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Upland Development Programme
in Southern Mindanao (UDP)

STOP

SLOPE TREATMENT-ORIENTED PRACTICES
FOR SUSTAINABLE
UPLAND FARMING AND SOIL CONSERVATION

by

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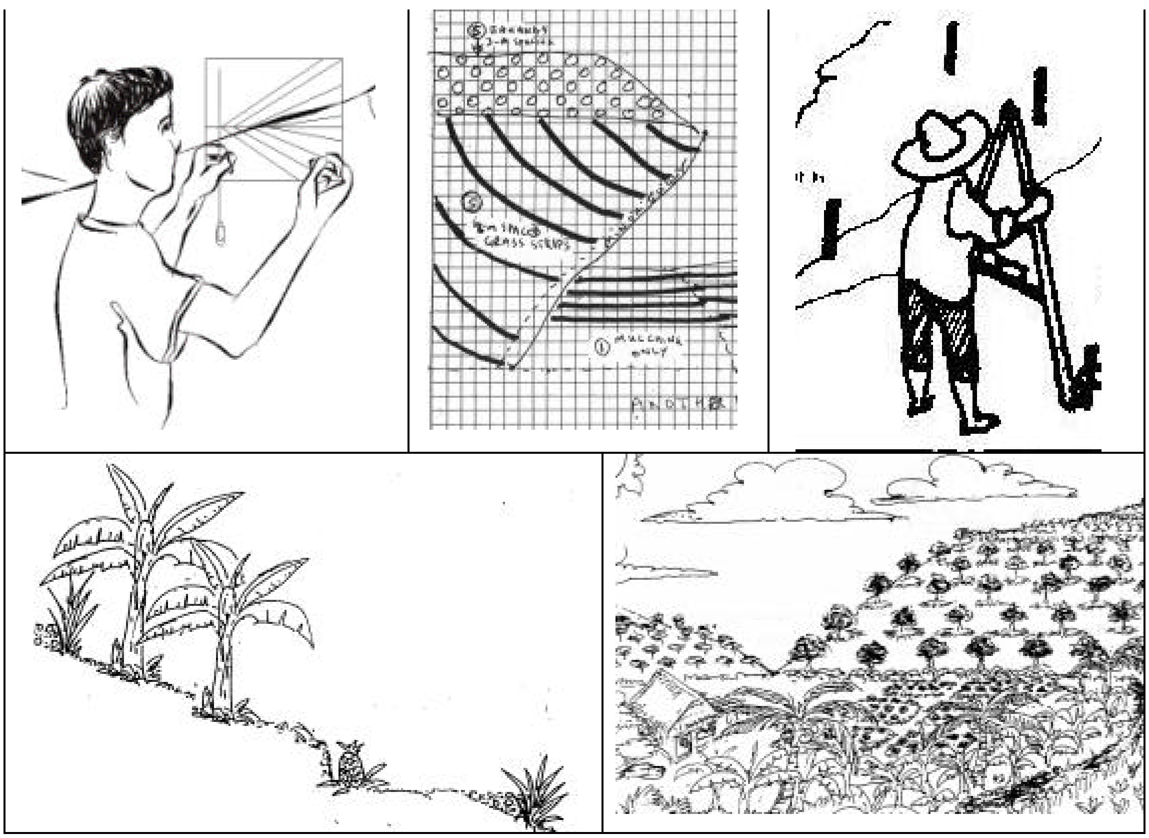

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SLOPE TREATMENT-ORIENTED PRACTICES
FOR SUSTAINABLE
UPLAND FARMING AND SOIL CONSERVATION

PESSIMISM

- ?? The general land development suitability of the uplands in the Davao Gulf Provinces is considered as ***forest conservation areas***.
- ?? The uplands are classified as ***not suitable for upland crops*** and half of the UDP-covered areas are considered ***not suitable for orchard development***.

(The 1999 Planning Atlas for RegionXI. *Davao Integrated Development Project (DIDP)*
Japan International Cooperation Agency (JICA), March 1999.

PRAGMATISM

- ?? It is too late to move the one million people living in the uplands on to other land.
- ?? The solution to arresting the environmental degradation in the uplands can only be tackled by changing the "present farming system of annual corn-based cropping to one which is more appropriate with permanent and diversified cropping systems".

(Section 12.1, Annex 4 of the Financing Proposal for the Upland Development Programme)

STOP (Slope Treatment-oriented Practices) is a farm-level land suitability classification which identifies a choice of site-specific, environmentally-sound soil conservation strategies and diversified land use options based on slope, soil type and soil depth.

OPTIMISM

"Introduced by the UDP in 2003, the diversified farming system using the *Slope Treatment-oriented Practices* (STOP), is a pioneering effort to improve upland farming for sustainable agricultural development…..it has surpassed expectations in helping preserve the resource base of the uplands and has also boosted farm production and income generation of farmers". *From;* **Sun Star** *Nov 25 2004.*

END USER REACTIONS

- ?? "I'm switching to bananas!" Farmer Santos Bidiot from Sto. Rosario, on realizing that he had spent P6,000 in labour to produce a corn crop worth just P2,800.
- ?? "We have a word for that: *Short*!"A group of farmers in Marabatuan, after calculating that one of them had spent P9,600 in labour to harvest P6,000 worth of corn.
- ?? "I have resigned from poverty!" Farmer Vicente Aliwanon from Del Pilar, on his greatly increased income after switching from corn to fruit trees.
- ?? "My income averaged P1,000 a month when I grew corn. Now I only grow fruit and vegetables, and I get over P10,000 a month!" Saturnino Ellios, fromTaguibo
- ?? "Despite my farm having steep slopes, by using the right technology it became a productive and replicable model for others to copy." Pastor Guinang Fucal of Libi. His income rose from P4,000 from corn, to P20,000 a harvest after diversifying into bananas, pineapples, *monggo*, and fruits using STOP. His neighbours are copying him.

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SUMMARY OF STOP OBJECTIVES FOR LAND CARE AND DIVERSIFIED FARMING IN THE UPLANDS OF SOUTHERN MINDANAO

Land suitability issues

Due to steep slopes and fragile, infertile soils, the Davao Integrated Development Project (DIDP/JICA) in 1999 classified the uplands of Southern Mindanao as *not suitable* for upland crops, and about 50% of the area as *not suitable* for orchard development. The recommended use is forest conservation areas. However, people have been allowed in to settle, and clear the forest cover from very steep slopes of critical watersheds to plant coconuts, corn and other crops without any restrictions. Reductions in soil depths of over 50 cm in the past 20 years (= 3 cm a year) under coconut plantations and on slopes due to the continuous cultivation of corn and cassava, has proved this classification to be correct.

The Upland Development Programme in Southern Mindanao (UDP), acknowledging that it is too late to move the one million people from the uplands to other lands, opted to arrest the on-going environmental degradation in the uplands by changing the "present farming system of annual corn-based cropping to one which is more appropriate with permanent and diversified cropping systems".

This is being achieved by identifying small areas, often only a few hundred square metres in area, within the rugged terrain of the uplands, that have the gentle slopes suitable for annual crops, and protecting them with appropriate soil and water conservation measures (SWC). On long, steep slopes, corn is being replaced with bananas and fruit trees. It should be noted that UDP's experience with SALT technology confirms that of other projects and soil conservationist: that SALT is only applicable on very few sites at the tops of hills with short slopes of less than 20%. By referring to the UDP's Slope Treatment-Oriented Practices (STOP), a land suitability classification designed for micro-scale planning at the upland farm level, appropriate site-specific SWC measures and land use options can be identified.

Objective

The objective of STOP is to promote a change from *unplanned* upland agriculture, in which annual and perennial crops are planted anywhere, regardless of slope or soil depth and texture, to a *planned* one in crops are matched to the most appropriate slopes and soils. For over 90% of upland farmers growing corn as a cash crop has proved to be financially disastrous, as labour costs are more than the value of the crop. Diversifying into bananas, fruit trees, and vegetables, lessens dependence on a single crop, ensures food security, and increases productivity and income generation. However, it requires recognition that the land itself imposes limitations on what is ecologically sustainable.

The UDP recognises that self-sufficiency in food is an important consideration to many upland farmers. Farmers are therefore encouraged to grow sufficient corn to feed their households until such time as the tree crops produce regular and reliable incomes sufficient to purchase household staples. Planting high-yielding varieties of corn and using the recommended applications of fertilizer enables farmers to reduce the area under corn to less than 1,200 sq metres.

Approach

?? Restrict the cultivation of annual crops to sites receiving the least amounts of run-off, i.e. the shorter gentler slopes of crests and ridge tops, where cross-slope barriers such as hedgerows, suited to slopes below 20%, become appropriate soil conservation measures.

?? Plant contour grass hedges of Napier Grass or Vetiver Grass at approximately 4-m intervals on short 12-15 m lengths of upper slopes up to 45%. Two-metre wide natural vegetative strips (NVS) occupy the land immediately below the Napier-Vetiver grass hedges and are planted with bananas. Use the remaining 2-m wide strip to grow annual crops. Contour cultivation and the processes of erosion will form terraces over a 3-5 year period.

