# TECHNICAL EVALUATION OF LIVING HEDGEROW GARDENS IN HAITI

## REPORT OF OBSERVATIONS AND RECOMMENDATIONS

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PROJE PYEBWA, HAITI

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## EXECUTIVE SUMMARY

1. The report is based on extensive field visit in Region 1 (in and around Les Cayes) and discussions with farmers, field staff and PADF/AID/CARE/SECID and other relevant officials. It evaluates the technical aspects of on-going project, and suggests recommendations on improving them as well as designing a possible longer-term project.

2. Significant success has been accomplished in establishing hedgerows on farmers' fields in the project area. The gardens are usually less than one hectare, and are in terrains with rolling topography with slopes ranging from 25-50%. The most common hedgerow species is Leucaena leucocephala; several others are also being tried. The planting and management of hedgerows are left to the farmers, with the result that there is considerable variation in planting distances between hedgerows, their pruning schedules and other aspects of management. In addition to addressing soil conservation and site improvement, the hedgerows should also address fuelwood and fodder scarcity problems.

3. Leucaena leucocephala has proven to be the most successful and widely adapted hedgerow species. Although in some other places the species is reported to be weedy, competitive, and susceptible to psyllid attack, these negative features have not come to the surface in any serious form in the project area. The relative merits of a few other hedgerow species that are used in the project area are also evaluated in the report.

4. The hedgerows are spaced too far apart (an average of 10 m between rows) on slopes of 25-50%, so that the full potential of hedgerows is not realized in terms of either soil conservation or soil fertility improvement.

5. Most hedgerows are composed of only one species and usually in single-row thickness. Mixed hedgerows of tree species and a grass species, both planted on the same row can offer better soil conservation and provide different outputs (fodder grass and mulch). There is also scope to try various planting configurations.

6. Pruning regimes (height, and time/frequency of pruning) of the hedgerows need to be better understood and adopted in order to derive better benefits from the hedgerows. Various hedgerow species differ considerably in their response to pruning. Moreover, the use of hedgerows for production of fodder/fuelwood/green manure are mutually exclusive and competing options. Therefore, pruning schedules have to be situation-specific, and they need to be well thought-of.

7. The efficiency of hedgerows for site improvement can be expressed in terms of soil erosion characteristics, site (fertility) enrichment, soil moisture regimes, and crop growth and yield. Judging from visual observations (in the absence of field data) it is evident that hedgerows that have been established for about two years or more have contributed substantially to micro-site enrichment. An enriched micro-site can be delineated behind each hedgerow extending up to about 3 m up-slope from the hedgerow, where the accumulated soil has created a much favorable medium for crop growth, compared with the rest of the alleys. The characteristics of these micro-sites need to be quantified in terms of measurable parameters of soil-plant relationships.

8. The evaluation has brought to light a few technical inadequacies of the project. These include the risk involved in placing too much emphasis on one single tree species (Leucaena leucocephala) as the omnipresent hedgerow species, the reliance on he ad-hoc, trial-and-error approach (due to weak technical back-up and research support) for solving technical problem, and lack of adequate training and guidance of the extension agents. Scattered locations of the project sites (gardens) throughout a country like Haiti with poor communication networks make administrative as well as technical supervision and co-ordination difficult and inefficient.

9. The present project has a term of 17 months more to run. The most important management improvements during this period can be in establishment and management of the hedgerows. Wherever new hedgerows are established, their row spacings may be fixed at or near 5 m. Farmers may be persuaded to plant an additional row in between existing hedgerows that are widely-spaced at or near 10 m. Perennial fodder grasses may be tried to be incorporated along with trees along the hedgerows in new, and if possible, existing hedgerows. Efforts may be stepped up to adopt a rigorous pruning regime in existing hedgerows.

10. Technical monitoring from the project gardens may be undertaken during the remaining life of the project. Estimation of biomass production vis-a-vis species and pruning regimes, assessment of crop yields near and away from the hedges, measurement of microsite enrichment parameters such as soil moisture changes, soil fertility improvements and soil conservation benefits may be carried out from different locations.

11. The project has made substantial progress and considerable impact. The benefit of agroforestry approaches are just being understood by the farmers, and the barrier of their initial reluctance to accept new technologies is just being broken. The scope and enthusiasm generated by the project should not be allowed to dry up by abruptly terminating the project when its current life expires at the end of 1989. A follow-up project with similar objectives is highly recommended.

12. While hedgerow technology should continue to be a major technical aspect of such a longer-term project, the scope of the project should be broadened to include other aspects of agroforestry as well. Special mention is made of the scope for improving the fruit trees and incorporating them into agroforestry production systems. In extremely eroded and very steep sites, block planting of tree lots for production of fodder, fuelwood, etc. may be encouraged instead of hedgerow cropping.

Other suggestions pertaining to the longer-term project are:

- increased research capability should be built into the project to provide technical backstopping;
- demonstration farms with appropriate technologies may be set up at selected representative areas; such farms will also serve as "on-station" research sites;
- technical competence of the project staff may be constantly up-graded through facilitating their participation in training courses, seminars, etc.

- the limited project resources of trained manpower and money can be more efficiently utilized if the project is targeted on a few districts/regions instead of spreading too thinly over the entire country.

