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# LARGE-SCALE HILLSIDE RE-VEGETATION OF

# THE UPPER GRISE AND BLANCHE RIVER WATERSHEDS

**by**
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## LIST OF ACRONYMS

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| **ASEC** | Assemblée des Sections Communales |
| **ASOSYE** | Projet d'Appui à l'Association de Societé Civile |
| **ASSET** | Agriculturally Sustainable Systems and Environmental Transformation |
| **CAMCORE** | Central American and Mexican Coniferous Resources Cooperative |
| **CARE** | Cooperative for Assistance and Relief Everywhere, Inc. |
| **CIAT** | Centro Internacional de Agricultura Tropical |
| **CBO** | Community-based Organizations |
| **DFPC** | Direction de la Formation et du Perfectionnement des Cadres |
| **COSAR** | Coopérative de Saint André de Rendel |
| **ECHO** | Educational Concerns for Hunger Organization |
| **FGDP** | Fédération de Groupements des Planteurs de Belle Fontaine |
| **FORDEB** | Fédération des Organisations pour le Développement de Belle Fontaine |
| **HBF** | Haitian Botanical Foundation |
| **IFAS** | Institute of Food and Agricultural Sciences (University of Florida) |
| **IITF** | International Institute of Tropical Forestry |
| **NGO** | Non Governmental Organization |
| **NRM** | Natural Resource Management |
| **PADF** | Pan American Development Foundation |
| **PLUS** | Productive Land Use Systems |
| **PRESTEN** | Prese Sove Tè Nou |
| **REA** | Regional Environmental Advisor |
| **RGB** | Rivières Grise et Blanche |
| **SECID** | South-East Consortium for International Development |
| **UNICORS** | Union des Coopératives de la Région Sud d'Haïti |
| **USAID** | United States Agency for International Development |
| **USDA** | United States Department of Agriculture |
| **USFS** | United States Forest Service |
| **UTM** | Universal Transverse Mercator |

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## EXECUTIVE SUMMARY

This report covers the finding and recommendations to ASSET regarding the large-scale re-vegetation of the upper drainage basins of the Grise and Blanche rivers. The purpose of this study is to support the institutional strengthening component of NRM focused on direct- and broadcast seeding trials to restore degraded hillsides, decrease soil erosion and increase biomass production. The justification and rationale that supports this strategy is provided in the terms of reference (Annex 1), covering the period from November 16 – December 13, 1998. A schedule of activities and contacts with program-related personnel and institutions in Haiti are provided in Annex 2.

**Direct Seeding Trials** Five direct seeding trials were designed for selected sites in Section 1 of Belle Fontaine. Four of the trials were established during this period as an example of what could be done on a larger scale. Each trial is explained in detail with a trial map, description of the site, on modifications of traditional direct seeding practice, the needs of farmers to manage multiple-use species under strict economic constraints, and the desire of the farmers to explore land management strategies more suitable to sloping land. The sites were selected based on the participatory and organizational capacities of the farmers and the degree that the site was typical of a local land use category. Five woody species were selected for trial establishment, including the native *Colubrina arborescens*, an important house timber species, 3 woody legumes (*Leucaena diversifolia, Acacia angustissima, A. melanoxylon*) and castor (*Ricinus communis*). Further development of the trials, including the M & E activities relevant to direct- and broadcast seeding methods, are described in further detail.

**Integration of Landscape Elements with ASSET Interventions** The physical landscape comprising the watersheds is described according to the major land use categories reflecting the agricultural economy. Each category (annual field gardens, short-term fallows, tree-dominated residential areas and adjacent perennial gardens, water channel zones, secondary forests and public spaces) is described and followed by an appropriate set of technical and social interventions, here considered "ASSET Investment Opportunities." Together, these interventions form the core of an approach that is designed to mitigate the unsustainable environmental impacts of past and current exploitive practices. In order to expand beyond traditional practice, ASSET should continue to facilitate a series of support functions.

- Increase the availability and exchange of seed and germplasm representing a broad diversity of economic plant species adapted by functional land use;
- Recruit innovative farmers to form the nuclei of community-based NRM groups through participatory design;
- Provide access to a group of facilitators to assist the NRM groups in legal advice, conflict resolution, trainer-of-training workshops and the improved functioning of community-based organizations (CBOs);
- Facilitate technical assistance in a diverse array of fields: hydrology, animal husbandry, niche marketing, seed collection, crop storage and handling, soil conservation and agroforestry.

**Direct Seeding of Continuous Vegetation Cover** The direct- and broadcast seeding of continuous vegetation cover is considered in the context of key factors that determine program effectiveness. These should be taken into account by ASSET.

- Risks of species introductions, seed quality, and social constraints;
- Shift in land use strategies that are conducive to seed germination and incorporate social controls;
- Programming concerns focusing on germplasm quality, risk analysis and the indigenous knowledge of the farmers;
- Seed constraints regarding bottlenecks, both quantity and genetic quality;
- Traditional farming practices that can be modified to manage a broader suite of species;
- Innovative capacity of farmers to translate ideas to action, improvise and adapt to local physical, social and economic conditions;
- Community participation to build consensus and to identify community-wide priorities in environmental conservation and associated interventions;
- Participatory evaluation that meets the needs for information feedback and informed decision making by the beneficiary on a continuous basis.

**Community-based Capacities to Direct Seed** A diverse number of individuals and CBOs in the Mare Minerve area were interviewed to assess the local capacities to execute direct seedling trials and multiply successful ideas. Informants and trial participants were quick to understand the objectives and to improvise in response to anticipated benefits, change in land use and available resources. Criteria necessary for trial success should be explained in detail by ASSET facilitators to community members.

- Sufficient understanding of trial goals;
- Insight as to what inputs are required for adequate protection of the trial;
- Pro-active role in making principled choices to achieve trial goals;
- Ability to communicate effectively with community members and ASSET;
- Flexibility to innovate and improvise in response to unforeseen circumstances.

**Aerial Seeding** Social and technical considerations of aerial seeding were examined in the current context of the watersheds. The social concerns primarily focus on the need for community consensus and participation, including that of the Service des Ressources Naturelles, to share the risks and rewards. An educational and visionary perspective, as opposed to strict technical considerations, should be the inspiration of an exploratory mission. Technical factors that increase the potential for success focus on costs and economies of scale, species selection, site selection, seed bed conditions and predation. The Chauffard community in the Upper Momance River basin was visited to assess the feasibility of such an approach organized through a local NGO.

## I. INTRODUCTION

This report summarizes the findings of the author and offers recommendations to the USAID-funded ASSET project as part of the economic and environmental development of the upper watersheds of the Rivière Grise and Rivière Blanche. These two watersheds have been selected due to their strategic importance in the economies of downstream communities, specifically the increasing demand of fresh water by the agriculturally important Cul-de-Sac Plain and the growing Port-au-Prince metropolitan area. Together, the two basins provide an estimated equivalent replacement value of $59 million dollars per year of fresh water (Lowenthal et al. 1998) for irrigation and drinking water. An area of 700 $km^2$ that drains into these two rivers has been targeted for project intervention (Fig. 1).

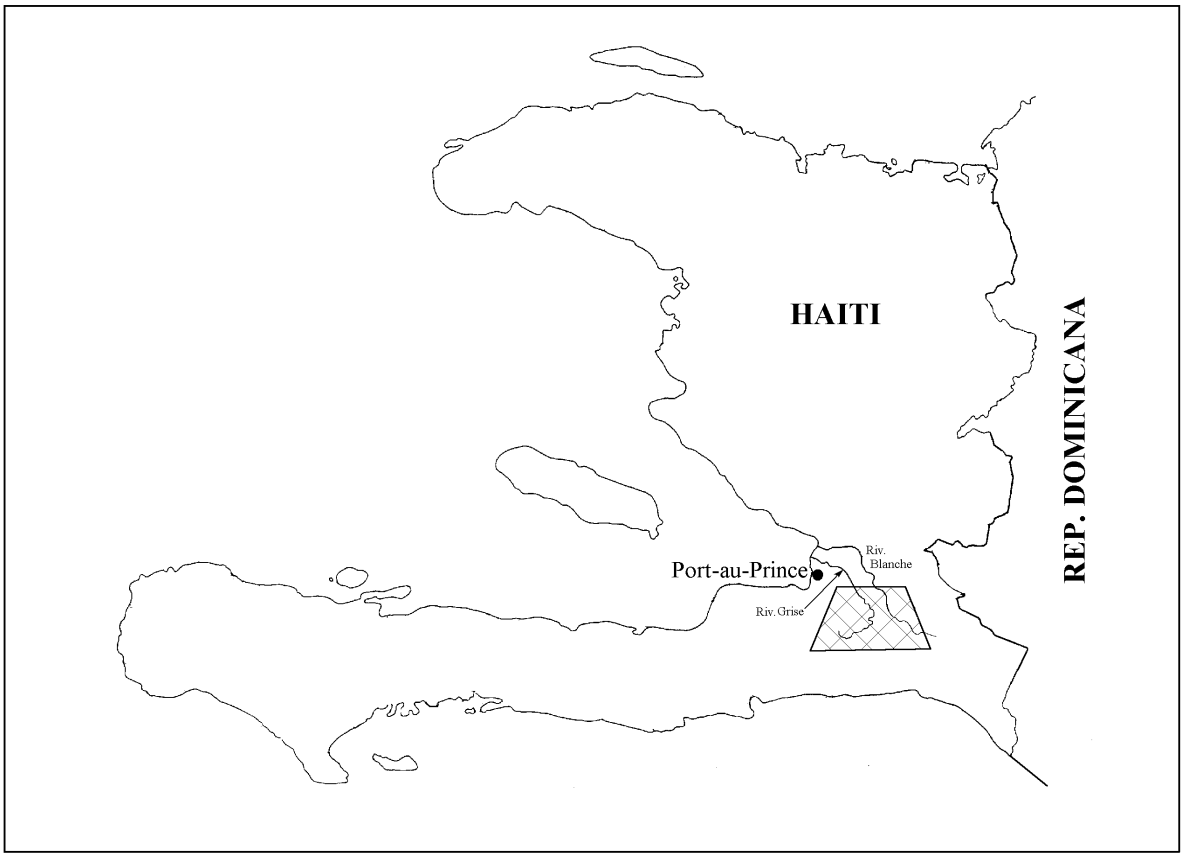



**Figure 1.** Map of Haiti showing ASSET project area described in this report. Boundaries are approximate.

Several options are being explored by ASSET that integrates natural resource management within a broader portfolio of strengthening the capacity of local institutions to respond to the economic, social and environmental needs of their communities. One option that is being considered is the feasibility of a large scale hillside re-vegetation program that combines direct seeding methods of economically

important plant species with community-based decisions to govern land use. An initial assessment of broadcast seeding options, including aerial seeding methods, was conducted in the summer of 1998 by the Regional Environmental Advisor (REA) for the USFS/IITF. The findings of the REA are included in Yocum (1998).

The purpose of the consultancy is to reinforce current ASSET activities that are promoting environmental friendly technologies, agricultural intensification and increased land productivity, economic diversification and institutional capacity building. Specifically, the author was responsible for the tasks summarized in the terms of reference (Annex 1). These focus on the social and technical aspects of large-scale seeding trials for re-vegetation of degraded hillsides, erosion control and increased biomass production. A schedule of activities and list of individual and institutional contacts made during the visit to Haiti are presented in Annex 2.

## II. OBJECTIVES

The maintenance of continuous plant cover on steep hillsides may appear improbable given the low value that such plant cover is generally attributed by the peasant farmer. Nevertheless, any ASSET project intervention that at least promotes this objective on principles of sustainability and good land husbandry should be given priority. The leading questions at hand are as follows:

(1) How can green cover be more permanently established or continuously maintained throughout the country?

(2) What are some of the social mechanisms that might effect the rate that green cover is permanently established and maintained?

(3) What type of green cover is the most appropriate for the upper drainage basins of the Grise and Blanche rivers?

The assumption is that some type of continuous plant cover is required to achieve acceptable levels of soil and water conservation. Furthermore, such vegetation cover can result only if it is supported by increased economic productivity and socially equitable arrangements associated with managing the land base. Based on these premises, the ultimate goal of ASSET is to improve soil and water conservation capacities of the target area selected for improved and sustainable economic development. This can follow several pathways, of which this consultancy focuses on promising social and technical elements that support the large-scale re-vegetation of the landscape.

## III. INTEGRATION OF LANDSCAPE ELEMENTS WITH ASSET INTERVENTIONS

The landscape of the upper watersheds, as seen from a bird's eye view, is a mosaic of vegetation cover predominately modified by the agricultural strategies of a highly dispersed peasant population. The social, economic and environmental milieu of these watersheds was analyzed by a multi-disciplinary team (Lowenthal et al., 1998). In general, the only part of the landscape that approaches permanent green cover are vestiges of the original forest cover on extremely steep and remote areas, residential areas more commonly known as *habitasyon* or *lakou*, and a combination

of secondary forest growth (*rak bwa*) and tree-dominated perennial gardens such as coffee groves. However, most of the landscape is in various stages of an annual cropping cycle that is rotated with grazing, resulting in a chronic state of disturbance that varies in intensity, frequencies and aerial coverage. It is this patchwork of highly disturbed and degraded lands that forms the theoretical target of ASSET's large-scale re-vegetation program.

Currently, ASSET is channeling assistance through the community groups that comprise a federation, Féderation de Groupements des Planteurs de Belle Fontaine (FGPB), headquartered in the first section of Belle Fontaine. Along the road that is being built from the Grise River to Mare Minerve, there exists the following categories of land use emerging from an agriculturally based economy. These are listed in order of their dominance in the landscape:

1) annually cropped agricultural parcels, currently in a mix of sweet potato, millet and congo pea;
2) short-term fallow lands currently being grazed by livestock, some of which will revert again to grain and tuber crops in early 1999;
3) tree-dominated residential areas (*lakou*) and adjacent perennial gardens;
4) riparian zones and water channels draining to the Grise and Blanche rivers, including ever-increasing amounts of severely degraded land (*tè glasi, roch glasi*);
5) secondary forests of varying age and structure, either due to relative inaccessibility or as *rak bwa* (woodlot);
6) public domain areas such as trails/roads and social gathering places (markets, church/schools).

Each functional category has it's logical counterpart in terms of continuous or permanent vegetation cover. Theoretically, each land use category can be converted to another. However, the general trend has been from natural forest cover to severely degraded land on the most fragile lands and from natural forest to agricultural land and urbanized areas on the least fragile land. It is improbable that severely degraded land could ever return to the quality of its native vegetation cover, though certain opportunities exist that might improve their hydrological function.