- ?? Replace annual crops with a mixture of tree crops and grass cover on long slopes or steep slopes up to 55%, that cannot be terraced that generate large volumes of run-off with highly erosive velocities.
- ?? Practice zero tillage and mulching on shallow soils less than 60 cm deep on gentle slopes (<25%). Above 25% slope the wisest choice is to plant perennial crops.
- ?? Reduce the risk of erosion on shorter slopes with rapidly steepening convexity by converting to medium- or long-term crops and grass.
- ?? Plant fruit trees by direct seeding followed by field-grafting of scions. This is particularly important on soils that have eroded down to <60 cm depth, as the tap-roots of the seedlings can penetrate through cracks in the rocky substrata to find moisture. Nursery-produced seedlings, which lose their taproots, have fibrous root systems near the surface and are more prone to drought.
- ?? Develop minor valleys for high value vegetable production on raised beds.
- ?? For farmers who only have access to very steep slopes above 55%: plant small-crowned fruit trees from seed; support intensive backyard gardening, livestock or fish production around the homes of farmers, or identify other off-farm opportunities,

Strategy

Model farms should be easily visible and accessible from roads and footpaths, and have a range of minority land units (crests, ridges, small valleys), so one or more of the following changes can be demonstrated:

- ?? Substituting corn-based farming on steep slopes with perennial crops.
- ?? Relocating the production of highly erosive crops (e.g. corn, peanuts or root crops) to the limited areas of gently sloping land units on upper slopes and hill tops, and adopting high-yielding varieties to compensate for the reduced area under cultivation.
- ?? Terracing fallow land with clay-textured soils over 100 cm deep, on upper slopes below 45%, through a combination of grass strips and contour ploughing.
- ?? Converting unproductive cogon grassland to fruit tree orchards (slopes 55%).
- ?? Intensifying vegetable production by improving backyard systems, or on land where supplementary, gravity-fed watering is possible.

Staff training

Extension workers should be trained in:

- ?? recognising *land units* such as crests, ridges, or valley bottoms, etc. with potential for sustainable cropping of annual crops.
- ?? farm mapping to differentiate areas of high potential for annual crops (including upper slopes that can be terraced), from slopes suitable for trees; and
- ?? applying the STOP menu of site-specific prescriptions to cover the wide range of combinations of slopes and soils occurring in the uplands.

Layout of the handbook

Part I of this handbook describes the three STOP strategies developed so far: *Land unit farming* (STOP 1), which aims to restrict the area suitable for annual crops to upper slopes by using cross-slope barriers and contour ploughing to promote terracing; *Multi-storey tree cropping* (STOP 2), in which mixtures of fruit trees of different heights replace annual crops on slopes too steep or too long for cross-slope barriers; and *Mulching and Zero Tillage* (STOP 3), to be applied when soils are too shallow for applying STOP1.

Part II gives details on how to make and use the laminated slope indicator, and assess soil texture in the field. Blank *Land Unit Prescription Forms* are provided along with examples of completed forms and farm maps.

INTRODUCTION

1. Land classification

Land classification places strict limitations on certain lands according to their location in the landscape, their slope, and soil depth, texture, etc. Land suitability is the fitness of a given type of land for a defined use, either in its present condition or after improvements. By grouping land units according to their suitability for specific kinds of land use unsustainable land use practices are avoided on fragile lands. The health of the land can be preserved until technologies are developed permitting sustainable exploitation while conserving soil and water.

2. Suitability of the Southern Mindanao uplands for agricultural development

Upland soils are highly sensitive to disturbance and low in resilience. Their use for agriculture precipitates or accelerates land degradation. The fragile nature of the soils and the rugged terrain dominated by steep slopes limits the area of land suitable for agriculture.

The land capability maps in the DIDP/JICA 1999 *Planning Atlas* for Region XI[1] show the uplands of the Davao Gulf Provinces as suitable as *forest conservation areas*, but over 90% of the UDP-covered barangay areas are *not suitable* for upland crops, with about 50% of the UDP area considered *unsuitable* for orchard crops.

Despite this, people have been allowed to settle in the uplands, and clear the forest cover from very steep slopes without restrictions. The long-term cultivation of corn and cassava, and coconuts on the fragile soils and steep slopes, has resulted in massive reductions in soil depths. Throughout the UDP areas farmers say soils are more than 50 cm shallower than 20 years ago (an average loss of 2-3 cm per year), with over 100 cm lost since the 1960s in some ancestral lands. Declining crop yields and periodic crop failures are normal.

Because it is impractical to move one million people out of the uplands, the UDP opted to try to change the corn-based cropping to diversified farming systems, to arrest the on-going environmental degradation. For over 90% of upland farmers, growing corn as a cash crop has been a financial disaster. The labour costs greatly exceed the value of the corn produced. All farmers agree, however, that growing bananas can be profitable (giving 2-10 times the income than corn), with lower labour costs and much less land degradation.

3. The need for site-specific soil and water conservation (SWC) measures

The “traditional” SALT leguminous hedgerows, initially tried by the Project, proved to be inappropriate SWC measures for the long, steep slopes found in much of the uplands. Reasons to doubt the suitability of hedgerow intercropping on steep slopes[2], [3] include:

- they were designed for gentle slopes below 20%;
- the very close spacing required on steeper slopes, and consequent reduction in cultivable land, make hedgerows unacceptable to some farmers;
- they are unable to prevent a build up in the volumes and velocities of run-off on long slopes.

4. Slope treatment-oriented practices (STOP)

Although the uplands have been classified as unsuitable for agriculture at the macro-scale, there are small areas, often only a few hundred square metres in area, within the steep

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[1] Japan International Cooperation Agency (JICA), March 1999. *Davao Integrated Development Project (DIDP), Planning Atlas*. Pacific Consultants Internatonal

[2] Young, A (1989). *Agroforestry for soil conservation*. Wallingford UK, CAB International

[3] Hudson, N (1992). *Land husbandry*. London. Batsford

uplands that are suitable for crops. These *land units,* with short slope lengths and gentle slope gradients, include plateaux, hill tops and crests, ridges, and minor valleys.

To exploit these areas of relatively high agricultural potential, UDP developed the STOP land suitability classification as a tool for micro-scale planning at the farm level. Based on slope angle, soil texture and soil depth, it takes into account farmer objectives, farm size, cost of labour, and the availability of markets. One hectare of land that includes slopes, hill tops and minor valleys is enough to provide an annual income of P100,000 if the correct management practices are applied. For example, by reducing the gradients of upper slopes through a combination of cross-slope barriers and contour ploughing, and planting a variety of short-, medium- and long-term crops matched to appropriate slope ranges and soil types.

STOP restricts annual crops to areas where the erosion hazard is lower (i.e. on gentler slopes or in minor valleys) or where the hazard can be lowered (i.e. by applying *appropriate* SWC measures). Long or steeper slopes, where cross-slope barriers are not effective in controlling run-off, are set aside for tree crops.

By taking three simple field measurements: slope angle; soil texture, and soil depth, the agricultural extension worker can sub-zone the upland farms into land units (see Part II). Based on the characteristics of the land units, and their location in the landscape (e.g. hill top, ridge, upper slope, minor valley, etc) the STOP table provides site-specific prescriptions for annual crops, vegetables and fruit trees, and the appropriate SWC measures. The extension worker draws maps of the farm showing the land units and recommended lay out of SWC measures, and in consultation with the farmer prepares a prescription form outlining the land use options for each land unit and the recommended SWC measures.

5. STOP 1, 2 and 3

To date, three forms of STOP intervention have been developed (see Part I):

- *Land unit farming* (STOP 1), which aims to extend the area suitable for annual crops by using cross-slope barriers and contour ploughing to promote terracing on the upper slopes where erosion risks and run-off rates are lower. An improved design for cross-slope barriers combines 2-m wide natural vegetative strips with contour hedgerows. This increases the distance between the hedgerows and improves soil conservation. Bananas planted in the NVS generate higher incomes than if the area was left to corn. The cultivable strips can be planted with any crop once they have been properly protected with cross-slope barriers.
- *Multi-storey tree cropping* (STOP 2), in which mixtures of fruit trees of different heights replace annual crops on slopes too steep or too long for cross-slope barriers.
- *Mulching and Zero Tillage* (STOP 3), to be applied when soils are too shallow for forming terraces under STOP1.

STOP 4 – *Vegetable Gardening on Raised Beds* in minor valleys is in preparation.

6. Limitations to STOP

There are many areas where the STOP soil and water conservation interventions cannot be safely or effectively implemented without increasing the erosion hazard. This may be due to excessively steep slopes, slope length and shape, highly erodible lahar soils, or severely truncated soil profiles overlying stone substrata. In these circumstances the DA and UDP should leave the decision to the DENR Secretary as to whether it is in the public interest that upland farmers be permitted to continue to try farm to these lands.

PART I

STOP 1
LAND UNIT FARMING

PRINCIPLE:
MINIMISE THE PROBLEMS OF SOIL EROSION BY RESTRICTING THE CULTIVATION OF ANNUAL CROPS TO MINOR VALLEYS AND FLAT TO GENTLE SLOPES, OR UPPER SLOPES WHERE CROSS-SLOPE BARRIERS REDUCE SLOPE GRADIENTS BY PROMOTING TERRACE FORMATION. RESERVE STEEPER AREAS FOR PLANTING TREE CROPS FROM SEED.

1. Objectives

The purpose of STOP 1 is to provide site-specific recommendations on the maximum intensity of land-use permitted and the type and spacing of soil and water conservation measures for a given piece of land, based on its slope, soil texture and soil depth (see Part II).

2. Land Units

A strip of land with the same slope range and soil type is termed a *land unit*. It can be expected to have the problems and potentials for agriculture as similar areas of land elsewhere in the landscape.