# 1. INTRODUCTION

1.1 This report is based on the extensive field visit undertaken by the consultant along with Mr. Michael Bannister in Region 1 (in and around Les Cayes) during 19-23 July 1988, and the discussions held with various PADF/AID/CARE/SECID officials and other relevant people before, during and after the field trip. See the accompanying report of M. Bannister for a detailed itinerary of field visit.

1.2 The scope of work of the consultant included an evaluation of the technical aspects of the project, including:

- the efficiency of hedgerows in contributing to the improvement of crops and soils;
- hedgerows establishment factors, in terms of species of trees and crops, length of and distance between hedgerows, etc.;
- hedgerow management aspects such as cutting/pruning regimes, operational schedules vis-a-vis constraints, etc.;
- parameters to assess the benefits of hedgerows in terms of soil conservation, soil fertility enhancement, crop yields, overall site improvement, etc.

1.3 During the initial briefing and discussions with PADF and AID officials, it was agreed that the consultant's report would deal with specific recommendations on the on-going project that is due to terminate at the end of 1989, as well as general programmatic recommendations for a possible longer-term project for up to 10 years after the termination, but as a continuation, of the existing project.

## 2. GENERAL OBSERVATIONS

2.1 The primary goal of PROJE PYEBWA living hedgerow gardens is to demonstrate to the Haitian farmers that they can improve the productivity of their farmland by planting trees as hedgerows on the farms and managing them as a routine part of their farm operations. The underlying technical assumption is that soil productivity will be improved by soil fertility enhancement (through organic matter addition and, sometimes, nitrogen fixation, by the trees) and reduction of soil conservation by planting the hedgerows along contours. Though not based on locally-conducted experiments, these technical assumptions are unquestionably valid in a broad sense; however, the

extent of benefits derived will depend on various site-specific factors such as soil type, magnitude of slope, management of hedgerows, types of trees and crops used, etc.

2.2 During the five days of extensive field trip, we visited about 20 sites (gardens), each less than one hectare in area, spread out in different parts of the region (Region I of the Project). In general, the region has a rolling topography, and all farms visited are on sloping lands with slopes in the range of 25-55%. The farms are owned/managed (land tenure situation not identical in all cases) by resource-poor, subsistence farmers whose basic farming system is an integrated mixture of crops, trees and animals, with little or no technical/external inputs, but high labor inputs. Governmental or other developmental assistance of any sort is usually unheard of, except in the project gardens, where extension agents ("animators") provide free tree seeds and technical advice on tree management. The planting and management of the tree hedgerows is, however, left to the farmer.

We also visited two farms that can be described as "on-station" trials, one by a church group (IRD, the development branch of the Baptist Mission), and the other by an AID-project affiliated entrepreneur (Mr. Sean Finnigan). These farms are run by technically-competent persons and the farm operations and hedgerow management are of a more "controlled" nature, according to technical standards.

2.3 The most commonly used hedgerow species is Leucaena leucocephala. Other species include Gliricidia sepium, Sesbania grandiflora, Cassia siamea, Albizia lebbek, Acacia auriculiformis, and, in some places, Samanea saman. The latter three species, wherever present, are in early stages of establishment in the gardens visited, and have not been pruned; so their coppicing behavior could not be assessed. Pruned hedgerows of Leucaena leucocephala and G. sepium showed that both species are extremely amenable to repeated pruning. Various other species have also been mentioned and/or recommended as possible hedgerow species, e.g. Simarouba glauca, Moringa oleifera; but their coppicing ability and soil conservation potential, and hence their value as hedgerow species, are doubtful.

2.4 There is considerable variation in hedgerow establishment and management. Most hedgerows of Leucaena and Albizia are established from seeds, and of Gliricidia from stem cuttings. (Availability of sufficient quantities of Gliricidia seeds/planting material is a constraint). While most hedgerows have been established on contours, thanks to the meticulous care of PADF animators, there is not much uniformity as regards between-row spacings and pruning regimes. Although a spacing pattern relating between-row distance to slope seems to have been recommended, the farmers do not adhere to this, and they space the hedgerows too far apart, thus limiting the effectiveness of the hedgerows for soil improvement or soil conservation. Cutting height and cutting frequency of the hedgerows are also variable which also affect their efficiency in terms of biomass production as well as shading of adjacently-situated crop rows.

2.5 The most common agricultural crops are maize, sorghum, pigeon pea, sweet potato, cassava, yam (Dioscorea alata), beans vegetables and fodder grasses, especially Napier grass Pennisetum purpureum. Maize is the most common crop in all the gardens visited and is usually grown in association with pigeon pea. Pigeon pea seems to have been dibbled on the same planting hole as maize when maize is at about tasseling stage, so that by the

time maize matures, the pigeon pea is about 50 cm tall, and almost starts flowering. On most farms visited, the maize crop has been just harvested, and sorghum that had been sown as a relay crop in standing (maturing maize crop) is about three-weeks old. Sweet potato and cassava seem to be grown year-round as is to be expected of these crops, the harvesting of which can be staggered in accordance with the family's food needs.

2.6 Most farmers identified fuelwood and animal fodder as major needs. It is a common feature that leucaena hedgerows that are left unpruned or cuttings that are laid as soil conservation mulch are stolen by neighbors to be used as pig feed and/or fuelwood, and, paradoxically, these people who indulge in stealing leucaena are the very same ones who do not wish to grow it in their own farms, seemingly due to its possible adverse effects! It is evident that fuelwood and fodder problems also need to be addressed in any farming system improvement scheme.