### 3.1 Annual gardens

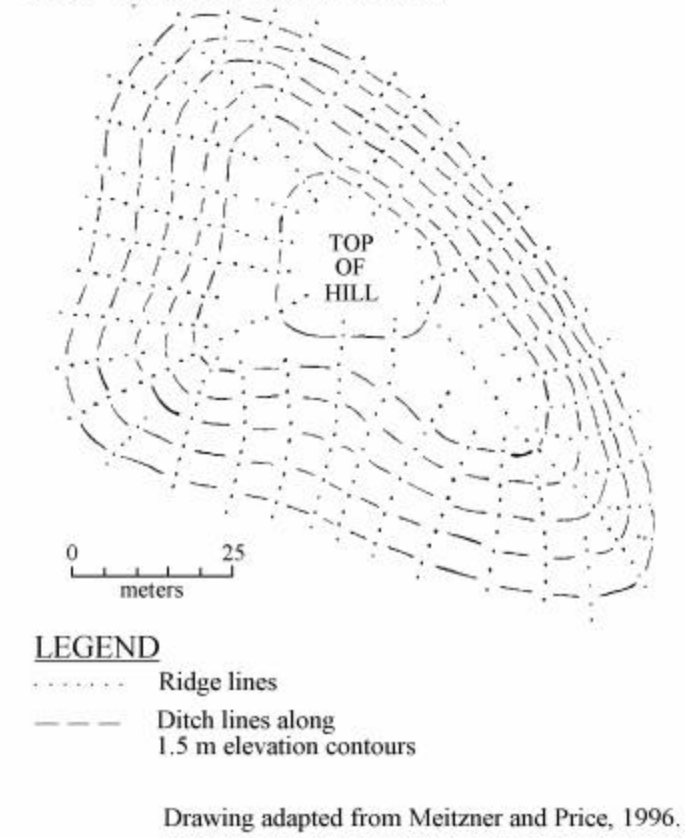
The norm is to clear the entire garden area of naturally regenerated vegetation for the cultivation of a mixture of annual and biannual crops, mostly grains and tubers. An occasional tree or shrub of economic value is left for shade or eventual harvest, but these have a negligible effect on soil conservation. The exposure of the soil to weather extremes, particularly torrential downpours, occurs periodically throughout the cropping season and is most vulnerable after clearing and until the crops reach canopy closure. Contour strips of natural vegetation left intentionally to mitigate the effects of runoff is not practiced.

Improved vegetation management designed for soil conservation typically comprise hedgerows, trash strips (*ramp pay*), gully plugs (*kleonaj, fasinaj*), rock walls and perennial forage grasses established

along the contour at intervals spaced according to slope. Most conservation technologies have been motivated through association with an outside organization (e.g., PRESTEN), but are uncommonly self-initiated or multiplied on a large scale as agricultural practice. "What's keeping multiplication from happening? How can this be improved?" are leading questions that should be addressed at the community level.

Labor intensive structures (contour canals, rock walls, terracing) is generally not practiced on a sustainable basis due to their low benefit:cost ratio. However, this may change as intensive gardening evolves with access to urban markets, the cultivation of high value vegetables, and an increased use of fertilizers and compost material. Under such conditions, it is plausible that labor intensive structures be considered necessary to protect one's investment in soil amendments such as fertilizer. One such example that should be explored for soil conservation is provided in Figure 2. Ridges are intentionally planted with soil-binding grasses to protect paths and avoid channeling runoff.

**Figure 2.** Ridge-canal-ridge system developed by Victor Wynne in Kenscoff, Haiti.




Drawing adapted from Meitzner and Price, 1996.

Cover crops and conservation tillage to minimize soil movement, manage weeds, improve soil structure and maintain green cover is generally absent in the target area. Lablab (*Lablab purpureus*), known locally as *pwa nouris*, is widely cultivated as a food crop at this elevation and should be managed more intensively in various strategies as a green manure and forage crop during vulnerable periods of soil erosion. Varieties should be selected accordingly.

**ASSET Investment Opportunities**

- Assist community groups in electing and training *animateurs* in conservation tillage, soil conservation technologies and management principles to organize on-farm diagnostics, planning, and evaluative methods.
- Monitor farm labor groups on improved vegetation management of annually cropped field gardens. Participatory activities facilitated by extension agents (*animateurs*) with such groups include the following steps: 1) diagnose problems, 2) clarify objectives, 3) determine methods of interventions, 4) develop plan of action to achieve objectives and meet stakeholders objectives, 5) implement plan, 6) monitor progress, 7) participatory evaluation, and 8) refine objectives and interventions to improve benefits and sustainability.
- Facilitate the access and availability of plant material destined for soil/water conserving vegetative structures, rotations including cover crops or conversion of land to improved pasture, tree-dominated perennial garden or *rak bwa* (see list of horticultural and forestry species below in Section 4.2).
- Improve soil conservation technologies with innovative designs adapted to site, preferably with locally available plant material. Incorporate live fence material in gully plug designs.
- Calculate the costs/benefits to the farmer or community group required to establish, maintain and improve soil/water conserving structures.
- Establish several model gardens in highly visible areas of the landscape with progressive farmers.
- Begin training-of-trainers program in vegetation management of annually-cropped gardens.
- Organize institutional building exercises designed to meet complex problems of resource sharing within community.
- Promote value-added marketing of niche market crops such as sesame (e.g., *Sesamum indicum* 'Inamar') and vegetables under intensive-gardening techniques that maintain cover crops and green manures (buckwheat, lablab bean, sun hemp) on soil during off-seasons. Adapt utilization of lablab bean (*pwa nouris*) for such purpose in the Fermathe area to local agricultural calendars.
- Promote the maintenance of natural regeneration for selected economically important plants.

**3.2 Short-term fallows/pastures**

This land derives from an annually cropped garden and is typically destined toward another one soon into the future. Thus, crop residues and weeds are typically what is available for grazing by livestock owned by the working group members. The grazing of crop residues, particularly by large livestock, contributes seriously to soil erosion on sloping land. Whatever is not grazed will eventually be tilled under for garden production. Hedgerows and forage grasses established during the gardening cycle are vulnerable to being over-grazed and often diminish in their soil and water conserving properties as a result. Rock walls, without the protection of being valued as terraces for the production of garden crops, are trampled by large livestock and broken down.

Soil conserving methods are oriented toward converting a portion of the land to permanent green cover (i.e., fodder banks), increasing forage production, timing the additional layering of forage grass

(e.g., *Panicum maxima*) prior to tilling or transitioning to a perennial garden. However, this makes little sense if not integrated with on-farm training of such fundamentals as animal husbandry and on-farm veterinary treatments, carrying capacities, improved pasture ecology and grazing rights. (Ex., a de-worming program may be more beneficial in increasing economic productivity than improved forage material). Furthermore, what has lacked in most project interventions of the past is assistance oriented toward male children who are often put in charge of changing livestock and determining their access to forage. The educational needs of the farmers and their children should revolve around the same labor pools that rotate livestock, using their combined land portfolios and livestock as an integral part of resolving constraints to animal and land husbandry. Rotational grazing, using more productive grasses, should be explored as a model among labor pools that can combine a series of sites for such purpose.

Browse resistant trees (*Zanthoxylum, Picrasma, Simarouba, Tecoma stans*), live fence species (*Comocladia, Yucca, Agave, Sambucus, Jatropha, Bocconia*) and wild herbs (*Lantana camara*) can be intentionally managed to diversify the product and service mix on the more degraded sites. Progressive farmers, larger landowners and leaders of the community groups or labor pools should be encouraged to establish silvopastoral parcels to serve as multiplication sites ('expanded nurseries') of improved pasture grasses, cover crops and seedlings from direct seeded or broadcast seeded areas (see Annex 2, Trial No. 4). However, such sites should be carefully monitored to confirm whether distance from primary residence and level of group participation are important factors in determining the security and control of land use affecting vegetation cover. Changing traditional grazing frequencies and intensities is difficult to change, much less manage under strained economic conditions. Community-based alternatives are not expected to be simple given the relatively high recurrent costs of protecting investments in improved forage production and social obligations of sharing increased returns. These are points to consider in a series of facilitated meetings with the community groups.

**ASSET Investment Opportunities**

- Establish forage and seedling multiplication parcels (expanded nursery approach) with high diversity of plant material for community group members. These can be designed as permanent pastures, though establishment and maintenance should be oriented toward optimum production for multiplication of site-adapted propagation material (cuttings, seed, stolons, seedlings).
- Direct seed pasture grasses and browse-resistant tree/shrub species along contour strips to enrich forage quality of fallow.
- Promote the management of naturally regenerated economic plants for wood, medicinals, teas and legumes, nectar and pollen, children's food. Enrich degraded fallow lands with higher diversity of economic plant species through direct seeding, cuttings and transplanting of wildings.
- Assist communities to organize the resolution of grazing rights, the execution of reasonable sanctions to control grazing violations, proper procedures for *arrêts* and associated environmental issues, particularly during open grazing periods of the year (like January - March slack season). Provide access to legal assistance and land surveyors if required.

- Promote alternative models of rotational grazing based on combined land portfolios of kin and labor pools. Link with introduction of improved pasture grasses, cover crops and browse-resistant trees.
- Assist communities in identifying fallow lands for designation as "red flag" zones for restoration, buffer zone management and perennial garden conversions. These include fallow lands that are particularly vulnerable to erosion and ravine formation (slopes greater than 60% on limestone soils; greater than 45% on basaltic soils) and requires immediate assistance in soil conservation technologies.
- Organize trainer-of-trainer programs to improve livestock management, including the control of parasite loads, increased diversity and quantity of forage material on land holdings and a component specifically addressing the needs of male children.

### 3.3 Tree-dominated residential areas and adjacent perennial gardens

The tree-dominated perennial garden, most often associated with homesteads, comes closest to meeting both environmental and economic needs of rural Haiti. This component can be improved with increased value in product mix of perennial plants and the maintenance of wind breaks to moderate weather extremes. In general, most of the trees and shrubs are fruit-bearing and traditionally propagated by seed. Project interventions generally focus on grafting and budding techniques to improve the commercial quality of fruit, resistance to disease and pests and improved processing and marketing. (*Interventions with fruit trees should be oriented toward the female head of the household*). Lumber species are improved by introducing improved genotypes or shifting to species that either decrease rotation age or increase the proportion of commercial grade wood products. Wind break species are selected that withstand the winds of exposed sites and offer a mix of shade, wood and minor products such as nectar/pollen for bees. (*Interventions with "wood" species should be oriented toward the male head of the household*). Perennial gardens are excellent sources of compost for adjacent vegetable gardens and nurseries to supply a sustaining source of plant material. Premium prices paid for products originating from shaded coffee production are based on marketing the environmental benefits to socially responsible consumers (e.g., migratory birds, organic and sustainable production).

**ASSET Investment Opportunities**

- Assist in the direct seeding of multi-tiered windbreaks on eastern edges of *lakou*. Certain species performed very well during Hurricane George: the introduced *Cassia fistula*, known locally as *kas*, *Alnus acuminata*, native *Zanthoxylum* sp. ("*bwa pini*"), *Acacia mearnsii, Grevillea robusta,* and *Pinus occidentalis*. Species prone to wind damage were *Cupressus, Acacia auriculiformis, Mimosa scabrella* and *Persea americana*.
- Assist in the introduction of a wide diversity of fruit, nut, spice and edible landscape plants to community group and backyard nurseries. Attempt to purchase new introductions in edible form and organize "taste-and-plant" exercises with community groups.
- Encourage the exchange of germplasm among community group members.

- Develop niche markets for those products already being produced in the area, but whose yields and profit margins can increase with incremental improvements in production management and processing: shaded gourmet coffee, *djon-djon* production, ginger, herbal teas, new vegetable cultivars, spices, and commercial fruit season production.
- Improve the quality of current fruit tree production with top-grafting or replacement with grafted stock.
- Organize trainer-of-trainer on horticultural techniques, especially grafting and budding; management of propagation material; seed production, harvesting, and handling; composting and preparation of nursery beds.

### 3.4 Water channel zones, including *roch glasi*

Due to the intensity and expanse of annually cropped gardens, abandoned land and unimproved fallow, the flow of runoff is generally unimpeded and quickly leads to rill erosion and ravine formation. The problem is exacerbated by the crisscross pattern of trails that channel water and remain a principal source of ravine formation if unchecked. The more gradual slopes of upper ravines are often cropped as tree-dominated perennial gardens, with the occasional rock wall to break the force of water flow. However, most ravines in the watersheds are untreated and feature exposed rock debris that eventually accumulates in the stream and river beds of the Grise and Blanche. Once erosion has proceeded to the extent of sheer rock and ravines of great magnitude, the capabilities of the average farmer or farmer group to adequately mitigate such problems are insufficient. In many cases, the costs of ravine stabilization are probably beyond current ASSET mandates.

Project interventions generally attempt to prevent rill and small ravines by establishing a series of trash barriers, gully plugs, rock berms and the establishment of edible plants behind the accumulated soil. Zoning such land out of any type of exploitative activity or instituting sanctions is an issue that ASSET should support through facilitated workshops with several pilot collective-action groups. Improved path and trail designs in heavy traffic areas included building the path on ridges protected by soil-binding grasses to prevent channeling (see Figure 2 above).

**ASSET Investment Opportunities**

- Assist community groups in prioritizing fragile areas prone to rill or ravine formation for treatment. (*Focus on prevention rather than remedy*).
- Facilitate the availability of designs that utilize locally available resources and add value to marginal lands.
- Stress interventions based on community or working groups that perceive shared stakes and benefits and are motivated out of common concern for the environment.
- Hire a hydrologist or environmental engineer on TA to assist in prioritization of target zones and to justify the investments of such zones.

### 3.5 Secondary forest and *rak bwa*

These are landscape elements that most nearly represent the original forest cover. Many are left intentionally for their yield of mixed products; others remain due to their inaccessibility, indivisibility (*tè minè, tè èritaj endivize*) or remoteness. If the secondary forest is in the early stages of the annual crop/fallow rotation, then usually a well-stocked seed bank and coppicing stumps of native species is present that reflects the original composition of the forest. The enrichment of these secondary forest patches with economically important plants is a promising alternative to grazing and environmentally more sustainable. Improved management of natural regeneration, particularly coppice growth, is typically lacking as a silvicultural method of the farmer.

**ASSET Investment Opportunities**

- Inventory and map the existing patches of remnant and secondary forest in the upper Grise and Blanche watershed.
- Enrich secondary forests with economically important plant species, including construction wood species, native fruit trees, melliferous plants, herbal teas, medicinals and edible greens.
- Design and incorporate simple models of natural regeneration and coppice management to supply construction wood.
- Monitor the conversion of secondary forest to land uses of higher environmental risk.
- Encourage community resolution to protect or conserve forest fragments, especially around springs, water courses, highly fragile areas and under private ownership.
- Provide access to legal assistance and a land surveyor, if necessary to resolve boundary conflicts and support the institutional strengthening of critical conservation areas determined by community consensus.
- Use forest fragments as instructional tools for schools, volunteer groups (e.g., Scouts), and tourists; as source of plant material and botanical study for nurseries, botanical gardens, ornamental industry and horticultural groups.

### 3.6 Public spaces, including trails/roads and social gathering places (markets, churches, schools)

Trails and roads have a significant impact on environmental quality because they channel runoff and cause serious erosion and ravine formation. Primary trails and roads linking localities are generally defined by borders (e.g., live fences) established around gardens for boundary markers and protection. However, most trails lack any investment in soil and water conserving structures, being that part of the "public domain" unattended by community or municipality. Shade trees are usually found around schools, churches, public squares and markets and are important loci for the gradual spread of useful species, especially by the transplanting of volunteers.

**ASSET Investment Opportunities**

- Facilitate the organization of community group assistance to landowners maintaining a "public domain" area of their private property, including boundary plantings, soil stabilization designs,

shade trees and windbreaks with live fence material, grasses and appropriate tree/shrub tree species (see below under **Roads**).

- Encourage the development of school nurseries and "botanical gardens" to combine education with cultural perspective of food, shade, aesthetics and practical horticultural knowledge among elementary students, their families and teachers.
- Assist local institutions and collective-action groups in the access of plant material for planned improvement of social gathering places, especially windbreak, shade and ornamentals.
- Facilitate the organization of collective-action groups to address "public domain" issues, particularly negative trail and road impacts on ravine formation and soil erosion, waste management, and public water systems (see below under **Rain Catchments**).