Land units are areas of land that are recognizable from their position in the landscape (e.g. a plateau, a hill crest, ridge, upper slope, mid-slope, spur, minor valley, etc). However, when the underlying geology changes, the width and length, slopes, soils and dissection of land units will also change. The boundaries of a land unit occur when there is a distinct break in slope (e.g. as between an upper slope and the crest of a hill, or a minor valley).

3. Land unit mapping

Land unit mapping involves the following steps (see Part II for details):

Step 1:	Sketching a map (plan- or overhead-view) showing the whole farm boundary, and the different land units (crests, ridges, upper slopes, side slopes, minor valleys, etc) basing boundaries on easily visible, major breaks in slope.
Steps 2 & 3:	Measuring the slope and soil depth, and assessing soil texture, the approximate area and the current land use of each land unit.
Step 4:	Referring to the STOP table for recommended land uses and SWC measures.
Step 5:	Filling in a land unit prescription form for every land unit specifying the proposed land use and the soil conservation measures for the particular land unit.. The inputs needed (Step 5a) and estimated incomes for various crops from each land unit (Step 5b), can also be included.
Step 6;	Preparing a second map showing the layout of the proposed SWC measures.

4. Land unit farming

Land unit farming is the development of crops on a series of land units usually, but not necessarily, from the top of a hill to the valley depending on their land qualities for agricultural crops (Table 1) and their susceptibility to erosion.

STOP 1 restricts the cultivation of short-term crops to hilltops, crests, ridges, upper slopes and minor valleys, where terracing can reduce effectively slope gradients. Cross-slope barriers consist of a hedgerow or strips of Vetiver or Napier grass, planted accurately on the contour using an A-frame, with a 2-m wide NVS immediately below, planted with banana trees (see Section 6). Provided there is a minimum soil depth of 100 cm, the spacings between the SWC measures given in the STOP Table (see Part II, *Step 4*) ensure a minimum soil depth of 50 cm will remain for growing crops at the back of the terrace when level bench terraces have developed.

Crops that can be productive with less water and therefore suitable for planting in the shallower 30-60 cm deep soil at the back of the terrace include the leguminous *monngo bean*, and the relatively drought-tolerant pineapple.

Because the prescriptions for a given land unit can be extrapolated to similar land units occurring in the same landscape, which may cover several square kilometres, land unit farming can be considered to be a replicable model for upland development.

5. Strategy for slopes too steep or too long for cross-slope barriers to be effective

A mixture of fruit trees should replace annual crops on slopes too steep or too long for cross-slope barriers. This is best done by direct seeding, followed by the field-grafting of scions when the young trees have pencil-thin stems (see *STOP 2: Multi-Storey Tree Cropping*). Fruit trees grown from seeds planted in the field develop stronger root systems and live longer.

Figure 1 illustrates how the landscape might look after land unit farming has been adopted.

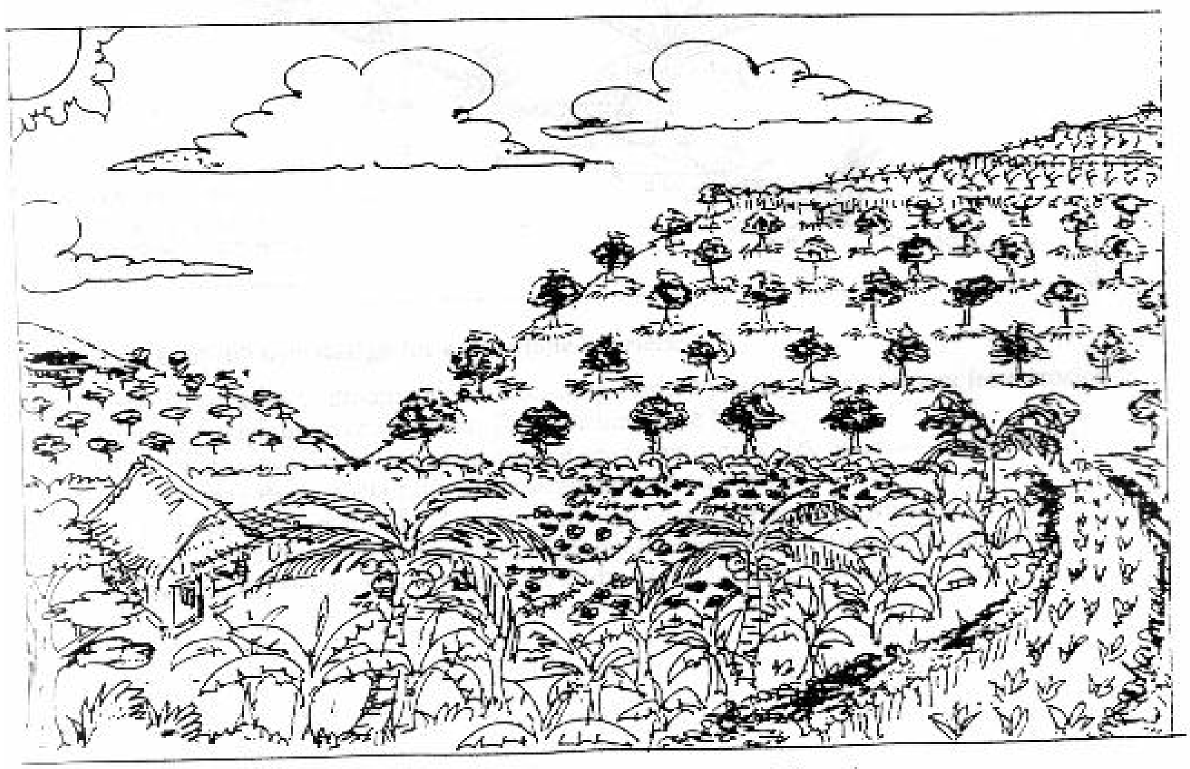


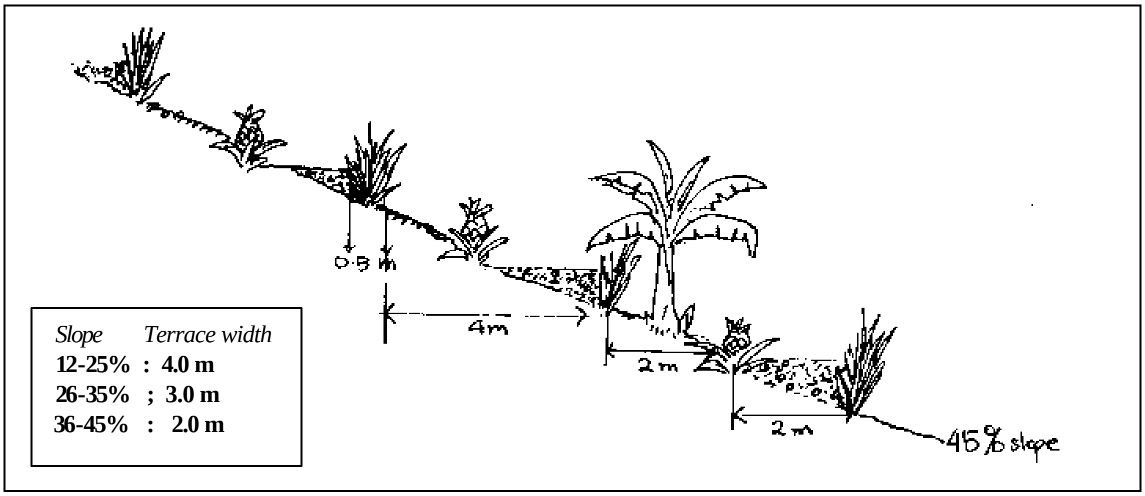
Fig. 1 An impression of a landscape formed after land unit farming

Terraces, for growing annual crops, have formed on the less steep hillcrest and upper slopes because of soil interception by cross-slope barriers. Trees, in a triangular spacing, are growing on the steeper mid - and lower slopes from seeds directly planted into well-mulched planting site. Vegetables are grown on raised beds in the more fertile alluvial soils in the minor valleys.

6. An improved design of cross-slope barriers

Figure 2 shows an improved design for cross-slope barriers on steep slopes when applying STOP on undeveloped land. It incorporates a 2 m wide NVS immediately below the hedgerow, which will dissipate the energy of run-off dropping from the terrace above so it doesn't undermine the terrace. The spacings given in STOP apply only to the width of the cultivable strip. The cross-slope barrier now includes both the leguminous hedgerow or Napier/Vetiver grass strip and the NVS. Bananas or pigeon peas planted in the NVS and pineapples at the back of the terrace, to prevent ploughing into the NVS, diversify the farming system if there is only a small area of land available to the farmer.

Fig. 2 Improved design for cross-slope barriers on steep slopes



Objectives of the new design for cross-slope barriers:

The new design aims to produce terraces on steep slopes by using soil movement from erosion and contour ploughing over 3-4 years. The function of the NVS is:

?? to reduce the riser height of the terrace and minimise the risk of terraces collapsing by absorbing the impact of run-off passing through the barrier.

?? to act as an alternative to planting additional contour hedgerows when the original hedgerows are too widely spaced. Mark out the width of the cultivable strip appropriate to the slope steepness and extend the width of the NVS beyond 2-m.

?? rather than reducing incomes, the NVS can yield higher returns than growing corn if bananas or other fruit trees are planted in it.