2.7 Judging from the general response of the gardeners as evidenced by the visual observations on upkeep and maintenance of the hedgerows, and also based on limited interviews with farmers and animators, the consultant is convinced that the project has accomplished its

objectives, and, that it is now in a "take-off" stage. The message is slowly but surely and steadily spreading. The effects of hedgerows and value of trees are being realized and appreciated. Considering the low level of subsistence farming conditions, the initial response to any such innovation can be very slow, if not negative. The project has accomplished the task of breaking this usually impenetrable barrier, and has successfully completed the most difficult and failure-prone early part of the running-in section of the take-off run. With renewed vigor and efforts, the momentum can now be accelerated considerably, and the expected benefits can be accomplished at a much faster pace in the next few years.

# 3. TECHNICAL EVALUATION OF HEDGEROWS

## 3.1 HEDGEROW ESTABLISHMENT

### 3.1.1 Hedgerow Species

A good hedgerow species should have the following characteristics:

- easy to establish
- adaptable to local site conditions
- fast growth and biomass production
- favorable litter quality and decomposition pattern

- nitrogen fixation and other ways of site improvement
- soil conservation capability
- good coppicing ability
- non-competitive interaction with other species
- absence of pests, pathogens and weediness
- multipurpose nature (fodder/fuelwood value)

Leucaena leucocephala has proven its merits on most of these attributes. The often-repeated drawbacks of the species include its competitiveness with other species especially under conditions of soil moisture stress, and its tendency for weediness. Signs of these drawbacks were not noticed in the project areas visited by the team.

Gliricidia sepium too has many of the above favorable attributes, its main drawbacks being the difficulty to get enough seed/planting material, and its poor fodder value.

Cassia siamea can withstand repeated cuttings, it sprouts back vigorously, and its

prunings are less-easily decomposed than those of L. leucocephala. However Cassia is not a nitrogen fixer.

Albizia lebbek is expected to do well in these conditions, and its performance needs to be observed carefully. Sesbania grandiflora, although a fast-growing nitrogen-fixing, soil improving species, has rather poor coppicing ability and soil conservation properties. Moringa oleifera is liked by farmers; but it has a weak stem and superficial root system, and may not withstand repeated prunings in the long run.

Although some other tree species have also been tried e.g. Samanea saman, Acacia auriculiformis, Simarouba glauca, and even Switenia mahogani, their values as hedgerow species are questionable. However, each one of these species is important and has a role in farming systems, but not necessarily as hedgerow species.

### 3.1.2 Hedgerow Spacing

The distance between hedgerows is usually decided based on the slope of the land (soil

conservation effect of hedgerow), climatic conditions (competition for moisture between the hedgerow species and the adjacently-grown crops), and biomass yield of the hedgerow species (vis-a-vis soil improvement). In humid lowlands, when there is no perceivable competition for moisture, and soil conservation is not a major concern (where slope is less than 10%), the usual hedgerow spacings in alley cropping vary from 4 to 6 m. In the present project, the average slope is about 40%, and the hedgerow spacing in most gardens about 10 m. This means a vertical drop of 3.75 m between hedgerows. Undoubtedly, this is an unsatisfactory situation for realizing the full potential of hedgerows in terms of both soil improvement and soil conservation.

3.1.3 Hedgerow Configuration and Species Composition. In most gardens a hedgerow consists of closely-planted (about 20 cm between plants) single lines of a single tree species. In some gardens, each hedgerow has a thickness of two or more lines of the same hedgerows. In a few places, a hedgerow will consist of a woody species planted in close association

with a herbaceous species such as grasses, such grass lines being either up-slope or down-slope from the tree line and the whole tree + grass hedgerow being up to 1 m thick. From the point of view of soil conservation, thicker hedgerows are more efficient. The efficiency will be more if the composition of the hedgerow involves a woody species and a grass species, because the tree with its deep top-root systems and the grass with its soil-binding but superficial root system can together provide better resistance to erosive forces. However, the effect of such a configuration on moisture availability to adjacently-grown crops and loss of area occupied by hedgerow for crop production are matters that need to be considered.

## 3.2 HEDGEROW MANAGEMENT

3.2.1 Pruning regime (time and frequency of pruning) of the hedgerow is one of the most important management consideration. The time of pruning will depend upon such factors as the nature of products, expected/desired amount of products, and the demand of products at specific times. For example, if

firewood rather than mulch for green manure is the desired product, the periodicity of pruning has to be less frequent, say once a year or three times in two years. On the other hand, if fodder is the main desired output, it will exclude the use of the leaf biomass for incorporation into soil, and maximum output would need to be obtained during the dry season feed gap. Application of mulch as green manure requires the pruning to be adjusted in such a way that the mulch is available to ensure availability of nutrients that are released by decomposition during the most critical periods of nutrient demand by crops. In general, green manure and fodder demands can be met from the same hedgerow because their peak demands are at different seasons (green manure during crop's growth and fodder during dry season); similarly, fuelwood and fodder demands can also be met to some extent from the same hedgerows. But the scope of using the same hedgerows for fuelwood and green manure is limited because green manure has to be used in relatively large quantities in order to be of any discernible benefit. Generally 4-5 harvests of a hedgerow are possible a year to

yield good-quality, easily decomposible green matter, if dry season does not exceed a month. However, in poorer soils, the frequency will be less. Although theoretical calculations are of limited value in these conditions, an approximate estimate gives the following yield from a leucaena hedgerow in a fertile soil: assuming four cuttings a year; each cutting yielding 1.5 kg fresh biomass per one meter of a well-established hedgerow; fresh biomass yielding 25% dry matter and 3% nitrogen for biomass dry weight, 100 linear meters of hedgerow can yield 100 x 1.5 kg x 4 times x 25% dry weight x3%N = 4.5 kg N/100 m leucaena linear hedgerow per year. If the hedgerows are spaced 5 meters apart, this will mean 90 kg N/ha/year, which is a substantial amount of N input to the soil.