## IV. DIRECT SEEDING OF CONTINUOUS VEGETATION COVER

During the course of the consultancy, several direct seeding experiments were installed in the Mare Minerve area for future observation by the ASSET technical staff. These are covered in greater detail in Annex 3. The purpose of these trials is to study direct seeding as a method of establishing vegetation in a manner that improves both economical and environmental criteria of sustainable development. It is important that the following considerations be kept in mind on direct seeding program of any combination of plant species:

### 4.1 Risks

Direct seeding does not necessarily substitute for other methods of plant establishment, but rather should be considered complementary. It is an appropriate method species by species. Any large-scale direct seeding program is limited by the availability of large seed volumes within the time window required for successful establishment. General problems include seed viability, predation and relatively poor germinating conditions associated with difficult sites. In most cases, the costs of improved seed necessitates a nursery. Within the Haitian context, the traditional *"leve pou kont li"* (e.g., grows by itself) perspective associated with non-cultivated species may be a constraint. An additional limitation of direct seeding is the comparative difficulty by land users to distinguish a preferred species that's normally attributed to a well-developed nursery seedling or branch cutting.

Alternatively, a key advantage in direct seeding is the scale that land can be sown economically and the flexibility of sowing schedules, being able to mobilize labor during slack periods prior to peak demands. Direct seeding essentially changes the proportion of seed in the soil to favor those species considered economic without considerable economic risk. Mixing tree/shrub species with cover crops to manage weeds and moderate site conditions is an option that appears promising for more sensitive perennial species.

### 4.2 Shift in Strategy

Direct seeding strategies shifts the emphasis from managing individual plants to managing an environment conducive to germination (seed bed preparation) and incorporating social controls to

maintain a favorable environment. The necessary factors for either have hardly been worked out in Haiti, though several opportunities exist for both. In general, any intervention that departs too greatly from traditional practice is considered riskier, thus slower to be accepted as an improvement that merits adoption. Models that are simple to understand, requiring slight shifts in farming practice and building on the farmer's expert knowledge of plant cultivation, appear to have the greatest chance of success. If cross-boundary issues come to the forefront as a social constraint, than options to access legal assistance, land surveyors and mediators (or facilitators) needs to be seriously addressed by ASSET.

### 4.3 Programming Concerns

Any proposed large-scale seeding program should start out with realistic goals focusing on quality of germplasm, analysis of long-term risks (especially biological characteristics that increase liabilities.), and a thorough understanding of the necessary social and biological factors determining success. The innovative side of direct seeding should be in the hands of the farmers, building on their experience of the local ecology and the constraints they face when changing to a new composition of plant species. The members of the community groups whose land is at risk and who are the intended beneficiaries of any re-vegetation program should be carefully selected for leadership and innovative enthusiasm. Once successful pilot sites are located in strategically placed watersheds, then ASSET will need to determine how best to replicate the patterns on a larger scale. (Scaling up from a collection of agricultural parcels to emergent landscape properties requires a whole new set of constraining factors to be considered, largely the application of enforceable laws that protect the public good, change in environmental awareness and economic alternatives that indirectly result in increased plant cover).

**Why not introduce a species?** A recent appraisal in the buffer zone of Macaya National Park by the author revealed the negative unforeseen consequences of intentional introductions. *Calliandra calothyrsus* was introduced as a promising, high-elevation species for yam stake production, fuelwood, hedgerows, green manuring and forage material. Farmers dislike the continuous weediness of the species and furthermore, associate the species with a new caterpillar pest that was not abundant before introduction. They call this caterpillar "*cheni kaliandra*". Furthermore, weedy species displace native and endemic species (sometimes to extinction) and are a threat to biodiversity and ecological functions of native plant communities. This may not be of concern to farmers, but it does decrease future intrinsic and environmental values of the National Parks.

### 4.4 Seed Bottleneck

While it is tempting to introduce large quantities of seed from outside the watershed communities, this is risky both in the short- and long-term. Nothing is known of the adaptive quality of imported seed to new areas. It would be far better to allow farmers the opportunity to select for themselves a diversity of species for direct seeding based on the known performance of the species in the community. Scaling down to that of the individual farmer, seed would have to be available and considered worthy to be collected and integrated into the farming system . Scaling up to the community-wide level, incentives and sanctions would have to be instituted to increase the security of new investments, resolve potential conflicts and ensure that the optimum value be gained by a wider diversity of species. At this point, biological diversity should be matched with a trend toward economic diversification to reinforce the link between improved vegetation management and rural livelihoods. There is an issue of genetic erosion that is taking place through selective pressures associated with over-exploitation and "mining" of plant resources beyond their regenerative capacities. This can only be addressed through periodic import of a wider genetic base for target species.

### 4.5 Traditional Direct Seeding

Past direct seeding research in Haiti (Dupuis, 1986; Reid, 1991; Timyan, 1996; Welle et al., 1995) has been directed toward forestry species under ecological and social conditions quite different than the higher and more moist elevations of the upper Grise and Blanche watersheds. The results of these experiments should not be considered indicative of what will happen in the current ASSET program. However, the findings of Campbell (1994) in the Lascahobas area are culturally relevant and may be applicable in a general way.

- 21% of the trees found on farms were direct seeded – 9% of the wood species and 46% of the fruit species.
- Planting seed was the most common method for establishing fruit trees, but uncommon for wood trees that were mostly volunteers left in place or transplanted.
- Traditional propagation methods varied widely by species of both wood and fruit species.

**----------Wood Species----------**

*Roystonea borinquena* palmist, royal palm...22.5% direct seeded (75.2% volunteer, 2.3% transplanted volunteer)
*Simarouba glauca* fwenn, bwa blan, simarouba...2.2% direct seeded (87.5% volunteer, 1.2% transplanted volunteer)
*Colubrina arborescens* bwa ple, colubrina...6.6% direct seeded (71.5% volunteer, 16.5 transplanted volunteer)
*Swietenia mahagoni* kajou peyi, W. Indies mahogany...1.0% direct seeded (55.0% volunteer, 41.7% transplanted volunteer)
*Senna spectabilis* kas mawon ...21.4% direct seeded (42.1% volunteer, 2.1% trans. vol.)
*Inga vera* sikren...14.5% direct seeded (51.8% volunteer, 19.1% trans. vol.)

49 species...5.4% direct seeded (51.8% volunteer, 14.3 stem cuttings)

**----------Fruit Species----------**

*Mangifera indica* mango...55.0% direct seeded (41.9% volunteer, 1.2% trans. vol.)
*Persea americana* zaboka, avocado...70.0% direct seeded (27.2% volunteer)
*Citrus aurantium* zoranj si, sour orange...23.8% sown seed (70.6% volunteer)
*Citrus sinensis* zoranj dous, sweet orange...18.5% direct seeded, 23.3% sown seed (29.0% volunteer, 20.1% transplanted volunteer)
*Cocos nucifera* kokoye pays, Jamaican Tall" coconut...27.9 direct seeded (71.3% nursery grown)
*Crescentia cujete* kalbash, calabash tree...(95.7% stem cuttings)
*Cocos nucifera* kokoye Damien, Malaysian Dwarf coconut...40% direct seeded (60% nursery grown)
*Artocarpus altilis* labapen, breadnut...63.8 direct seeded (20.7% trans. vol., 15.5% volunteer)
*Annona muricata* kowosol, prickly pear...29.9% sown seed (55.2% volunteer)
*Citrus aurantifolia* sitwon, lime...19.3 sown seed (61.4% volunteer)
*Citrus maxima* chadek, pummelo...57.4 direct seeded, 14.8% sown seed (14.8% trans. vol.)

### 4.6 Innovative Capacity of Farmers

It might appear to the novice that peasant farmers are constrained by their limited resources to innovate - at least at the rate environmental experts consider necessary to adapt to a declining resource base and changing climate. But farmers do innovate and adapt and have an actual potential to do so very quickly, but economic conditions must allow for this to occur. There are members in every agricultural community that are agents of change, whose presence has introduced new ideas from travels outside the community and who are benefiting from adaptive technologies unique to the region. Sometimes referred to as model or progressive farmers, these are the community members that should be encouraged to explore new variations of direct seeding, landscape design features and the ecological relationships that ensure regeneration beyond that of the traditional short-term fallow.

Interest groups are based on mobilizing those with common interests so that exchange of ideas and resources is facilitated. The educational environment and the exchange of ideas in groups can be challenged toward further refinement, but only by considering the socioeconomic constraints of community members. Every farmer already direct seeds, but generally in response to market demand for fruit, grain and vegetable crops. To extend this to forage plants, timber species, enriched fallows or some idea of a preferred landscape design is possible, but economic and organizational constraints keep it out of reach for most community members. For this reason, outside assistance is necessary, if only to serve as an external stimuli and facilitate the process of translating ideas into action and producing results. Normally, this is associated with collective bargaining agreements and offering a critical level of insurance to cover liabilities. An indicator of ASSET progress is the degree that innovative and adaptive technologies are adopted in the area of intervention. This is done by interview since farmers are generally knowledgeable about the historical development of new technologies. Variants on traditional direct seeding, particularly land use, social facets and scale considerations, would be considered significant if the result is conservation of soil, water and biodiversity.

### 4.7 Community Participation

In terms of aerial seeding (see below), what can be done from the air can generally be done on the ground with the additional benefit of involving community in participatory decision making, morale building and participatory training and evaluation exercises. Certain key questions should be answered by the communities that are candidates for a relatively large scale direct seeding program:

i) What role will the community play in determining prescribed areas and ensuring security by consensus (i.e., resolving limits placed on resource availability due to change in local peer pressure)?

ii) Are these land management decisions and resolutions achieved by community consensus through a process of debate and issue awareness sessions, or do they tend to be the agendas of more powerful members best positioned to monopolize anticipated project benefits?

iii) What functional land use categories are most conducive by local consensus to new approaches in managing continual plant cover?

iv) Are new land management technologies making community members more self reliant or more dependent on external assistance from ASSET?

v) Is the community able to identify priorities in soil conservation and plant management technologies, define objectives, prepare a community action plan and participate together in self-evaluation methods that measure levels of satisfaction, progress and improved well being? Is a mediator required to arbitrate debate, resolve negotiations, emerge key issues, identify a common vision, organize multi-phase time and resource frameworks?

vi) Do the impacts of a direct seeding program involve all generations and gender? If not, why not?

Improvements in vegetation management beyond the scale of the agricultural parcel will require a careful analysis of the constraints and opportunities faced by community-wide resolutions that extend beyond that of traditional working groups (e.g., *won, skwad*). FGBP, having successfully mobilized the cooperation of community groups in road building, water catchment and cistern construction and group nurseries, will probably continue to attract new energy if leadership remains stable and centrist. The federation can serve as a platform for exploring new community-wide issues and one of these should definitely build on what has succeeded in other parts of Haiti to address the environmental degradation of the land. If prior adoption of soil conservation technologies is the most important predictor of collective action and continued group cohesion, then ASSET should encourage FGBP to select individuals with such credentials to form the nuclei of working groups that focus on vegetation management improvements. Cross-boundary issues will require trained *animateurs* to facilitate an organized shift in attitudes and the emerging social responsibilities and change in relationships associated with community-wide environmental efforts.

### 4.8 Participatory Evaluation

Any direct seeding alternative should be intentionally done with a control and evaluated by the community members themselves. (Outside inquiry is an option that should be considered as well to verify the conclusions of the local community). The costs associated with the treatment should at least be covered by the perceived benefits. This would have to be weighed against the "control treatment," which would be traditional farming practice (typical field garden in fallow), or applying socially acceptable controls on land use and allowing natural regeneration to take its course. Such might be the case if suitable alternatives are worked out at both the technical and social levels. For example, if control is tightened on free grazing, then acceptable alternatives would have to emerge to offset the increased costs of raising livestock. These alternatives might be maximizing organic matter production, increasing the economic value of plant species that exploit a given unit of land and instituting optimum land use rules by all community participants.

Assessing the effectiveness of a direct seeding design by the farmers themselves should include indicators that are visibly perceptible, link short-term economic gains with positive environmental quality, and elicit their levels of satisfaction and understanding of project interventions. Such indicators might include those listed in Annex 4. ASSET would need to provide trained personnel in methods of participatory evaluation to facilitate this process among the community groups. Training-of-trainers workshops in self-evaluation techniques are generally the most effective way to multiply this approach, following methods that have been successful in rural development projects (Mondjanagni, 1984; Rugh, 1992; Gubbels, 1994; Hochet, 1995). Such methods answer key questions to a participatory evaluation process:

- Why evaluate? (the need for feedback and informed decision making);
- Evaluation for whom? (local participants versus project);
- Evaluation by whom? (local beneficiaries versus project facilitators);
- Levels of evaluation (preparation, activities, teaching, learning, application, impact);
- When to evaluate? (timing when decisions are required: daily, periodic, project time frame);
- What to evaluate? (quantitative versus qualitative indicators);
- How to evaluate? (tools such as surveys, interviews, community meetings, pictures, drama);
- Communicating the findings and making decisions (evaluation as an educational tool immediately available to beneficiaries).

During the course of other USAID-financed projects in Haiti, particularly since the latter part of the 1980s, monitoring and evaluation has gone through various stages of development. An example of such M & E methods can be found in Pagoulatos (1993, 1994), Romanoff et al. (1995) and Turbo (1996). For the most part, these M & E procedures are project-driven to satisfy donor requirements and rarely address a commitment to community-based training and self-evaluative approaches.

### 4.9 Assessment of community-based direct seeding program

Directly responding to Task 1 of the consultant's responsibilities (Annex 1), 3 community groups (Mare Minerve, Meji and Grand Fond), 3 schools (*Lekol Notra Dam de Loud, Lekol Rama de La*

*Sous, Lekol Gran Fon*) and many of the leaders involved in community-building efforts in Belle Fontaine were interviewed. A detailed list of individuals and groups that were contacted during the field study is provided in Annex 2.

As most of the FGBF membership was involved daily with various ASSET interventions (roads, water catchments, nurseries) during this time, it was difficult to make a complete assessment. Regardless, it was relatively simple to sell the objectives/benefits of various direct seeding strategies ("solution selling") and find the families and groups willing to improvise, mobilize and participate in establishing the trials described in Annex 3. Both the number and aerial extent of the trials are easily expandable pending the programming priorities of ASSET during the upcoming year. The difficulties associated with establishing and maintaining a direct- or broadcast seeding trial increased in relation to the number of unrelated participants, the size of the trial and primary logistical factors associated with remoteness of site, scheduling conflicts and source of seed. (Though all seed established in the trials originated from PADF storage, the time required to organize and collect seed of *Pinus occidentalis* and *Tecoma stans* in the Mare Minerve was organized and collected within 24 hours. Seed harvested from the Wynne Farm required a week to organize and process for storage, including *Acacia mearnsii, Leucaena* spp., *Cypressus* sp., and *Mimosa scabrella*.

**4.91 Trial Participants**

Trial participants fall primarily along families and extended kin (Trials 2 (Saintilus family) and 3 (Ministre family), community groups (Trials 1 (Groupement Mare Minerve) and 4 (Groupeman Grand Fond 1) or *ad hoc* working groups based on community-wide interests (Trial 5). Trials 2–4 were established on land owned by individuals and with the landowner's full participation during trial layout and establishment. Trial 1 was established on land owned by the Catholic parish at Mare Minerve and controlled by parish members. Trial 5 will be established on land that is a mixture of inherited and purchased land. Certain selection criteria of trial participants will emerge as critical for trial success: 1) sufficient insight as to what inputs are required for sufficient protection of the trial; 2) pro-active in making principled choices in favor of achieving trial goals; 3) ability to communicate openly with community members and technical assistance team of ASSET and 4) ability to successfully bargain with ASSET. These criteria should be explained to the trial participants in early 1999 so that word-of-mouth can travel the community for expansion of the program.

