-UNU Project
"Prácticas Agro-forestales tradicionales de los trópicos húmedos". Cordia alliodora-Theobroma cacao. Un estudio de caso.

3. NÚMERO Y NOMBRE DEL SUB-PROYECTO:
Cosecha y regeneración de Cordia alliodora en plantaciones de Theobroma cacao.

4. NÚMERO Y NOMBRE DEL EXPERIMENTO:
Finca "Babilonia", Sr. Miguel Mora Monge
Finca "Buchanon", Sr. David Buchanon.

5. ESPECIES: Laurel (Cordia alliodora)
Cacao (Theobroma cacao)

6. INVESTIGADOR INICIANDO EL EXPERIMENTO: Eduardo E. Escalante

A) FECHA DE LA INICIACIÓN: Abril 1980

B) PROBABLE DURACIÓN: Indefinida

7. PERSONAL COLABORADOR:
John Beer   Paulo Dittel   Sr. Carlos Mora

8. RAZONES PARA LLEVAR A CABO ESTE EXPERIMENTO:

Una de las asociaciones agro-forestables tradicionales del bosque húmedo tropical es la de Laurel-Cacao, la cual es muy común encontrar en el área de Cahuita; basado en lo anterior se establecieron parcelas de mediciones en sitios representativos de este tipo de asociación como parte de un estudio de caso. Datos sobre la rata de crecimiento de laurel establecido en plantaciones de cacao (D.A.P. mayor de 20 cm) son factibles de conseguir, pero muy poco es conocido por los otros estados de crecimiento, necesario para mantener una cobertura o estrato superior de esta especie maderable de mucho valor sobre la plantación de cacao.

9. OBJETIVOS:

1) Establecer parcelas permanentes de demostración para el sistema agroforestal Laurel-Cacao.
2) Medir los daños ocasionados a la plantación de cacao como consecuencia de la tumba o cosecha del laurel.
3) Cuantificar el aporte económico, realmente aprovechable por el productor, por concepto de la venta de la madera de laurel.
4) Determinar la capacidad de laurel para rebrotar y mantener dichos rebrotes.
5) Tomar datos sobre la rata de crecimiento de los rebrotes y de los arbolitos producto de la regeneración natural de laurel.

10. LOCALIZACIÓN:

La plantación de cacao está situada 300 metros después de la entrada a Puerto Vargas, en la vía hacia Puerto Viejo, a ambos lados de la carretera. A mano derecha están situadas las parcelas de regeneración natural y de rebrotes, 80 mts. dentro de la plantación, desde la orilla de la carretera.
Hoja 3645-III (Cahuita) 656888

A) AREA: 0.75 ha

B) ELEVACIÓN SOBRE EL NIVEL DEL MAR: 30 msnm

C) ZONA CLIMÁTICA: Precipitación media anual: 2388 (1978)

Temperatura media anual : 25.8°C

Otras características climáticas:

D) TIPO DE SUELO*: Inceptisols
Typic Tropaquept-Principal
Aeric Tropic Fluraquent-Asociado

E) TIPO DE VEGETACIÓN:
Originalmente bosque húmedo tropical/Uso actual Asociación Cacao-Laurel

11. DISEÑO DEL EXPERIMENTO-ESTUDIO DE CASO: Datos de producción de madera comercial son tomados en toda la finca. Mediciones anuales de regeneración en una parcela con la densidad más alta de plantitas (0.25 ha). Mediciones anuales de rebrotes de laurel en una parcela con la densidad más alta de troncos (0.5 ha).

El volumen de madera de laurel, cortado y sacado de las plantaciones de cacao situadas en las fincas que cooperan con el ensayo, fue determinado trabajando con un equipo de taladores. El diámetro del extremo más pequeño de la tuca y el largo de la misma en varas, de pequeños grupos ampliamente distribuidos o de árboles individuales fueron medidos después de tumbados. Medidas tales como volumen extraído por hectárea, no pueden ser por lo tanto, tomadas o calculadas en forma empírica y deben ser estimadas a partir de la densidad de árboles por hectárea, basada en mediciones tomadas en parcelas permanentes que han sido establecidas.