In the project area, pruning regime has not at all been uniform, nor frequent enough -- about two cuttings per year on average. Farmers seem to be ill-advised, or advice is unheeded; they seem to decide the pruning regime based on their own judgement of requirements and conditions. In order to derive better benefits from hedgerows, their

pruning regimes must be handled more seriously.

3.2.2 Cutting Height of the hedgerow is important for regrowth of the branches and for the effectiveness of the cut hedgerows to offer resistance to erosive forces. Although no "standard" cutting height can be recommended for all species and all conditions, a "safe" recommendation, if it were to be made, would be a cutting height of 50 cm when the hedgerow is fully established. There is lack of uniformity in this factor also in the project area.

## 3.3 HEDGEROW EFFICIENCY

The efficiency of hedgerows can be expressed in terms of production attributes such as production of green manure, fodder, and fuelwood, or protective functions such as soil conservation, site fertility enrichment, soil moisture characteristics, etc. However, these direct and indirect benefits are inseparably associated, and more than one, if not several, criteria have to be employed to express the efficiency. Given the conditions of the project area as well as project objectives, the important indicators of hedgerow efficiency are soil erosion characteristics, soil

moisture changes, soil nutrient levels as indicated by plant growth, and crop yields near and away from the hedgerows. Quantification of all these parameters require periodic monitoring by competent individuals using simple and easy but acceptable methods. Most of the measurements have to be repeated over a considerable length of time in order to ascertain their validity, after the hedgerow systems have been established.

Many fields in the project area have young hedgerows; some of them have not been pruned even once. Obviously it is too early to draw any conclusion from such hedgerows. Nevertheless, some gardens have hedgerows that are two or more years old, and despite the lack of any technical measurements, certain indications on changes in some of the earlier-mentioned parameters can be clearly observed.

3.3.1 Site Enrichment (Enriched Microsite). Wherever natural terrace formation has been facilitated by the presence of hedgerows over a sufficiently long period of two years or more, a 2-3 m wide area up-slope from the hedgerow has been built-up by accumulation of soil from above the slope. This is clearly evident from the physical appearance of the

soil as well as relatively better growth of crops in this area as opposed to the rest of the area of the alley between hedgerows. This area can be called "enriched microsite".

The delineation of enriched microsite and a summary of hedgerow efficiency attributes are schematically presented in Figure 1. The width of the enriched microsite will vary considerably at different sites; in general, the enriched area will be narrower in steeper alleys.

3.3.2 Soil Moisture Characteristics. That the soil moisture retention is more in the enriched microsites than the rest of the alley is also clear from the visual observations.

Evidently, the presence of more soil organic matter and better physical conditions (moisture retention and aggregate stability) will contribute to more desirable soil moisture regimes in the enriched microsite, and their magnitude need to be quantified.

