RECOMMENDATIONS FOR THE DESIGN AND
ESTABLISHMENT OF DEMONSTRATION TRIALS
AT THE ETHIOPIAN CENTRE FOR COMMUNITY
FORESTRY AND SOIL CONSERVATION

A Model for the Application of Agroforestry
and Soil Conservation Techniques in Tropical
Highlands

by

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EXECUTIVE SUMMARY (by Jerker Thunberg)

The Centre for Community Forestry in Ethiopia, located at Mertu Lemariam, Mota Awraja, Gojam Region, was established formally in 1984 with the following main objectives:

- Training of all categories of staff working within the field of community forestry and students at the Forest Resource institute.
- Establishment of trial and demonstration plots over as wide a range of ecological and social conditions as possible, including both production of fuelwood and timber, soil and water conservation, agroforestry and silvipastural practices etc.

This report contains recommendations on interventions/demonstrations to be introduced and established at the four Peasant Associations, located at altitudes varying between 2,000 m.a.s.l. and 3,200 m.a.s.l., selected to act as hosts for the trial and demonstration plots.

The recommended interventions/demonstrations, in detail described in the report, are:

- Pasture improvement along watersheds, by planting of fodder trees in spot terraces/micro catchments and broadcast sowing of grasses,
- Improvement of cropland on steep slopes, by construction of bench terraces and planting resp. rill-sowing of tree-species and grasses,
- Improvement of cropland on medium slopes, by establishment of Fanya Juu terraces reinforced by planting/rill sowing of tree-species and sowing of fodder legumes,
- Improvement of pasture on heavily eroded slopes by manual breaking/levelling of pointed pinnacles, reinforced by gully planting of trees and sowing of fodder legumes,
- Live fences.

- Cropland improvements, by establishment of Fanya Juu type terraces, reinforced by rill-sowing of trees/bushes,
- Grassland improvements, by borderline planting of trees and sowing of fodder legumes,
- Establishment of a cropland multi-treatment observation trial, including ploughing along the contours and planting or sowing of different trees and forages/grasses on the bunds,
- Pasture improvement, by construction of crude contour ridges, planting of fodder hedgerows, sowing of fodder legumes and planting of fodder trees,
- Live fences.
pasture improvements, by ripping up the area and broadcast sowing of fodder legumes and borderline planting of trees,

river bank fixation by planting of trees,

rehabilitation of seasonally water-logged depressions by planting of trees,

pasture improvement combined with fuelwood production by planting of multipurpose trees and construction of spot terraces along the contours,

live fences.

improvement of cropland on medium slopes, by construction of Fanya-Juu terraces and planting of fodder grasses and multipurpose trees on the terrace ridges,

improvement of cropland on steep slopes, by construction of bench terraces combined with planting of multipurpose trees and rill-sowing of fodder grasses on terrace banks,

improvement of shrub lands on steep slopes, by construction of spot terraces in lines along the contours and planting of trees,

establishment of demonstrations on school compounds, including grassbunds, hedgerows, woodlots for fuel, fruit-tree border planting and planting of shade-trees.

A workplan, including required inputs in terms of labour and number of seedlings or weight of seeds is attached to each of the proposed interventions/demonstrations.

In general terms, improvements of house-compounds and bee-keeping are also presented as well as guidelines for the establishment of community nurseries.
1. INTRODUCTION

The technical report presented in this Working Paper is the result of a 14-day field mission to Ethiopia as an ICRAF consultant to ORGUT-SWEDFOREST. The mission was carried out in November 1985 in the company of Jerker Thunberg from SWEDFOREST and Hakan Sjoeholm and Mesfin Admassu from the Ethiopian Community Forestry and Soil Conservation Department.

The area selected for the demonstration trials is situated around the town of Mertu Lemariam, which is located approximately 350 km NNW of Addis Ababa in the Ethiopian highlands. Mertu Lemariam is the host town of the Ethiopian Centre for Community Forestry and Soil Conservation. The geographical coordinates for this location are 11°N and 38°E.

A rough pre-selection of the demonstration sites and the participating Peasant Associations was carried out in May 1984 by a combined team of members of ORGUT-SWEDFOREST and of the Ethiopian Community Forestry Department. The Baseline Survey Report prepared by this team, which describes in detail relevant social, economic, forestry and bio-physical aspects of the area, has provided the diagnostic background for the final selection of the trial plots and for the recommendations presented in this Working Paper.

The trial plots were selected at four altitude levels ranging from 2000 to 3200 metres. As each of these plots is different from the others in terms of climatic and topographical characteristics, different technical approaches and, especially, different species, both of woody perennials and of crops, grasses and forage legumes, are required. As a result a wide range of soil conservation techniques, of species and of combinations of both are being applied, thus enhancing the demonstration effect with regard to the training programme of the Centre.

When recommending the various agroforestry and soil conservation interventions a balance was sought between maximizing the demonstration effect for training purposes on the one hand and observing site-specific requirements on the other. However, the multi-locality of the trial sites and the deliberate expansion of recommended interventions to the limits of their site-specific acceptability justify the presumption to regard many of these interventions as being a model which is extrapolable not only to the Ethiopian highlands but also to the tropical highlands in general. For these reasons it was felt appropriate to make this report and the suggested techniques and recommended interventions contained in it available to a wider public by publishing it in ICRAF's Working Paper series, with the kind permission of SWEDFOREST.
2. **PROCEDURES FOR THE SELECTION OF DEMONSTRATION SITES**  
(by Jerker Thunberg)

The guiding principle when designing and selecting the demonstration areas was:

To introduce a community forestry-soil conservation "package" incl. e.g. small local nurseries, small woodlots> cropland and pasture improvements) live fences, riverbank fixation, homestead planting etc. in each of the Peasant Associations without changing the existing landuse. The demonstrations should also be based upon local resources in terms of labour and economy, and implemented in full agreement and cooperation with the local villagers. In this connection it should be noted that the team based their job on the data from the base-line survey. These background data are not repeated in this report unless they have changed during the meantime or new facts have been found.

The sites for demonstrations at each Peasant Associations were selected through the following procedure:

1. Discussions with the Woreda Administration regarding aim and kind of land for the demonstrations.

2. Meeting with representatives of each Peasant Associations (chairman, members of executive committee etc.) in which the aim, possible improvements on different kind of land were explained. Regarding agricultural land the villagers were e.g. told to think of any land where a decrease in production during the last years had been noticed.

3. The final selection of demonstration sites was then done, re. agricultural and grazing land, by the villagers themselves without any interference by the team.

4. The land owner (or peasants presently using the land, in case of common land) and the team then discussed, on the spot the various demonstrations to be established on his (their) land (both re type of tree species, fodder improvement and soil conservation measures etc.)

5. Finally, concluding meetings were held in each Peasant Associations, describing to all villagers present, what kind of demonstrations to be implemented and on what kind of land.

When selecting demonstration sites at the lowest located Peasant Associations (Ansana Gondel, 2000-2600 m.a.s.l.), the team decided together with the PA-members, to exclude - for the time being - the proposed site at the riverside at 1600 m.a.s.l. (cf. baseline survey). The reasons being:

- the site is not representative of Ethiopia at this altitude^ being partly flooded during the rainy season and without any permanent settlement. (All farmers using the land are living at the 2000 m level - due to mainly malaria problem.)
- the area is already very well utilized, by irrigation system and well maintained terraces ("paddy-field type") and thus very little could be done to improve the existing landuse practices. The area could already in a way act as a demonstration area without further interventions.

- the long distance from the Centre in Mertu Lemariam, necessitating road construction at high costs, due to partly very steep approach.

In summary this means that the Centre would have demonstration areas in four Peasant Associations, located at elevations 2,000, 2,400, 2,800 and 3,200 m.a.s.l.

Another change from the original plans as described in the baseline survey, is due to lack of water at the 2000 m level. The water supply from the spring "Umbud-bud" has decreased during the last years drought, to a level insufficient to supply the need in a nursery. Consequently no nursery will be established at this altitude until the water supply has increased again. However, it is still considered feasible to establish demonstrations in the area, see further Chapter 4.6, using seedlings produced at the nursery at 2,400 m altitude. This could be done without problems, provided the road from Mertu Lemariam will be constructed.

GENERAL OBSERVATIONS

Topography

With the exception of the Ansana Gondel Peasant Association which is embedded at about 2000 m elevation half way down a river gorge, the project area forms a basically rolling landscape with an altitude ranging from 2400 to 3400 m. In some places distinct catchment areas are marked by relatively steep slopes with gradients up to 50-60%. These slopes are often characterized by rock outcrops and a stony surface - obviously a result of erosion of top soils. Owing to the still unharvested crops at the time of the field trip, erosion on cropland was less visible. However, gully and sheet erosion occurring on sloping pasture land offered evidence of erosion on cropland as well as erosion control measures constitute the exception rather than the rule, and contour ploughing, as a minimum precaution against erosion, is often not observed.

Present Landuse

The whole area comprising the four Peasant Associations, which were previously selected to demonstrate agroforestry and soil conservation interventions with a view to improving land-use, is intensely farmed. The outstanding feature of the present landuse is the competition between cropland and pasture. In all of the four Peasant Associations farmers expressed concern over the insufficiency of pasture. At the same time the reluctance is obvious to convert even those croplands on relatively steep slopes into pasture which by land capability standards would be classified as unfit or at least marginal for growing crops.
It is difficult to establish whether the individual farmers or the Peasant Association as a whole do not realize the lack of balance between the carrying capacity of the present pasture in its current condition and the number of livestock units, or whether they consciously take the risks involved in the overstocking in a desperate effort to beat the cash flow problems they obviously all experience.

The inappropriateness of pasture and, occasionally, the lack of agreement among individual members of a given Peasant Association impose serious limits to the often recognized need for rotation grazing. This puts additional stress on the grazing land to the point of substantially reducing resources, as no recovery period is or can be allowed. Subsequently any intervention aiming at improving the pasture and its carrying capacity is facing considerable difficulties. Any planting of browse species or grass re-seeding requires a temporary closure of the part of the pasture land under treatment. This further reduces in size the already insufficient pasture for a certain period. Suggestions to this effect are therefore often met with reluctance by farmers.

3.3 Tree Vegetation and Its Present Use.

The area at elevations of 2400 m.a.s.l. and above is practically without tree vegetation. Only protected church compounds bear witness of the former, obviously widespread, natural tree vegetation. On more or less steep slopes, most of which are in use as pasture, Croton macrostachvs, for example, is only found as coppicing stumps, providing proof to the need of sizable timber.

Some scattered Acacias (A. pilispina, A. nigrii) occur and are kept and managed throughout the area under consideration in a pollarding system in want of thorny fence material. Thorny branches are used for the protection of crops adjacent to tracks and livestock trails, for livestock enclosures and for protecting house compounds. The often observed use of quickly decomposing and only marginally suitable thistles as fencing material proves clearly the insufficiency of the material generated from the few Acacias left in the area. But this also provides ample evidence for the need for introducing live fences wherever these are of a more permanent nature.

With regard to the obvious shortage of wood for a wide range of uses and to the subsequent high demand for it, Eucalyptus globulus is playing an absolutely vital role. With the exception of the Peasant Association Ansana Gondel at 2000 m. elevation there is hardly a house compound to be found which is not, to some extent, surrounded by belts or small woodlots of E. globulus. Most of the fuelwood, construction timber, poles and posts are made up of this species.
A number of factors make this species a vital asset to farmers' holdings and daily life: the ease of establishment and of reproduction by coppicing; the unpalatability, which saves it from damaging early browsing; and the wide range of uses. The growth performance is demonstrably superior to all other species in the region, although it is admittedly grown on more or less fertile cropland. A remarkable feature of this species is that it also thrives extremely well at altitudes of 3400 m. Although accuratic climate data are not available, an educated guess for the location combining a latitude of 11 degrees and an altitude of 3400 m is that absolute temperature minima occur as low as possibly -10° C. According to FAO (1976) temperatures of -6 to -8 degrees have been reported as the limit of the cold resistance of E. globulus. Yet no frost damage is reported. Although the above guesses on possible minimum temperatures may be inaccurate, precautions should be taken in obtaining germplasm. In case local land races have developed by natural selection in terms of frost tolerance only seed for further use at this altitude should be collected from provenances of an altitude of at least 3000 metres; preferably from stands in the same locality.

3.4 Bee-keeping

In the local subsistence and cash economy honey plays an important role as evidenced by the many bee hives to be seen in the area and by a reported market price of 6-10 birr/kg. Honey is the main ingredient of a local beer called "Tetch", and is used as food mixed with Nuk-oil. It appears that the potential of bee-keeping has not yet been fully realized.

4. DESIGN OF TRIAL AND DEMONSTRATION PLOTS

4.1. Some General Considerations

In calculating the intervals of contour bench terraces, Fanya Juu, grass strips or any other soil conservation measure on cropland a field approximation is used as a matter of convenience by applying the following formula:

\[
\text{HI} = \frac{\text{VI} \times 100}{\% \text{ of slope}}
\]

\[
\text{VI} = -S + 2
\]

The vertical slope is calculated as follows:
Strictly speaking \( S \) (slope in \%) is the fall in metres over a horizontal line of 100 m. As this is hardly measureable (if at all) in praxis, the fall is measured down the slope. As the resulting difference is negligible up to a gradient of 50\% slope, the horizontal interval (HI), as calculated using the above formula, is regarded equal to the on-the-ground interval.

The suggestions presented hereunder for various agroforestry and soil conservation interventions are made according to the local requirements in terms of prevailing socio-economic, topographic and land-use conditions and problems. They may therefore neither be exhaustive, nor all of them necessarily replicable elsewhere in the Ethiopian highlands where conditions may be distinctly different from those in the project area.

Many of the woody perennial and forage species which are suggested for their perceived suitability for the purposes they are to be used for, are exotics and have not yet been planted in the area under consideration. Although the suggested exotic species are carefully selected by considering such parameters as altitude vis-a-vis latitude, comparable climatic conditions and soil adaptability, ideally multi-location species elimination trials should be carried out. As such an exercise would be time consuming and would require a considerable time input of trained staff, it has been decided against it. Instead the immediate use of a large number of species in a "best-bet" approach has to be seen as a compensatory "species elimination" trial in itself. With this concept in mind the number of species to be used at each site is deliberately increased in view of their reciprocal replacement capability. Should one species fail or perform badly in the course of the implementation of the project, emphasis will be placed on the use of another one which has been more successful. The expected difference in performance of the various species may also be seen as a demonstration by itself. As many of the species recommended are new to the area inoculation of those which are leguminous with appropriate Rhizobium species or strains should be considered. In the table presented in Annex 3, reference will be made to those species for which inoculation may be considered.