Table 2. Land qualities necessary for farm production systems

ROOT CROPS

Soils:	Loose, deep, free-draining soils, well-structured and free from compaction. Preferably loamy soils, with little stoniness. Shallow soils to be avoided.
Slopes:	Flat to gentle slopes (12%) or on terraces on steeper slopes.
Drainage:	Well-drained soils important.
Others:	Animal manure or mineral fertilisers are necessary to maintain fertility.

VEGETABLES

Soils:	Light workable soils, preferably alluvial or volcanic, which retain fertility and structure.
Slopes:	Flat to gentle slopes (0-12%); low risk of erosion.
Drainage:	Good drainage. Proximity to water supplies would be an advantage.
Others:	Good shelter. Access to markets.

SEMI-PERENNIALS e.g. pineapples, bananas

Soils:	Pineapples can be grown on a wide range of soils. Prefer sandy loams with pH 5-6.5. Bananas grow on a wide range of soils. The best soils are fertile of volcanic or alluvial origin. Low pH favours spread of Panama disease in Gros Michel bananas.
Slopes:	High erosion results if pineapples are grown without mulching on steep slopes. Bananas should be hilled up on steep slopes, and planted on the contour with adequate soil conservation measures.
Drainage:	Pineapples do not tolerate water-logging. Bananas require good drainage.
Others:	High calcium and manganese content in soil results in chlorosis in pineapples. High sodium chloride content is deleterious for bananas, but they respond well to added N and have a high K requirement.

FRUIT TREES

Soils:	Wide range of soils acceptable but less suitable on shallow sandy soils due to risk of drought. Avoid waterlogged soils.
Slopes:	Flat to steep slopes (up to 58%) depending on size of mature tree.
Drainage:	Good to moderate, or moderate to imperfect.

Others: Good grass cover with little encroachment of cogon (Imperata cylindrica).
Supplementary water advisable if high value fruits are to be grown.

STOP 2

MULTI-STOREY TREE CROPPING

PRINCIPLE:

IMITATING THE MULTI-STOREY CANOPY OF THE ORIGINAL RAIN FOREST, BY PLANTING A MIXTURE OF TREES OF DIFFERENT HEIGHTS, PROTECTS THE SOIL FROM EROSION BY DISSIPATING THE ENERGY OF RAINDROPS

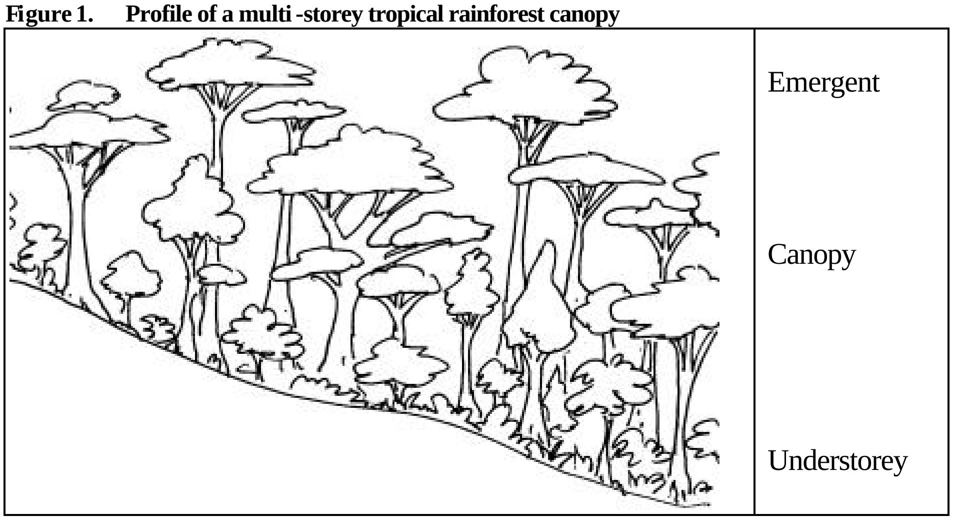
1. Importance of a vegetative cover in dissipating the erosive energy of rainfall

Vegetation intercepts and dissipates the kinetic energy of raindrops before they reach the soil, and prevents the detachment of soil particles. The main function of cover crops such as *Pueraria*, *Calopogonium* and *Centrosema* is to protect the soil from the impact of raindrops falling from the canopy - particularly tall trees when drops may approach their terminal velocity. A disadvantage is that the shade produced by the established tree crop may causes the cover crop to die out, preventing a satisfactory ground cover from developing.

The height of the canopy is important. Water drops falling from seven metres attain 90% of their terminal velocity, while small raindrops intercepted by the canopy may coalesce to form larger drops that are more erosive. Soil loss rates of 360 tons/ha/yr have been recorded under industrial tree plantations such as coconuts, compared with 6 tons/ha/yr from undisturbed tropical rain forest (i.e. a reduction in soil depth of 2.5-3.0 cm/yr).

The much lower rate of soil erosion under tropical rain forest, even on steep slopes, is due to its multi-storey canopy (see Figure 1) and heavy mass of feeder roots immediately under a thick layer of litter on the forest floor. These combine to protect the soil from the direct impact of falling rain and increase its porosity. By enhancing infiltration of rainfall into the soil, the amount of run-off is reduced, and stream flows are maintained through the year.

Figure 1. Profile of a multi-storey tropical rainforest canopy



2. Lesson learned

A UDP study found that slopes of 75-80%, protected by a mixed tree cover of coconuts, bananas, fruit trees and ipil-ipil, had soil depths of over 80 cm. Less than 50 m away years of cultivating corn on slopes of 50% had reduced soil depths to 20-50 cm.

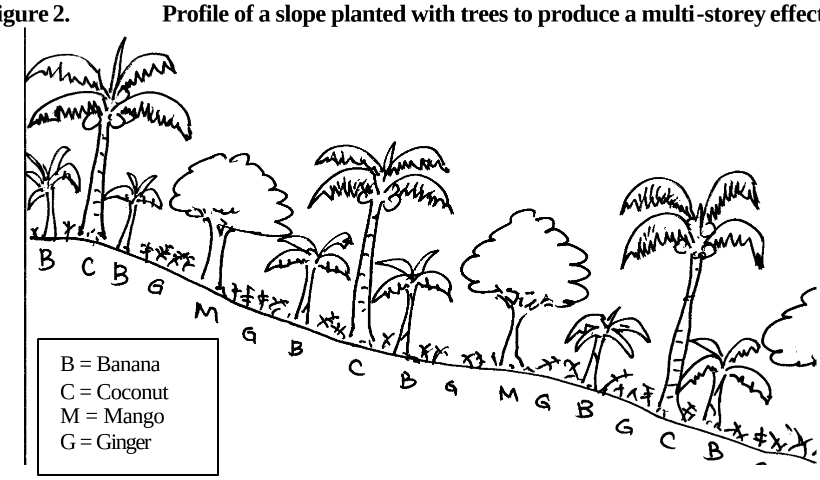
The closer the soil cover resembles the upper canopy and protective undergrowth or leaf mulch of the natural forest, the lower the rates of soil erosion.

3. Multi-storey tree cropping

For a highly productive, sustainable, permanent upland cultivation to succeed in the humid tropics soil erosion must be kept to a minimum. This is best achieved by imitating the tropical rainforest that originally covered the soils. Multi-storey tree cropping, in which a mixture of trees and shrubs are planted together, is a good solution (see Figure 2).

While the canopy of natural forests is most effective at reducing erosion, a dense growth of grass under tree crops may be almost as efficient. However, for adequate erosion protection at least 70% of the ground surface must be covered. Unless the trees are widely spaced, the shade of an established plantation tends to kill off most of the grass under the trees.

Figure 2. Profile of a slope planted with trees to produce a multi-storey effect



4. Planting sequences

Slopes unsuitable for arable crops should be given over to tree crops, preferably planted in rows running east-west to avoid shading and to maximize the utilization of solar radiation. Different types of tree are planted in sequence. For example:

Stage	Plants to be planted	Comments
1	Banana, citrus, ginger	Rows oriented E-W.
2	Coconut, mango or durian, lansones	Rows oriented E-W between the 1st stage trees
3	Coffee, cacao, jackfruit, medicinal plants	Plant in the shade produced by the 2nd stage trees

With established coconut plantations start the sequence by planting with bananas, citrus, coffee and ginger to get short-term and medium-term income. Phased cropping gives a continuous supply of food, fruits and fibre, and spreads labour requirements throughout the year.

5. Mulching

Because cleared land doesn't have the layer of dead leaves found on the floor of the original forest, the planting sites of the seeds or seedlings should consist of a 3-meter diameter circle heavily mulched to a depth of 30 cm (e.g. using cogon). A layer of 2-3 coconut fronds should be used to mulch ginger.

The mulch will help retain soil moisture during dry spells, improve soil porosity, and help support soil micro-organisms. Eventually, the leaf litter from bananas and coffee will provide the mulch to protect the soil.

6. Maintaining soil fertility

Under natural conditions the tropical rain forest is a closed system, with the small amounts of nutrients leaving the forest balanced by the few inputs from outside. Between 12-30 tons of organic matter per hectare are recycled per year. On the other hand, harvesting fruits, removes substantial amounts of nutrients. Farmers should expect to supply fruit trees that have been planted in soils depleted of nutrients by crops of corn and cassava, with N, P and K, and some micronutrients. This can be in the form of composts or manures and/or inorganic fertilizers.