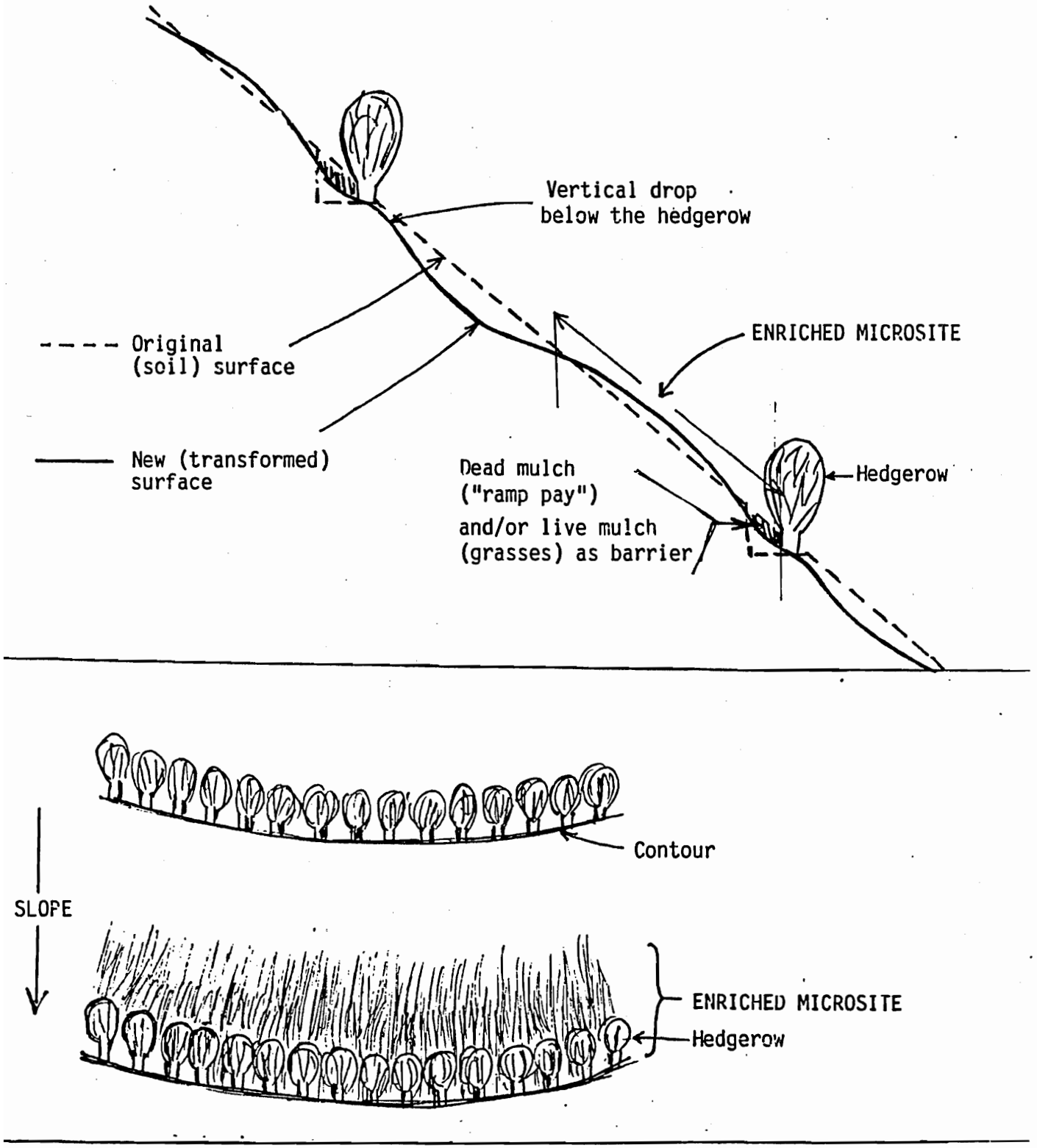


Figure 1. Schematic presentation of the formation of "Enriched Microsite" behind the hedgerows.

3.3.3 Soil Erosion Characteristics. Terrace formations behind (up-slope) the hedgerows are clearly visible in all gardens that have two-or-more-year-old hedgerows. In most places, a vertical drop of 30-50 cm down the slope just below the hedgerow is a common phenomenon. Terrace formation is more in places where the hedgerow is thicker (more than one line of trees, or trees + grasses). Signs of erosion around trees are visible in places where trees are planted in single lines and the inter-spaces between trees along rows have not been protected by grass strips or dead mulch. Farmers seem to be aware of this problem because in most places, they place twigs and branches of lopped hedgerows behind (up-slope) the hedgerows and thus provide a barrier to running water. The extent to which any possible improvement in infiltration rate would have resulted in reduced run-off cannot, however, be indicated without technical data.

3.3.4 Crop Growth and Yield. This again is obviously better in the enriched microsite, but measured data are not available. One clear indication that farmers are

appreciative of the possibility of better crop growth in the hedgerow plot as compared with the no-hedgerow plot is that in some gardens, farmers have planted a sorghum (and sometimes maize) crop before the harvest of first season maize in hedgerow plots, whereas the adjacently-situated non-hedgerow-plot owned/managed by the same farmer has not been planted with the second crop.

Yield of subsidiary products such as fodder and fuelwood could not be evaluated in the present study due to lack of any sort of data. The only anecdotal information was the stealing of mulch by "anti-Leucaena" farmers from the plots of their "pro-Leucaena" neighbors for use as pig fodder and fuelwood.

## 3.4 TECHNICAL DRAWBACKS AND INADEQUACIES

A technical evaluation loses its purpose if drawbacks and inadequacies are not pointed out and corrective measures suggested. The following points that have become obvious in the evaluation are mentioned here not to belittle the importance of the work that has been accomplished, but to aid in deciding future action plans.

3.4.1 Too much emphasis has been placed on one single tree species, Leucaena leucocephala, as a hedgerow species. Although leucaena is a remarkably well-suited species, and although a native cultivar of the species has been said to be in existence often in co-habitation with pests such as the psyllid bug (Heteropsylla cubana) that has assumed epidemic proportions in other countries, the risks involved in placing too much emphasis on one (or a limited number of) species needs to be highlighted.

3.4.2 The technical aspects of the project is based more on a "trial-and-error" or "hit-and-miss" approach rather than on scientific and technical evidence. In a relatively new scientific area such as agroforestry where scientific evidence on most of the essential aspects is not available, and the time taken to obtain such evidence from experiments is too long, some arbitrary and ad-hoc approach is justifiable. But while implementing such a major project, efforts should be made to organize at least a nucleus of scientific investigations to tackle the common field

problems, and provide continuous technical backstopping.

3.4.3 The extension staff (animators) seem to be inadequately trained/advised on technical problems and solutions. While hedgerows have been laid out on contours -- which is a definite indication that the animators can be made to do things correctly --, other technical aspects such as spacing of hedgerows, cutting regimes, species selection, etc. seem to have not received the deserving degree of attention.

3.4.4 Too much emphasis on hedgerows can be counterproductive. Hedgerows have their limitations too. They are not a panacea. In extremely steep slopes (over 50% slope) and very poor (calcareous and rocky) sites, where crop production is inadvisable, widely-spaced hedgerows with crops in between may not be the best option. Other planting arrangements such as bulk or zonal planting of trees need to be considered for such sites.

3.4.5 Hedgerow management should be location-specific rather than following a general pattern throughout the project area.