In selecting individual demonstration plots and determining their size a balance was sought between the concessions farmers were prepared to make, and the minimum size and the lay-out required to achieve an adequate demonstration effect. By not forcing the farmers concerned into accepting anything which meets their outright suspicion, it is hoped that their full cooperation in the implementation phase is secured. This attitude, however, resulted in the demarcation of plots of limited size. In cases involving soil conservation measures, particularly on cropland, care was taken that the plots always start at the watershed or at the top of a slope or mountain in order to demonstrate the proper topographical sequence of soil conservation activities.
4.2 Peasant Association Derdj

4.2.1 Description of the selected demonstration plot

The selected demonstration plot of approximately 300 x 60 m (= 1.8 ha) is part of the western flank of a distinct water catchment extending from North to South. Half-way up the slope, to the North, the plot borders the farm compound of the Peasant Association chairman. The plot covers an altitude range of 3290 to 3400 m. a.s.l. The slope gradient ranges from 30% to about 50%.

Access to both the nursery, situated at the bottom end of the sloping plot, and the plot itself is by a recently constructed rough road leading to Mertu Lemariam.

The whole catchment area is under intensive agricultural use. The major crops are barley and potatoes. Onions are grown in vegetable gardens on or close to the farm compounds.

Pasture of obviously below optimum quality is restricted to the steep slopes mostly at the higher parts of the catchment area.

A conspicuous feature of the area is the almost complete absence of any trees. Only around the farm compounds may small belts or clusters of Eucalyptus globulus be found constituting the sole source of woody material used for literally every purpose (e.g. fence post, construction, fuelwood, etc.).

With regard to the use of woody perennials, grasses and other forages it is important to take note of the fact that the climate is temperate with temperatures dropping distinctly below 0º C quite frequently. Absolute minima may be occasionally as low as -8 to -10º C, thus limiting the range of species of both agricultural plants and woody perennials. However, as the plot is sloping in its entire length, it is hoped that a katabatic airflow into frost hollows will reduce the danger of frost damage on the plot itself.

As depicted in Figures 1.1 and 1.2 (pages 6 and 7) the plot is sub-divided in four sections, each one representing a particular land-use and/or a distinctly different slope gradient. Consequently different treatments for each of the four sections are suggested hereunder.

4.2.2 Recommended interventions/demonstrations

4.2.2.1 Pasture improvement (Figure 1.1 and 1.2, Section 1 and Fig. 1.3)

The uppermost section (section 1) of the demonstration plot forms a slightly elevated top along the watershed of the catchment area mentioned above. This top is a small, flat to slightly sloping plateau, descending towards E and W at a rather steep gradient. The Western slope of 30%, declining to 50%, is part of the demonstration plot.
Figure 1.1 Sketch map (1:1500) of the selected demonstration plot at Derdj Peas Assoc. (approx. on-the-ground distances) — Vertical aerial view —
Figure 1.2  Cross Section View (1:1500) of Selected Demonstration Plot at Derdj Peasant Association in its Present Condition
The existing vegetation consists of sparse grass and heavily browsed shrubs, among which Erica arborea and Hypericum revolutum and some lesser browsed herbs are dominant. Among stones, holders and rock outcrops patches are free of any vegetation.

In June 1985 Eucalyptus globulus and Cupressus lusitanica were planted. Although due credit should be given to the fact that probably no other species were available, it cannot be ignored that this choice of species appears inadequate. The irregular but in average dense spacing (estimated 1.5 x 1.5 m) would turn this part of the plot from pasture into a wood lot, provided that the survival is satisfactory which, however, is doubtful, at least for C. lusitanica, given the presumably high wind speeds prevailing occasionally at this exposed location and the shallowness of the soil.

Under the circumstances and conditions of the site as described above, and accepting the need to maintain and possibly improve the pasture, the following interventions are suggested:

- Leaving the already planted Eucalyptus globulus and Cupressus lusitanica to grow at least into stick fuelwood before their extraction, woody perennials more suited to the specific hill top climate, to the shallow soil and to the required improvement of the pasture should be interplanted.

In view of the high altitude and the shallow soils Robinia pseudoacacia and Acacia saligna being less-demanding species should be used alternately in a spacing of about 5 x 5 m. Where the site descends in a slope towards West, planting in staggered contour lines should be conducted wherever the terrain permits such pattern. The planting itself should be carried out in spot terraces/micro catchments. Care should be taken that beginning gully or rill erosion is intercepted by micro catchment construction and planting; if necessary on expense of regular spacing (see Figure 1.3). The relatively wide spacing is chosen to allow sufficient grass growth between the trees which will necessarily form the bulk of the fodder production.

Both the suggested species are known to provide leaf fodder and may serve as emergency feed during the dry season. They are also a source of good fuelwood, particularly Robinia pseudoacacia. and both species, flowering early and in abundance, are known to be excellent bee-forage species. While Acacia saligna as an evergreen species maintains its foliage throughout the year, Robinia pseudoacacia is deciduous. This may prove advantageous if its deciduousness follows the inherited pattern of shedding its leaves around October and resprouting around March/April, which would be in the second half of the dry season when fodder from woody perennials is in particular demand in the absence of sufficient grass fodder.
Figure 1.3: Improvement of pasture plot (section 1) on steep sloping part with interception of beginning gully erosion.
- After planting of fodder trees protection against early damaging browsing by livestock is essential. The farmers volunteered to assign special guards to keep out livestock for the duration required for the trees to firmly establish and to grow out of the reach of the mouth of the animals. This way of temporary protection is definitely in the spirit of community forestry or agroforestry development. However, should it be conducted insufficiently in view of the prevailing pressure, particularly at the end of the dry season, it might be necessary to fence the plot.

- As a result of the temporary closure of the pasture the danger of an "invasion" of unpalatable herbs, thus reducing the value of the pasture, should not be overlooked. In order to preclude such an unwanted development and to improve the carrying capacity at the same time, broadcast sowing of Lespedeza bicolor and Festuca grasses is recommended, particularly on presently uncovered patches.

4.2.2.2 Improvement of cropland on upper steep slope (Figure 1.1 and 1.2, Section 2 and Figure 1.4)

This section bordering the pasture site described above is characterized by a slope gradient of 50% and by an abundance of stones. Although not immediately visible at the time of the field visit, it can be assumed that owing to the steep gradient and the complete absence of any soil conservation measures a deposition of top soil has taken place.

By normal land capability standards this part of the demonstration plot has actually to be considered unsuitable for cropping. However, as a conversion into more appropriate pasture is unthinkable for reasons given in chapter 3.2, the following interventions are suggested to curb erosion and to maintain fertility and thus sustainability of yields:

- At an on-the-ground interval of 14 m graded bench terraces should be constructed (Fig. 1.4). The many stones should be incorporated in the terrace banks together with the soil. It is not recommended to construct the banks only with stones, as this reportedly creates a favourable habitat for rodents, thus increasing their population and subsequently damage to crops.

- Along the upper edge of the terrace bank a rill-sown double line (30 cm row-to-row spacing) of Lespedeza bicolor and L. thunbergii should be established as an additional barrier to soil eroding down the slope.

- The terrace banks should be planted alternately (every second terrace) to Acacia saligna in a fairly dense staggered spacing of 0.8 m in-row by 0.4 m row-to-row, thus achieving quick stabilizing root penetration and ground cover. On every other terrace the banks should be sown in rills 20 cm apart to Trifolium cryptopodium.
Figure 1.4: Graded Bench Terracing on Steep Sloping Cropland (Section 2); Scale 1:220
4.2.2.3 Improvement of cropland on medium slope  
(Fig. 1.2, Section 3 and Fig. 1.5)

This section of the plot is a continuation of the cropland described in the previous sub-chapter. However, with a distinctly less steep gradient of 32-34% as compared to the 50% of the upper portion. The many stones of various sizes are more apparent in remnants of previously constructed but now neglected widely spaced terraces. There are 5-6 of these terraces on the total on-the-ground length of this section of about 140 m.

This less steep gradient of this section of the cropland allows the following soil conservation measures:

- The above-mentioned badly neglected and eroded bench terraces should be repaired with a minimum of effort by grading the terraces using the surplus soil and stones to form a terrace-front ridge (See Fig. 1.5).

- In between these bench terraces, "Fanya Juu" type terraces are to be constructed whereby the basic intervals of 15-16 m between "Fanya Juus" have to be adjusted accordingly. The up-hill ridge should be rill-sown in a double line to Lespedeza bicolor.

- The bench terrace banks are to be re-enforced by planting one line of Grewia oppositifolia seedlings at an in-row spacing of 5 m. and by broad-cast sowing of Trifolium cryptopodium as a soil cover forage crop. Although high altitudes and frost are critical factors to its growth performance Desmodium uncinatum may also be tried as a terrace bank soil cover at every second "Fanya Juu" ridge. This perennial forage legume is cold tolerant but susceptible to frost; the latter may kill terminal shoots but not the plant, which quickly recovers. In case of repeated failure it can be replaced by Trifolium. D.uncinatum should be sown in 2-3 lines, each 50 cm apart on the terrace wall.
FIGURE 1.5: 'FANYA JILLI' TYPE TERRACES AND REHABILITATION OF OLD NEGLECTED BENCH TERRACES ON MEDIUM SLOPING CROPLAND (SECTION 3); Approx. Scale 1:670
4.2.2.4 Improvement of pasture on lower slope  
(Fig. 1.1 and 1.2, Section 4)

Due to heavy erosion this section of the demonstration plot at the bottom of the slope has developed a ragged broken surface, making it unfit for cultivation and is therefore left to pasture. The grass and herb vegetation is incomplete and in gully-like breaks in the surface non-existent.  

Levelling of this roughly 0.4 ha area in order to turn it into cropland seems unfeasible. Also the shortage of pasture land speaks against such a venture. Therefore the following simple measures to stabilize and improve this pasture plot are recommended:

- Manual breaking/levelling of the most pointed pinnacles, thus roughly closing gully-like gaps.

- These so treated gully-like gaps should then be re-enforced and stabilized by planting Ervthrina abyssinica of which the foliage provides fodder (see also Fig. 1.3).

- As additional fodder, Grewia oppositifolia at an average spacing of 8 x 8 m should be planted for lopping.

- Barren patches should be sown to Trifolia cryptopodium and Festuca abyssinica.

- Fencing for about 3 years is required until the existing and re-seeded forages have been recovered and established and the terminal shoots of the trees have grown out of reach of livestock.

4.2.2.5 Live fences

"Within the demonstration plot and in its near vicinity there are many opportunities to demonstrate live fencing and its benefits. Live fences are only to be recommended where protection against unwanted intrusion of livestock is of a more permanent nature.

Possible and recommended intervention points are the following:

- Nursery

- Along the borderline between the pasture on the highest elevation of the demonstration plot (see Fig. 1.2, Section 1) and the adjacent cropland (section 2).  

A live fence established and maintained there would not only confine the livestock to the pasture but also form an additional barrier to erosion.

- Surrounding the pasture (section 4) at the lower slope (at least the fenced-in part as far as it borders cropland).
- Outside the demonstration plot along the newly constructed rough road, leading from the nursery towards Mertu Lemariam. Initially 100 m of live fence should be established for demonstration on either side of the road where it passes through land permanently assigned to growing crops.

**Species to be used:** The limitations imposed by altitude and occurrence of frost limits the number of species to be considered. Probably the best species as being spiny (but palatable!) are Erythrina abyssinica and *E. brucei*. Also *Prunus serotina* and *Croton macrostachys* should be used on a "trial and error" basis. As an effective low-to-ground barrier *Aloe berhana* or any other locally occurring *Aloe* species may be used. However, the altitude under consideration is probably beyond the range of these species. Therefore it should only be tried along the feeder road, constituting the lowest of the suggested sites in terms of elevation. The required seedling stock of *Aloes* can be easily obtained from vegetative propagation by uprooting and splitting *Aloe* plants in the vicinity.

**Establishment and Maintenance**

The following two designs may be used:

- *Erythrina abyssinica* or *E. brucei* or *Croton macrostachys* or *Prunus serotina* seedlings are planted in a dense staggered double line with a 40 cm in-row, and 50 cm row-to-row spacing (see Fig. 1.6)

- As above, plus a third line of *Aloes* with a 40 cm in-row and row-to-row spacing. This third line is to be planted on the side from where the livestock is to intrude into a plot to be protected.

In order to achieve an effective protection by the live fence the following has to be observed:

- immediate replacements of mortalities

- if necessary mechanical intertwining of lower branches

- regular trimming as soon as required height (usually 1.2-1.4 m) is reached.
FIGURE 1.6: VERTICAL AERIAL AND CROSS SECTION VIEW OF THE DESIGN OF LIVE FENCES (Scale 1:16)
The above calculation is based on the assumption that for those woody perennials for which seeds are immediately available at the Ethiopian Forestry Research Centre (see Appendix 4) seedlings will be ready for planting out by June 1986 at the start of the rainy season. Only activities concerning the establishment of the plots are taken into consideration, and not follow-up maintenance activities (e.g. beating-up, weeding).

4.3 Peasant Association Sholana Woncher

4.3.1 Description of the selected demonstration plots

The general impression was that this Peasant Association as compared to the others visited is least well off in economic terms. The major concern, as repeatedly expressed, is the insufficiency of pasture both in size and in quality as could be observed on site. This situation is aggravated by a rather large number of livestock (according to the people about 1000 cattle and 200 sheep) and by the obviously complete absence of any rotation grazing. As a result the plots set aside for grazing are visibly over-utilized with no resting and restoration period allowed. As one of the reasons of no rotation grazing lack of agreement among farmers was mentioned. Farmers were aware of the beneficial aspects of fodder trees; these had, however, long since disappeared or were reduced to isolated remnants, and the few still to be found are grazed down to almost root collar level.

What has been mentioned earlier also applied here, that in view of an increased population the conversion of some of the cropland was considered impossible as food production is now already marginal, particularly during frequent drought.

Tree vegetation is scarce and limited to some Eucalyptus globulus trees around compounds and along a small permanent river passing east of the settlement. The few remaining Acacia appeared slightly stunted in growth, obviously due to constant, quick rotation and intensive lopping of branches, often of the entire crown, in order to generate thorny fence material.
In this situation the process of selection of suitable demonstration plots run into some difficulties, not so much because of lack of understanding and appreciation of innovation but because of desperation.

Frost will occur occasionally. However, absolute temperature minima are not likely to fall below -4° C.

Finally two demonstration plots at an altitude of about 2700 m. a.s.l. were selected and agreed upon by the peasant. Both are situated along the road/trail leading in roughly E-W direction from Sholana Woncher to Mertu Lemariam, and are about 1000 and 500 m respectively away from the permanent river mentioned above.