Con el objeto de estimar el daño a la plantación de cacao, un área en la cual una alta densidad de laurel había sido extraído, fue localizada. Una parcela, de 50 x 100 m fue establecida en esta sección. Las ramas de las copas de los árboles que permanecían encima de las plantas de cacao fueron repicadas y quitadas de encima de las mismas, 3 meses después de tumbados los árboles, de manera que se facilitara la estimación del daño al cacaotal. Todas las plantas de cacao ubicadas dentro de la parcela y fuera de ella, que fueron afectadas o dañadas por los árboles de laurel (ubicados dentro de la parcela) al caer fueron incluidos dentro de la estimación de daño.

12. TRATAMIENTOS (INCIALES Y FUTUROS):

El manejo de los rebrotes debe ser llevado a cabo por los investigadores en cooperación con el propietario de la finca.

Si la plantación es abandonada por causa del problema o ataque de Monilia, su manejo debe ser continuado por CATIE.

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*Pérez, Alvarado y Ramírez, Asociación de sub-grupos de suelos de Costa Rica. San José, Costa Rica, Oficina de Planificación Sectorial Agropecuaria. Ministerio de Agricultura y Ganadería. 1978. s. p.

Formulario No. 4 (Cont.)

No. del Experimento 165 (79-16)

13. **MÉTODO PARA DESLINDAR Y SEÑALAR LA (S) Y LOS ÁRBOLES:**

Las esquinas de las parcelas fueron marcadas por estacas de madera que tenían pintado un anillo amarillo alrededor de ellas. Todos los troncos de los árboles de los cuales se tomó los datos de cosecha y aquellos localizados en la parcela permanente de demostración fueron marcados con pintura amarilla y placas de metal numeradas (B346-B356) (B314-B334) (B357-B365) (B379-B391) (B357-365) 799. Los árboles de regeneración natural ubicados en la parcela adyacente fueron marcados con pintura amarilla y placas de metal numeradas: (B425-B443) al igual que los ubicados en la parcela de rebrotes (815-823). La posición relativa de los árboles fue visualmente estimada y ubicados en mapas de las parcelas.

14. **MEDICIONES REQUERIDAS Y SUS FECHAS:**

Anualmente, preferiblemente entre los meses de marzo y abril se harán mediciones de altura, diámetro y densidad a los arbolitos marcados en las parcelas de regeneración natural; así mismo se contará el número de rebrotes en cada tronco en la parcela de sistema de rebrotes; a estos rebrotes también se les medirá la altura y el diámetro y se les dará el manejo necesario.

Se hará una estimación de la recuperación de las plantas de cacao dañadas por los árboles de laurel al caer.

15. **ANÁLISIS PROPUESTO DETALLADO DE LAS MEDICIONES:**

(Debe indicarse la magnitud de las diferencias esperadas en los resultados).

a) Número y crecimiento de los rebrotes en los troncos de árboles de laurel ya cosechados. Se determinará la altura promedio y crecimiento del diámetro de dichos rebrotes.

b) Altura promedio y diámetro de los árboles de regeneración natural.

c) Area basal y los incrementos en volumen para la parcela permanente.

d) Estimación del porcentaje de recuperación del cacao dañado.

e) Datos empíricos del volumen de madera cosechada por árbol y comparación de ésta con datos de volumen comercial potencial.

Formulario No. 5

No. del Experimento 165 (79-16)

CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
Programa de Sistemas Agroforestales
Turrialba, Costa Rica

DESARROLLO DEL EXPERIMENTO

Fecha e iniciales del que anota	DETALLES
Junio/Julio 1981 Jud.	Plantaciones abandonados por razon de enfermedad "Monilia". Algunos rebrotes de laurel suprimidos por las malezas. En la sesión del terreno que contiene los laureles Nº 314-319 todos los arboles (de cacao y de sombra) estan talados. El platano estuvo sembrado a 3x3 m en este sesión. Hay rebrotes de cacao y de los arboles de sombra pero estan dañados por herbicidas (inclusivo los laureles). En este mismo sesión algunos rebrotes de laurel han sido cortados al limpiar las malezas. En las parcelas de regeneración algunos laureles jovenes se les han hecho rondas para protección contra las malezas. La forma de los rebrotes de troncos viejos de laurel parecen peor que la forma de los arbolillos, producto de la regeneración natural.