Schools, religious institutions, CBOs nor NGOs were not included at this time *per se*, but past experience has shown that such groups are generally persuaded to innovative uses of land and open to appropriate trials that would benefit conservation and the community. However, CBOs and NGOs range widely in the degree of control they actually render over the land. Such organizations need to be carefully screened through interview with the local community concerning their reputation. Generally, a contact person or guardian is selected by the institution responsible for allocating the land after terms have been met concerning requisite security and maintenance issues. The guardian would work directly with ASSET to establish the trial and assume responsibility for maintaining security. The guardian would remain under management of the institution and all conflicts with land use would flow through the institution. Trial monitoring and maintenance responsibilities would be

worked out between ASSET and the institution. Land rent is generally not considered if direct- or broadcast seeded vegetation belongs to the institution. Benefits generally belong to the guardian as reward for services rendered.

The interview with the teachers and directors of 3 schools (Mare Minerve, La Source and Grand Fond 1) focused on the possibility of integrating nurseries and direct seeding programs with the school curriculum. The response by the teachers was positive. While it is optimistic that an environmental education program might be offered during the school year, other issues must be resolved such as how the teachers can be better supported by their constituency and a needs assessment in terms of their knowledge of teaching methods and classroom material that supports greater biological education. (See **Schools** below).

### 4.92 Site Physiographic and Land Use Features

Soil characteristics did not affect site selection. Three of the trials occur at the top of hills (mostly *tè demi frèt/demi cho*), one on a moist western aspect (*tè fret*) and one on a dry eastern aspect (*tè cho*). Most of the soils are derived from limestone (Trials 1, 3, 4, 5) with one that is of basaltic origin (Trial 2). Slopes range from flat to typically steep slopes of 65%. Most of the sites were formerly occupied by a mosaic of pine- and hardwood dominated forests and cleared for agriculture during this century. The most wooded site, Trial 2, is typical of the remnant patches of mixed hardwood and pine forests still found scattered throughout the region. All trials occur on land converted to annual cropping cycles. Trial 1 is now reserved as a nursery area near the Catholic church; Trial 2 occurs on land that is a mix of 2-year fallow and a recently harvested bean garden reverted to tethered grazing; Trial 3 is established with a mixture of pigeon pea and sweet potato; Trial 4 is established on a recently harvested bean garden that was reverted to tethered grazing; and Trial 5 occurs on land that is currently under a mixture of annual gardens, free browsing by goats and tethered grazing by cows.

## V. AERIAL SEEDING

### 5.1 Social Considerations

In addition to the issues of direct seeding, aerial seeding is a totally foreign practice in Haiti with associated fears of foreign intervention, unpredictable consequences and questionable community support. There is a persistent fear among peasant communities (and for good reason) of grand political schemes and ASSET certainly wants to avoid contributing to this.

Aerial seeding should be the consensus of local communities that have a vested interest in the land and will determine its successful outcome. Debate forums, with the goal of informing local communities and contributing to their educational needs, is a worthy effort that will require a commitment on the part of ASSET in terms of trained *animateurs* and facilitators able to negotiate and persuade both sides of the table. This is uncharted territory, so the process should be slow and selective. This is not to say that aerial seeding is an impossible venture under the current social,

economic and political context of rural Haiti. But it would require a concerted extension effort to parlay the vision and details beyond a gamble toward common sense at the local level. Regarding legal concerns, the active participation of the Ministry of Agriculture is appropriate, not only to build solidarity, but share the political liabilities and the risk/rewards of such an effort. Again, the whole effort should be considered in its educational and visionary context with the whole-hearted commitment of the Direction des Ressources Naturelles, particularly the Service des Ressources Forestières.

### 5.2 Technical Considerations

Yocum (1998) explored several constraining factors that should be considered prior to aerial seeding in Haiti. Among these, the most important would seem to be costs, appropriate species selection, site selection, seed bed conditions and predation.

⇒ **Costs** The high fixed costs associated with aerial seeding technology and the variable costs of high seed volumes demands that economies of scale be considered. It is unlikely that there are large tracts of land truly out of production available for aerial seeding to be economical. However, as an experiment, costs are generally considered less a priority than the knowledge and experience gained by implementing a new approach in Haiti.

⇒ **Species Selection** The ideal species would be able to remain viable, but dormant, until sufficient rainfall can ensure emergence and establishment rates, easy to manage (not weedy!), successional (i.e, disclimax species to be avoided), hurricane resistant, available in terms of seed volumes required, not a preferred food source (see *Predation*) and useful in terms of goods and services provided. Tree species such as *Colubrina arborescens* and *Acacia mearnsii* come close to being ideal. *Zanthoxylum* spp., *Pinus* spp., and *Eucalyptus* spp. are appropriate, though may suffer large losses to predation. *Calliandra calothyrsus* would seem too aggressive at high elevations. *Acacia auriculiformis* is of marginal economical utility and susceptible to wind damage. Grass species would be selected based on a combination of soil binding properties, forage quality and compatibility with tree/shrub species.

⇒ **Site Selection** The steepest slopes of the watershed seem to be out of the question unless significant investments were first made to break the force of water and allow the seed to remain on slope. Landslides and fires occur throughout the upper watersheds and are obvious sites for experimentation. Sites near residential areas are not appropriate due to any political liabilities associated with risks to human life.

⇒ **Seed Bed Conditions** Soil surface roughness would appear to favor aerial seeding success. Limestone skeletal soils (with abundant rocks) and grass-dominated sites are favorable sites due to their ability to retain the seed on slopes and provide conditions that would allow seed to germinate.

⇒ **Predation** Insects, rats, mice and birds are all likely to consume sown seed. No experiments to date have estimated the magnitude of predation, much less in the higher elevations during the ideal sowing season (end of winter drought). Experience in Haiti has shown that insects, mostly ants, consume much of the *Eucalyptus* and *Casuarina* seed that falls naturally to the ground– a likely reason why these species regenerate rarely in Haiti. The high oil content of *Pinus* and *Zanthoxylum* seed, as well as for many of the grasses, is relished by birds. If seed is sown when predation rates are low compared with other food sources on site, then timing of other variables, such as favorable weather, would likely be missed. At this stage, predation should be given a lower priority than favorable weather and sufficient seed bed preparation. Sowing rates are calculated to compensate for predation, much the same that occurs in nature. Environmentally safe repellents should be explored, which might be as simple as coating the seed with neem oil.

### 5.3 Prospects on the Upper Momance Watershed

On December 10, the author visited the Catholic parish of Chauffard with Fr. Julien Estiverne. Fr. Estiverne has expressed interest to ASSET about the possibilities of an aerial seeding project in his parish which includes much of the upper drainage basin of the Momance River. The river flows mostly in a northerly and northwesterly direction toward the Leogâne Plaine, where it supplies irrigation water for the fertile plains of Leogâne. The parish is located along the banks of the Chauffard River which flow into the Momance about 2 km downstream. The Chauffard irrigates thriving gardens of watercress (*Nasturtium officinale*) that is a valuable crop destined for Kenscoff and the urban market.

Given the time constraints, it was decided that the only reasonable option was to drive to Chauffard, 11 km due east from Kenscoff, for an overview of the landscape and background discussion of the prospects of interventions on the part of ASSET. The trip to Chauffard (via Godet, Belo and Clemensso), took approximately 2 hours with the 4-wheel drive Toyota and dropped 1,000 m in elevation to 800 m.

Fr. Estiverne pointed out the mountain range that he targeted for possible intervention. (He also mentioned the Débauché area west of Furcy as another area he would like to investigate). This range is west of the Momance River, lying between Morne Cochon (el. 1218 m), Morne Malanga (el. 1,235) and Morne Berly (el. 1,250 m). A chapel he visits in this area is about an 8-hour mule ride from Chauffard. The soils of the area derive from a mixture of basalt and limestone, highly eroded and covered with a mixture of grasses, herbs without the presence of the former *Pinus occidentalis* on the drier slopes and broad-leaved forests on the wetter sites. According to Fr. Estiverne, the area is too dry for vegetables and the local population mostly subsists in the same manner as other parts of rural Haiti. He indicated however, that the population is destitute in terms of options available for economic opportunity and that whatever was being offered by ASSET would be taken seriously.

The east facing slopes and ridges are relatively dry, being exposed to the weathering of continual wind and driving rain. Naturally, there is hope that shaded coffee or other economical variant of a

perennial polyculture can make a comeback, an option that appears unlikely except in sheltered conditions that occur in scattered fashion across the landscape. Though human presence appears to be low in many parts of the area, this is unlikely the case. Several questions came to mind concerning this area.

* What type of human and livestock presence occurs throughout the year on such sites relatively remote from human settlements?
* How does the local community view these lands in terms of their livelihoods?
* Are they willing to negotiate among themselves a set of rules and an organizational structure that would give aerial seeding a chance for success?
* Through what channels would the community be mobilized to respond , make decisions and take action on ideas put forward by ASSET?

When addressed with such questions, it became apparent that no serious discussion had taken place among these remote communities and that Fr. Estiverne was still exploring the more reasonable idea, in his mind, of establishing a nursery at Chauffard to propagate improved fruit tree varieties and coffee. These would be for distribution to members of his parish.

The next logical step is for ASSET to develop the above questions with the local communities that Fr. Estiverne has in mind to help. Direct and broadcast seeding trials, not unlike those established by the author in the Mare Minerve area (see Annex 2) should be established, preferably at the onset of the Spring rains, with local community members to answer several technical questions.

- *Seed bed and slope conditions*. Given the typical slopes (65%) and sparse vegetation cover on highly eroded basaltic sites, what is the establishment rate and movement of broadcast seed? Contour trenches would be installed at intervals of 5 meter to trap sediment and seed.
- *Appropriate species.* A mixture of quick-germinating green manure crops (*Crotalaria, Desmodium, Lablab*) and tree seed (*Acacia mearnsii, A. mangium, Colubrina arborsecens, Eucalyptus globulus, Pinus occidentalis, P. patula, P. oocarpa, Zanthoxylum elephantiasis, Z. flavum, Z. martinicense*) would be used. What is the relative establishment rate of broadcast seed? Is establishment rate improved by spot seeding? Should the seed of a cover crop be mixed with the seed of a slower-germinating tree species?
- *Predation and human presence*. Seed could be covered with a repellent, such as neem oil, or covered with screen traps to keep seed from rodent and bird predation. Human presence and the prevalence of livestock grazing/browsing pressure would have to be gathered from informal conversations with local community. What seasons are humans most actively present on the land? What is their purpose for being there? What are the social arrangements of those visiting the land or using it for any purpose?

## VI. GENERAL OBSERVATIONS

During the course of the consultancy, the author observed specific project interventions that might be improved to increase the economic potential and opportunities of the Grise and Blanche upper watershed communities.

◊ **Biomass Energy** Harvesting plant material for energy, either for domestic use or sale, has a direct impact on an integrated approach to conservation and vegetation management in the watersheds. "A tree saved is a tree planted." Several opportunities exist to increase energy conversion efficiencies and utilization of agricultural waste material. Briquetting is a technology that is currently in Haiti (contact Dr. Flannigan @ Albert Shweitzer Hospital in Deschapelles) that might be demonstrated to community members in the lower watersheds, like La Voute, where ample compost material and water is found. Dr. Flannigan is coordinating the adaptation of the technology in Haiti and has worked on designs that could be constructed and managed at the farmer level. ASSET should inquire regarding constraints, resistance to adoption, market potential of briquettes, and general acceptance of this technology to convert waste material to an energy source. ASSET should continue to take the lead in introducing alternative energy sources that are environmentally friendly and foster energy self-sufficiency of the local communities and meet the growing energy needs of economic development. A combination of solar, wind and hydroelectric systems should be studied for an integrated, regional approach. Improved stove designs for domestic cuisine and the processing of value added agricultural products (essential oils, roasting, bread making) would help tremendously in energy conservation.

◊ **Introduction of Horticultural Varieties** One of the greatest impacts that the ASSET project can have on the agricultural community is the introduction and multiplication of economically important plant species not currently available to the farmers. Attention should be given to genetic quality and diversity to allow the farmers the greatest degree of selection potential and success in site-specific adaptive processes. Too often, seed is purchased indiscriminately with a narrow or unimproved genetic base that limits its economic potential far after the project is terminated. Local improved seed sources should be coordinated with the PADF PLUS Seed Center or other reputable nurseries in Haiti and complemented with strategic and periodic imports from proven seed sources recommended by research institutions such as CAMCORE, CIAT, Forestry Research Center (www.zimbabwe.net/business/frc), Tropical Seeds, Ltd. (Siguatepeque, Honduras, Fax (504)-773-2767, Tel (504)-773-2339. ECHO (www.xc.org/echo/osseed.htm) provides seeds in small quantities of a wide assortment of useful plants. Imports should be spread throughout community-based nurseries as small seed lots to spread risk, geographic coverage and ecological conditions. Improved seed has shown 20-40% increases in productivity (both biomass and merchantable). Seed sources should originate from similar ecological conditions as target areas.

Species that should be considered for introduction that were deficient in the area:

**Fast Growing Quality Lumber Trees (to decrease rotation age, increase land unit productivity)** *Cordia alliodora, Grevillea robusta, Pinus patula, P. tecunumanii, P.*

*oocarpa, P. taeda,* Honduran/Belize/Nicaraguan provenances of *Cedrela odorata, Swietenia mahagoni* x *S. macrophylla* hybrid. Introduce at provenance and seed orchard level with seed from former IRG/SECID orchards and imported seed.

**Other Native Tree Species (selected for wood trees)** *Zanthoxylum* spp., *Ocotea* spp., *Licaria triandra, Lysiloma sabicu, Micropholis polita, Beilschmeidia pendula, Calaphyllum calaba, Mastichodendron foetidissimum, Prunus* spp.

**Useful Tree Species (selected for hardiness and browse resistance)** *Tecoma stans, Bumelia salicifolia, Mastichodendron foetidissimum, Picrasma excelsa, Zanthoyxlum elephantiasis,* Peruvian accessions of *Prosopis* selected from Thomazeau trial.

**Useful Tree/shrub Species (selected to attract birds, bats, bees and butterflies)** *Persea anomala, Sambucus simpsonii, Miconia* spp., *Ocotea* spp., *Chrysophyllum* spp., *Mastichodendron foetidissimum, Micropholis polita, Ficus* spp., *Roystonea borinquena, Eugenia* spp.

**Fast Growing Nitrogen Fixing Trees (windbreaks, poles/posts, fodder banks, shade, hedgerows, fuelwood)** *Acacia angustissima, A. mearnsii, A. melanoxylon, Alnus acuminata, Casuarina glauca, Leucaena diversifolia* x *L. leucocephala* hybrid (e.g., KX3), *L. diversifolia, Mimosa scabrella* (NB: *Mimosa scabrella* and *Acacia auriculiformis* are not wind firm and should not be considered for exposed areas. Wood of *Mimosa scabrella* of questionable quality. *A. mearnsii* does not coppice well. All nitrogen fixers should be introduced with species specific inoculants (*Rhizobium, Frankia*) ordered from such organization as Agroforester Tropical Seeds, P.O. Box 428, Holualoa, HI 96725 Fax (808)-324-4129 Tel (808)-324-4427.

**Other Fast Growing Trees or Ornamentals** *Eucalyptus globulus, E. grandis, E. camaldulensis, E. citridora, Auracaria excelsa, Bucida burceras.* (*Cupressus* spp., though attractive, are not wind firm).