The plot closer to Mertu Lemariam has an approximate size of 1.75 ha and forms a 190 m long and 60 m wide rectangle stretching from the watershed in NE down towards SW into a plain levelling out at a slope gradient ranging from 10% at the bottom to a maximum of 20% further up the slope. With the exception of a small area of 40 x 60 m (= 0.2 ha) NE of the road/track which is grassland, the whole demonstration plot is under cultivation.

Hereunder this plot is referred to as "cropland demonstration plot".

The second plot is situated only a few hundred meters away from the permanent river mentioned above. It constitutes a SW-oriented slope of 30-45% gradient. On its eastern flank it is close to a house compound. The plot stretching down from a plateau is bordered at its bottom by the road/track leading to Mertu Lemariam.

The entire plot is assigned to pasture. Rill and slight sheet erosion is apparent between the stones and occasional rock outcrops. The grass, herb and shrub vegetation is incoherent and leaves much to be desired in terms of quality.

The plot extends about 110 m from top to bottom and is 60 m wide (= 0.7 ha).

Hereunder this plot is referred to as "pasture demonstration plot".

4.3.2.1 Cropland demonstration plot

As shown in Fig. 2.1 and 2.2 the plot is sub-divided into three sections. Section 1 at the upper slope is with a gradient of 15-20% the steepest part of the plot. Its size is approximately 110 x 60 m.
It is followed by Section 2 constituting a small plot of grassland of about 40 x 60 m with a slope with an average gradient of 15% and being bordered by the road/track to Mertu Lemariam. The remaining part of the plot below the road is the largest with an approximate size of 140 x 60 m (= 0.8 ha). The entire plot is largely free of sizable stones. With the exception of a small *Eucalyptus globulus* cluster at the nearby farm compound, there are no trees on the plot or in the surrounding plot.

For the uppermost part (section 1), the following demonstration is suggested:

- Depending on the exact distance from the top (edge of the plateau to the grazing section) 5 to 6 "Fanya Juu" type terraces will be constructed at an interval of 20 m, the first one being 30 m measured from the plateau downwards (see Fig. 1.5, for construction specification).

- The terrace-front ridges will be rill-sown in 2 lines to *Lespedeza bicolor* for binding the soil, for providing fodder and possibly some stick fuelwood.

The following grassland (section 2) will be treated as follows:

- Along the upper borderline between the cropland of section 1 and the grassland of section 2 and along the road at the lower end of the grassland one line of *Acacia saligna* with one *Robinia pseudoacacia* every 10 m will be planted on a raised ridge at an in-row spacing of 1 m. (see Fig. 2.3). The *Robinia pseudoacacia* should be allowed to grow big and to form a widely-spaced upper storage. It can be lopped for fodder and individual branch pruning conducted for fuelwood.

- On the grassland itself barren and sparsely vegetated patches will be ripped up along the contours and sown to *Trifolium cryptopodium* and *Festuca abyssinica*.

The cropland below the road (section 3) will be divided in equal halves for separate treatment and demonstrations of different designs.

It is suggested that the upper half with a size of 60 m width and 70 m down-the-slope length be allocated to a multi-treatment observation trial.

For the implementation of this trial on cropland the following lay-out and activities are suggested:

- With an interval of 20 m three furrows along the contours are ploughed or manually prepared in preparation of the bunds to be planted or sown to tree seedlings and forages/grasses respectively.
Figure 2.3: Vertical Aerial and Cross Section View of Section 2 of the "Cropland Demonstration Plot" (Sholana Woncher)
- Each furrow contour line is divided into 4 lengths of 15 m each, resulting in a total of 12 equal lengths of bunds/furrows.

- The following three treatments are recommended:
  
  (a) One line of *Erythrina abyssinica* with an in-row spacing of 50 cm.
  
  (b) As under (a), but with an additional line of *Lespedeza bicolor*, the seed dibbled at an in-row spacing of 20 cm, the line being up-slope 30 cm apart from the line of *Erythrina abyssinica*.
  
  (c) Two lines of *Lespedeza bicolor*. the seeds dibbled in a double line of an in-row spacing of 20 cm and a row-to-row spacing of 30 cm (staggered).
  
  (d) One line of *Morus alba* with an in-row spacing of 50 cm.
  
  (e) As under (d), but with an additional line of rill-sown *Festuca abyssinica* grass on the up-slope side and 30 cm apart from the line of *Morus alba*.
  
  (f) Grass/legume bund, 50 cm wide and slightly raised (furrow), rill-sown to *Trifolium semipilosum*.

The six treatments will be replicated once and for demonstration purposes arranged (not randomized!) as shown in Fig. 2.4.

The remaining cropland will be treated as follows:

- At an interval of 30 m down the slope contour ridges will be ploughed or hand-made in preparation for the establishment of grass bunds.
  
  - Alternately these ridges will be sown in parallel rills, 20 cm apart, to *Trifolium semipilosum* and *Festuca abyssinica*.

As an alternative technique and in order to cope with a possible problem to obtain germplasm for the forage species mentioned above, but also to demonstrate other grass bund establishment methods, sods of the required species (possibly including local *Medicago* spp.) should be transplanted from the range on to the levelled ridges to form the grass bunds.

In the preparation of this kind of treatment the cooperation of a competent botanist/rangeland expert should be sought. To this end, a resource person, such as Dr. Tadesse or Ato Mesfin Tesfay, both of the Animal Breeding and Feeding Nutrition Team, Ministry of Agriculture. NW Regional Zone in Bahar Par, should be requested to indentify on site the species required. Thereafter patches on which these species grow naturally should be pegged out. With the first rains sods of an easy to handle size should be peeled off and immediately transplanted on to the bunds with a total width of 60-80 cm. (See Fig. 2.5).
FIGURE 2.4: VERTICAL AERIAL AND CROSS SECTION VIEW OF GRASS BUNDS AND HEDGEROWS ON THE SELECTED "CROPLAND DEMONSTRATION PLOT" (SECTION 3) - SHOLANA WONCHER
**Figure 2.5:** Design of transplanting grass sods on bunds (free scale)
4.3.2.2 Borderline tree planting

The cropland demonstration plot described in chapter 4.3.2.1 is bordered on its NW-side along its lower part SSW of the road/track by the cropland used by another member of the Peasant Association.

Along this borderline of about 140 m. a line of Grevillea robusta and Grewia oppositifolia should be planted alternately at a spacing of 8 m. This line would serve not only as boundary demarcation, but would also produce fuelwood from lopping/pruning branches, valuable leaf fodder from pollarding Grewia oppositifolia and timber from Grevillea robusta once the latter has grown to appropriate dimensions.

4.3.2.3 Management considerations for the cropland demonstration plot

- In order to secure efficiency as barriers against soil erosion the hedgerows of woody perennials as described above require immediate and constant replacement of mortalities.

- They should not be allowed to grow higher than 60-70 cm. Upon reaching this height, regular lopping has to be conducted to maintain the appropriate height and width of the Erythrina abyssinica and Morus alba hedgerows. The lopping operations should usually be done at the time when the adjacent crops start to germinate or have just germinated. The lopped material can serve as supplementary fodder for livestock.

- The same time schedule should be kept for pruning and lopping of the Grevillea robusta and the Grewia oppositifolia planted along the border plot (see chapter 4.3.2.2) in order to reduce competition with the crops for light during the early development of the latter.

- Initial protection, particularly of the hedgerows, against early damaging browsing by free-grazing livestock is crucial for a successful establishment. The local technical project staff should be charged with the task of securing this protection by constant dialogue with the farmers concerned and by close supervision.

4.3.2.4 Pasture improvement plot

The location and features of the second demonstration plot (pasture land) have been described already in chapter 4.3.1 (see also Fig. 2.6 and 2.7).

The planned interventions with a view to rehabilitating and improving the carrying capacity are as follows:
FIGURE 2.6  VERTICAL AERIAL VIEW (1:1200) OF SELECTED "PASTURE DEMONSTRATION PLOT" AT SHOLANA WONCHER PEAS, ASSOC.

FIGURE 2.7  CROSS SECTION VIEW (1:1200) OF PLOT SHOWN IN FIGURE 2, IN ITS PRESENT CONDITION.
Steep upper slope. (Figure 2.7, Section 1)

- At vertical interval of 15 m, 10 m long hand-hewn crude contour ridges in 10 m horizontal staggered intervals will be constructed in preparation for the establishment of fodder hedgerows (see Fig. 2.8).

- At an in-row spacing of 1.5 m Acacia saligna will be planted

- Along the contours between the fodder hedgerows ripping-up of the soil is to be conducted and *Trifolium semipilosum* to be sown

Lower, slope. (Fig. 2.7, Section 2)

- Ripping up and sowing *Trifolium semipilosum* as above

- Planting of *Grewia oppositifolia* at a spacing of 8 x 8 m

The entire plot will be fenced to protect the planted or sown plant material and to allow the existing grass and shrub pasture to recover. After the establishment of the planted woody perennials and after the latter have attained a height at which browsing by livestock is no threat any more, the fence will be moved to the next plot to be rehabilitated.

4.3.2.5 Live fences

For the same reasons discussed in chapter 4.2.2.5 live fences should be established on an initial demonstration basis at the following points where the demonstration purpose is likely to be most effective:

- Along the last roughly 200 m of the approach road from the Mertu Lemariam - Gundewoyn main road to the Sholana Woncher nursery.

- Along the track leading from Sholana Woncher in the South-eastern direction towards Mertu Lemariam passed the two demonstration plots discussed in chapters 4.3.2.1 and 4.3.2.3 with a length of 250 m.

The establishment technique, the spacing and maintenance considerations of the live fences are the same as described in chapter 4.2.2.5.

The components will be *Erythrina abyssinica* and cuttings of local *Aloe spp*

4.3.3 Work plan - time schedule and inputs

The activities described above will require the following estimated inputs:
Figure 2.8: Vertical aerial view of fodder hedgerow design on the selected "pasture demonstration plot" at Sholana Woncher (scale 1:400)
<table>
<thead>
<tr>
<th>Activity</th>
<th>Locality</th>
<th>Units</th>
<th>Labour m/d</th>
<th>Species</th>
<th>No. of Seedlings</th>
<th>kg. of Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Construction of &quot;Fanya Juu&quot; terraces</td>
<td>Uppermost cropland</td>
<td>300 m</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Fig. 2.2, section 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Rill sowing on terrace-front ridges</td>
<td>- ii -</td>
<td>300 m</td>
<td>1</td>
<td>Lespedeza bicolor</td>
<td>1.5 kg. seeds</td>
<td></td>
</tr>
<tr>
<td>(c) Borderline planting of trees</td>
<td>Borderline (Fig. 2.1,</td>
<td>120 m</td>
<td>2</td>
<td>Acacia saligna</td>
<td>108 seedlings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>section 1 along section 2 and along track)</td>
<td></td>
<td></td>
<td>Robinia pseudoacacia</td>
<td>12 seedlings</td>
<td></td>
</tr>
<tr>
<td>(d) Ripping up of barren patches, grass sowing</td>
<td>Pasture (Fig. 2.2, section 2)</td>
<td>0.1 ha</td>
<td>1</td>
<td>Trifolium cryptopodium</td>
<td>0.5 kg. seeds</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Festuca abyssinica</td>
<td>0.5 kg. seeds</td>
<td></td>
</tr>
<tr>
<td>(e) Contour furrow preparation</td>
<td>Cropland upper part of section 3 Fig. 2.2</td>
<td>180 m</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(f) Hedgerow planting</td>
<td>Cropland upper part of section 3 Fig. 2.2</td>
<td>30 m</td>
<td>1</td>
<td>Erythrina abyssinica</td>
<td>60 seedlings</td>
<td></td>
</tr>
<tr>
<td>(g) Hedgerow planting + rill sowing</td>
<td>- ii -</td>
<td>30 m</td>
<td>2</td>
<td>Erythrina abyssinica</td>
<td>60 seedlings</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lespedeza bicolor</td>
<td>0.5 kg. seeds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>Distance</td>
<td>Seedlings</td>
<td>Species</td>
<td>Seed Rate</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------------</td>
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<td>-----------</td>
<td>--------------------------</td>
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<td></td>
</tr>
<tr>
<td>(h)</td>
<td>Rill sowing</td>
<td>30 m</td>
<td>1</td>
<td>Lespedeza bicolor</td>
<td>0.5 kg. seeds</td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Hedgerow planting</td>
<td>30 m</td>
<td>1</td>
<td>Morus alba</td>
<td>60 seedlings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cropland, upper part of section 3, Fig. 2.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(j)</td>
<td>Hedgerow planting</td>
<td>30 m</td>
<td></td>
<td>Morus alba</td>
<td>60 seedlings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+ rill sowing</td>
<td></td>
<td></td>
<td>Festuca abyssinica</td>
<td>0.5 kg. seeds</td>
<td></td>
</tr>
<tr>
<td>(k)</td>
<td>Rill-sowing</td>
<td>30 m</td>
<td></td>
<td>Trifolium semipilosum</td>
<td>0.5 kg. seeds</td>
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<tr>
<td>(l)</td>
<td>Contour furrow preparation for grass bunds</td>
<td>240 m</td>
<td></td>
<td>Trifolium semipilosum</td>
<td>0.5 kg. seeds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cropland, lower part of section 3, Fig. 2.2</td>
<td></td>
<td></td>
<td>Festuca abyssinica</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(m)</td>
<td>Rill sowing/sod transplant</td>
<td>30 m</td>
<td></td>
<td>Trifolium semipilosum</td>
<td>0.5 kg. seeds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cropland, lower part of section 3, Fig. 2.2</td>
<td></td>
<td></td>
<td>Festuca abyssinica</td>
<td>0.5 kg. seeds</td>
<td></td>
</tr>
<tr>
<td>(n)</td>
<td>Borderline tree planting</td>
<td>140 m</td>
<td></td>
<td>Grevillea robusta</td>
<td>9 seedlings</td>
<td></td>
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<tr>
<td></td>
<td>Cropland, lower part of section 3, Fig. 2.2</td>
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<td></td>
<td>Grewia optiva</td>
<td>9 seedlings</td>
<td></td>
</tr>
<tr>
<td>(o)</td>
<td>Crude contour ridging and pitting</td>
<td>90 m</td>
<td></td>
<td>Acacia saligna</td>
<td>60 seedlings</td>
<td></td>
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<tr>
<td></td>
<td>Cropland, upper slope for fodder hedgerows</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Pasture demo, plot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(p)</td>
<td>Fodder tree planting</td>
<td>90 m</td>
<td></td>
<td>Acacia saligna</td>
<td>60 seedlings</td>
<td></td>
</tr>
<tr>
<td>(q)</td>
<td>Ripping up, sowing</td>
<td>0.2 ha</td>
<td></td>
<td>Trifolium semipilosum</td>
<td>0.5 kg. seeds</td>
<td></td>
</tr>
<tr>
<td>(r)</td>
<td>Ripping up, sowing</td>
<td>Pasture demo-plot lower slope section 2 Fig.2.8</td>
<td>0.3 ha</td>
<td>4</td>
<td>Trifolium semipilosum</td>
<td>1.0 kg. seeds</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------</td>
<td>-----------------------------------------------</td>
<td>---------</td>
<td>----</td>
<td>------------------------</td>
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</table>