3.4.6 Scattered location of the project sites all over the country makes technical supervision ineffective and difficult.

# 4. RECOMMENDATIONS

The recommendations pertain to both the on-going project and a possible long-term, highly recommended, follow-up project. While those related to the existing one can be somewhat specific and action-oriented in nature, the recommendations on the follow-up project are of a general nature that will need to be translated into appropriate action plans by the project designers in due course.

## 4.1 EXISTING PROJECT

The project's life expires at the end of 1989. That leaves a remaining project life of 17 months. The first cropping season of 1988 is over, and the second grain crop of the year (sorghum, in most places) has already been sown. Therefore, what remains of the project's life is two cropping seasons but three rainy seasons. Although establishment of hedgerows of varied structure (nature and arrangement of components) can still be undertaken during the period, more effort should be on intensifying hedgerow management, and more importantly, on technical monitoring of existing hedgerows. The recommendations given below are of a general nature, and they will have to be modified appropriately according to site-specific local conditions.

4.1.1 Multispecies hedgerows are preferable to single species ones. Mixing a tree species with a grass species or another herbaceous species offers more benefit in terms of soil conservation (because of different rooting patterns and varying soil-holding abilities of the species) and yield of a more balanced fodder (mixture of species). Herbaceous species that could be tried include grasses such as Pennisetum spp., hybrid napier (P. purpureum x P. typhoides), Panicum maximum and Panicum coloratum (which is particularly suitable for dry regions); legumes such as Stylosanthes guineensis, fodder cowpea (Vigna unguiculata), etc. Using more than one tree species on the same hedgerow also could be tried.

4.1.2 Thicker hedgerows are better for soil conservation and site-quality improvement. But farmers will not accept thicker hedgerows on farms because of loss of crop-producing area. However, in most of the existing hedgerows, lopped branches from hedgerows or other plant parts ("ramp pay") are applied as a dead mulch behind the tree hedgerows to hold the soil back and reduce erosion. One

way of incorporating a herbaceous component with the tree component in hedgerows without unduly increasing the total thickness of the hedgerow is to use the space occupied by the dead mulch for growing the herbaceous species. This will necessitate corresponding adjustment of tree spacing within the hedgerow, leading to a reduction of the total number of trees per hedgerow without adversely affecting the hedgerow efficiency.

4.1.3 Hedgerows may be spaced more closely than at present. A vertical drop of more than a meter between hedgerows is unsatisfactory for soil conservation, but farmer reaction may not favor very closely-spaced hedgerows. Considering these contrasting factors, it is recommended that the average between-row spacing of 10 m (as at present) be reduced by half, to 5 m.

4.1.4 Managing the hedgerows properly is as important as establishing them, and pruning regime of the hedgerows is one aspect that needs to be improved considerably in existing hedgerows. The time of first cutting is important for facilitating proper regrowth:

plants that are cut too early or too close to the ground produce fewer, weaker and delayed re-sprouts. A rough rule of thumb to decide the time of first cutting is that a plant may be cut when it can be held tightly by the thumb and first finger from tip to tip, around the stem at the base; this will be about 3 cm basal diameter.

A cutting height of 50 cm is recommended for an established (2 years and older) hedgerow; earlier cuttings can be at lower heights.

Cutting frequency will depend upon the desired end product. If fuelwood is the product, cutting frequency may be limited to about one per year. But if green manure is the primary product (which is, or should be, the case in most instances), it is important that the hedges are cut at the proper time to yield succulent and easily decomposable biomass that can provide, after soil incorporation and subsequent decomposition, nutrients to crops at critical stages of the crop's nutrient (nitrogen) needs, and to ensure that shading effect of the hedgerow on crops is minimized. Considering these

factors, a cutting frequency of 4 times a year, two during each cropping season is recommended -- one just before sowing each crop, and the next one 6-8 weeks later.

Although it may sound trivial, it needs to be mentioned that cutting frequency will be less in drier regions, and pruning should not be done when soil moisture can be a limiting factor for up to one month after pruning.

4.1.5 Monitoring and measurement of soil and plant characteristics that can describe hedgerow efficiency may be undertaken systematically. A technical Coordinator, who is scientifically competent and familiar with Haiti should be recruited to undertake this task.

Plant parameters will include;

- crop yields near the hedgerows and away from the hedgerows in order to establish a crop-yield profile within an alley.
- biomass yield from hedgerows, expressed separately for fuelwood (wherever applicable) and leaf biomass.

Characterization and quantification of the enriched microsites can be undertaken by

periodic analysis of soil parameters at various points of transects from the hedgerows. The best and simple measure of soil fertility status is organic matter; additional measurements may include pH, CEC and nutrients, especially nitrogen. Aggregate stability, infiltration rate and soil moisture fluctuations will give indications on physical properties and erosion characteristics. The extent of erosion reduction by hedgerows can be checked by periodic measurements and comparison against "bench-mark" sites on both hedgerow and non-hedgerow plots.

Quantitative measures of complimentary and competitive interactions between the hedgerows and crops, and their effects on site productivity can be estimated from these plant and soil data.

4.1.6 Unfortunately there is no simple method that can be recommended with confidence, to be adopted by PADF field staff, to characterize the enriched microsite and hedgerow efficiency. A technically competent and experienced person can use a relative scoring system to estimate the extent of the enriched microsite and some of its visible effects in different gardens; but such a system cannot be recommended for general, large-scale adoption by a group of relatively inexperienced field personnel.