STOP 3

MULCHING AND ZERO-TILLAGE

PRINCIPLE

EMULATING THE ORIGINAL FOREST FLOOR BY COVERING THE SOIL WITH A THICK LAYER OF MULCH PROTECTS IT FROM RAINDROP IMPACT, IMPROVES INFILTRATION OF RAINFALL, RETAINS SOIL MOISTURE, AND ENCOURAGES SOIL MICRO-ORGANISMS, SUCH AS MYCORRHIZA. ZERO-TILLAGE INVOLVES PLANTING SHORT-TERM CROPS THROUGH THE MULCH WITHOUT TURNING THE SOIL.

1. How it works

The following layers of compost in various stages of development can be found covering the natural forest floor: *freshly fallen leaf litter, barely decomposed leaf litter, partially mature compost, mature compost, then the soil*. A root mat can be seen drawing nutrients from the compost layers. With minimal removal of forest products such an essentially closed nutrient recycling system[4] has successfully supported the high biomass and bio-diversity of the tropical rainforest for hundreds of thousands of years.

However, when leaves, fruits, shoots, and roots are continuously harvested, the nutrients removed from the soil must be continuously replaced from outside sources. This is especially important to maintain a sustainable agriculture system.

2. The Problems

The expansion of impoverished smallholder farming producing unfertilised arable crops on depleted soils in the tropical uplands destroys forests and wildlife and causes serious erosion. For example, in Vietnam the continuous cultivation of hill rice and cassava has resulted in one million hectares of eroded skeleton soils with no value for agriculture or forestry[5]. If this happens in the Philippines there will be a mass exodus from extensive areas of the uplands. The treeless landscapes and shallow soils will exacerbate the risk of flooding in the lowlands.

The continuous cultivation of corn and cassava on sloping lands in the UDP areas is resulting in soil depth reductions of 2-4 cm per year. In some areas soil depths have been reduced from depths of over 85 cm to less than 25 cm. Because shallow soils are unable to store sufficient soil moisture to support plant growth during the dry season, crop failures will become more frequent and the land may be unable to support tree crops. Efforts must be intensified to increase the awareness of the problems facing the uplands and effect a change to tree crops as soon as practical.

3. A solution. STOP 3 – Mulching and Zero-tillage (ZT)

STOP 3 is an attempt to address the problem of how to grow short-term crops when there is less than 100 cm depth of soil needed for terracing under STOP 1. The objective is to maintain the present soil depth by preventing any further movement of soil down slope. As with STOP 1, growing short-term crops will have to be restricted to gently sloping hilltops and ridges and minor valleys. Drought-tolerant Vetiver grass should be planted as cross-slope barriers to keep soil in place, as other hedgerow species are likely to die off.

Most tree crops will not survive on shallow soils. Short-season crops such as *monggo* (mung beans), or drought-tolerant crops such as pineapples and sorghum, will make more efficient use of the limited amount of moisture stored in shallow soils. ZT (see 2.2 below) must be adopted to minimise exposure of the soil to the erosive impact of raindrops. Heavy mulching

[4] Depending on soil type and vegetation between 8-25 t/ha need recycling annually to sustain the undisturbed forest

[5] Thai Phien and Nguyen Tu Siem (1996). Management of sloping lands for sustainable agriculture in Vietnam. *In*: The Management of Sloping Lands in Asia. (IBSRAM/ASIALAND. Network Doc #20 pp. 275-314

will be needed to prevent any further reduction in soil depths and to conserve soil moisture. Tree crops with tap roots will have to be planted from seed, as their tap roots can penetrate cracks in the 'hardpan' and access deeply stored moisture.

3.1 Mulching

Mulching is the covering of the soil to simulate the effect of the leaf litter-covered forest floor. Suitable materials include crop residues (e.g. corn stalks, rice straw or rice hulls, coconut fronds, sawdust or wood shavings). If cogon or other grasses are used, they should be cut before they set seeds to avoid creating a weed problem. To be effective a mulch should cover at least 70-75% of the soil surface.

Mulching improves the soil's ability to absorb rainfall and slows down the drying out of the soil during the dry season. This can be particularly important when planting the durian. Durians do not have root hairs. The roots that absorb water and nutrients are fungus roots which grow out from the secondary or tertiary roots, and which grow only within about 50 cm of the soil surface. Without a deep layer of mulch to keep the soil moist, the fungus roots die off affecting the growth and productivity of the tree.

Mulching also protects the soil against erosion; prevents soil temperatures from getting too high; and suppresses weed growth. Crop residues used as mulch increase or retain the level of organic matter in the soil, stimulate soil organisms, and make the use of chemical fertilizers, such as phosphates, more effective if they are applied on top of a layer of mulch, than if they are applied on bare soil[6]. However, as organic mulches decompose they compete with the main crop for nitrogen. Pests such as termites and snails, which harm the crops, may be attracted.

3.2 Zero -tillage (ZT)

As its name implies, ZT (also termed *minimum tillage*, *no-till*, etc.) is a system of crop production where the soil is not ploughed or loosened with hand tools. Instead of tillage, the seed is planted directly into the soil[7]. The main features of ZT are:

- ?? Spraying with herbicide 3-5 days before planting to replace hand-weeding, or ploughing and harrowing as the way to control weeds (this saves time and money).
- ?? Planting seeds in holes made by hand using sticks to make the opening (dibbling).
- ?? Using fertilisers and crops that produce a large amount of residues, otherwise mulching materials have to be obtained from outside the farm.
- ?? Establishing a continuous cover of crops by intercropping techniques.
- ?? Retaining the crop residues as a mulch to reduce evaporation and limit weed growth.
- ?? Applying pesticides to control insect pests that spend part of their life cycle in the soil.

4. Principles of STOP 3: Mulching and Zero Tillage

In summary, the principles of STOP 3 are:

f) *Boost organic matter production*
In the first year it may be necessary to plant crops such as HYV corn, which produce large amounts of residues, to generate sufficient mulching material. Plenty of inorganic fertilizer, particularly N, will be needed to the boost the production of corn stalks, especially on shallow soils to offset the nutrients lost through harvesting.

g) *Keep the soil covered with a layer of mulch*
In the second year: establish a continuous cover of crops by intercropping techniques. These maintain soil fertility by N-fixation and biomass recycling as a substitute for fallowing. Mulches of crop residues and fast-growing cover crops such as *Arachis pintoi* suppress the growth of weeds, protect the soil from raindrop impact and

[6] See "A Guide to Mulching Fruit Trees" prepared for UDP by KRS Proud, Tree Crops Consultant. September 2003
[7] Special planting equipment is usually required. Most commonly the seeders need wheel tractors

promote infiltration. Shading the soil from the sun minimizes oxidation of organic matter.

h) *Practice zero tillage (ZT)*
Instead of tilling the soil, use a stick to plant (or dibble) the seeds through the mulch (i.e. the large amounts of plant residues accumulated in the previous year). ZT enhances biological activity under the mulch. Higher infiltration rates result by reducing soil compaction.

i) *Diversify crop production*
Diversify production by growing a wide range of crops to minimize the impact of price fluctuations, and damage to any particular crop by diseases and insect pests. Include legumes such as monggo (mung beans) in the rotation to maintain soil fertility. Plant vegetables in the minor valleys where soil eroded from the slopes has accumulated, and water is available.

j) *Apply fertilizer on top of the mulch*
Many short-term crops develop a dense mat of feeder roots which penetrate the mulch, just like forest trees. As there are not enough nutrients in the available organic matter to sustain a vigorous crop of vegetation, inorganic fertilisers can seldom be replaced by manures and composts. Fertiliser should be applied on top of the mulch to avoid 'burning' the crop roots. Phosphate fertilizers, in particular, are more effective if they are applied this way, as contact with bare soil makes P unavailable to plant roots. P inputs are needed to sustain crop yields on the highly weathered soils of the uplands. Deficiency of P prevents nodulation by legumes, resulting in low levels of N-fixation and increased competition between crops for available P.

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PART II

STEPS TO USING STOP

The objective of the UDP is to arrest the environmental degradation in the uplands by changing the present farming system of annual corn-based cropping and root crops to one which is more appropriate with diversified cropping systems and perennial crops. The choice of conservation measures and land use options depend on the slope, soil type and soil depth.

Using Slope Treatment-Oriented Practices (STOP)

Step 1
Draw a "bird's eye view" map of the whole farm.

Step 2
Measure the slope using the Slope Indicator

Step 3
Determine the soil type and dig a hole and measure the depth to the "hard pan".

Step 4
Locate the appropriate *conservation treatment* and *intensity of land-use* on the STOP table. Note that with STOP, as slopes get steeper and soils become sandier:

- ?? annual crops are replaced by agroforestry and forestry..
- ?? the spacing of cross-slope barriers gets closer.
- ?? on 45-55% slopes: plant tree crops in micro-basins, preferably using seeds, to encourage a long taproot. No hedgerows needed.
- ?? only forest cover is to be developed from seed above 55%. Tap-rooted species preferred.

Encourage the farmer to use an A-frame to lay out and plant appropriately spaced cross-slope barriers (hedges plus NVS) on the upper slopes and hilltops of his farm, and intensify and diversify annual crop production there.