<table>
<thead>
<tr>
<th>(s)</th>
<th>Pitting for fodder tree planting</th>
<th>- • -</th>
<th>65 pits</th>
<th>2</th>
</tr>
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<table>
<thead>
<tr>
<th>(t)</th>
<th>Fodder tree planting</th>
<th>Pasture Demo-plot lower slope section 2 Fig. 2.8</th>
<th>0.4 ha</th>
<th>1</th>
<th>Grewia oppositifolia</th>
<th>65 seedlings</th>
</tr>
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<table>
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<tr>
<th>(u)</th>
<th>Live fences</th>
<th>See chapter 4.3.2.5</th>
<th>65</th>
<th>Erythrina abyssinica Alop spp.</th>
<th>2800 seedlings</th>
<th>1200 cuttings</th>
</tr>
</thead>
</table>

**Total** | 140 m/d | Seedlings : 3300 Cuttings : 1200 Forage Seeds : 7 kg. |
|----------|---------|-------------------|-------------|

### Time Schedule of Implementation

<table>
<thead>
<tr>
<th>Earliest Implementation Date</th>
<th>Activities (code letters of previous table)</th>
<th>Required Labour Input (m/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediately</td>
<td>Nursery establishment (seed- and transplant beds, irrigation channel etc. - not live fence)</td>
<td>Permanent nursery staff</td>
</tr>
<tr>
<td>As of January 1986</td>
<td>(a), (o), (s)</td>
<td>Est. 44</td>
</tr>
<tr>
<td>Approx. mid Jan. 1986</td>
<td>Sowing of those tree seeds into seed beds/boxes obtained then</td>
<td>Permanent nursery staff</td>
</tr>
<tr>
<td>June 1986 (following start of rains)</td>
<td>(b), (c), (d), (e) - (h), (k), (l), (m), (p), - (r), (u)</td>
<td>Est. 92</td>
</tr>
</tbody>
</table>
Dec. 1986/Jan. 1987  Sowing of remaining required permanent nursery
tree seeds into seed beds/staff
boxes

June 1987  (i), (j), (t)  Est. 4

In setting the above dates for the implementation and in calculating the input requirements the following assumptions are made, and the following explanatory remarks offered:

- The woody perennials for which seeds are immediately available at the Ethiopian Forestry Research Centre (See Appendix 4) will be ready for planting out by the onset of the rains in June 1986.

- In the course of the implementation of the interventions suggested in section 4.3.2 of the previous chapter changes may occur which affect both the level of material and labour inputs. For example, instead of rill sowing on to grass bunds, grass sods, generated in the vicinity of the demonstration plot, may be used. This would reduce the quantity of seeds of forage legumes or grasses to be purchased, but increase labour inputs.

In preparation for the establishment of live fences furrow ploughing may be impossible or insufficient. In this case pits would have to be dug which would increase labour requirements by about 80-100 man-days.

- One man-day is budgeted with 6 hours considering that a peasant labourer will be unable to spend the whole day on off-farm employment.

4.4 Peasant Association Ibsana

4.4.1 Description of the selected demonstration plot

This Peasant Association, situated east of Mertu Lemariam, appears to be under less economic stress than the other Peasant Associations selected for conducting demonstration trials. Although seasonal shortages of fodder for livestock were mentioned as a problem the general impression is that economic problems are less prevalent and are of a less permanent nature.

The generally undulating terrain which slopes gently towards east from the village to a permanent river is almost completely bare of trees. Exceptions are clusters and small woodlots in and around the village, almost entirely made up to Eucalyptus globulus, and occasionally in depressions or along waterways. The few Acacias are heavily lopped for generating thorny fence material mainly used along roads and trials to protect adjacent crops against livestock.
It may be regarded as a visible indication of the need for fuelwood and other wood products, but also as a sign of the less strenuous economic situation and less distinct pressure on land that about 3/4 of a hectare of crop land obviously suitable for cropping and having been cropped has recently been planted to Eucalyptus globulus. Although this may also be seen as an expression of a certain ranking of priority, it should nevertheless be noted that under similar economic circumstances other Peasant Associations could simply not afford setting aside agricultural land for plantations of the kind mentioned above.

On much of the cropland, particularly East of Isbana village, stone terraces have been built for soil conservation (see Fig. 3). Although this was commented on as having led to a somewhat crop-obstructive increase of rodent population, there seems to be no scope now for soil conservation cum agroforestry interventions of another kind and concept. Therefore suggested interventions focus on pasture improvement, live fences and river bank fixation.

The area selected for pasture improvement and river bank fixation is located east and south-east of Isbana village. Descending at a slope gradient of about 15% towards east from the village, the pasture stretches along a permanent river and along an affluent which only seasonally carries water. Part of this pasture land is seasonally flooded, the water normally subsiding quickly after downpours during the rainy season, but leaving waterlogged patches in small depressions (see Fig. 3).

4.4.2 Recommended interventions/demonstrations

4.4.2.1 Pasture improvement

As shown on the sketch map (Fig. 3), the selected demonstration plot is located roughly south-east of Ibsana village. It borders in the south the seasonal river which extends towards north-west into a depression in the terrain rather than into a distinct river bed. It was agreed with the peasants concerned that the northern corner (see sketch map, Fig. 3) will be set aside for the demonstration plot. The existing pasture is slightly degraded, although rotation grazing is conducted whenever general vegetation growth, depending on the quality of the rainy seasons, permits.

The following interventions are suggested to improve the quality of the pasture and its carrying capacity

- The roughly 2-ha. plot is to be ripped up and broadcast sown to Trifolium semipilosum and Festuca abyssinica.

- The borderline between the pasture and the adjacent cropland should be planted to Grevillea robusta at an in-row spacing of 6 m. Although not a fodder species (with the possible but unconfirmed exception that the leaves are taken up by horses),
this species reportedly mixes well with adjacent crops. It can be lopped for fuelwood and may provide good timber when grown into usable dimension. Along the seasonal river Populus euphratica is to be planted at a spacing of 6 m. This species can be lopped for fodder and may provide timber for household utensils.

4.4.2.2 River bank fixation

Along the meandering permanent river traversing the pasture plains east of Ibsana village Populus euphratica at 10-m intervals and 1.5-2 m from the immediate river bank are to be planted. At even spacing two Dalbergia sissoo seedlings between every two P. euphratica are to be planted. Both species provide leaf fodder and the timber is suitable for farm implements.

In the initial demonstration phase, and considering the difficulty of protection against browsing, only a length of about 150 m on both sides of the river should be planted.

4.4.2.3 Rehabilitation of seasonally water-logged depressions

As mentioned earlier, seasonal flooding of the pasture plains mentioned above tends to be more persistent in small depressions scattered over this area. In an attempt to better utilize these patches of limited pasture value it is suggested to plant them to Sesbania sesban at a spacing of 1 x 1 m.

The altitude of 2300-2400 m which occurs in the area under consideration may be marginal for this species. Since, however, S. sesban seems to be rather flexible in its environmental requirements, it is assumed that the performance will be at least satisfactory.

S. sesban provides good leaf and shoot fodder. The lignified material can be used as stick fuelwood. The species coppices well and through its litter fall adds nitrogen to the soil.

The establishment of S. sesban is usually done by direct sowing. However this alternative to planting is only advisable if flooding is not persistent throughout the rainy season. As a security measure it is suggested that nursery-raised seedlings should be planted at the beginning of the rainy season, prior to actual flooding.

4.4.2.4 Management considerations

For all interventions suggested in sub-chapters 4.4.2.1 to 4.4.2.3 protection against early damaging browsing by livestock is essential for an initial period. The peasants concerned agreed that the roughly 2-ha pasture area as described in 4.4.2.1 will be protected by specially assigned guards after the rehabilitation activities have been completed. The herders will be instructed accordingly.
As both species recommended for the river bank fixation are susceptible to browsing protection is essential also at this location. Considering that only about 100 seedlings have to be protected, individual treatment by way of putting sticks or thorny material around each seedling is suggested. The other alternative would be to establish a 150 x 2 m rectangular fence on both sides of the treated river bank.

4.4.2.5 Live fences

Live fences are suggested to be established at two sites:

- the last 200 metres of the approach road from Mertu Lemariam to Ibsana;
- around the compound of the Service Cooperative at the western outskirt of Ibsana village.

Contrary to the earlier mentioned design, *Euphorbia candelabrum* in one line on both sides of the approach road at a spacing of 50 cm should be planted. The plant material to be used is to be obtained from cuttings using plants occurring naturally in the area. In the case of the Service Cooperative compound *Gleditsia triacanthos* seedlings are to be used in the same spacing described in chapter 4.2.2.5. Every 15 m one plant should be allowed to grow for fodder pod production, while the others are to be lopped/trimmed to form an impenetrable hedge. The pods are sweet and edible. The branches are thorny, thus forming an

4.4.3 Work plan - time schedule and inputs

In the course of the implementation of the activities described in chapter 4.4.2 the following estimated inputs are required:

<table>
<thead>
<tr>
<th>Activities</th>
<th>Locality</th>
<th>Units</th>
<th>Labour m/d</th>
<th>Species</th>
<th>No., of Seedlings</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Ripping up + broadcast sowing</td>
<td>S-E of Ibsana village</td>
<td>2 ha</td>
<td>6</td>
<td><em>Trifolium semipilosum</em></td>
<td>3 kg. seeds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><em>Festuca abyssinica</em></td>
<td>3 kg. seeds</td>
</tr>
<tr>
<td>(b) Pitting for borderline planting of trees</td>
<td>- &quot; - Approx.</td>
<td>5</td>
<td></td>
<td></td>
<td>100 pits</td>
</tr>
<tr>
<td>(c)</td>
<td>Borderline planting of trees</td>
<td>-</td>
<td>Approx. 100 trees</td>
<td>2</td>
<td>Grevillea robusta (65 seedlings)</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------</td>
<td>----</td>
<td>-------------------</td>
<td>---</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>(d)</td>
<td>Pitting for river bank fixation</td>
<td>Permanent river on pasture E of Ibsana</td>
<td>Approx. 100 pits</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>(e)</td>
<td>Planting for river bank fixation</td>
<td>-</td>
<td>Approx. 100 trees</td>
<td>2</td>
<td>Populus euphratica, Dalbergia sissoo (70 seedlings)</td>
</tr>
<tr>
<td>(f)</td>
<td>Protection against browsing</td>
<td>&quot;</td>
<td>Approx. 100 trees</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>(g)</td>
<td>Planting in waterlogged depressions</td>
<td>Pasture E of Ibsana</td>
<td>Approx. 0.1 ha</td>
<td>15</td>
<td>Sesbania sesban (1000 seedlings)</td>
</tr>
<tr>
<td>(h)</td>
<td>Live fence + obtaining cuttings from range</td>
<td>Along approach road from Mertu Lemar iam</td>
<td>400 m</td>
<td>20</td>
<td>Euphorbia candelabrum (800 cuttings)</td>
</tr>
<tr>
<td>(i)</td>
<td>Live fence</td>
<td>Around school compound</td>
<td>Approx. 400 m</td>
<td>26</td>
<td>Gleditsia triacanthos (1600 seedlings)</td>
</tr>
<tr>
<td>(j)</td>
<td>Live fence</td>
<td>Nursery</td>
<td>160 m</td>
<td>5</td>
<td>Gleditsia triacanthos (320 seedlings)</td>
</tr>
<tr>
<td>Total inputs</td>
<td>89</td>
<td>3720 seedlings, 800 cuttings, 6 kg. forage seeds</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Approx. = approximately
4.5 Peasant Association Genbocha

4.5.1 Description of the selected demonstration plot

Demonstration activities in this Peasant Association bordering Ibsana Peasant Association to the north will be restricted to one small plot of about 0.6 ha being part of a south-west-oriented mountain slope, roughly 600 m up hill of the nursery site (see Fig. 4).

The plot stretches from the slightly sloping, plateau-like top down to the adjacent cropland at the foot of the mountain face. Going down hill there is a distinct change in slope gradient from 20-25% to 60% at the lower part of the slope. The altitude is about 2600 m.

The whole mountain slope is used as pasture. The many stones, boulders and rock outcrops suggest shallow soils. The demonstration plot is fairly well covered by vegetation, to a large extent made up to shrubs and Aloe spp. and of coppiced shoot of removed Croton macrostachys trees.
FIGURE 4: SKETCH MAP (1:1000) OF A SELECTED DEMONSTRATION PLOT ON SLOPING PASTURE LAND AT GENDOCHA PEAS ASSOC.
IN ITS PRESENT CONDITION
In July 1985 open patches have been planted at a rather narrow spacing to Cupressus lusitanica and Grevillea robusta. It is doubted that these species will perform well considering the shallowness of the soil. Furthermore both species are unpalatable and therefore do not contribute to the improvement of the pasture.

4.5.2 Recommended interventions/demonstrations

In an effort to improve both the value of the pasture and the precarious fuelwood situation the following, rather extensive measures are suggested:

- On the upper slope (Fig. 4, Section 1) 100 to 150 seedlings of Acacia saligna and Robinia pseudoacacia should be planted at irregular spacing, but always far enough apart to allow grass vegetation to recover once the plot is closed to grazing.

- On the lower steep slope (Fig. 4, Section 2) backward sloping spot terraces should be constructed along the contour at in-contour intervals of 5 meters and contour-line to contour-line spacing of 6 meters. The spot terraces are to be staggered to achieve maximum retention of soil erosion, and to be planted to the same species as above.

- The peasants concerned have agreed to mount special guards to keep livestock out of the plot for the period required for the terminal shoots of the trees to grow out of reach of animals. The herdsmen will be instructed accordingly.

The inputs required would amount to the following:

- 90 seedlings of *Acacia saligna*

- 90 seedlings of *Robinia pseudoacacia*

- 10 man-days for pitting to be carried out any time prior to June 1986

- 4 man-days for planting out, of which 2 are to be mounted in June 1986 provided that the *Acacia saligna* seedlings are ready for planting. The remaining 2 man-days will be left to June 1987, assuming that the *Robinia pseudoacacia* seedlings will not be ready for planting in the next rainy season (1986).