**Fruit, Nut and Spices** Guatemala x W. Indian hybrids of *Persea americana* (late bearing varieties); commercial cultivars of *Citrus reticulata, C. sinensis, C. paradisi, C. aurantifolia,* and *C. maxima*; commercial cultivars of *Mangifera indica, Cinnamomum verum, Pimenta dioica, P. racemosa, Syzygium aromaticum, Malpighia glabra, M. punicifolia, Omphalea triandra, Morus nigra, Zingiber officinale, Allium sativum, Syzgium rosea.* The Kampong in Coral Gables, FL; Fairchild Tropical Garden in Coconut Grove, FL (305-667-1651); and the IFAS/USDA Tropical Horticultural Station in Homestead, FL (305-246-6340) are excellent sources of fruit, nut and spices that would be appropriate to the Grise and Blanche upper watersheds. Larry Schockman (Kampong) and Richard Campbell (Fairchild) can expedite shipments via DHL for plant material (seed, graft and bud material) and could exchange germplasm at little cost to ASSET.

**Green Manure and Ground Cover Plants (combine weed management, soil improvement and forage production)** *Desmodium intortum, D. uncinatum* (check availability from seed sources; adapt cultivation practice at the UNICORS/COSAR Grand Plaine coffee coop), *Fagopyrum esculentum* (buckwheat), *Lablab purpureus* (locally available in several varieties of *pwa nouris*; adapt cultivation practice in Fermathe gardens), *Crotalaria ochroleuca* (sun hemp; adapt cultivation practice from Mark Rutledge, Marmont, Haiti). Wider use of local *pwa nouris* and *pwa grate* (*Mucuna pruriens*) as cover crops should be investigated.

**Grasses (to bind soil, increase forage production, build soil carbon)** *Cynodon plectostachys* (stargrass), *Vetiveria zizanioides* (vetiver), *Panicum maximum* (Guineagrass), *Pennisetum purpureum* (elephant or Napier grass), *Sorghum* x *drummondii* (Sudan grass).

◊ **Polybag Nurseries** These nurseries should be perceived as important channels of improved horticultural varieties to the local communities. At the present time, there does not seem to be near enough diversity of economically important plant species. Furthermore, more discrimination is necessary of species selected for polybags. Varying volumes should be used to minimize waste and increase efficiencies (There are at least 4 bag volumes that are used). It was observed that a large number of polybags went to the field in times past and were planted in the soil with the seedling. This could be avoided through group demonstrations that includes 1) proper preparation of the planting hole, 2) removal of the bag, 3) root and shoot pruning techniques to encourage survival and plant vigor. Why are the nurseries located where they are? This same security can support a selection of key commercial varieties of fruit species in the vicinity of the nursery as budwood sources for grafting and budding opportunities.

◊ **Container Nurseries** At least one container nursery should be set up as a model nursery to increase the capacity to produce a large number of high-quality seedlings. If water and space is scarce, it only makes sense to conserve with increased efficiencies associated with container nurseries. The improved Winstrip should be compared with the Rootrainer for cost effectiveness and seedling quality. All sizes should be compared and a high diversity of vegetable and tree seedlings should be propagated from seed.

◊ **Seed Exchange and Storage** Sawyers in the area should be encouraged to collect seed for exchange or sale with seed distributors (e.g., PADF PLUS seed center) and nurseries in the Kenscoff and Port-au-Prince area. ASSET should promote the recruitment of candidate seed collectors, training of seed technology and handling methods and the exchange of propagation material (including seed) with the curators of botanical gardens and nurseries interested in the native flora of Hispaniola. Exchange with outside suppliers should benefit the horticultural basis of production and result in the increased diversity of economic plants in the watershed. Preferably, most propagation material used in the nurseries should be selected from within the watershed and ASSET should facilitate the communication and exchange among nurseries in the watershed. Strategic import of improved genotypes would be necessary to increase genetic

diversity of plant material throughout the watershed and this is most effectively channeled through the nurseries.

◊ **Rain Catchments** Land associated with water catchments links a valuable asset to potential area of seed production, windbreak, soil/water conservation. In the higher elevations, fog capture is an important source of precipitation and the ideal species are the cloud forest conifers (*Pinus, Juniperus* and *Podocarpus*. **NB:** Excellent opportunity to propagate endemic *Juniperus ekmanii*). Saturated soil surfaces would increase the amount of runoff to the cisterns. Woody perennials should be planted some distance from concrete to avoid root penetration and eventual maintenance problems. Instead, contour strips of vetiver separated by wider bands of a binding grass (*Cynodon* spp.: bermuda, African star grass) would be a useful trash barrier next to concrete catchment. No grazing should be allowed in the catchment areas.

◊ **Road from Rasard to Mare Minerve** Ditches should be planted to appropriate soil-binding grass. Live hedge or fence material (*Euphorbia, Agave, Yucca*) should separate public access from private garden at an agreed upon distance from the road (approx. 3 m). Owners of private land bordering the road should be encouraged to plant a mix of wind resistant shade trees and hardy shrubs such as *Cedrela odorata, Grevillea robusta,* thornless *Acacia*, *Buceras bucida*, *Zanthoxylum* sp., *Swietenia mahagoni*, *Mastichodendron foetidissimum, Tecoma stans*. Culvert areas, where water is channeled away from the road, should be engineered appropriately to break the water force (canals planted with soil-binding grasses, bamboo, vetiver, sugar cane) and fan it to water catchment areas planted with fruit trees. Community groups should be encouraged to adopt their section of the road and build a sense of pride by keeping the road clean, maintained and voicing their opinion on necessary improvements.

◊ **Schools** All the schools in the Belle Fontaine area are elementary and many of the instructors volunteer their services. There is an opportunity for greater environmental education, practical skills and support of the volunteer spirit that is keeping these local institutions alive. Field science, art, exploration and experimentation seem completely absent from the curriculum that would raise levels of self awareness, environmental pride, sense of place and analytical skills. Biological understanding can be encouraged by drawing landscape elements, creating drama and role playing sequences, direct seeding a small patch of land with a wide diversity of native tree, shrub and herb species (particularly bird and bat attractors), linking local schools with urban schools through pen pals and organizing a small nursery to grow plants for the school and take home. Educational games, clubs (e.g., Boy or Girl Scouts) and sports are lacking.

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## Annex 1. TERMS OF REFERENCE

### Position Title

Forestry Consultant for large-scale re-vegetation trials

### Purpose

To reinforce select community groups' institutional capacity for NRM through participatory design, organization and implementation of large-scale seeding trials for re-vegetation of degraded hillsides, erosion control and increased biomass production.

### Background

Following a year of experience working in the upper watersheds of the Rivières Grise and Blanche (RGB), ASSET project personnel have developed a good rapport with community groups in the region. With repeated visits to the area and discussions with farmer group representatives, ASSET has been successful in promoting participatory planning and implementation of development activities. To date, these initial activities have focused on institutional capacity building, the establishment of tree nurseries, the construction of rainwater catchment systems, and the extension of improved agriculture and soil conservation techniques. Cooperation with and among community groups has been outstanding.

In July 1998, at USAID's request for technical assistance, the Regional Environmental Advisor (REA) for the USFS/IITF visited the RGB with ASSET personnel. One of her specific tasks was to examine the feasibility of prospects for aerial seeding of the degraded hillsides. In her subsequent report, based on field visits and background research, recommendations were not limited solely to consideration of aerial seeding, but considered other promising forms of broadcast and direct seeding for hillside re-vegetation. The tasks described in this TOR are intended to further conceptualize and implement the recommendations and strategy for large-scale hillside re-vegetation outlined in the REA's report.

### Justification

For decades, USAID and other donor agencies have been actively funding projects aimed at environmental restoration of Haitian hillside farmlands. Despite massive injections of technical expertise and capital, Haiti's environmental condition has continued to worsen. Clearly, the classic approach of hillside reforestation has been an insufficient response to a complex problem that involves an increasing population relying on a shrinking resource base, resulting in ever-deepening and widespread poverty.

Recognizing that land use patterns are often dictated by a complex web of socio-economic factors, ASSET proposes building upon the strong relations it has established with community groups in the

RGB area to promote the behavioral change necessary for environmental transformation. This change will be effected through the design of appropriate and effective re-vegetation trials that will ultimately be managed by concerned community organizations for improved community-based NRM. Astute and experienced TA is requested to augment ASSET's in-house technical capacity for the design and implementation of such trials in order to assure a greater degree of success.

**Responsibilities**

The Consultant will work under the supervision of the Community Development Specialist and in close collaboration with ASSET technical and administrative staff in the performance of the following tasks:

1) Establish contacts with a variety of designated community groups (CBO's, NGO's, schools, religious institutions, etc.) to ascertain those most willing and capable of participating in trial plot design and management.

2) Perform site visits to determine the appropriateness of proposed trial sites; consider both physical and social (e.g., land ownership, security of tenure, current land use, etc.) factors.

3) Design a variety of direct-seeding trials using different species (herbaceous and woody), species combinations (including nurse crops), seeding techniques (broadcast, direct, dibble, etc.) and configurations appropriate to each situation; where practical, begin implementation of trials.

4) Further explore the possibilities for aerial seeding; offer recommendations for the accomplishment of this task

5) Assist ASSET staff in identifying appropriate sources for the necessary seed stocks and advise as to proper storage and treatment techniques.

6) Propose a calendar for the implementation of trials.

7) Propose a monitoring plan for assessing the effectiveness of trials in sustainability, increased biomass production and impact on erosion; stress participatory M&E techniques for concerned community groups.

8) If, due to seasonal or logistical complications, implementation must be delayed until after consultancy, train ASSET staff and concerned community groups in trial implementation and monitoring techniques; advise on what additional resource requirements are needed for the proper execution of trials.

**Deliverables**

1) A brief work plan prepared in collaboration with the Community Development Specialist and his team.

2) Detailed trial plot designs for at least 5 different agro-ecological zones (as per soil characteristics, aspect, elevation, etc.) covering a minimum of 1 hectare each (contiguity within eco-zone desired but may not be practical in every instance), and including, but not limited to, implementation schedule, site descriptions, summary of factors influencing site and species choice (include socio-economic factors), management recommendations and logistical requirements.

3) A final report including, but not limited to: summary of findings and recommendations, consultancy schedule and list of contacts.

**Annex 2. Consultancy Schedule in Haiti for the period November 16 – December 13, 1998.**

| DATE | PLACE | ACTIVITIES |
|---|---|---|
| Nov 16 | Port-au-Prince | Arrive AA 377; Villa Creole |
| 17 | Port-au-Prince | ASSET office; mtg. w/ D. LaFrambroise, E. Scott |
| 18 | PAP - Mare Minerve | Travel to MM |
| 19 | MM - Meji | Sel. of site DS Trial No. 2; Meji water catchment |
| 20 | Mare Minerve | Sel. of site DS Trial No. 1, 3. mtg. w/ Ministres |
| 21 | Mare Minerve | Est. DS Trial No. 1 @ Catholic Parish nursery |
| 22 | Mare Minerve | Attend Mass; mtg w/ FORDEB members |
| 23 | Mare Minerve | Est. DS Trial No. 2 @ Fon Gèp |
| 24 | Mare Minerve | Est. DS Trial No. 3 @ Kalfou Mòn Bremon |
| 25 | MM - PAP | Travel to Port-au-Prince |
| 26 | Port-au-Prince | Thanksgiving @ D. LaFrambroise |
| 27 | Port-au-Prince | Visit Wynne Farm w/ D. LaFrambroise |
| 28 | Port-au-Prince | Develop slide film; mtg w/ S. Michal (HBF) |
| 29 | Port-au-Prince | Mtg w/ R. Bulten (CARE) |
| 30 | Port-au-Prince | ASSET mtg w/ IRG staff; ASOSYE mtg. |
| Dec. 1 | PAP - Mare Minerve | Travel to MM |
| 2 | Mare Minerve | Visit Roch Glasi as possible DS trial site. |
| 3 | Mare Minerve | Check seed of native spp.; visit DS Trial No. 2 |
| 4 | Grand Fond | Community Group & M. Fleurant mtg. |
| 5 | Grand Fond | Est. Direct Seeding Trial No. 4 |
| 6 | MM - Port-au-Prince | Travel to PAP via Kenscoff to arrange w/ Estiverne. |
| 7 | Port-au-Prince | ASSET office; I. Lowenthal mtg. |
| 8 | Port-au-Prince | ASSET office; J. Wynne mtg. |
| 9 | Port-au-Prince | AA office; Elia M-Béliard & M. Bannister mtg.; ASSET (Wynne Farm) seed stored @ PADF |
| 10 | Port-au-Prince | ASSET office; Final Report draft |
| 11 | PAP - Chauffard | Père Julien Estiverne mtg; Béatrice Lecomte (DFPC) mtg. |
| 12 | Port-au-Prince | Lunch w/ D. LaFrambroise; write Final Report draft |
| 13 | Port-au-Prince | Depart PAP on AA 1568 |

**List of Contacts during consultancy**

ASSET: most of the staff with IRG, Winrock and Datex
FORDEB: officers and several members including Pierre Ramélus Saintilus, Marius Ministre, Orilyen.
FGBF: President Félix Toussaint
ASEC officers of Belle Fontaine, 1ere Section
Assemblée Munipale de Mare Minerve officer: Marius Ministre
L'Ecole de Notre Dame de Lourde teachers: Alcindor St. Pierre, Félix Toussaint
L'Ecole Rama (d'Eglise Evangélique Internationale): Director Aléxandre Herman

Mouvement Paysan de La Source: President Sedieu Ceus, Vice-President Saintville Aristile
PRESTEN officers (Mésen Jeine, Alcindor St. Pierre, Saint Félix Orvilus, Félix Toussaint)
Groupement de Grand Fonds officers and members: President Remy Laurent, Vice-President Louis Saintville Saintlaurent, several members including Gerard Laurent and Michaël Laurent
Groupement de Mare Minerve members (Pascal, Mésen, Meridor St. Pierre, Michel St. Pierre, Mesinor St. Pierre, Gerard St. Pierre, Marc St. Pierre, Frère Jean, Mme Ramélus, Mme Jean, Mme Marc St. Pierre, Mme Gerard St. Pierre)
Meji landowner of rainwater catchment: M. Dieu Donné
Groupement Communautaire de Meji members
ASOSYE: Bert Laurent and Richard Forbes
PACT: Ira Lowenthal
CARE: Robert Bulten, Jérémie
DFPC: Béatrice Lecomte
HBF: Suzanne Michal, Kenscoff
PADF: Lee, M. Bannister, E. Mora-Béliard, Renauld
Jane Wynne, Kenscoff
Père Julian Estiverne, Chauffard
Double Harvest: Ido and Henrietta Kerpels
SECID: Zach Lea, Carine Bernard, Villefranche

## Annex 3. Direct seeding trials in established in Belle Fontaine Section 1 (Mare Minerve and Grand Fond areas) during November - December, 1998.

**INTRODUCTION**

Multipurpose vegetation management trials were established as part of an overall program to assist the Mare Minerve and Grand Fond communities in soil and water conservation technologies. The overall goal of these trials is to create sustainable models of land use that can be applied by farmers in their agricultural portfolios within the decision making context of community participation. Specific goals include:

(1) To locate these trials on highly visible areas of the landscape vulnerable to environmental degradation ("green billboards");
(2) To integrate them as an instrument to strengthen community-based natural resource management decisions;
(3) To introduce germplasm to communities that otherwise would not have access to improved and more productive species and varieties; and
(4) To make available plant material for multiplication using concept of "expanded nursery zones" of direct- and broadcast seeded soil beds.