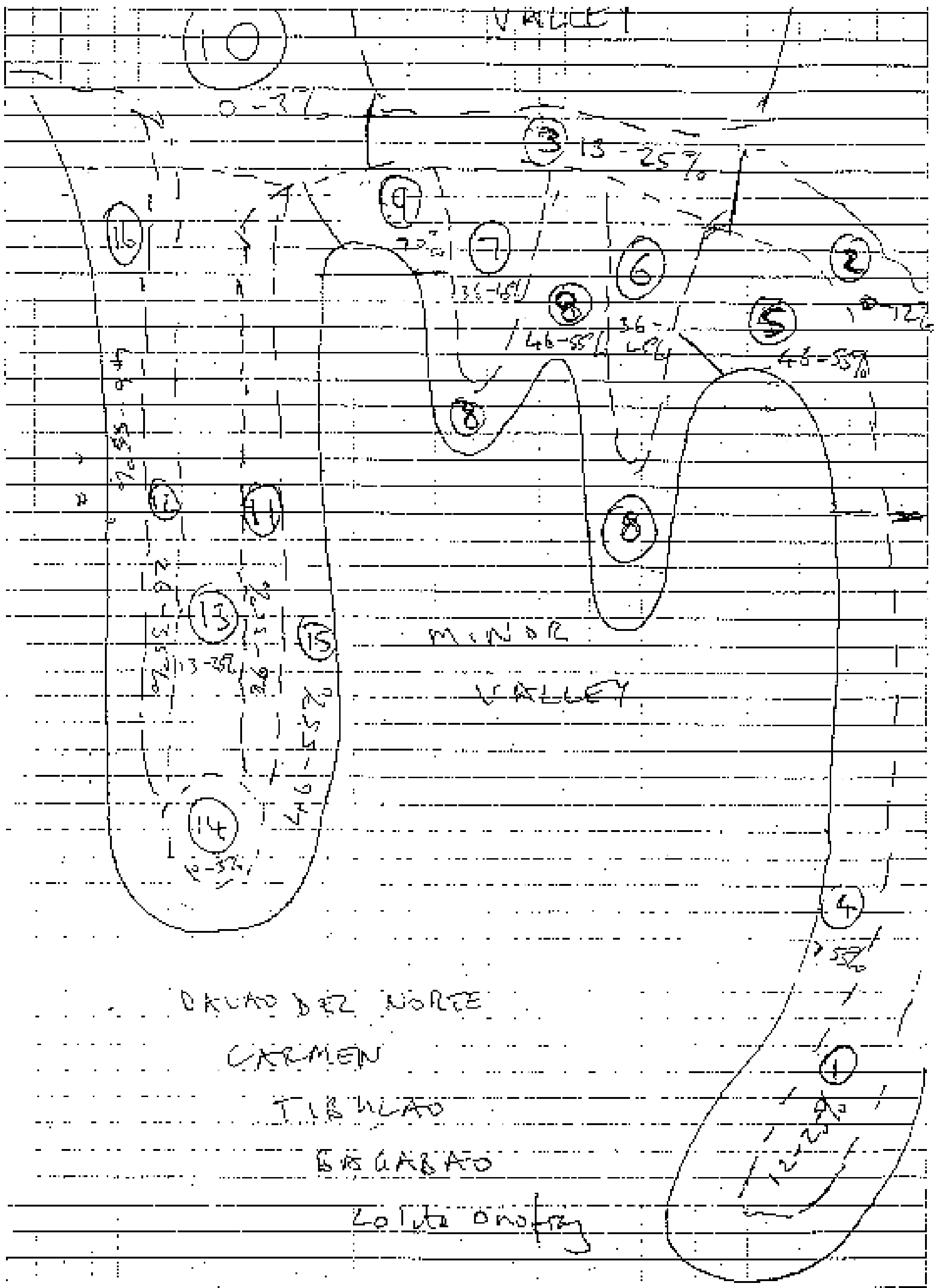
On the steeper areas, start to replace corn and root crops by planting bananas and fruit trees such as mango, durian and lanzones.

Step 5
Fill in a *land prescription form* detailing the proposed crops and SWC measures for each land unit. If necessary, indicate the number of Napier grass or vetiver splits needed, and the expected incomes for different fruit trees and annual crops from the land unit.

Step 6
Draw a second map showing the layout of the proposed SWC measures

STEP 1: DRAW A MAP SHOWING THE DISTRIBUTION OF LAND UNITS ON FARM

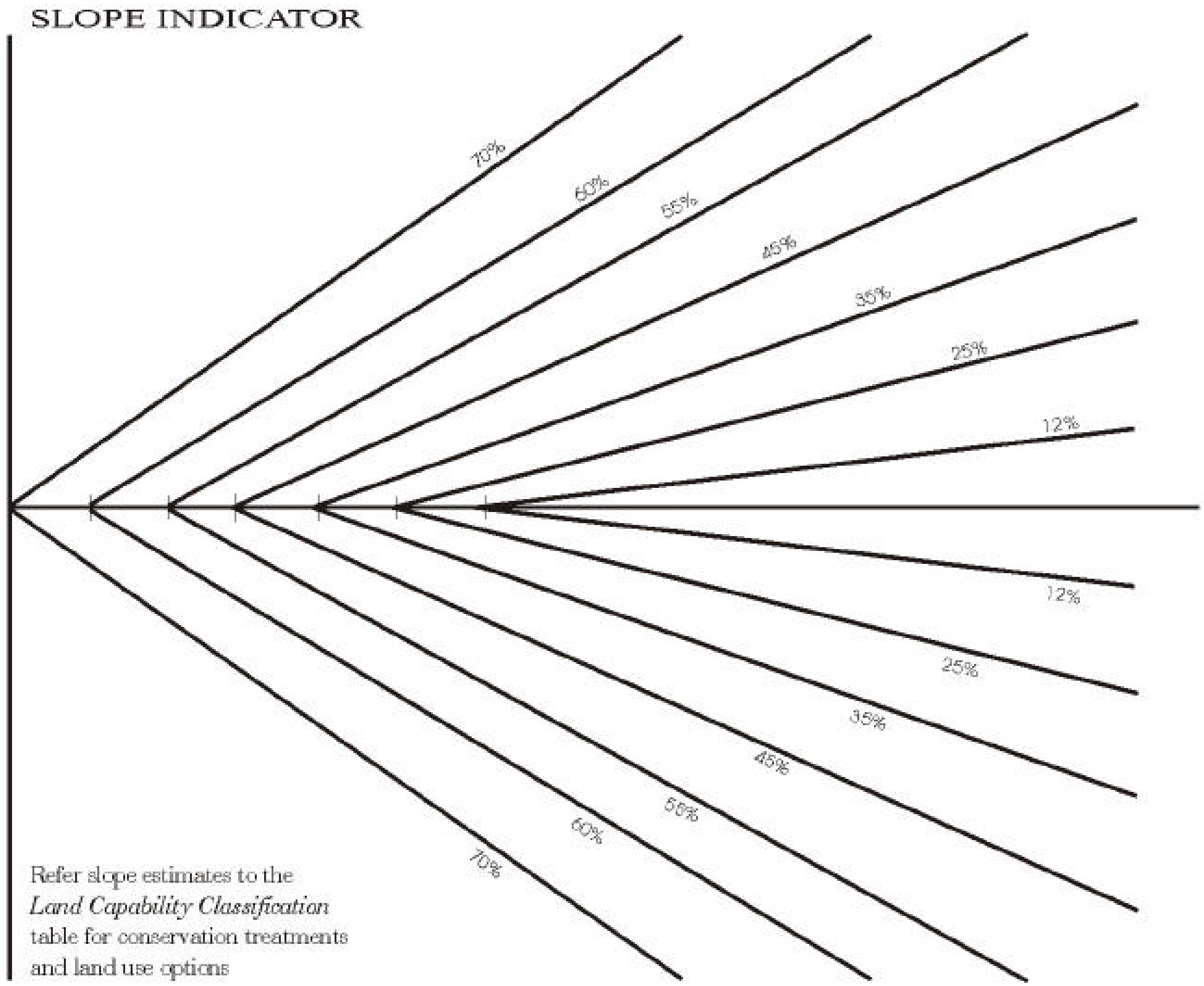
- Go to the highest point on the farm, if practical, and draw a "bird's eye" view of the whole farm (*not* an oblique view of one hectare).
- Obvious changes, or breaks, in slope indicate a change from one land unit to another.
- Identify each land unit with a number on the map.



STEP 2: MAKING AND USING THE SLOPE INDICATOR

STEP 2a: MAKING THE SLOPE INDICATOR

- Photocopy the template for the Indicator onto a piece of acetate.
- Laminate the acetate.