4.6 Peasant Association Ansana Gondel

4.6.1 Description of the selected demonstration plots

The area chosen for the demonstration trials in Ansana Gondel Peasant Association differs distinctly from the other Peasant Associations so far described.
Not only is the altitude of about 2000 m. crucially lower, but also the orography shows different features relevant to climate conditions and subsequently to the choice of species.

Ansana Gondel is located half way down a deep gorge descending from the rolling plateau at about 2400 m to the Niffa river basin at 1600 m. Ansana village, where the two demonstration sites have been selected, lies on a plateau which is divided by medium to deep slopes.

The annual rainfall stated in the Baseline Survey Report (Orgut-Swedforest, 1984) as being 1200 mm is doubted. The orographically "sheltered" location and such indicator plants like Calotropis gigantea and Euphorbia tirucalli rather suggest an annual rainfall below 1000 mm. It is important to know that no frost occurs and this is confirmed by the prevailing kind of vegetation. As a whole the climate of the area seems to be slightly atypical for this altitude and appears to compare with that of a somewhat lower altitude.

The water supply situation in Ansana village is critical. During the dry season the natural well serving the village yields hardly enough water to support the people in their essential needs. Under these conditions and in the absence of any dams to preserve water during the rainy season, the establishment of a nursery cannot be recommended.

According to the people living in Ansana there is no immediate fuelwood problem. The latter is collected from lower altitudes. However, the conditions with regard to the natural cover of woody perennials suggests that fuelwood is harvested in excess of the annual increment. This will inevitably lead to an energy problem in the future.

Throughout the year the livestock is kept for grazing at the lower altitude in the river basin. Although fodder appears to be a less pressing problem as compared to the other Peasant Association, there is nevertheless a fodder gap which leaves room for improvement by introducing fodder trees to be used mainly in a cut-and-carry system.

Although erosion prevails as much of the cropping is done on medium to steep slopes, no soil conservation measures could be observed in the area.

In collaboration with the peasants the following two sites were chosen for the demonstration trial plots:

- roughly at the north-eastern vicinity of the village part of the w-oriented slope, about 60 m wide and extending from the top, bordered by a Euphorbia tirucalli live hedge, about 160-170 m down the slope. Because of changes in the slope gradient and/or changes in present land-use, the whole length has been divided into 3 sections (see Fig. 5.1) for separate treatment. The plot is slightly stony. Erodibility of the soil is estimated to be medium.
**Figure 5.1**: Sketch map (1:1000) of a selected demonstration plot on mainly cropland, roughly NE of the school compound of Peasant Association Ansana Gaon Gaon (present condition).
4.6.2 Recommended interventions/demonstrations

4.6.2.1 Improvement of the cropland on upper slope (Fig. 5.1, Section 1)

Starting at the live fence of Euphorbia tirucalli which demarcates the village boundary, this section slopes evenly towards west at a gradient of 22%. No immediate erosion was visible at the time of the field visit. However, the slope gradient, the loamy soils and the absence of any soil conservation measures suggest that soil erosion takes place reducing fertility.

The following interventions for this slope section are suggested:

- construct at an on-the-ground interval of 18 metres two "Fanya Juu"-type terraces;

- plant on the front-terrace ridge of the first upper terrace Panicum maximum in two parallel lines 20 cm apart. A fine seed bed is essential and seeds should be sown not deeper than one to two centimeters. P. maximum is rooting deeply and densely, thus allowing survival in long dry periods and providing an additional barrier to moving soil. Its value as fodder is high.

- on the front-terrace ridge of the second terrace plant in one single line Leucaena leucocephala at an in-row spacing of 20 cm. Once established, the hedgerow of L. leucocephala should be pollarded/trimmed regularly to a height of about 40 cm. The leafy material generated in the process may be used as supplementary cut-and-carry fodder for livestock.

4.6.2.2 Improvement of the cropland on medium slope (Fig. 5.1, Section 2)

Having more or less the same soil features this section of the cropland distinguishes itself from the upper section by a steeper slope gradient of 35-40%. The latter requires a different treatment as described hereunder:

- construct graded bench terraces (see Fig. 1.4) at an on-the-ground interval of 15 meters

- plant along the upper edge of the terrace bank one line of Cassia siamea and alternating from terrace to terrace of Leucaena leucocephala with an in-row spacing of 20 cm. The management of these tree lines should be the same as described in the previous section

- rill-sow two lines of Panicum maximum on all terrace banks
- plant at the entire length of the northern flank (along cropland only) one line of Grevillea robusta at an in-row spacing of 10 m. This tree line not only demarcates the border between the land cultivated by different peasants, but will also provide some fuelwood from lopping branches and ultimately poles and timber once grown into the appropriate dimension.

4.6.2.3 Improvement of the shrub land (Fig. 5.1, Section 3)

Adjacent to the cropland described in the previous chapter, this part of the demonstration plot slopes down towards W into a seasonal waterway at a gradient of 45-50%. It is incompletely covered with shrubs and grasses. Rock outcrops are apparent. The following treatment is suggested:

- construct backward sloping spot terraces in lines along the contours. From the centre of one spot terrace to the other the spacing should be about 3.5 meters. The vertical interval should be 4m. From contour line to contour line the spot terrace are to be staggered to provide maximum erosion control and water retention. The spot terrace itself should have an approximate diameter of 1.3 meters (see Fig. 5.2).

- plant the terraces to Acacia saligna. This species is not only known to be useful in soil conservation, but also provides "emergency" fodder during dry spells, and small-dimensioned fuelwood. The suggested spacing of approximately 3.5 x 4 m is a compromise between increasing biomass production (fodder and fuel), providing sufficiently effective protection against erosion and increasing the waterholding capacity on the one hand, and leaving enough space to allow ground cover to develop on the other.

4.6.2.4 Demonstrations on the school compound (Fig. 5.3)

For demonstration purposes and to achieve as high as possible a dissemination effect of visibly displayed improved land-use techniques, a school compound appears to be particularly suited. The Ansan a school compound is centrally located within the village and is not only daily visited by school children, many of whom will work the surrounding land in future, but also seems to be a focal point for the people at large.

It is fortunate that the size of an area estimated at 2-3 hectares and the lay-out permits a number of different interventions to be demonstrated. Furthermore the commendable support by the headmaster of the school for such a demonstration venture promises success towards the understanding of the aims and objectives of the demonstrations.
**Figure 5.2**: Design of staggered contour spot terraces in the pasture (Fig. 5.1, Section 3) of the demonstration plot at Ansana Gondoel Peas. Assoc. (free scale)
FIGURE 5.3: SKETCH MAP (free scale) OF THE ANSANA GONDEL SCHOOL COMPOUND AND OF THE PLANNED AGROFORESTRY AND SOIL CONSERVATION DEMONSTRATIONS (Dotted Lines and Images)
The school compound is flat to slightly sloping towards north-west. The lay-out, the position of buildings and borders are depicted on the sketch map (Fig. 5.3).

In order to make the best use of the demonstration potential of this site the following interventions are suggested:

- **Sloping. cropland front, of the school building.**

  At a gradient of about 10% the cropland slopes towards the north-western corner of the compound.

  At intervals of 25 m furrows should be ploughed along the carefully aligned contours. These furrows will serve as foundations for grass bunds and tree hedgerows, both acting as barriers to soil erosion and providing cut-and-carry fodder (and mulch, although not to a significant extent given the widely spaced intervals).

Four types of treatments will be applied

(a) a grass bund rill-sown to *Panicum maximum*, the two rills/lines making up the grass bund are 25 cm apart

(b) a hedgerow of one line of *Leucaena leucocephala* with an in-row spacing of 20 cm

(c) a grass bund rill-sown to a mixture of *Panicum maximum* and the forage legume *Desmodium uncinatum*

(d) a hedgerow of one line of *Cassia siamea* with an in-row spacing of 20 cm.

The above treatments are to be established contour line by contour line in the sequence given above, starting from the side where the school buildings are located (see Fig. 5.4).

- **Woodlot for fuel**

  In the far bottom corner (see sketch map, Fig. 5.3) a small, highly productive woodlot of 15 x 20 metres should be established. At a spacing of 2 x 1.5 m *Eucalyptus camaldulensis* is to be planted. *E. camaldulensis* coppices freely, grows usually fast and straight and provides excellent material for posts, poles and fuelwood.

- **Fruit-tree-borde planting**

  All around the borders of the compound *Morus alba* and *Psidium guajava* will be planted alternately at a spacing of 8 m. Wherever the border is lined by a *Euphorbia tirucalli* of live fence the distance of the trees to the live fence should not be less than 2 meters. This and the wide in-row spacing is essential to allow sufficient light reception and hopefully stimulate early flowering and fruiting. Both species usually produce edible fruits in abundance. *P. guajava* wood is known to be suitable for farm tools. Leaves and bark of this species are used for medicinal purposes against dysentery.
Figure 5.4: Design of grass bunds alternating with hedge rows on Angana Gonde school compound cropland (free scale)

School Buildings

Double rill-sown Grass Band of Panicum maximum

25 m

Leucaena leucocephala Hedge row

Slope Direction

Double rill-sown Grass Band of Panicum maximum and Desmodium uncinatum

25 m

Cassia siamea Hedge row
Shade Trees for the school

On the back side of all three school buildings two Acacia albida ("umbrella") trees are recommended for planting. A two-meter distance from the building is to be maintained.

It is suggested that an equal number of trees should be planted in front of the building. However, as the open space in front is used as a playground by often bare-footed children the non-spiny and faster growing species Ficus benjamina is suggested.

Maintenance and management of all plantings are essential. Apart from the general considerations mentioned already in chapter 4.3.2.3 and 4.4.2.4 (replacement of mortalities, timely lopping and pollarding, protection against early damaging browsing) the following site-specific additions are given hereunder:

- during the establishment phase weeding of all plantings is to be done to remove competition for light, moisture and nutrients. This also includes the Panicum maximum grass bunds;

- when harvesting Panicum maximum for fodder, a cutting height of at least 10 cm above ground should be maintained. Harvesting should take place before flowering;

- after successful establishment of the Psidium guajava trees, pruning aimed at producing 3 to 4 main branches is advisable to enhance fruiting.

4.6.3 Work plan - time schedule and inputs

In order to implement the various interventions suggested in chapter 4.6.2 for the demonstration of soil conservation and agroforestry practices the following labour and plant material inputs are required:

<table>
<thead>
<tr>
<th>Activities</th>
<th>Locality</th>
<th>Units</th>
<th>Labour m/d</th>
<th>Species</th>
<th>No of Seedlings/ kg. of Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Construction Cropland,</td>
<td>of &quot;Fanya upper</td>
<td>120 m</td>
<td>15</td>
<td>Fig. 5.1, Section 1</td>
<td></td>
</tr>
<tr>
<td>&quot;Fanya Juu&quot; slope,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>terraces</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Rill-sowing on terrace-</td>
<td>&quot; - &quot;</td>
<td>60 m</td>
<td>7</td>
<td>Panicum maximum</td>
<td>0.5 kg. seeds</td>
</tr>
<tr>
<td>front ridge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Activity</td>
<td>Length</td>
<td>Width</td>
<td>Species</td>
<td>Count</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------</td>
<td>--------</td>
<td>-------</td>
<td>--------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>(c)</td>
<td>Line planting - &quot; - on terrace-front ridge</td>
<td>60 m</td>
<td>4</td>
<td>Leucaena leucocephala</td>
<td>300 seedlings</td>
</tr>
<tr>
<td>(d)</td>
<td>Construction of graded bench terraces</td>
<td>300 m</td>
<td>38</td>
<td>Cropland, medium slope</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fig. 5.1, Section 2</td>
<td></td>
</tr>
<tr>
<td>(e)</td>
<td>Line planting - &quot; - on terrace-front ridge</td>
<td>180 m</td>
<td>12</td>
<td>Cassia siamea</td>
<td>900 seedlings</td>
</tr>
<tr>
<td>(f)</td>
<td>- &quot; -</td>
<td>120 m</td>
<td>8</td>
<td>Leucaena leucocephala</td>
<td>600 seedlings</td>
</tr>
<tr>
<td>(g)</td>
<td>Rill-sowing on terrace banks</td>
<td>300 m</td>
<td>2</td>
<td>Panicum maximum</td>
<td>1 kg. seeds</td>
</tr>
<tr>
<td>(h)</td>
<td>Border line tree planting</td>
<td>120 m</td>
<td>0.5</td>
<td>Grevillea robusta</td>
<td>12 seedlings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fig. 5.1, Section 1+2</td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Construction of spot terraces + pitting</td>
<td></td>
<td></td>
<td>Shrub land, 220 spot terraces +</td>
<td>0.3 ha 40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>lower slope, 220 pits</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fig. 5.1, Section 3</td>
<td></td>
</tr>
<tr>
<td>(j)</td>
<td>Tree planting</td>
<td>0.3 ha</td>
<td>3</td>
<td>Acacia saligna</td>
<td>220 seedlings</td>
</tr>
<tr>
<td>(k)</td>
<td>Furrow ploughing</td>
<td>Est. 500 m</td>
<td>1</td>
<td>School compound, cropland, Fig. 5.3</td>
<td></td>
</tr>
<tr>
<td>(l)</td>
<td>Rill-sowing on furrows/bunds</td>
<td>200 m</td>
<td>1</td>
<td>Panicum maximum</td>
<td>0.5 kg. seeds</td>
</tr>
</tbody>
</table>
### Hedgerow planting
- **Hedgerow planting**
- **100 m**
- **7**
- **Leucaena leucocephala**
- **500 seedlings**

### Pitting for wood lot
- **School compound, NW bottom corner**
- **300 m²**
- **4**

### Tree planting
- **School compound, border, Fig. 5.3**
- **300 m²**
- **2**
- **Eucalyptus camaldulensis**
- **100 seedlings**

### Pitting for fruit tree planting
- **School compound, border, Fig. 5.3**
- **Est. 350 m**
- **2**
- **Morus alba**
- **Psidium guajava**
- **22 seedlings**

### Fruit tree planting
- **School compound, border, Fig. 5.2**
- **Est. 350 m**
- **2**
- **Morus alba**
- **Psidium guajava**
- **22 seedlings**

### Pitting for shade tree planting
- **School compound, school buildings, Fig. 5.3**
- **12 pits**
- **0.5**

### Shade tree planting
- **12 trees**
- **0.5**
- **Acacia albida**
- **Ficus benjamina**
- **6 seedlings**

### Total inputs:
- **151**
- **3200 seedlings**
- **3 kg. seeds of forages**

---

**Note:**
- **Pitting:**
  - **100 m²**
  - **2**
  - **300 m²**
  - **100 pits**

**Species:**
- **Panicum maximum**
- **Desmodium uncinatum**
- **Leucaena leucocephala**
- **Cassia siamea**
- **Eucalyptus camaldulensis**
- **Morus alba**
- **Psidium guajava**
- **Acacia albida**
- **Ficus benjamina**

**Seed inputs:**
- **0.5 kg. seeds**
- **500 seedlings**
- **22 seedlings**
- **3 kg. seeds**

**Figures:**
- **5.2**
- **5.3**
Time schedule of implementation

<table>
<thead>
<tr>
<th>Earliest Implementation Date</th>
<th>Activities</th>
<th>Required Labour</th>
</tr>
</thead>
<tbody>
<tr>
<td>As of January 1986</td>
<td>(a), (d), (i), (k), (p), (r), (t) and sowing of immediately available tree seeds in Ibsana - Genbocha nursery</td>
<td>Est. 100 Permanent nursery staff</td>
</tr>
<tr>
<td>June 1986 (following start of rains)</td>
<td>(b), (c), (e), (f), (g), (h), (j), (l), (m), (n), (o), (q)</td>
<td>Est. 48</td>
</tr>
<tr>
<td>Dec. 1986/Jan.1987</td>
<td>Sowing of remaining + required tree seeds in Ibsana - Genbocha Nursery</td>
<td>Permanent nursery staff</td>
</tr>
<tr>
<td>June 1987</td>
<td>(s), (u)</td>
<td>Est. 3</td>
</tr>
</tbody>
</table>

The above outlined time schedule of operations with most activities— including tree planting— completed in June 1986, is based on the assumption that seeds for all species, except for Morus alba and Psidium gujava, are immediately available as indicated by the Ethiopian Forestry Research Centre.