Most of the trials build on the indigenous knowledge of the farmers in an effort to diversify and intensify production through enhanced participation and reinforced institutional capacities of community groups. It is most useful, given the agro-ecological categories of land use in the region, to design the trials according to their role in improving the productivity and economic value of any one land use category. The trials that were established in November and December, 1998 represent the following land use categories:

(1) Secondary fallow land of former *rak bwa* or associated native plant cover (Trial No. 2), springs and rain catchment areas;
(2) Unimproved pasture that is actually a fallow period between annual cropping gardens (Trial No. 4); and
(3) Current annual crop production (Trial No. 3) chosen for conversion to managed wood lot or the incorporation of permanent vegetation cover (hedgerows, *bann manje*, contour grass strips).

Proposed additional land use categories include:

(4) Highly degraded land occurring on catchment basins locally referred to as *tè glasi* (or *roch glasi*);
(5) PRESTEN rock walls and soil conservation technologies on agricultural parcels; and
(6) Major water channels and ravines.

**Tree Seed**

Seed of 5 species was obtained from the PADF Seed Center. Seed lot information is summarized below. The species selected were those that have already shown adaptation under the site conditions of the Mare Minerve area (elevation ranging from 1000 - 1,400 m) and have good potential as direct seeding candidates during the winter drought period. A summary of the tree seed used in the trials to date is provided in Table 1.

| SPECIES | LOT NO. | DATE OF HARVEST | QUANT. (kg) | PADF GERM. (%) | TRIAL NO. |
|---|---|---|---|---|---|
| *Acacia angustissima* | 2458 | 1995 Hond. | 1.6 | 56 | 1,2,3,4 |
| *Acacia melanoxylon* | 1054 | 1993 Zimb. | 1.0 | 58 | 1,3,4 |
| *Colubrina arborescens* | 3158 | 1998 Haiti | 1.0 | 52 | 1,2,4 |
| *Leucaena diversifolia* | 3543 | 1998 Haiti | 1.7 | 93 | 1,2,3,4 |
| *Ricinus communis* | 3538 | 1998 Haiti | 1.4 | 80 | 1, Ramélus |

**Trial No. 1**

The first direct seeding trial is actually designed to measure the emergence rate of 5 tree species from the soil. Each species was selected for their economic importance under the ecological conditions of the Mare Minerve area. The seed was taken from storage at the PADF seed facility in Port-au-Prince and sown without scarification or any other treatment (e.g., inoculation) of any kind. This was to preserve normal seed dormancy characteristics.

It is recommended that such tests be given sufficient importance in order to better understand some of the problems that may occur under less controlled conditions and to obtain a performance index of the seed that is being used for wider distribution to farmers. Laboratory tests cannot be considered a reliable predictor of seed performance under direct seeding conditions.

A summary of the trial information is provided in Box 1. The randomized complete block design with circular plots of 0.3 m diameter is shown in Figure 1. The trial is being watered every two days and measured by the Secretary of the Mare Minerve #1 Groupman. During the first 2 weeks, it rained 3 times in which case the trial was not watered. It is expected that the trial should last for a minimum of 4 weeks or until it is determined that most of the seeds have germinated. After 2 weeks in the ground (Saturday, 05.12.98) average emergence by species was as follows: *Ricinus communis* 42%, *Acacia angustissima* 7%, *Leucaena diversifolia* 6%, *Colubrina arborescens* 0% and *Acacia melanoxylon* 0%.

**BOX 1. Summary of direct-seeded germination test at the Catholic Parish, Mare Minerve.**

**Land owner:** L'Eglise Catholic de Notre Dame de Lourdes. **Date of Est.:** 21.11.98 **Location:** UTM 18 Q 0804644, 2038557. North side of the defunct water cistern in back of church, NE of current coffee nursery. **Elevation:** 1,198 masl **Slope:** 2-5%. **Aspect:** 35° **Area:** 3m X 3m = 0.009 ha marked by 5 pickets w/ pink flagging. **Design:** Randomized complete block design, 4 replications and 5 treatments representing 5 species: *Colubrina arborescens* (3158), *Ricinus communis* (3538), *Leucaena diversifolia* (3543), *Acacia angustissima* (2458), *Acacia melanoxylon* (1054). (PADF seed lots numbers in parentheses). 100 seeds were sown per circular plot of 0.3 m diameter, non-scarified & non-inoculated. Experiment established by Joel Timyan, Robert Philippe and Meridor. Watered every 2 days with seed counts recorded on data sheets prior to watering. Robert Philippe assigned Mesen responsibility to collect data. **Dominant Vegetation:** Common weeds found near periphery of gardens and areas trampled by livestock and humans.

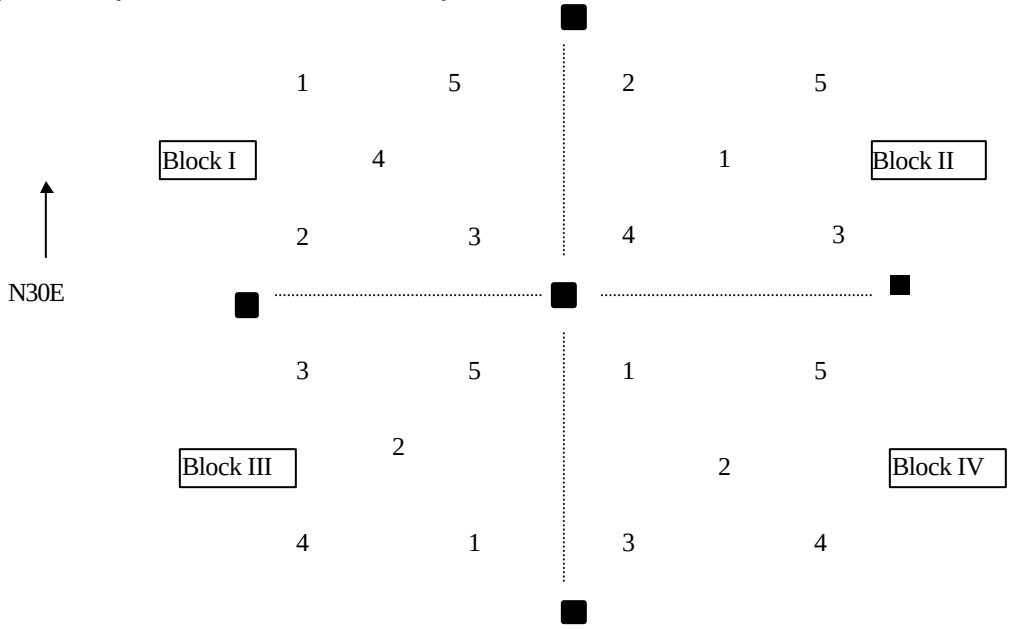
An XY graph plotting the cumulative number of emergents per 100 (Y) versus days since sowing (X) for each species is a valuable tool to compare with laboratory germination tests. Since the trial is watered every 2 days, the trial data would be an overestimate of total emergence and emergence rates under typical field conditions.

Problems to look out for: 1) Reliability of results due to uncontrolled trampling of plot area by humans and animals, 2) accuracy of data collection by local personnel in the absence of ASSET personnel, 3) damages by crickets and other insects known to attack emergents under field conditions.

This trial should be analyzed after sufficient time is given for the *C. arborescens* and *A. melanoxylon* seed to emerge. This may be as late as January or February. At this time, an analysis should be done and written up for the records. Subsequent trials such as this should be established for each seed lot selected for direct seeding or distribution to farmers.

***Trial Calendar:*** **Dec. 98 - Feb. 99** Count number of emergents and pull out weeds. Analyze percentage emergence based on 100 seeds/plot. Write up short report. **Mar 99** Establish another trial with seed used in direct seeding experiments during Spring, 1999 season.

**Fig. 1. Layout of direct seeding trial No. 1 at Catholic Church, Mare Minerve.** NB: Each numbered plot is represented by 100 sown seeds and randomly allocated within block.




1 = *Leucaena diversifolia,* 2 = *Ricinus communis,* 3 = *Colubrina arborescens,* 4 = *Acacia angustissima,* 5 = *Acacia melanoxylon*

**Trial No. 2**

The second direct seeding trial is designed to simulate normal farming conditions and the capacity of local farmers to establish a desirable tree species of known economic value on land designated for wood lot management (*rak* bwa) and conservation purposes. The significance of the trial is that it builds on traditional methods of establishing *Colubrina arborescens* as reported by Barbour (1926) in the southwest of Haiti. It also falls within the vision of the Ministre kin who, under the visionary leadership of Marius Ministre, have decided to set aside part of their collective land portfolio for wood lot and native forest conservation. Marius is currently elected in the Assemblée Municipale and also an active member of FORDEB and FGBF.

The *C. arborescens* seed was sown by the male children of the two residing elders, Michel and Mesinor Ministre. This is an important feature of the trial, since the Ministre males are responsible for tethering the livestock in the area surrounding the trial. Establishment of *Colubrina arborescens* is expected to significantly add economic value to the 2-year fallow which comprises many native species important in the local ecology. Such management of *rak bwa* also supports environmentally important activities of bee keeping, the extraction of medicinals, teas, children food and fuelwood harvests, the yield of high quality construction wood and the conservation of soil/water services associated with relatively dense secondary forest cover.

A minor portion of the trial was the establishment of contour hedgerows utilizing 2 species (*Leucaena diversifolia, Acacia angustissima*) that were direct seeded and 2 species that were establis hed by branch cuttings (*Jatropha curcas, Sambucus simpsonii*). This part of the trial was established to slow progress of a ravine resulting by the channeling of water off the primary trail leading to the trial. The gully plug part of the trial should be expanded prior to the onset of the Spring rains and monitored carefully by the landowner. A summary of the trial is provided in Box 2 and the layout of the trial is shown in Figure 2.

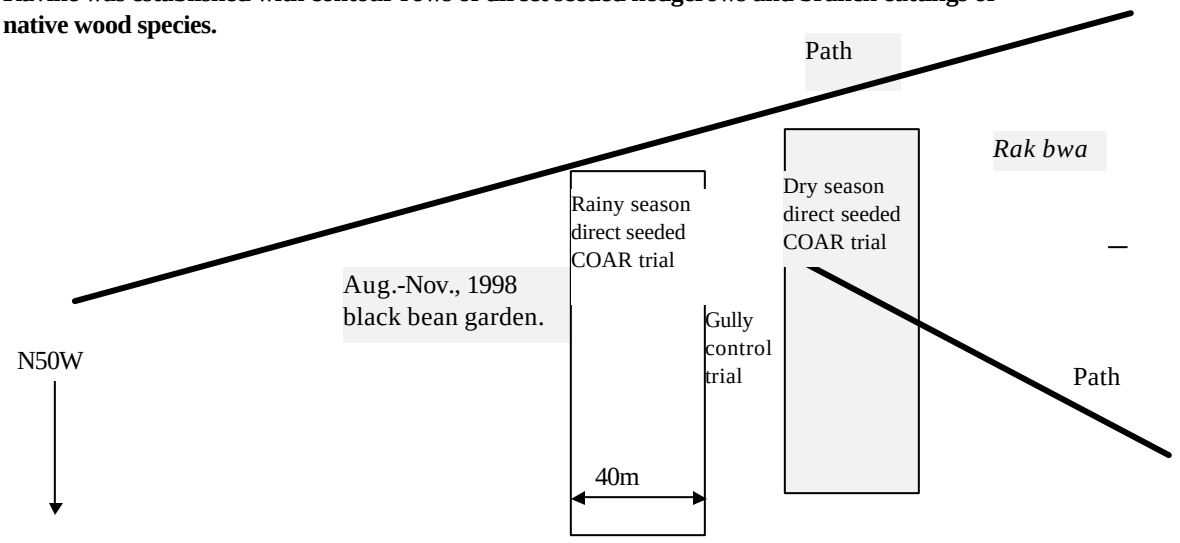
**Box 2. Summary of *Colubrina arborescens* direct seeding trial at Fond Gueppes**

**Land owner:** Michel purchased the land for his eldest son, Gerard Ministre. **Date of Est.:** 23.11.98 **Location:** UTM 18 Q 0805170, 2039090. East side of the deep ravine running approximately NNE from Mare Minerve; most of land owned by Ministre family. Patriarchs include Michel and Mersinor; matriarch includes Elimenn. **Elevation:** 1,258 masl **Slope:** 65%. **Aspect:** 310**?** **Area:** 40m X 100m = 0.4 ha strip running parallel to slope. **Design:** *Colubrina arborescens* seed dibbled in same manner as corn w/ 4-5 seeds per hole and spaced throughout 2-year fallow area at 1m X 1m. Flagging marks the trial area. Direct seeded by Gerard, his brother Renauld, his two cousins Renise and Dieu Met. **Dominant Vegetation:** 2-year fallow since 1996 bean garden. Trees/shrubs: *Tabebuia* (*gwo po*), *kompari, bwa kodinn* (*Bocconia frutescens*), *bonbon* (*Miconia*), *bwa leksi, bwa blan, bwa kabrit* (*Psychotira berteriana*), *bwa danjou* (*Didymopanax tremulum*), *bwa zen* (*Tecoma stans*), *bwa pen* (*Pinus occidentalis*), *bwa sèd* (*Cedrela odorata*), *bwa koma* (*Mastichodendron foetidissimum*), *bwa mang , bwa dinn* (*Myrcianthes fragrans*). Herbs: *zeb finn* (*Sporobolus indicus*), *zeb able* (*Trichachne insularis*), *jako* (*Pluchea*), *tonton makout, lang bèf* (*Pseudelephantopus spicatus*), *langi chat* (*Eupatorium*), *zegwi blansh & nwa* (*Bidens*).

**Summary of gully plug design at Fond Gueppes using hedgerows and branch cuttings**

Hedgerows were spaced approximately 3 m parallel to slope of 65%. Hedgerows were laid out along the contour using a line level. Shallow ditches were dug with a sickle and machete. Seed was sown densely (about 300 seeds per meter) in-row, alternating *Leucaena diversifolia* and *Acacia angustissima*. A row of branch cuttings was placed immediately down slope of each hedgerow using a mixture of *Sambucus simpsonii* and *Jatropha curcas.* A pasture grass, such as African star grass or cover legumes, such as *Desmodium* or *Lablab* could be substituted for inter-row soil binding and forage production.

**Figure 2. Layout of direct seeding trial at Fond Gueppes. COAR - *Colubrina arborescens* direct seeded wood lot. Ravine was established with contour rows of direct seeded hedgerows and branch cuttings of native wood species.**




***Trial Calendar:*** **Dec 98 - Feb 99** Monitor the presence of livestock and traffic in direct seeded area. Estimate number of emergents per number of holes planted. Encourage Gerard Ministre to sow additional area down slope toward ravine. **Mar 99** Replant portion of gully plug and expand operation to bottom of ravine. Pending rains, prepare contour hedgerows and branch cuttings for expanded area. Establish rows of vetiver as alternative to direct seeded hedgerow. **Apr - May 99** Estimate number of emergents per number of holes planted. Lightly arrange planting area as water catchment and mulch with herbs and grasses. Select an equivalent area of Ministre land of similar fallow type and direct seed at same density either same seed lot (if available, confirm germination rate!) or another seed lot of large-leaf variety of *C. arborescens.* The objective of the second area is to compare

dry season direct seeding with rainy direct seeding. **August 99** Estimate number of emergents per number of holes planted in both dry season and rainy season trials. Observe gully plug and refine technology to suit conditions. Use as an educational tool to community group members interested in replicating techniques on their own land.