El autor agradece a los doctores Jochen Heuveldop, Pedro Oñoro y Gilberto Páez, a los ingenieros M.S. David Boshier y John Palmer por su revisión y valiosos comentarios y al Ing. M.S. Eduardo Somarriba, por la traducción al español.

APPENDIX 9

CONTACT PERSONS*

Mr. Luke Ratuvuki, Director Agricultural Extension, Ministry of Primary Industries (M.P.I.).

Mr. Param Sivan, Director Agricultural Research, M.P.I.

Mr. Franko, South Pacific Commission Community Training Centre.

Mr. J. Balawa, Acting Principal Silviculturist Research, Department of Forestry.

Mr. Fatiaki Varamasi, Principal Agricultural Officer, Nausori.

Mr. Misieli Naivalu, Senior Agricultural Officer, Lomaivuna Project.

Mr. Timoci Salabogi, Locality Field Officer, Lomaivuna Project.

Mr. Eremasi Donu, Locality Field Officer, Nausori.

Mr. Sakiusa Bole, Field man, Waidina.

Mr. Jone Sega, Ginger farmer, Waibau.

Mrs. Naomi Saunivalu, Ginger farmer, Waibau.

Mr. Matai Nete, Farmer, Lomaivuna.

Mr. Maciu Talemaimaleya, Farmer, Lomaivuna.

Mr. Koroi Siganaivalu, Farmer, Naivurevure.

Mr. Waisale Nabokotia, Farmer, Wainawaqa.

Mr. Jone Matanimere, Senior Agricultural Assistant, Korovou.

Mr. Tanappa Mudaliar, Agricultural Technical Officer, Naduruloulou Research Station.

Dr. Randy Thaman, University South Pacific.

Prof. W. Clarke, University South Pacific.

Mr. I. Ali, University South Pacific.

Mr. Kilioni S. Turaga, Senior Agricultural Officer (Cocoa extension), Korovou.

Mr. Mesake Senibulu, Cocoa farmer, Waivora.

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* The author apologises to any persons contacted, whose names have been accidentally omitted from this list.

Mr. Vilikesa Paulo, Cocoa farmer, Vunivesi.

Mr. Lemeki Lenoa, Divisional Forest Officer, Western, Department of Forestry.

Mr. Joseva Nagauna, Forester Western, Department of Forestry.

Mr. Leon Sugrim, Research Officer, Fiji Sugar Coorporation (F.S.C.).

Mr. N. Shiromani, Technical Field Extension Officer, F.S.C.

Mr. S.S. Krishna, Field Officer, F.S.C.

Mr. V. Singh, Farm Advisor, F.S.C.

Mr. Alivereti, Farm Advisor, F.S.C.

Mr. Navin Chandra, Farm Advisor, F.S.C.

Mr. Devi Prasad, Sugar-cane farmer, Lautoka.

Mr. Ram Auter, Sugar-cane farmer, Lautoka.

Mr. Himmat Raniga, Sugar-cane farmer, Lautoka.

Mr. Ilimo Matitalula, Sugar-cane farmer, Lautoka.

Mr. Philip Alifereti, General Manager, Yalavou Project.

Mr. Sant Kumar, Project Manager, S.V.R.D.P.

Mr. Emosi Rabuka, Area Livestock Officer, West, Sigatoka.

Mr. Sanaila Turaga, Extension Officer, Yalavou.

Mr. William Lee, Accountant, Yalavou.

Mr. Tevita Balewai, Extension Officer, Lawaga.

Mr. Jone Rekomatu, Extension Manager, Yalavou.

Mr. Vikram Chand, Administrator Legalega Research Station, M.P.I.

Mr. Shiu Chand, Research Officer, Sigatoka Research Station, M.P.I.

Mr. Osea Tuinivanua, Fiji German Forestry Extension Project.

Dr. Kees van Tuyll, Fiji German Forestry Extension Project.

Mr. Martin Homola, Fiji German Forestry Extension Project.