4.7 House Compound Improvement

4.7.1 Traditional house compounds

Considering that apart from cash problems fuelwood, food and fodder shortages are the problems most often cited, introduction of multipurpose trees in house compounds can make a contribution to overcome these constraints and to improve living conditions for the occupants of these compounds.

In the Peasant Associations visited it became obvious that considerable efforts had been made already to cope with their problems. In planting Eucalyptus globulus woodlots or belts on and around their compounds the
ever-present problem of domestic fuelwood supplies has been addressed already, particularly within the altitude range of 2400-3400 metres. As mentioned already earlier Eucalyptus globulus shows a remarkably good growth performance at these high altitudes and appears so far to be free of any devastating attacks by fungi and insects. Therefore it is strongly recommended to further promote the establishment or completion, where already started, of shelterbelts composed of IS. globulus. Apart from its fast and straight growth and from its easy management, in terms of establishment and its coppicing qualities, farmers are well aware of its multiple use for posts, poles, construction timber, fuelwood, etc. Furthermore, due to the unpalatability protection against livestock is not required.

These shelterbelts should be planted all around compounds in at least three rows at a dense spacing of 1x1 to 1.5x1.5 m-for maximum woody biomass production. Early thinnings would produce fuelwood, and according to the particular needs of individual farmers the required dimension of the trees can be determined by the degree of thinning and by the rotation period. Given the very good performance as observed in the area, it can be assumed that the average annual increment of usable wood is likely to exceed 20 m$^3$. Should the total length of the shelterbelt average about 100 m, the annual sustained yield would be in the range of 1.5-2.0 m$^3$. This may be insufficient for a larger family, but would considerably reduce the pressure on the natural vegetation in the range.

Shelterbelts would further provide protection against cold wind and thereby improve the general living conditions. In the case of Ansana Gondel Peasant Association, with its distinctly different frost-free climate and lower rainfalls, Eucalyptus globulus should be replaced by Eucalyptus camaldulensis, IS. cladocalyx. Cassia siamea and Azadirachta indica. all of which are fast growing and are producers of high woody biomass yields.

It is common practice to keep livestock overnight in an enclosure close to or in the farm compound. Most of these enclosure are made of stone walls and cut thorny branches and short duration of effectiveness. Therefore live fences for livestock enclosures could prove extremely useful, particularly as thorny branches are getting rapidly in short supply.

For the higher altitudes, 2400-3200 m Gliditsia triacanthos (northern race for the highest altitudes at Derdj) should be tried. The thorny branches are known to make impenetrable live fences, but require frequent trimming.

The Ansana Gondel Euphorbia tirucalli is a well established species which, when planted densely, makes an effective enclosure. It can easily be propagated vegetatively by cuttings and its unpalatability (safe of very young new shoots) precludes damaging browsing.

The question of fruit trees is difficult to address for the high altitudes between 2400-3200 m. All known tropical fruit trees are unsuitable for the climate prevailing in this altitude.
This leaves only temperate zone deciduous fruit trees, like apples, pears, cherries and walnuts, to consider. However, in order to obtain varieties which have reasonable yields, one has to go through a process which appears to be rather complicated, given the prevailing conditions and the lack of experience in the area. Grafting or budding on suitable root stock is required. However, both grafting and root stock material has to be imported. If such undertaking was decided on, the temporary employment of a competent horticulturist as a consultant would be required. As an immediate option only the planting of a few Gleditsia triacanthos on compounds for shade and fruit production is left. The species grows moderately fast and produces sweet pods relished by both people and animals. The pulp of the long pods is rich in sugar and the seeds contain a high level of crude protein. However, problems may arise from the fact that most specimen are dioecious and therefore not one but a number of these trees have to be planted on one compound to be reasonably sure that both sexes are represented to make fruiting possible.

The choice of species for Ansana Gondel is less problematic. Although the altitude of 2000 m appears to be marginal for some species, the atypical climate in this location, which is orographically so different from the other Peasant Associations, will permit the growing of a number of fruit tree species which are less complicated to propagate. Psidium guaiava and Morus alba have already been mentioned, and Passiflora edulis, a vigorous liana, which becomes woody at the base, may be added.

Although it is difficult to provide specific designs beyond a general discussion of areas of possible interventions and to assess exact numbers of seedlings required of each species, adequate production in the three nurseries should be planned.

To be on the safe side the following initial estimated production figures are offered which would cater for all possible farm compound improvements discussed above:

<table>
<thead>
<tr>
<th>Species</th>
<th>Nursery</th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Derdj</td>
<td>Sholana Woncber</td>
<td>Genbocha</td>
<td></td>
</tr>
<tr>
<td>Eucalyptus globulus</td>
<td>2000</td>
<td>2000</td>
<td>2000</td>
<td>6000</td>
</tr>
<tr>
<td>E. cladocalyx</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Cassia siamea</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Azadirachta indica</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Gleditsia triacanthos</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>4500</td>
</tr>
<tr>
<td>Psidium guajeva</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Morus alba</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Passiflora edulis</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3500</strong></td>
<td><strong>3500</strong></td>
<td><strong>6500</strong></td>
<td><strong>13,500</strong></td>
</tr>
</tbody>
</table>
For demonstration purposes at least one or two compounds should be selected (e.g. the one of the Peasant Association chairman of Derdj), and upon agreement with its occupant developed in the manner discussed above.

4.7.2 Villagisation programme - outline of a model for compound improvement

The Ethiopian Government has embarked on a large-scale villagisation programme which is aimed at concentrating the rural population in villages yet to be constructed, with better communal and communication facilities. According to the plans and blueprints prepared by the Rural Infrastructure Development Main Department of the Ministry of Agriculture each family unit will be housed on compounds of a standard size of 0.1 ha. Within the village each of these compounds will be surrounded by other compounds, also rectangular in shape other compounds or at least semi-attached to each other. Each village will have more or less centrally located communal installations, such as kindergartens, schools, but also recreational centres such as, for example, parks, sports fields and open greens.

One village will accommodate an initial number of 250 families. This number may later be increased to 500.

Both the individual compounds and the communal installations would offer a vast potential for improvements of the kind discussed in connection with the improvement of traditional house compounds. Live hedges to demarcate individual compounds, shade and ornamental trees and fuelwood-producing shelterbelts around the parameter of these villages would require a considerable number of seedlings of various species.

The 160 ha., set aside in a standard village for multipurpose community forest plantations, would further require some 50,000 seedlings per year, assuming a management plan based on a 10-year rotation period and an average spacing of 1.5 x 2 m.

At the time of the mission neither the location of the future village nor villages in the project area, nor the time schedule of their construction could be established. This, therefore, makes it impossible to determine the site-specific species and to schedule the production of seedlings. Therefore considerations with regard to the biological or vegetative improvements of these villages are at present being limited to qualitative rather than quantitative statements. Should the planned villages be constructed in the near future it should not be overlooked that the major portion of the total production capacity of the 3 nurseries presently being under establishment could be easily re-allocated to these villages. Depending on the exact location of these future villages it may, however, be considered for infrastructural and site-adaptational reasons to establish a new nursery close to village sites to cater for their needs. In any case a technical mission would have to be mounted again to adapt the design, the magnitude of annual seedling production and the required facilities and inputs to the changed conditions.
4.8 Improvement of Bee-keeping

In chapter 3.4 the importance of bee-keeping and honey production in the local subsistence and cash economy has already been outlined briefly. The high market price of 6-10 Birr/kg and the preference of "Tech" as a traditional beverage explains why bee-keeping is quite common in the area. Even at the Derdj Peasant Association with its altitude considerably higher than 3000 meters, two peasants are reportedly practising bee-keeping.

The bee-hives used compare with those common throughout East Africa, only that instead of hollowed logs papyrus is used to form tubes 30-40 cm thick and about 1.5 m long, plugged at both ends. Similar to the common practice in the rest of East Africa fire and smoke is used in the process of harvesting the honey. It is known that this method is often destructive to a part of the bee population and thereby counter-productive to further honey crops.

This situation leaves room for improvement both on the technical side by introducing better bee-hives and on the biological side by extending the flowering calendar. It may turn out fortunate in terms of extension service rendered to peasants in the area that one of the diploma graduates assigned to the project has a personal interest in bee-keeping. By using the same material commonly used in the area (papyrus) he has already experimented with a new type of bee hive (European-type straw or wicker skep), which allows honey harvesting in a manner less detrimental to the bee population. It may also be worthwhile to promote the introduction of other improved bee hives, such as the Kenyan top bar bee hive.

On the biological side the suggested introduction of species of exotic woody perennials, many of which are known to flower profusely and to provide excellent bee forage as, for example, Acacia saligna, Robinia pseudoacacia, Gleditsia triacanthos and Lespedeza bicolor, will improve the bee forage base in quantitative terms, and will at the same time extend the overall flowering season. However, as some of the exotic species are from temperate climate zones the flowering time at the site in which they are introduced may not fully correspond with that at the location of origin. Therefore a flowering calendar cannot yet be drawn up.

In view of the doubtlessly interesting economic potential of bee-keeping consideration should be given for a short consultancy mission of a bee-keeping expert in about 1-2 years' time when an initial assessment of the performance of newly introduced species will be possible. Bee-keeping as an aspect of traditional land-use should definitely be considered as part of the training and demonstration at the Community Forestry Training Centre. For these reasons it is suggested that a bee-keeping centre is being established at Ibsana Peasant Association, where different types of bee hives are used and demonstrated.
4.9 Community Nurseries

4.9.1 General considerations

The size of a nursery should always be determined by the required output of seedlings. This is of particular concern in areas where land availability is limited. Other considerations are the maximum distance and total area which can logically be served by a nursery under given infrastructural and logistical conditions and the maximum absorption capacity of the area so defined.

In a community forestry and/or agroforestry approach to land-use it should furthermore be considered that unlike in the case of a commercial nursery or a nursery set up to serve large commercial forestry plantations, nurseries of the kind under consideration should be based on a self-help approach of groups of peasants or relatively small peasant associations. Usually no sophisticated inputs are available to establish and to operate nurseries. Transportation of seedlings is mostly restricted to the carrying capacity of humans or animals, thus considerably limiting the distance which can be covered.

The concept adopted in the project area is in line with these considerations. However, this does not rule out the possibility that a change in socio-economic circumstances may necessitate a modification in the approach. Such a modification may be necessary if, for example, the villagisation programme is implemented in the area. A concentration of 250 peasant families with their cropland surrounding the village with maximum distances of 5 km and a reasonable road infrastructure would call for a larger nursery concentrating the seedling production at a strategically well placed site suitable for the purpose.

Within the multi-altitude project area a problem may arise from the impossibility of establishing a nursery at the 2000 m level in the Ansana Gondel Peasant Association. The insufficiency of the water supply rules out the operation of even a small nursery which could consume, particularly during the dry season when water is scarcest, more water than is available, and would compete intolerably with human consumption. Therefore no other alternative can be offered than producing the seedlings required for Ansana Gondel in the Ibsana/Genbocha nursery which is situated at 2400 m altitude, being the next lowest to Ansana Gondel. However, the difference in altitude of 400 m between the two sites may be decisive as to success or failure in seedling production for those species which are less tolerant to low temperatures. In such events, as it may be the case with Edulis passiflora, Psidium guaiava and even with Leucaena leucocephala, it has to be considered whether such species should be raised from seeds to transplantable seedlings in mini nurseries of only a few square meters on compounds of Ansana Gondel Peasant Association members.
2 Lay-out and production capacity

The chosen sites for the three nurseries in Derdj, Sholana Woncher and Ibsana-Genbocha are of similar topographic and soil characteristics. They are all situated in valleys close to permanent rivers or a well to provide the required water for the nursery. The soils in all three nursery sites are characterised by a clay content which varies insignificantly in degree. All nursery sites slope at an even gradient of around 10%.

The proposed standard lay-out which only in the case of Ibsana-Genbocha requires an insignificant modification is depicted in Fig. 6.1 and does not need further explanation. As explained in the cross section view in Fig. 6.2, terracing is necessary to avoid damage to the seed and transplant beds and possible waterlogging at the lower side of the nursery.

The standard size has been determined as 30 x 50 m, which gives an overall size of 0.15 ha. Deducting the service space (motorable road, working shade, shelterbelt/live fence and paths between the beds), the remaining actual production area amounts to 450 m excluding the seed beds. The total annual production capacity ranges from a minimum of 45,000 to 65,000 seedlings, depending on the size of the polythene containers used. In order to illustrate the potential of such a small-sized nursery, it should be mentioned that enough seedlings can be produced to establish 14-20 hectares of plantations at a spacing of 2 x 1.5 m annually, if that would be the objective.