## 4.2 LONG-TERM (FOLLOW-UP) PROJECT

4.2.1 While hedgerows should continue to receive serious attention and efforts in the follow-up project, the scope of using trees on farmlands for better land management in Haiti may be broadened to include some other agroforestry approaches as well. After all, hedgerows have limitations too. They cannot be recommended for all types of lands and land-use systems. Some other agroforestry possible interventions are listed below:

i. Fruit trees. Various indigenous fruit trees play a major role in the nutrition and cash economy of rural people in Haiti. No serious effort has been made to improve them or integrate them scientifically in farming systems. The efforts in this direction are worth serious consideration. Different types of mangoes, bread fruit (Autocarpus heterophylla), guava, papayas, and a large number of indigenous fruit tree are included in this category.

ii. Intercropping and other forms of tree and crop associations. There are some tree species that are highly valued by the local farmers, but they can be poor hedgerow species; e.g. Moringa oleifera and most fruit trees. The best strategy for their integration on farmlands is by boundary planting around field plots, and/or growing them in a scattered manner on farms so that intercropping between or under them would be possible.

Tree species that are indigenous to, or have a long history of adaptation in Haiti, need to be given more prominence in these efforts.

iii. Woodlots. Hedgerows for alley cropping are of limited applicability and doubtful value in seriously eroded, very poor and extremely sloping (>50% slope) lands. A better technology for such lands would be to bring them under woodlots that produce fuelwood, small timber, fodder and mulch for cut-and-carry system, etc. and they can improve such sites in the long run. Recommended tree species include all species that can be used for hedgerows and others such as Acacia auriculiformis, A. mangium, Azadirachta indica, Casuarina equisetifolia, Cupressus lusitanica, Grevillea robusta, Tamarindus indica, etc.

iv. Short rotation fallows. There are some soil-improving, fast-growing leguminous woody species, the life durations of which are too short to allow them to be

grown as hedgerow species. Many Sesbania species such as S. sesban, S. aculeata, S. bispinosa and even S. grandiflora belong to this category. In some parts of Haiti, the land topography and other factors of land use are so unfavorable that farming is too risky and crop failures are as frequent as in four out of five years. It is recommended that these lands may be brought under short rotation fallows of 2-3 year duration to alternate with cropping cycles which will enable considerable degree of site improvement and soil conservation. Farmers who are used to frequent crop failures might not be very reluctant to try such approaches.

A schematic presentation of an "ideal" site utilization plan for the sloping farmlands of Haiti, incorporating these agroforestry options, is presented as Figure 2.