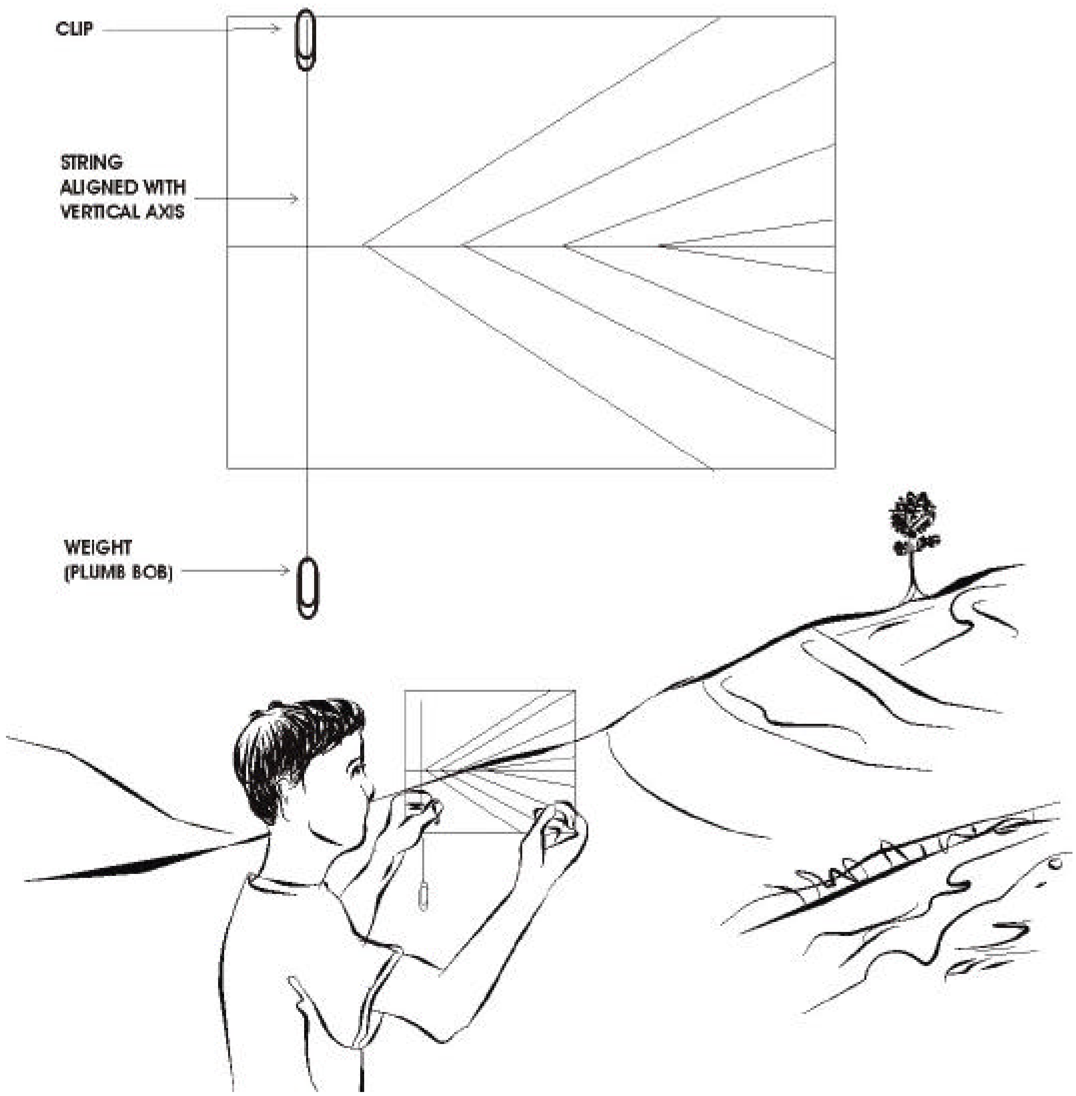
STEP 2 b: USING THE SLOPE INDICATOR

The farmer must always accompany the BEW or AT to assess the land capability of the farm

1. THE SLOPE INDICATOR

The Slope Indicator is used to estimate the slopes appropriate for various land use options .It is an acetate sheet with a horizontal and a vertical axis. The angles shown on the horizontal axis indicate the maximum slope gradients for the conservation measures and soil types suitable for various land use options. It can help locate the least steep areas on the farm, as these have the best potential for arable cropping. A template is provided overleaf (Section 2).

USING THE SLOPE INDICATOR



Using the Slope Indicator

a) Attach a weight, e.g. a large paper clip or a ball pen, to a 30 cm long piece of string or thread. This is the *plumb bob* that ensures the *Slope Indicator* is level.

b) Clip the *plumb bob* securely to the *Slope Indicator* using a bulldog clamp or paper clip and position the *plumb bob* so it coincides with the vertical axis on the *Slope Indicator*.

c) Hold the *Slope Indicator* upright and tilt it until the string of the *plumb bob* exactly follows the vertical axis. The *Slope Indicator* is then level.

d) Keeping the *Slope Indicator* level, line it up along the farm slope. Note which lines on the Indicator the farm slope falls between. This is the approximate gradient of the land.

STEP 3: DETERMINING SOIL TEXTURE IN THE FIELD

After determining the slope of the land, follow the instructions in the sheet titled *Hand Tests to Determne Soil Texture in the Field* to identify the soil type on the land. For each major change in slope you should check whether there has been a change in soil texture.

The objective is to try to avoid using sandy and sandy loam soils for arable crops, because their poor water retention capacity means they tend to suffer from severe moisture stress, even during the rainy season. Sandy soils are also much more sensitive to erosion than clay soils.

TO DETERMINE SOIL TEXTURE IN THE FIELD

The extent to which moist soil can be shaped by the hand is indicative of its texture.

METHOD

?? **Pick up a handful of soil (without stones) from the slope.**

?? **Slowly drip water on to the soil and mix it well into the soil until it starts to stick to the hand. If water is not available use saliva.**

?? **Form the sample according to each picture below until the next one is no longer possible:**

1) The soil remains loose and single grained and can only be heaped into a pyramid:

SAND (1)

2) The soil contains sufficient silt and clay to become cohesive and can be shaped into a ball that easily falls apart:

LOAMY SAND (2)

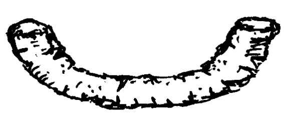
3) The soil can be rolled into a short thick cylinder:

SILT LOAM (3)

4) The soil can be rolled into a cylinder about 15 cm long:

LOAM (4)

5) The soil can be bent into a U:

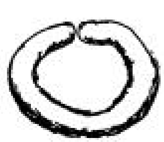


CLAY LOAM (5)

6) The soil can be bent into a circle that shows cracks:

LIGHT CLAY (6)

7) The soil can be bent into a circle without showing cracks:



HEAVY CLAY (7)

***Note*: Texture classes (1) to (4) are sandy to silty soils and generally have good infiltration. Texture classes (5) to (7) are clayey soils that have generally poor infiltration but have a higher potential for arable agriculture.**

STEP 4: SLOPE TREATMENT-ORIENTED PRACTICES FOR STEEP LANDS (STOP) MODIFIED 16 Dec 2004

OBJECTIVE: To produce a series of outward sloping bench terraces with a minimum soil depth of 50 cm at the back of the terrace.

Max. slope (%)	Min. soil depth (cm)	Sandy – Loam soils		Clay loam– Clay soils	
		Soil and Water Conservation treatments	**Maximum intensity of land-use between NVS/ hedgerows**	**Soil and Water Conservation treatments**	**Maximum intensity of land-use between NVS/ hedgerows**
12%	50 cm	Contour cultivation	Any. Fallow with forage peanut.	Contour cultivation.	Any. Fallow with forage peanut
25%	100 cm*	Contour hedgerows or strips of Vetiver or Napier grass with 2-m wide NVS and 3-m wide cultivable strip[2] Contour cultivation[3].	Relay planting with rice/maize-root crops-beans-peanuts to suppress weeds.	Contour hedgerows or strips of Vetiver or Napier grass with 2-m wide NVS and 3-4.5 m wide cultivable strip[2] . Contour ploughing to form terraces [3].	Rotations of corn, root crops and legumes. Relay planting of rice or corn-root crops-beans-peanuts to suppress weeds.
35%	100 cm	No hedgerows. Vetiver or Napier grass strips with 2-m wide NVS, and 2.5 m wide cultivable strip)[2]. Zero tillage. Heavy mulching.	Gradually replace maize and root crops with fruit trees planted among close cover crops and semi-perennials.	Vetiver or Napier grass strips with 2-m wide NVS and 3-3.5 m wide cultivable strip[2]. Contour ploughing to form terraces [3]. Mulching.	Rotations of corn and legumes. Relay planting of rice or corn-beans-peanuts to suppress weeds.
45%	100 cm	No hedgerows. Vetiver or Napier strips with 2-m wide NVS. And 2-m wide cultivable strip[2]. Zero tillage, Heavy mulching	Replace maize and root crops with agroforestry model of semi-perennials and fruit trees. No cultivation of beans and peanuts after 3 years.	Vetiver or Napier grass strips with 2-m wide NVS and 3 m wide cultivable strip[2]. Contour ploughing to form terraces[3]. Heavy mulching	As above. If ploughing is not possible, replace corn and root crops with agroforestry model of fruit trees planted among close cover crops and semi-perennials, over three years.
55%	100 cm	No hedgerows. Grass cover. Direct seeding and mulching around young trees	No cultivation Tree crops and grass cover	Vetiver or Napier grass strips with 2-m wide NVS and 2 m wide cultivable strip[2]. Contour ploughing to form terraces[3]. Heavy mulching	Agroforestry model of semi-perennials and fruit trees.
65%	50 cm	Grass cover. Direct seeding and mulching of trees	No cultivation. Forest trees and grass only.	Grass cover. Direct seeding and heavy mulching of trees	No cultivation Tree crops and grass cover only.
>65%	-	None suitable.	No cultivation. Forest trees and grass only	None suitable	No cultivation. Forest trees and grass only

* A slope with 100 cm depth of soil will give a terrace with 50 cm depth of soil below the hedgerow at the spacing indicated.
[2] The indicated cultivated strip width is the maximum permissible for 100 cm depth of soil, if 50 cm soil is to remain at the back of the terrace [3]Advisable to follow contour ploughing on slopes above 12% with a harrowing to obliterate furrows which, if not exactly on the contour, channel run-off to low points causing gullies