**Trial No. 3**

This trial occurs near the summit of Morne Carrefour Brémon (*Mòn Kalfou Bremon*) along the main trail from Mare Minerve to Meji. It is part of a rather large tract of land owned by the Saintilus family, including individual land holdings by Pierre Ramelus Saintilus, President of the ASEC and leading member of FORDEB.

The reason Ramelus chose this particular site is because tree planting activities in association with PRESTEN have been marginally successful. The site is very rocky, with the blocky type of crystalline limestone rocks dominating the surface and interspersed with a much smaller volume of black soil common to ridges in the area. Several species had been planted that are definitely not adapted to this mid-elevation site considered *tè cho*, including *Albizia saman* and *Swietenia macrophylla*. The lone *Pinus occidentalis* is testimony that this was once dominated by *Pinus occidentalis*, and the vision of Ramelus is to re-establish *Pinus* on the site.

With this in mind, I advised him of several points to consider:

1) Encourage natural regeneration of pine wildings (there are several that are present) by flagging them and protecting them with rock water catchments to make them observable to anyone else that might be working the site;
2) When planting any new pine seedling to site, make sure that mycorrhizae is present (We dug up some surface roots of the mature pine and I explained to him that the white mycelial layer around the hair roots was the ectomycorrhizae so critical to nutrient uptake by pine and means the success/failure of establishing pine on poor sites such as this);
3) Avoid outplanting in polybags, since the seedling root ball is already likely malformed with a circular root system. (This problem is common throughout Haiti without proper instruction in tree planting on site). The root ball should be pruned to encourage lateral roots to radiate out from base of developing seedling. This will have a positive effect on wind firmness and productivity of the tree for life.
4) Pay more careful attention to preparing the planting hole by removing boulders and rocks and rearranging them to form a water catchment to retain the black soil and collect rain water. Mulch to conserve moisture, enrich soil and encourage development of lateral feeding roots.

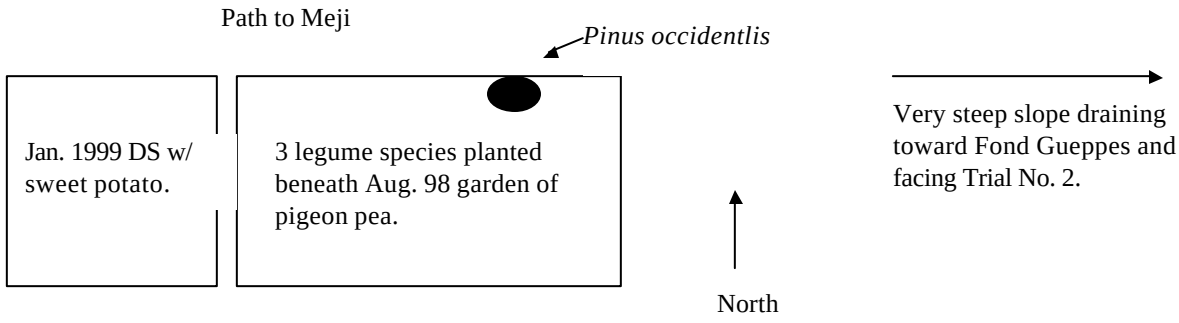
The objective of this direct seeding trial is to enrich the site with legume cover, using several legumes to capture the site and improve site conditions for the eventual establishment of pine mixed with a selection of fruit and wood trees. Again, the simplest method was to direct tree seed in the same manner as pigeon pea or corn. The tree species were sown under the nearly mature canopy of pigeon pea (*Cajanus cajun*), ready for harvest in December/January.

Ramelus flagged the perimeter of the area to be direct seeded and he included both a current pigeon pea garden as well as an area that is about to be planted in sweet potato. We only planted the pigeon pea garden, with the intention that the sweet potato garden would be seeded following the planting of sweet potato.

Normally the legume seed would be scarified in a hot water treatment and inoculated with an improved strain of *Rhizobium* specific to each species. However, no seed treatments were conducted to ensure the dormant character of seed entering the dry season and enduring the irregular rains of the December – March period. This trial, as with the other trials sown during the end of the Fall rainy season, should be monitored carefully at the onset of the Spring rains to decide whether the sites should be re-sown. An estimate of emergent and establishment rates should be monitored during the initial 2 years of the trial. A summary of the trial is provided in Box 3 and the layout of the trial is shown in Figure 3 below.

**Box 3. Summary of leguminous direct seeding trial at Morne Carrefour Bremon**
**Land owner:** Pierre Ramelus Saintelus. **Date of Est.:** 24.11.98 **Location:** UTM 18 Q 0804869, 2039051. West side of the deep ravine running approximately NNE from Mare Minerve. **Elevation:** 1,353 masl **Slope:** 25-50%. **Aspect:** 300-360? **Area:** 27 m X 15 m = 0.04 ha block in pigeon pea garden. **Design:** Seed of 3 tree legumes (*Acacia angustissima, A. melanoxylon, Leucaena diversifolia* dibbled in same manner as corn w/ 4-5 seeds per hole and spaced throughout garden at 1m x 1m. Each species makes up a 1/3 of the planted holes. Flagging marks the trial area. Direct seeded by Orilyen, Joel Timyan and Robert Philippe; holes dug with sickle by Ramelus and Meridor. **Dominant Vegetation:** *Cajanus cajun, Pinus occidentalis, Daucus carota, Verbascum thapsus, Foeniculum vulgare, zegwi blansh, jako, madan michel.*

**Figure 3. Layout of the Mòn Kalfou Bremon direct seeding trial.**




***Trial Calendar:*** **Dec 98 - Mar 99** Finish direct seeding sweet potato section of garden to be planted in January, 1999. Monitor emergence rates of the 3 species. **Apr - May 99** Expand direct seeding trial to include other land to eventually planted in *Pinus*, especially toward the summit of Morne Carrefour Bremon and the east facing slope of Grand Ravine. Estimate the emergence rate by species and direct seed again if necessary. Replace *Acacia melanoxylon* with *A. mearnsii* if the former does not perform adequately.

**Trial No. 4**

This trial is located within an hour's walk SE of Mare Minerve past Grand Fond, a significant coffee production area by local standards. The site was selected to extend the range of functional land use categories under consideration for promising vegetation management designs.

The selection of this site recognizes several converging interests to meet ASSET goals:

- A sharing of land owned by a community leader for the future benefit of group members;
- The establishment of a community-level, multiple species propagation area that extends beyond the level of the community nursery;
- The introduction of improved forage and tree species in combination that meets both economic and conservation goals of the local community; and
- The strengthening of community morale by direct support of ASSET in the form of technical assistance and material procurement.

The actual locality is Tèt Mòn Dekouvè on land owned by Michaël Fleurant. He is a respected community leader and head of one of the 3 working groups comprising Gwoupman Gran Fon # 1. Michaël was recommended to ASSET by the President of the community group, Remy Fleurant and cousin of the landowner. The site drains into the Boucan Greffin, including a very picturesque series of cascades ("Telembo") that can be heard and seen

from the ridge of Tèt Mòn Dekouvè. The area where the trial was established was formerly under a stand of *Pinus occidentalis* that was destroyed by fire in the mid-1940s. Since that time, the land has been mostly under cultivation of sweet potato, beans, pigeon pea and corn. The last bean crop was sown in August, 1998 and harvested in November. It was currently being used as pasture with a combination of goats and cows at the time of trial establishment. Michaël Fleurant has owned the land since 1976, having purchased it from Doicius Louis who owned it previously for 4 years.

M. Fleurant selected this site based on the idea that an improved forage production and multiplication trial could be combined with the rapid production of a high quality construction wood (*Colubrina arborescens*). It is envisioned that the trial will take several planting seasons to fully establish it as a model of an improved silvopastoral system. The significance of the trial is the direct seeding approach of establishing trees, the potential of using the "expanded nursery" model as a tool to multiply and supply seedlings and plant material to participating group members, and as a practical introduction of fodder banks for livestock husbandry. Areas such as this reserved for the production of non-cash crops are generally not improved and lack the investment necessary to both conserve the soil and the biomass capital necessary for sustained productivity. This trial will demonstrate the capital required for such opportunities in improved livestock management.

The trial was demarcated with fluorescent flagging tied to live stakes of *flè siwo* (*Sambucus simpsonii*) and *gomye* (*Bursera simarouba*). Stakes were also used to align the contour rows spaced at 10 m intervals parallel to slope. The general layout of the trial includes triple rows of *C. arborescens* spaced 1 m apart in triangular fashion and 10 m between the triple rows. A densely sown row of 3 legumes (*Leucaena diversifolia, Acacia angustissima, A. melanoxylon*) was sown midway between the *C. arborescens* rows. The 3 species are roughly planted equally and 0.8 m in-row. African star grass and a cover legume, *Desmodium incinatum,* will be established at the onset of the Spring rains. The site should be eliminated as best as possible of the current cover of weeds prior to establishment of the grass and cover legume. The total length of *Colubrina arborescens* rows is approximately 687 m, roughly equivalent to the same number of sown holes. The total length of mixed legumes rows is 275 m or approximately 115 sown holes per species.

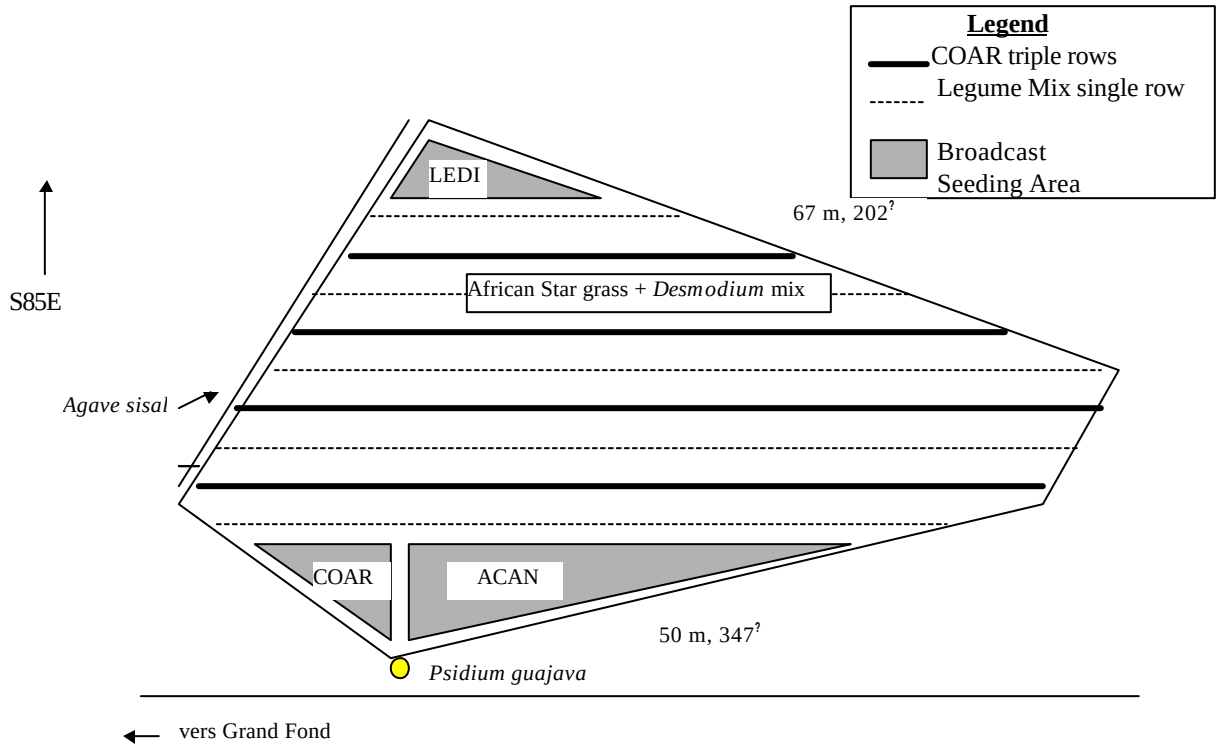
Three areas were broadcast seeded with *C. arborescens, Acacia angustissima* and *Leucaena diversifolia*. These areas and their respective sowing densities are as follows:

| **Species** | **Area** | **Broadcast Sowing Density** |
|---|---|---|
| *Colubrina arborescens* | 120 $m^2$ | 20.8 kg $ha^{-1}$ (NB: approx. 50-65,000 seeds per kg.) |
| *Acacia angustissima* | 120 $m^2$ | 58.3 kg $ha^{-1}$ (NB: approx. 119,000 seeds per kg.) |
| *Leucaena diversifolia* | 92 $m^2$ | 54.3 kg $ha^{-1}$ (NB: approx. 35,000 seeds per kg.) |

A summary of the trial is provided in Box 4. Layout of the trial is shown in Figure 4.

**Box 4. Summary of improved silvopastoral trial at Tèt Mòn Dekouvè, Gran Fon.**
**Land owner:** Michaël Fleurant. **Date of Est.:** 05.12.98 **Location:** UTM 18 Q 0807152, 2036980. West side of Boucan Greffin and overlooking the Telembo cascades. **Elevation:** 1,162 masl **Slope:** 40%. **Aspect:** 95**?** **Area:** Approx. 0.3 ha. **Design:** Rows oriented along contour of slope. Triple rows of *Colubrina arborescens* sown at density of 1.0 $m^2$ and 10 m between triple rows. 3 tree legumes (*Acacia angustissima, A. melanoxylon, Leucaena diversifolia*) sown in a single row midway between *C. arborescens,* spaced 0.8 m in-row and alternating by species. 3 areas were broadcast seeded with *C. arborescens, A. angustissima, L. diversifolia.* Flagging marks the trial area. Direct seeded by kin of M. Fleurant, Joel Timyan and Meridor St. Pierre; holes dug with pick ax by kin of M. Fleurant. **Dominant Vegetation:** *Daucus carota, Verbascum thapsus, Foeniculum vulgare, zegwi blansh, jako, madan michel.*

**Figure 4. Layout of direct and broadcast seeding trial at Grand Fond. Trial area is approx. 0.3 ha.**




***Trial Calendar:*** **Dec 98 - Feb 99** Monitor the emergence of the direct seeded tree species. Estimate emergence rates. Check broadcast areas for presence of seed. Note predation or disturbance by animals, human traffic in these areas. Note presence of animal tethering or grazing within trial perimeter. Discuss problems with landowner Michaël Fleurant **Mar 99** Prepare the site by eliminating weeds for the establishment of African Star grass and a forage legume such as *Desmodium intortum.* Estimate orders for grass and place order with Wynne Farm, Kenscoff. Estimate seed amount for *D. intortum* and order from reputable seed supplier or get plant material from UNICOR at Grand Plaine). **Apr - May 99** Decide whether to re-seed the tree species pending their emergent rates. Plant grass and direct seed *Desmodium.* (Keep distance from direct seeded rows of 0.5 m). Keep weeded for pure establishment of improved forage. Discuss with Grand Fond community groups objectives of multiplication and separation of plant material among members. Emphasize "expanded nursery" concept for appropriately selected species. **Aug 99** Second weeding of trial for pure capture of site by tree, grass and forage legume species.