The table below compares the productivity of the nursery with the demands made by the demonstration plots according to the recommendations made in the previous chapters:

<table>
<thead>
<tr>
<th>Nursery Demonstration Plots in P.A.:</th>
<th>Derdj</th>
<th>Sholana Woncher</th>
<th>Ibsana-Genbocha</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seedlings to be produced</td>
<td>7810</td>
<td>6800</td>
<td>6620</td>
<td>13,000</td>
</tr>
<tr>
<td>Total Project</td>
<td>7810</td>
<td>6800</td>
<td>13,000</td>
<td>27,610</td>
</tr>
<tr>
<td>Total Annual Prod. Capacity (average)</td>
<td>50,000</td>
<td>50,000</td>
<td>50,000</td>
<td>150,000</td>
</tr>
<tr>
<td>Uncommitted Surplus for Distribution (rounded figures)</td>
<td>42,200</td>
<td>43,200</td>
<td>37,000</td>
<td>122,400</td>
</tr>
</tbody>
</table>
Figure 6.1: Layout of Standard Nursery (1:200) - Vertical Aerial View

Live Fence/Shelterbelt of Erithina abyssinica/E. brucei (●) + Alocasia (●)
Figure 6.2: Cross Section View of Standard Nursery (1:200)
The figures in the above table indicate clearly that the chosen size of the nurseries is more than sufficient not only to cater for the project needs, but also for all unforeseen additional demands and for distribution to peasants whenever they require more seedlings for volunteer plantings.

It is important to note that the demands made by the various demonstration plots are unique and not repeated year by year. Apart from necessary beating-up activities (replacement of mortalities) which may require any percentage between 20 and 40 amounting to 5500 - 11,000 seedlings for one or two years following the initial establishment, almost the whole production of the nurseries can be committed to extension activities not related to the project. This is particularly true as most of those species, which will be subjected to cuttings for fuelwood or for fodder and mulch, have confirmed coppicing and pollarding qualities and therefore do not require replanting.

4.9.3 Some operational considerations

Depending on the species, sowing of seeds has to be conducted 4-6 months prior to the expected planting out at the beginning of a rainy season. In some cases (e.g. Hagenia abyssinica) the time required may extend to 8-9 months. When sowing the seeds the following has to be observed:

- pre-treat the seeds according to the advice given in the table of Annex 6.4
- carefully prepare a fine seed bed
- cover the sown seeds by a layer of fine sand at about the thickness of the seed diameter
- keep the seed bed wet but do not water it to the point of water-logging.

In view of the considerable clay content of the soils in and around all three nurseries one part out of three has to be sand when mixing the soil for filling the polythene containers for the seedlings. Another part should be manure, preferably sheep manure. The third part should be sifted ordinary soil. If available some NPK-fertilizer should be added. Pricking-out from the seed beds to the polythene containers should be conducted as soon as the first 3 or so leaves are fully developed. Be selective in this process. Do not use weaklings which are unlikely to perform well.
Both the seed beds and the transplant beds have to be shaded. For this purpose a frame of about 1 m in height should be constructed in whose shade mats are to be mounted. The material for the shade mats may be papyrus, split bamboo or long grass, depending on availability. Note that 4-6 weeks prior to planting out the seedlings should undergo a hardening-off process which is conducted by gradually removing the shade.

All seed and transplant beds should be labelled, indicating the species, the time of sowing, and the number of seedlings (in the case of transplant beds).

4.10 Germplasm Acquisition and Handling

For a realistic scheduling of the implementation of the project is is essential to properly consider the time required for the entire process from the placing orders for seeds to the stage when the seedlings are ready for planting out.

In the table of Appendix 4 (column 4) the number of weeks is stated, whenever known, which the suppliers usually require to despatch seed lots after having received the order. Some 5 to 14 days have to be added for the airmailed seed lots to reach the recipient. In addition about one week may be required to clear the seeds with the Plant Quarantine Authorities and to forward them to their final destination. Depending on the species another 4-6 months will pass by before the seeds have developed from germination to seedlings ready for planting out. In the case of Psidium guaiava this period extends to 10-12 months. The time requirement for the above outlined process adds up to a total of about 6-8 months; in the case of Psidium guaiava to more than 13 months. The time schedules provided in chapters 4.2.3, 4.3.3, 4.4.3 and 4.6.3 have made allowances for the above-mentioned time requirements.

When ordering seeds from any of the companies listed in Appendix 4 the following information should be conveyed to the seed supplier:

- Scientific name of species and authority (e.g. Acacia saligna (Labill)H.Wendl.)

- Altitude, latitude, total annual rainfall and seasonality, and temperature (absolute minimum - frost or no frost) prevailing at the site of future use of the species

- Quantity required (column 5 and 6 of Appendix 3 provide an aid for a rough calculation at required number of seedlings as per work plans)
Upon orders of seedlots most suppliers mail proforma invoices to recipients requesting advance payments. In order to shorten this process orders should be placed by cable or telex. The text of the telex/cable should not only contain the specification of the order as listed above, but also the request for obtaining a phytosanitary certificate for which often extra charges are made.

It should be made sure that ordered seedlots are sent by air mail, then passed through plant quarantine immediately and forwarded to the final destination without delay. As the viability of seeds is not unlimited the germination rate often depends on the speed by which seeds are being processed.

In the case of Populus euphratica no seed supplier, could be identified at present. Therefore enquiries should be made immediately with the seed companies mentioned in column 3 of Appendix 3. In the case of Lespedeza thunbergii for which also no seed supplier could be identified, it may be decided to replace this species by Lespedeza bicolor. if finding an appropriate supplier for seeds of L. thuribergii turns out to be too difficult. In case of the unobtainability of the required seed quantities for Trifolium cryptopodium this species should either be replaced by Trifolium semipilosum or seeds could be produced from small quantities obtainable from ILCA under own management in one of the project nurseries.

Cuttings of Euphorbia candelabrum and of Aloe spp. produced in the natural range for vegetative propagation should be wrapped in water-soaked cloth and transported to the planting site for immediate use without undue delay.

Neither the author of this report, nor ICRAF can accept responsibility for the availability and sufficiency of seeds requested from any of the suppliers listed in Appendix 4. Neither the author nor ICRAF can be held liable for any deficiency in quality, viability and germination of seeds obtained from suppliers contained in Appendix 4 or for any other problem arising from contacts between orderers and suppliers.
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6.1 : Lay-out of Standard Nursery (1:200) - Vertical Aerial View

6.2 : Cross Section View of Standard Nursery (1:200)
APPENDIX 1

TERMS OF REFERENCE

for ICRAF'S Cooperation in the Design of
Trial and Demonstration Activities at the
Ethiopian Centre for Community Forestry
in Enebsena Sar Midir Woreda

1 General Objectives

1.1 Establishment of trial plots to demonstrate in different Peasant Associations surrounding the Community Forestry Centre appropriate land-use methods and techniques, with particular reference to land-use practices prevailing in the Gojam Highlands and to required improvements.

1.2 Establishment of small nurseries in the vicinity of selected sites for the above-mentioned demonstration trials with the following objectives -

- to raise and provide sufficient quantities of seedlings of suitable multipurpose tree species

- to produce surplus quantities of seedlings for distribution to members of adjacent Peasant Associations in accordance with their needs and requirements

- to demonstrate to both the course participants at the Community Forestry Centre and members of Peasant Associations appropriate nursery techniques

1.3 The predominant purpose of the trial plots and the nursery is to serve as practical demonstrations supplementing class-room lectures provided to course participants of the Community Forestry Centre. Furthermore it is hoped that the trial and demonstration plots will promote the dissemination of appropriate land-use methods in the region.

2 Duties and Responsibilities of the ICRAF Staff Member in His Capacity as a Consultant to Swedforest

2.1 Based on the Baseline Survey Report (Orgut-Swedforest, 1984) and on findings and observations in the field, select specific sites for trial and demonstration plots in collaboration with the Ethiopian-Swedish team and the Peasant Associations concerned.
2.2 Design appropriate agroforestry and soil conservation interventions according to prevailing biophysical conditions and in consideration of the current land-use.

2.3 Suggest suitable multipurpose tree and shrub species and forage grass and legume species

2.4 Provide information and seed sources for the suggested trees, shrub and legume species

2.5 Advise on appropriate nursery techniques, and on size and lay-out of the nursery

2.6 Compile and submit a technical report on the findings and results of the consultancy mission to SWEDFOREST.

3 Time Schedule

3.1 Field Mission: 27.10.85 to 12.11.85, including 6 days' field trip to Mertu Lemariam.

3.2 Compilation of the technical report to be submitted latest by 15.12.85.
APPENDIX 2; CHARACTERISTICS AND USES OF WOODY PERENNIAL SPECIES
RECOMMENDED FOR THE DEMONSTRATION PLOTS