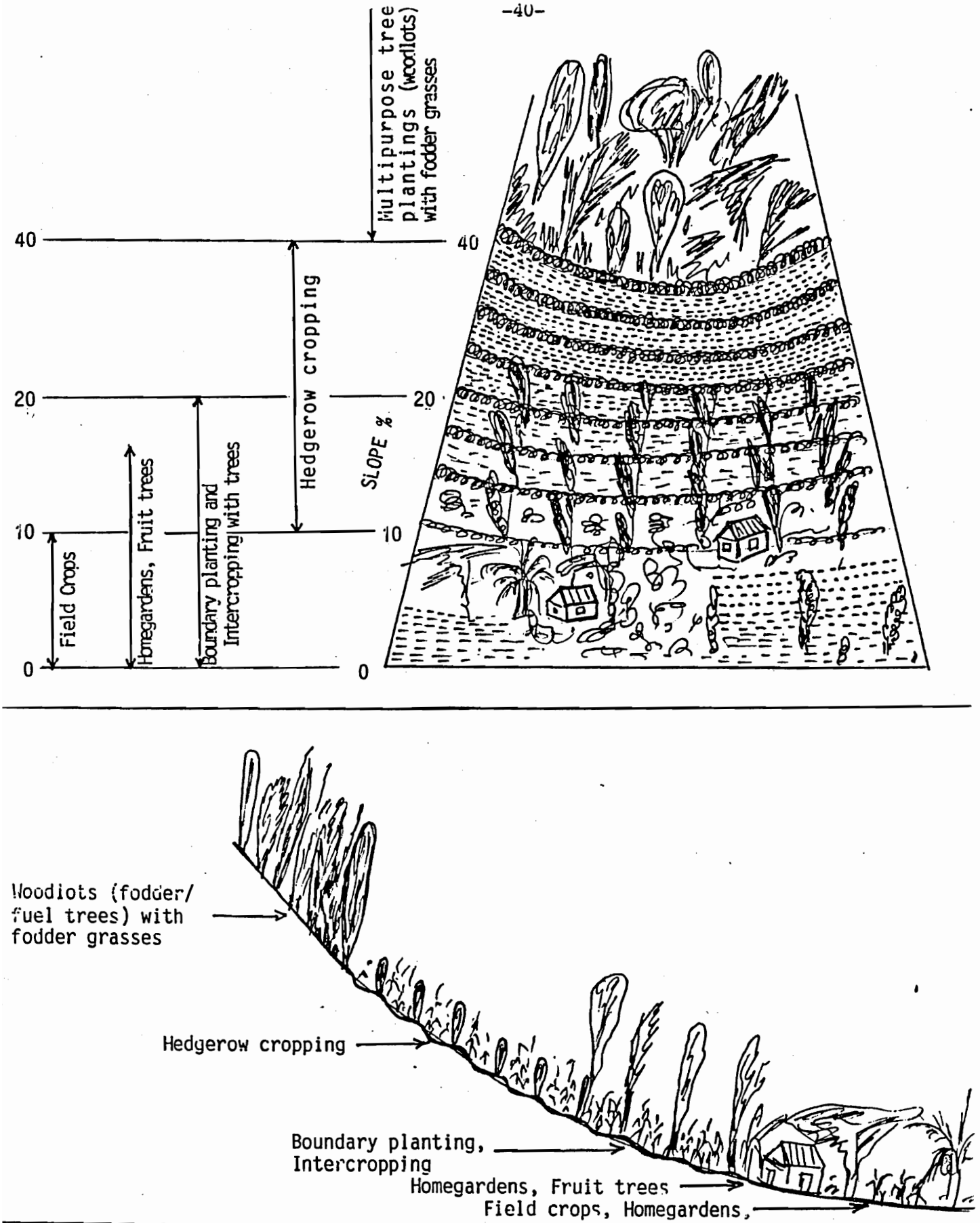


Figure 2. Schematic presentation of agroforestry approaches to sustainable land use in the sloping farmlands of Haiti.

4.2.2 A long-term project should have mechanisms for research support and technical back-stopping of the project on a continuing basis through the work of an effective and functional technical unit under a full-time Scientific Co-ordinator. It is recommended that demonstration farms at different representative regions throughout the country be set up by this unit, where some of the "improved" and innovative approaches could be tested and demonstrated, in collaboration with technically competent and cooperative voluntary organizations and individuals; and such sites could be used for "on-station" trials, evaluations and monitoring periodic technical seminars and farmers'days..

4.2.3 The technical competence of the project staff, especially field personnel, is a key factor for the success of such a development project. The field personnel will need to be acquainted and constantly up-dated with modern developments in relevant field-adoptable technologies. The project should have necessary mechanisms to facilitate participation of project staff in training

courses, seminars etc. elsewhere. Some organizations where such short-term (2-3 weeks) and longer-term trainings are offered at present are:

- ICRAF - International Council for Research in Agroforestry, Nairobi, Kenya.
- IITA - International Institute of Tropical Agriculture, Ibadan, Nigeria.
- CATIE - Center for Tropical Agricultural Research and Education, Turrialba, Costa Rica.

The University of Florida, Gainesville also has plans to initiate such short training courses.

The training courses and opportunities in these institutions are, however, of a professional nature. Therefore, these are not suitable for the field staff without required level of professional background and foreign language capabilities. It will be appropriate if the supervisory staff of the project are sent for such training, who, in turn, could be trainers of the field technicians.

4.2.4 Technical seminars for field (extension) personnel may be organized periodically, say, once every six months. The "on-station" trial sites recommended above could be the venue for such seminars. Farmers' days also may be organized on these stations to demonstrate the improved technology to farmers.

4.2.5 Trial of new tree species may be undertaken on a continuing basis for identification of appropriate species for eventual field adoption. Leucaena diversifolia, various Leucaena hybrids, etc. are candidate species.

4.2.6 The availability of seeds and other planting materials can be a serious constraints in such a large-scale project. Seed orchards for selected species, and procurement and importation of seeds from overseas will need serious consideration, in collaboration with relevant other organizations/agencies.

4.2.7 The financial and other resources needed to implement a longer-term project with broadened scope as outlined above will be much more than those of the existing project.

Given that Haiti is a country with rugged terrains, and limited communication network and other infrastructural facilities, it is doubtful whether scattering the project sites throughout the country would be the most desirable strategy to effectively utilize the limited resources and efficiently co-ordinate the activities both administra-tively and scientifically. Even if resources were not limiting, it may be too risky to extend the project throughout the country because the technical assumptions on which the project is based have not been substantiated by extensive field trials anywhere in the world. A more desirable approach, therefore, would be to limit the project to a few manageable regions/localities during the early phases and gradually extend it to other areas as experience, resources, and farmer interest become more plentiful. Such an "Intensive Area Development Program" is recommended as the operational strategy for a follow-up project.

## 4.3 CONCLUDING REMARKS

4.3.1 The existing project has made substantial progress and considerable impact. The benefit of agroforestry approaches are just being understood by the farmers, and the usually difficult-to-cross barrier of farmers' initial reluctance to accept new technologies is just being broken. The scope and enthusiasm generated by the project should not be allowed to dry up by abruptly terminating the project when its life expires at the end of 1989. A follow-up project withy similar objectives but broadened operational plans, more focussed activities and sufficient technical back up can be expected to provide the benefits that have just begun to be realized, at a faster pace in the next few years. Such a project is highly recommended.

4.3.2 The criteria to be used to measure the success of such projects may be defined realistically and the goals set within meaningful limits. Development administrators, donors and scientific evaluators should not have any illusions about

miraculous transformation of the peasant Haitian agriculture that are now at very low levels of subsistence farming, into a prosperous scientific farming system within the relatively short life span of a development project. Any change brought about by the project should be expressed in comparison not only with the situation at the start of the project, but also with what the situation would have been had there been no such project. The conventional methods of economic analyses, project evaluations, statistical techniques for research, etc. may not be able to accommodate the philosophy and objectives of such multiple-out, integrated peasant farming systems, and therefore, the results of such evaluations and assessments need to be reviewed with caution until modified analytical methods become available and acceptable.