**Trial No. 5**

This trial was not established during the consultant's visit to Haiti, but is an example of a sociopolitical opportunity to explore cross-boundary issues of watershed management while engaging community-level environmental concerns. After lengthy conversation with Marius Ministre, official of the local Assemblée Municipale and an active participant of ASEC, there emerged the idea of designating fragile zones in the Mare Minerve area for special treatment regarding restoration and policing by locally elected community members. (Organizing a group based on vested interests in a degraded watershed would be unique to the area and certainly significant if successful. It would cross normal kinship and labor pool boundaries). A naturally defined catchment area was selected at Gran Ravine, directly across from Trial No. 2 and on the east facing slopes of

Morne Carrefour Bremon. Grand Ravine is a very steep and fragile slope with much rock debris, rills and ravines. The upper slopes are currently in congo pea and sweet potato. The middle and lower slopes are grazed by cattle and goats. Scrub forest remnants, formerly dominated by *Pinus occidentalis*, hug the steepest and most inaccessible sites; galata (*Agave antillarum*) on the rockiest sites and a mixture of herbs, grasses and shrubby plants on the remainder of the land that is not already sheer rock or rubble. A goat's walk across parts of the site causes rock to fall below.

My first question was whether this was a priority site for restoration and whether it was worth any amount of community investment in terms of political organization and labor in slope stabilization. (After a more extensive inventory of the greater Mare Minerve area, other catchments may be considered by local leaders as better investment of time and energy). For example, the number of people implicated in just one of the *tè minè* parcels was over 50, including the descendants of the original heirs. Obviously, each family would have to elect a representative in order to keep the resolution and decision making process manageable among stakeholders.

I set up an appointment with Dorcelus Dor, an elder in Mare Minere and related to the Saintilus clan, to assist in mapping ownership, land users and physiographic features of the catchment area. Though the map (below) was not completed, several members who own land in the area found it an informative. It would serve as an instructional tool toward organizing a working group and begin discussion with regard to vision, objectives, a resolution and plan for action over a period of time. ASSET would need to provide a facilitator, preferably one trained to foster the social organizational side of establishing and managing special use areas. The facilitator would assist with the stakeholders by defining a set of goals that would be achieved at intervals during the calendar year. The accomplishment of these goals in subsequent years would eventually accustom the idea of restoration to those with vested stakes in the treatment zone *and* serve as a viable demonstration area for community-wide interests.

A step-wise approach in organizing the vested interest of the catchment area:

1) Name the stakeholders as a working group within the community group(s) membership.
2) Arrange a schedule for a meeting of the working group or representatives of those with vested interests. ASSET and the Assemblée Municipale should moderate the meeting.
3) Clarify the vision, discuss whether it is a common vision, identify unsustainable features of current land use, identify potential conflicts including conflicts of interests and non-cooperative behavior of land users, sell a technical and social solution that meets conservation goals, set action goals for technical, social and political categories, prepare a plan of intervention with roles and responsibilities, schedules, budgets and targets.
4) Elect officers to be responsible for action plan.
5) Begin interventions on catchment area that coincide with appropriate agricultural calendar.
6) Periodic monitoring and self-evaluation exercises.

***Trial Calendar:***

**January, 1999**: Meet with Dorcelus Dor (Ramelus' uncle) and visit Gran Ravin degraded site that starts at top of Mòn Kalfou Bremon. Map individual landowner boundaries of catchment basin to bottom of ravine. Inventory of all landowners and users having vested interest in Grand Ravine catchment basin. Inventory of land use and plant cover. Prepare land ownership map, land use and plant cover maps. Finalize maps at February meeting with agreement of stakeholders.

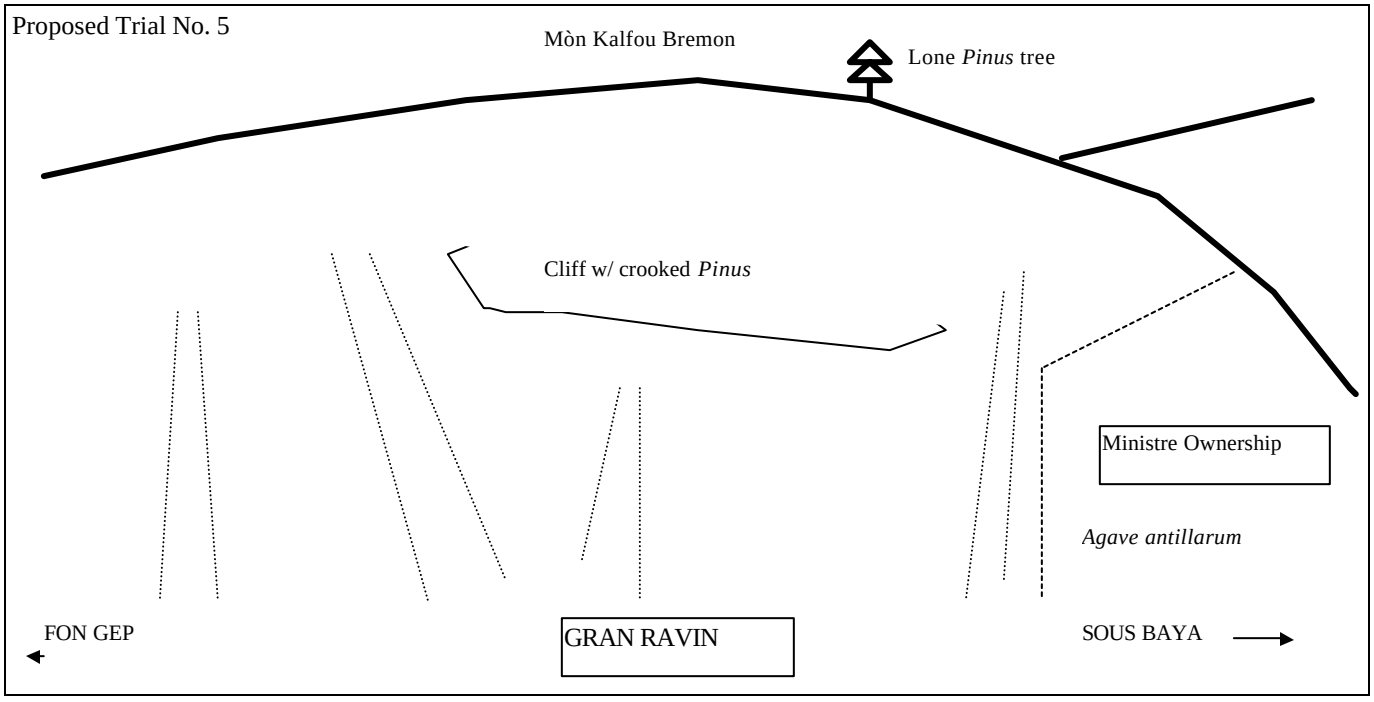
**February, 1999**: (ASSET to provide facilitator). Meeting # 1: Set up date with Marius Ministre to meet w/ landowners and discuss mission, objectives, methods and results expected from improved vegetation management of catchment basin. Meeting # 2: Organization of collective action group including representatives of all stakeholders in Grand Ravine. 1) Presentation of Grand Ravine land ownership and land use map. 2) Election of leaders to prepare needs assessment, to organize and to prepare resolution of stakeholders, to discuss ownership and statement of rules and their enforcement, to develop restoration activities and organize labor pools, to clarify role of collective group vis-à-vis ASSET and to prioritize areas of intervention for Spring rainy

season. 3) Estimate amount of vegetative material required for Spring interventions (vetiver, cuttings of live fence species, other grasses, tree seed). 4) Arrange for local provision of plant material or import via ASSET.

**March, 1999**: Prohibit all grazing and browsing for establishment of improved forage banks in Spring, 1999 priority areas. Investigate whether an *arrêt* is the proper instrument to enact grazing restrictions or whether consensus of collective action group is sufficient.

**March-May, 1999**: Begin biological conservation technologies with top part of catchment basis and prioritize small rills and areas prone to sheet erosion. Attempt to cover as many land units as possible to spread experimentation among group members. Monitor labor requirements, social organization of labor pools and conflict resolution within prescribed area. Prepare less sensitive zones of catchment basin for tethered grazing, including the establishment of more productive, soil-binding forage grasses (alternate banks of African star and vetiver), cover legumes, and terraces. Prepare rocky areas for browsing with rock terraces and establishment of fodder banks mixing woody legumes, cover legumes, drought-resistant grasses (*Panicum maximum*), and hardy vetiver contour strips.

**August, 1999**: Participatory evaluation by group members of Spring, 1999 interventions. Refine goals and methodology regarding technical and social issues. Plan for Fall, 1999 interventions. Repeat discussion, planning, intervention, participatory evaluation cycle.



## Trial Calendar

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1998** | | | | | | | | | | | | |
| Trial 1 | | | | | | | | | | | Est. Phase I direct seed | |
| Trial 2 | | | | | | | | | | | Est. Phase 1 | |
| Trial 3 | | | | | | | | | | | Est. Phase 1 | |
| Trial 4 | | | | | | | | | | | | Est. Phase 1 |
| Trial 5 | | | | | | | | | | | Site visit | |
| **1999** | | | | | | | | | | | | |
| Trial 1 | Phase 1 Monitor & Evaluation total emergence | | Est. Phase 2 direct seed | Phase 2 Monitor and Evaluation | | | | Est. Phase 3 direct seed | Phase 3 Monitor and Evaluation | | | |
| Trial 2 | Monitor dry season emergence & gully plug; plan w/ landowner for rainy season direct seed and gully plug expansion of Phase 2 | | | Est. Phase 2 | Monitor and evaluate both direct seeding trials and gully plug demonstration. Self-evaluative approach w/ entire Ministre family; elicit satisfaction & problems. | | | Est. Phase 3 by Ministre | Monitor and evaluation by Ministre family. Organize community group demonstration and workshop. Replicate approach on fallow lands with local seed collection, exchange of economic plant species. | | | |
| Trial 3 | Direct seed w/ sweet potato | Monitor & evaluate dry season phase | Phase 1 re-seeded & Phase 2 est. | Monitor & evaluate emergence, stocking density, problems w/ annual cropping activities. | | | | Est. Phase 3 by Saintilus | Monitor and evaluate by Saintilus family. Combine with community group demonstration and workshop. Elicit satisfaction and problems. Refine model for replication. | | | |
| Trial 4 | M&E for emergence, land use conflicts, member interest. Plan Phase 2. | | Order seed & prepare site Phase 2 | Est. Phase 2; reseed Phase 1 if needed. | | | Community group maint. and self-evaluation training session | | Expansion of multiplication/demonstration silvopastoral model w/ other community groups. Organize training session, plan distribution of forage material to individual parcels. | | | |
| Trial 5 | Map ownership, vegetation, landuse. Stakeholder's meeting, inform & organize. | | Prohibit grazing; stakeholding group participation on biotechnologies - gully plugs, improved pasture strips, vetiver bands, direct seeded browse resistant trees - & social issues | | | Self-evaluation of group: conflicts, satisfaction, member interest, costs. | | Phase 2 refinements | M & E, training sessions and demonstration w/ facilitator for degraded land restoration models. Replicate on priority sites with FGPB membership | | | |

Trial 1 = **Mare Minerve**: Direct seed control. Trial 2 = **Fond Gueppe**: Direct seeded *Colubrina arborescens* in 2-year fallow + direct seeded ravine control. Trial 3 = **Morne Carrefour Brémon**: Direct seeded mixture of *Acacia angustissima, A. melanoxylon, Leucaena diversifolia* in annual garden conversion. Trial 4 = **Grand Fond**: Direct and broadcast seeded *C. arborescens, A. angustissima, A. melanoxylon, L. diversifolia* in silvopastoral demonstration plot. Trial 5 = Grand Ravine micro-catchment restoration area.

**Considerations in Direct Seeding**

Timing of trial activities. It is recommended that ASSET personnel refine the above schedule after concurrence with trial participants. Peak labor activity associated with annual cropping and other income-producing activities of trial participants is a chief concern. This suggests that direct seeding of non-cash crops take place during the slack part of the agricultural calendar. However, from year to year rainy seasons shift slightly and there is no way of accurately predicting the best time to direct seed at this stage. For some species, direct seeding during the slack season (e.g., December - March) if fine. For others, including the establishment of grass cuttings, it is important to plant at the onset of rains (e.g., March, August) and this will directly compete with peak labor demands. How critical this is remains uncertain. Other trial activities should be coordinated by the ASSET agronomist in charge directly with the trial owner.

Seed and Plant Material. This should be ordered and stored at least a month in advance of proposed trial establishment. It is recommended to store the material at the PADF seed center or other controlled environment. Humidity and temperature levels are critical to maintain seed viability and this has been worked out for many species (Timyan, 1990). Inoculation with *Rhizobium*, *Frankia* and mycorrhizae is often overlooked for the colonizing species, but has shown such tremendous differences in field producitivity, that it is standard procedure to re-vegetate sites. Scarification is also important to break dormancy for many species. However, scarification is not recommended if germination conditions are such that seed must be stored in the ground for lengthy periods prior to rains.

## Annex 4. Useful indicators to evaluate direct seeding program

| Financial Indicators | Means of Verification |
|---|---|
| 1a. profitability due to technology adoption | 1b. enterprise budgets, observations |
| 2a. improved management techniques | 2b. farm records, observations |
| 3a. investment levels | 3b. timely studies |
| 4a. increase in farm revenue | 4b. check number of products marketed |
| 5a. increase in inputs use | 5b. examine inputs purchased |

| Farm Management | Means of Verification |
|---|---|
| 1a. change in production techniques | 1b. studies, individual interviews |
| 2a. change in work habits | 2b. observation, field studies |
| 3a. change in attitudes to innovations | 3b. examine levels of adoption, studies |
| 4a. examine changes in efficiency | 4b. examine input/output relationships |

| Technology Adoption | Means of Verification |
|---|---|
| 1a. direct seeding of cover crops being practiced | 1b. examine cropping cycle, seed varieties used |
| 2a. improved methods of establishing economical plant species | 2b. economic analysis, examine techniques, field observation |
| 3a. improved cultural practices | 3b. field observation |
| 4a. greater use of on-farm inputs | 4b. field observation |
| 5a. integration of crop and livestock | 5b. farm study |

| Social Indicators | Means of Verification |
|---|---|
| 1a. distribution of benefits | 1b. studies on income distribution, examine purchases |
| 2a. capacity of working in groups | 2b. examine group records, changes in attitudes |
| 3a. changes in self-reliance | 3b. examine degree of autonomy, flow of resources |
| 4a. control of social costs | 4b. examine negative and positive social happenings |
| 5a. effects of program on women | 5b. examine role of women, women employed |
| 6a. effect of program on education | 6b. change in attitude & farm practice by children, men, and women. |

| NGO Effectiveness | Means of Verification |
|---|---|
| 1a. program effectiveness | 1b. number of satisfied clients |
| 2a. management of program | 2b. examine fiche and management records |
| 3a. efficiency of training programs | 3b. number of trained farmers per resource used |
| 4a. production improvement | 4b. number of hectares planted, farmers yields |
| 5a. program regularity | 5b. record of activity |
| 6a. profitability of program | 6b. study program cost effectiveness |
| 7a. improvement in quality of life | 7b. examine social statistics |

| Impact on Soil Erosion & Water Quality | Means of Verification |
|---|---|
| 1a. continuous plant cover | 1b. timely studies |
| 2a. increased biomass production | 2b. farmer interviews, peak cycle studies |
| 3a. runoff | 3b. infiltration of treated vs. non-treated parcels |
| 4a. rill, gully and ravine formation | 4b. aerial photo interpretation, farmer interviews |
| 5a. water quality | 5b. sediment load during peak rainy periods |
| 6a. soil retention | 6b. soil depth as function of vegetative control & slope |

| Sustainability | Means of Verification |
|---|---|
| 1a. economic efficiencies | 1a. input/output analyses, adoption rates |
| 2a. energy production and conservation | 2b. sources and conversion efficiencies |
| 3a. biodiversity conservation | 3b. species structure and ecological function |

4a. soil/water conservation

4b. plant cover quality