<table>
<thead>
<tr>
<th>No</th>
<th>Botanical Species</th>
<th>Code No. of Seed Supplier</th>
<th>Recommended Seed Pre-treatment</th>
<th>No. of Seeds Per kg</th>
<th>Usual % of Germination</th>
<th>Response to Management/Tree Manipulation</th>
<th>Uses</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acacia saligna (Labill.) H. Wendl. Syn. A. cyanophylla Lindl. (Golden wreath wattle)</td>
<td>ET1, US3, AU2, CR1, US1, NL2</td>
<td>Soaking in boiling water for 512 h.</td>
<td>14-80</td>
<td>70</td>
<td>Coppices well</td>
<td>Firewood; leaf fodder, bee-forage; acid gum for pickled food stuff; soil conservation; shelter belt; N-fixing.</td>
<td>Usually evergreen; tolerant to wide biophysical range</td>
</tr>
<tr>
<td>2</td>
<td>Aloe spp.</td>
<td>cutting from plants in local range</td>
<td></td>
<td></td>
<td></td>
<td>propagated by cuttings</td>
<td>Live fences</td>
<td>Spiny</td>
</tr>
<tr>
<td>3</td>
<td>Azadirachta indica A. Juss Syn. Melia azadirachta (Neem)</td>
<td>US3, AU2, INI</td>
<td>Fresh seeds none required; old seeds soaking in warm water 24 h</td>
<td>4-6</td>
<td>60-80</td>
<td>coppices well</td>
<td>Poles; post; construction; mulch; windbreaks; insect repellent (leaves)</td>
<td>Usually evergreen; wood decay + insect resistant</td>
</tr>
<tr>
<td>4</td>
<td>Cassia siamea Lam. (Yellow cassia)</td>
<td>US3, AU2, INI, CR1, US1, NL2</td>
<td>Fresh seeds none required; old seeds soaking in hot water 12 h.</td>
<td>30-40</td>
<td>30-70</td>
<td>coppices and pollards well</td>
<td>Firewood; posts; poles; N-fixing soil improvement</td>
<td>evergreen; leaves toxic to pigs (obviously not to other livestock)</td>
</tr>
<tr>
<td>No</td>
<td>Botanical Species</td>
<td>Code No. of Seed Supplier (see Table, App. 4)</td>
<td>Recommended Seed Pretreatment</td>
<td>No. of Seeds Per kg. (in Tsd.)</td>
<td>Usual % of Germination</td>
<td>Response to Management/Tree Manipulation</td>
<td>Uses</td>
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<tr>
<td>5</td>
<td>Croton macro-stachys Hochst ex Del. Syn C. acuminatum</td>
<td>ET1</td>
<td></td>
<td></td>
<td></td>
<td>Live fences; furniture; medicinal</td>
<td>Coppices; not suitable for firewood (bad smell); usually dioecious</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Dalbergia sissoo Roxb. (Sissoo)</td>
<td>US3, INI, NP1, NL2</td>
<td>soaking in warm water 24 h.</td>
<td>12-20</td>
<td>70-90</td>
<td>Coppices</td>
<td>Excellent firewood, furniture; farm implements; fodder (young leaves); soil conservation; N-fixing</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Desmodium uncinatum (Silverleaf Desmodium)</td>
<td>AU2</td>
<td></td>
<td>7 kg/ha</td>
<td></td>
<td>Fodder legume</td>
<td>Perennial; special rhizobium recommend. (should be ordered with seeds)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Erythrina abyssinica Lam. ex DC Syn. E. tomentosa (Red Hot Poker Tree)</td>
<td>ET1</td>
<td></td>
<td>3-4</td>
<td>30-70</td>
<td>Coppices; pruning</td>
<td>Live fences; N-fixing; bee-forage; leaf fodder</td>
<td>Spiny; deciduous; propagates from cuttings</td>
</tr>
<tr>
<td>No.</td>
<td>Botanical Species Name; Synonyms, (Vernacular Names)</td>
<td>Code No. of Seed Supplier (see Table, App. 4)</td>
<td>Recommended Seed Pre-treatment</td>
<td>No. of Seeds Per kg. (in Tsd.)</td>
<td>Usual % of Germination</td>
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<tr>
<td>9</td>
<td>Erythrina brucci Schweinf. Syn. E. Senegalensis</td>
<td>ET1</td>
<td>None required</td>
<td>350-1000</td>
<td>50-70</td>
<td>coppices; pruning</td>
<td>Live fences; N-fixation</td>
<td>Spiny; deciduous; propagates also from cuttings;</td>
</tr>
<tr>
<td>10</td>
<td>E. camaldulensis Dehnh Syn. E. rostrata (Red River gum)</td>
<td>ET1, US3, AU2, INI, CR1, US1 NL2</td>
<td>None required</td>
<td>108-600</td>
<td>30-70</td>
<td>coppices well</td>
<td>Firewood; posts; light-construction</td>
<td>Evergreen; leaves unpalatable-usually no protection against browsing required</td>
</tr>
<tr>
<td>11</td>
<td>E. cladocalyx F. Muell. (Sugar gum)</td>
<td>ET1, AU2, US1 NL2</td>
<td>None required</td>
<td>90-300</td>
<td>70-100</td>
<td>coppices well</td>
<td>Poles; bee-forage; firewood</td>
<td>Evergreen; usually no protection against browsing required</td>
</tr>
<tr>
<td>12</td>
<td>Eucalyptus globulus Labill. (Southern blue gum)</td>
<td>ET1, US3, AU2, INI, CR1, US1 NL2</td>
<td>None required</td>
<td>90-300</td>
<td>70-100</td>
<td>coppices well</td>
<td>Firewood; posts; tool handles; light construction</td>
<td>Evergreen; leaves unpalatable-usually no protection against browsing required</td>
</tr>
<tr>
<td>13</td>
<td>Euphorbia candelabrum</td>
<td>cuttings from plants in local range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Live fences</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Botanical Species Name; Synonyms, (Vernacular Names)</td>
<td>Code No. of Seed Supplier (see Table, App. 4)</td>
<td>Recommended Seed Pre-treatment</td>
<td>No. of Seeds Per kg. (in Tsd.)</td>
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<tr>
<td>14</td>
<td><em>Festuca abyssinica</em></td>
<td>AU2, NL1(?), US1, ET2 (Res. Oty.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>fodder</td>
<td></td>
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<tr>
<td>15</td>
<td><em>Ficus benjamina</em></td>
<td>NL1, AU2, INI, US1, NL2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ornamental; shade</td>
<td></td>
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<tr>
<td>16</td>
<td><em>Gleditsia triacanthos</em> L. (Honeylocust)</td>
<td>US3, AU2, US1, NL2</td>
<td>soaking in hot water until seeds swell</td>
<td>6-8</td>
<td>70-100</td>
<td>coppices well; root cuttings</td>
<td>Pods sweet and edible; pod fodder; posts; furniture; utensils, shade; live fences; windbreak; firewood; N-fixing</td>
<td>Thorny (some varieties thornless); usually dioecious</td>
</tr>
<tr>
<td>17</td>
<td><em>Grevillea robusta</em> A. Cunn. (Silkoak, Silver oak)</td>
<td>ET1, US3, AU2, US1, NL2</td>
<td>None required</td>
<td>70-100</td>
<td>30-70</td>
<td>pollards; lopping</td>
<td>Firewood, furniture; posts; timber deciduous; bee-forage; shade; mixes usually well with crops</td>
<td>Short term deciduous;</td>
</tr>
<tr>
<td>18</td>
<td><em>Grewia oppositifolia</em> Syn. <em>Grewia optiva</em></td>
<td>INI, NP1</td>
<td>Soaking in warm water</td>
<td>12-15</td>
<td>60</td>
<td>pollards well</td>
<td>Leaf fodder;</td>
<td>no tannin content; high digestibility</td>
</tr>
<tr>
<td>No</td>
<td>Botanical Species Name; Synonyms, (Vernacular Names)</td>
<td>Code No. of Seed Supplier (see Table, App. 4)</td>
<td>Recommended Seed Pretreatment</td>
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<tr>
<td>19</td>
<td>Lespedeza bicolor</td>
<td>NL1, AU1, KR1</td>
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<td></td>
<td></td>
<td>Firewood; leaf fodder; bee-forage; soil conservation; N-fixing soil-improvement</td>
</tr>
<tr>
<td>20</td>
<td>Leucaena leucocephala (Lam.) de Wit. Syn. L. glauca (Leucaena)</td>
<td>Omit Species or enquire with KR1 and AU1</td>
<td></td>
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<tr>
<td>21</td>
<td>MW1, ET1, US3, CR1, NL2</td>
<td>hot water shock treatment, then soaking in water 48 h.</td>
<td>20-24</td>
<td>60-80</td>
<td>copices and pollards well; cuttings</td>
<td>Firewood; leaf fodder; N-fixing soil improvement</td>
<td></td>
<td>deciduous (dry season), mimosine content - only about 30% of fodder diet allowed - more may be toxic</td>
</tr>
<tr>
<td>22</td>
<td>US3, INI</td>
<td>soaking in cold water 4 days</td>
<td>400-450</td>
<td>10-20</td>
<td>coppices well; propagates also from cuttings</td>
<td>Food fruits; leaf fodder</td>
<td></td>
<td>Deciduous; fairly shade tolerant</td>
</tr>
<tr>
<td>23</td>
<td>Panicum maximum (Guinea grass)</td>
<td>IN1, AU2, NL2</td>
<td>None required</td>
<td>700-1500 (10 kg/ha)</td>
<td></td>
<td>Fodder; soil conservation</td>
<td>Perennial; tall</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Botanical Species Name; Synonyms, (Vernacular Names)</td>
<td>Code No. of Seed Supplier (see Table, App. 4)</td>
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<tr>
<td>24</td>
<td>Passiflora edulis Sims (Purple passion fruit)</td>
<td>NL1, US1</td>
<td>None required</td>
<td>50-55</td>
<td></td>
<td>pruning; propagation also by cuttings and grafting</td>
<td>Fruits; woody base may be used as firewood</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Populus euphratica Oli.v. Syn. P. diversifolia (Euphrates poplar)</td>
<td>enquire with INI, NP1 and AU2</td>
<td>None required</td>
<td>3-5</td>
<td>30-70</td>
<td>root suckers; coppices well, pollards</td>
<td>Firewood; leaf fodder (goats, sheep); farm utensils; dental-&quot;tooth brush&quot;</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Prunus Serotina Ehrh.</td>
<td>NLI</td>
<td>(pre-chill 1-4°C for 120 days)</td>
<td>9-11</td>
<td>30-70</td>
<td>Small edible fruit; deciduous live fences; bee-forage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Psidium guajava L. (Common Guava)</td>
<td>US3, INI</td>
<td></td>
<td></td>
<td></td>
<td>pruning; propagated from air layering; grafting; coppices</td>
<td>Fruits, medicinal (leaves + bark against dysentery); wood for farm implements</td>
<td>Requires 10-12 months from seed to stage for planting out</td>
</tr>
<tr>
<td>No</td>
<td>Botanical Species Name; Synonyms, (Vernacular Names)</td>
<td>Code No. of Seed Supplier (see Table, App. 4)</td>
<td>Recommended Seed Pretreatment</td>
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<tr>
<td>28</td>
<td>Robinia pseudo-acacia Li (Black locust, false acacia)</td>
<td>NL1, US3, AU2, KR1, NL2</td>
<td>(mechanical scarification), immersion 20 Min. in Sulferic acid, soaking in not water for 24 h</td>
<td>35-70</td>
<td>70-100</td>
<td>Coppices well</td>
<td>Firewood, bee-forage; posts, leaf fodder; soil conservation; N-fixing</td>
<td>Spiny, deciduous; durable wood; non-demanding to soils</td>
</tr>
<tr>
<td>29</td>
<td>Sesbania sesban (Linn)Merrill Syn. S. aegyptiaca (Sesb, Egyptian rattle pod)</td>
<td>MW1, ET1, US2</td>
<td>None required</td>
<td></td>
<td></td>
<td>coppices; pruning</td>
<td>Flowers edible; leaf fodder; carving; bark for ropes; N-fixing-soil improvement</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Trifolium cryptopodium (Clover)</td>
<td>US1(?), NL1(?), ET2 (Res. Oty.) (enquire with AU2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>fodder legume</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Trifolium semipilosum (clover)</td>
<td>AU2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>fodder legume</td>
<td></td>
</tr>
</tbody>
</table>
### APPENDIX 3: GERMPLASM SOURCES AND OTHER RELEVANT INFORMATION

<table>
<thead>
<tr>
<th>Code No</th>
<th>Name, Mailing Address, Telex, Cable and Telephone of Seed Supplier</th>
<th>Species for which Seeds are available</th>
<th>Time usually Required by Supplier to Dispatch Seeds as of Receipt of Order (weeks)</th>
<th>Mode of Payment and Currencies accepted by Supplier</th>
<th>Advanced Payment required by Supplier (% of Tot. Purchase Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AU1</td>
<td>H.G. Kershaw Pty. Ltd. P 0 Box 84, Terrey Hills 2084, Australia Telex: KERSHA AA75606 Tel.: 61-2-450 2444</td>
<td>Lespedeza bicolor</td>
<td>Usually 1</td>
<td>certified cheque, letter of credit Austr. $, US$</td>
<td>?</td>
</tr>
<tr>
<td>AU2</td>
<td>Kimberley Seeds, 51 King Edward Road, Osborne Park 6017, Western Australia Telex: AA94371 Tel.: (619)446 4377</td>
<td>Acacia saligna, Azadirachta indica, Cassia siamea; all Eucalyptus spp.; Ficus benjamina, Gleditsia triacanthos; Grevillea robusta, Robinia pseudoacacia, Panicum maximum, Festuca spp.; Desmondium uncinatum; Trifolium semipilosum</td>
<td></td>
<td>bank transfer, letter of credit Austr. $, US$</td>
<td>not required</td>
</tr>
<tr>
<td>CR1</td>
<td>Latin American Forest Tree Seed Bank, CATIE Turrialba, COSTA RICA Tel.: 56-6021</td>
<td>Acacia saligna; Cassia siamea; Eucalyptus camaldulensis; E. globulus; Leucaena leucocephala (many diff. provenances)</td>
<td>4</td>
<td>certified cheque, letter of credit, US$</td>
<td>100</td>
</tr>
<tr>
<td>Code No</td>
<td>Name, Mailing Address, Telex, Cable and Telephone of Seed Supplier</td>
<td>Species for which Seeds are available</td>
<td>Time usually required by Supplier to Dispatch Seeds as of Receipt of Order (weeks)</td>
<td>Mode of Payment and Currencies accepted by Supplier</td>
<td>Advanced Payment required by Supplier (% of Tot. Purchase Price)</td>
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<tr>
<td>1</td>
<td>Forestry Research Centre, P 0 Box 1034, Addis Ababa Tel. 185444,185445</td>
<td>Acacia saligna, Grevillea robusta; Leucaena leucocephala; Croton macrostachys; Erythrina abyssinica; E. brucei; Eucalyptus globulus; E. camaldulensis; E. cladocalyx; Sesbanias sesban</td>
<td>no charge</td>
<td>no charge</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>International Livestock Centre for Africa (ILCA), FLAG Unit, P 0 Box 5609, Addis Ababa, Ethiopia. Telex: 21207 ADDIS Cable: ILCAF Addis Ababa Tel.: 183215</td>
<td>most Trifolium and grass species (but only very small quantities)</td>
<td>no charge</td>
<td>no charge</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Kumar International Ajitmal 206121, Etawah (U.P), INDIA</td>
<td>Azadirachta indica; Cassia siamea; Dalbergia sissoo; all Eucalyptus spp. required, Ficus benjamina, Grevillea robusta; Morus alba, Grewia oppositifolia; Panicum maximum, Psidium guajava</td>
<td>varies</td>
<td>letter of credit, US $</td>
<td>50%</td>
</tr>
<tr>
<td>Code No of Supplier</td>
<td>Name, Mailing Address, Telex, Cable and Telephone of Seed Supplier</td>
<td>Species for which Seeds are available</td>
<td>Time usually required by Supplier to Dispatch Seeds as of Receipt of Order (weeks)</td>
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<td>Advanced Payment required by Supplier (% of Tot. Purchase Price)</td>
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<tr>
<td>KR1</td>
<td>Forest Research Institute Chungyangni-Dong, Dongdaemun-Ku, Seoul, Korea Tel.: 966 8961-5</td>
<td>Robinia pseudoacacia; Lespedeza bicolor</td>
<td>10</td>
<td>no charge</td>
<td></td>
</tr>
<tr>
<td>MW1</td>
<td>Forestry Research Institute of Malawi, P 0 Box 270, Zomba - MALAWI Tel.: 522 866</td>
<td>Leucaena leucocephala; Sesbania sesban</td>
<td>1</td>
<td>certified cheque, bank transfer in Pounds and US$</td>
<td>100</td>
</tr>
<tr>
<td>NL1</td>
<td>MEDIGRAN, P 0 Box 731, 1180 AS Amstelveen-Holland Telex 37980 (Attn. Medigran)</td>
<td>Ficus benjamina, Gleditsia triacanthos; Lespedeza bicolor, Passiflora edulis; Prunus serotina, Robinia pseudoacacia (ask for other forage spp. required)</td>
<td>30 days from date of invoice in Dutch Guilders (enquire on other currencies)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Code No of Supplier</td>
<td>Name, Mailing Address, Telex, Cable and Telephone of Seed Supplier</td>
<td>Species for which Seeds are available</td>
<td>Time usually required by Supplier to Dispatch Seeds as of Receipt of Order (weeks)</td>
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<td>Advanced Payment required by Supplier (% of Tot. Purchase Price)</td>
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<tr>
<td>NL2</td>
<td>SETROPA, P O Box 203 1400 AEBussum, Holland Telex: 73255 SETRO NL Cable: SETROPA Bussum Tel.: (3D-2152-58754</td>
<td>Acacia saligna; Cassia siamea, Dalbergia sissoo; Eucalyptus camaldulensis, E. Clado' calyx, E. globulus; Ficus benjamina, Gleditsia triacanthos; Grevillea robusta; Leucaena leucocephala; Robinia pseudoacacia; Panicum maximum</td>
<td>mostly 2</td>
<td>US $ (bank draft?)</td>
<td></td>
</tr>
<tr>
<td>NP1</td>
<td>Tree Seed Unit, Officer-in-Charge, Hattisar, Naxal, Kathmandu, NEPAL</td>
<td>Grewia oppositifolia, Dalbergia sissoo</td>
<td>Mostly 2</td>
<td>US $</td>
<td>100</td>
</tr>
<tr>
<td>US1</td>
<td>Carter Seed Co., 475 Mar Vista Drive, Vista, California 92083, U.S.A. Telex: 269174 SEED UR Tel.: 619-714-5931</td>
<td>Acacia saligna; Cassia siamea, Eucalyptus camaldulensis; E. clado-calyx; E. globulus, Ficus benjamina, Gleditsia triacanthos; Grevillea robusta; Passiflora edulis; Trifolium spp. and grass spp.</td>
<td>Mostly 2</td>
<td>Bank draft</td>
<td></td>
</tr>
<tr>
<td>Code No of Supplier</td>
<td>Name, Mailing Address, Telex, Cable and Telephone of Seed Supplier</td>
<td>Species for which Seeds are available</td>
<td>Time usually required by Supplier to Dispatch Seeds as of Receipt of Order (weeks)</td>
<td>Mode of Payment and Currencies accepted by Supplier</td>
<td>Advanced Payment required by Supplier (% of Tot. Purchase Price)</td>
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<tr>
<td>1 US2</td>
<td>Dept. of Agronomy and Soil Science, Univ. of Hawaii at Manoa, 190 East-West Road Honolulu, Hawaii 96822 U.S.A.</td>
<td>Sesbania sesban (only research quantities)</td>
<td>2</td>
<td>no charge</td>
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</tr>
<tr>
<td>2 US3</td>
<td>Tree Seeds International, Suite 802, 1015, 18th Street, N.W., Washington, D.C. 20036 Telex: 650 1150 665 Cable: TreeSeeds Washington D.C. Tel.: (301) 587-07 80</td>
<td>Acacia saligna, Azadirachta indica, Cassia siamea; Dalbergia sissoo; Eucalyptus camaldulensis; E. globulus; Gleditsia triacanthos; Grevillea robusta; Leucaena leucocephala; Morus alba; Psidium guajava; Robinia pseudoacacia</td>
<td>2</td>
<td>US $, draft cheque</td>
<td>100</td>
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