STEP 5: FILL OUT THE LAND UNIT PRESCRIPTION FORMS

STEP 5 (a): EXAMPLE OF A LAND UNIT PRESCRIPTION FORM SHOWING PROJECTED INPUTS FOR SWC

LAND UNIT INPUTS

LAND UNIT		Site factors			Prescriptions / Recommendations	Projected Inputs
1 * **Shape+** **Width m** **Length m** **Area: m²** **(W x L)**	**RIDGE** Convex 8 80 640	**Slope: %** **Soil texture** **Soil depth (cm)** **Erosion:** **Stoniness:** **Land use:**	**13-25** Sandy clay loam 50 Carabao track Small stones Cogon		?? Contoured leguminous hedgerows/Napier or Vetiver grass strips, using improved design for cross-slope barriers (Barrier of 0.5 m hedgerow + 1.7 m wide grass riser, and terrace of 3.8 m). ?? Plant peanuts, mungo, beans, pineapples. Mulch well with cogon from side slopes	Vetiver splits 1100 **OR** Napier splits# 2200 **OR** Fleming/Rinson 106m Pineapple suckers 180
2 * **Shape+** **Width m** **Length m** **Area: m²** **(W x L)**	**CREST/Plateau** Flat 50 70 3500	**Slope: %** **Soil texture** **Soil depth (cm)** **Erosion:** **Stoniness:** **Land use:**	**0-12** Clay loam >60 Sheet None Bananas		?? Contoured Napier grass or Vetiver grass barrier at plateau/side slope interface ?? Ring weed the existing fruit trees and mulch with cogon. (Note: Bananas, are recommended for planting on flat areas, as farmers will be prepared to cut them down should there be a need to open up land for corn cultivation in future. E.g. in 20 years time, when Vietnam and Thailand no loner have surplus rice to export)	Vetiver splits 500 **OR** Napier splits# 1000
3 * **Shape+** **Width m** **Length m** **Area: m²** **(W x L)**	**RIDGE** Convex 6 80 480	**Slope: %** **Soil texture** **Soil depth (cm)** **Erosion:** **Stoniness:** **Land use:**	**13-25** Sandy clay >100 cm Sheet None Mango, banana		?? Ring weed the existing fruit trees and mulch with cogon. ?? Apply 200 g complete fertilizer per tree ?? Plant more trees in gaps as required	2 kg Complete
4 * **Shape+** **Width m** **Length m** **Area: m²** **(W x L)**	**SIDE SLOPE** Convex 100 30 3000	**Slope: %** **Soil texture** **Soil depth (cm)** **Erosion:** **Stoniness:** **Land use:**	**>55** Sandy clay >50 cm Sheet None Cogon		?? Lay out triangular planting arrangement with spacing according to fruit trees to be planted). ?? Cut cogon on slope and pile 30-40 cm deep in 300 cm diameter circles on planting area to kill the cogon rhizomes in the soil. ?? After 5-6 weeks (provided it has rained) plant seeds of fruit trees in 30 cm diameter cleared area in middle of cogon mulch. Graft scions later.	Fruit seeds Scions
5 * **Shape+** **Width m** **Length m** **Area: m²** **(W x L)**	**SIDE SLOPE** **Concave** 60 40 2400	**Slope: %** **Soil texture** **Soil depth (cm)** **Erosion:** **Stoniness:** **Land use:**	**46-55** Clay loam > 50 cm Sheet None Cogon		?? Lay out triangular planting arrangement with spacing according to fruit trees to be planted). ?? Cut cogon on slope and pile 30-40 cm deep in 300 cm diameter circles on planting area to kill the cogon rhizomes in the soil. ?? Make 90 cm diameter eyebrow basins and plant seeds of required fruit trees, mulch with cogon, and graft scions later	Banana suckers 240 **OR** Seeds Scions

 # Napier needs double row of splits

STEP 5 (b): EXAMPLE OF A LAND UNIT PRESCRIPTION FORM SHOWING PROJECTED INCOMES PER LAND UNIT

Land unit prescription form comparing incomes from bananas and fruits with corn

LAND UNIT	Site factors	Prescriptions / Recommendations	Projected yields/ incomes
1 * UPPER SLOPE **Shape+ Straight** **Width 20 m** **Length 40 m** **Area:** **(W x L) 800 m^2**	**S lope: >70 %** **Soil texture: Clay loam** **Soil depth: cm** **Erosion: Rill** **Stoniness: None** **Land use: Corn**	TOO STEEP FOR PROJECT INPUTS, BUT ADVISE FARMER TO: ?? REPLACE CORN WITH BANANAS AT 3 METRE SPACING (Triangular layout) FOR REGULAR MEDIUM TERM INCOME. TREES WILL NEED TO BE PROPPED UP WITH BAMBOO. ?? PLANT SMALL-CROWNED TREES (to minimise risk of toppling at maturity) E.G. COFFEE, LANSONES, RAMBUTAN ETC *FROM SEED* (in case bananas affected by bunchy top virus at later stage). ALIGN IN EAST -WEST DIRECTION. ?? TRAIN FARMER IN GRAFTING ON SUITABLE SCIONS.	1.6 t/ha of corn twice/yr =3.2 t/ha/yr = 3.2 kg/10 m^2 @ P14/kg = P45 1 hill banana/10 m^2 yields 30 kg @ P4/kg = P120/yr **Income from Land Unit 1** *CORN: 800/10 * P45 = P3,600* *BANANAS: 800/10 * P120 = P9,600* *LANSONES: 800/10 * P186 =P14,880* (see below)
2 * RIDGE **Shape+ Convex** **Width 15 m** **Length 35 m** **Area:** **(W x L) 525 m^2**	**Slope: >70 %** **Soil texture: Clay loam** **Soil depth: cm** **Erosion:** **Stoniness:** **Land use: A few fruit trees**	AS ABOVE.	156 Lansones/ha yielding 40 kg/tree after 8 years @ P30/kg = P186/10 m^2/yr **Income from Land Unit 2** *CORN: 525/10 * P45 = P2,362.50* *BANANAS: 525/10 * P120 = P6,300* *LANSONES: 525/10 * P186 =P9,765*
3 * MID-SLOPE (a) **Shape+ Concave** **Width 40 m** **Length 30 m** **Area:** **(W x L) 1200 m^2**	**Slope: 35-45 %** **Soil texture: Clay loam** **Soil depth: cm** **Erosion:** **Stoniness:** **Land use: Corn with a few mango trees**	?? PLANT MANGO AND DURIAN SEEDLINGS OR SEEDS AT 10 m SPACING (triangular layout) IN 1.5 M DIAMETER MICRO-BASINS, ALIGNED IN EAST-WEST DIRECTION. ?? HEAVILY MULCH MICRO-BASINS. ?? APPLY COMPLETE FERTILISER AT RECOMMENDED RATES WITH ANNUAL INCREMENTS. ?? INTERPLANT WITH BANANAS TO GET EARLY INCOME.	8 year-old Mango yields 100 kg/tree or 10 kg/ 10m^2 @ P12/kg = P120/ 10m^2. **Income from Land Unit 3** *CORN: 1,200/10 * P45 = P5,400* *BANANAS: 1,200/10 * P120 = P14,400* *LANSONES: 1,200/10 * P186 =P22,320* *MANGOES: 1,200/10 x P120 =P14,400*
4 * MID-SLOPE (b) **Shape+ Straight** **Width 15 m** **Length 20 m** **Area:** **(W x L) 300 m^2**	**Slope: 35-45 %** **Soil texture: Clay loam** **Soil depth: cm** **Erosion: Land slippage at lower end** **Stoniness: None** **Land use: Corn**	AS ABOVE.	**Income from Land Unit 4** *CORN: P1,350/yr* *BANANAS: P3,600 @ 1.5years* *LANSONES: P5,580 @ 8 years* *MANGOES: P3,600 @ 8 years*

STEP 5 (c): BLANK LAND UNIT PRESCRIPTION FORM

Province:	Mun.	Brgy:	Sitio:

Farmer name:	Ann. food requirements:	Corn:	sacks	kg
Family size:		Vegetables	sacks	kg
Farm area:		Roots:	sacks	kg
Land tenure: :		Fruits:	sacks	kg

LAND UNIT		Site factors			Prescriptions / Recommendations	Projected yields/ incomes
1 * **Shape+** **Width m** **Length m** **Area:** **(W x L)**		**Slope: %** **Soil texture** **Soil depth:cm** **Erosion:** **Stoniness:** **Land use:**				
2 * **Shape+** **Width m** **Length m** **Area:** **(W x L)**		**Slope: %** **Soil texture** **Soil depth:cm** **Erosion:** **Stoniness:** **Land use:**				
3 * **Shape+** **Width m** **Length m** **Area:** **(W x L)**		**Slope: %** **Soil texture** **Soil depth:cm** **Erosion:** **Stoniness:** **Land use:**				
4 * **Shape+** **Width m** **Length m** **Area:** **(W x L)**		**Slope: %** **Soil texture** **Soil depth:cm** **Erosion:** **Stoniness:** **Land use:**				

* Describe as Crest, Ridge, Spur, Upper Slope, Mid-slope, Foot slope, Minor valley

\+ Describe as: *Convex, Concave, Straight* or *Compound* (i.e. Concavo-Convex)

STEP 5 (c) (cont'd): BLANK LAND UNIT PRESCRIPTION FORM

LAND UNIT	Site Factors			Prescriptions / Recommendations	Projected yields/ incomes
5* **Shape+** **Width m** **Length m** **Area:** **(W x L)**	**Slope: %** **Soil texture** **Soil depth:cm** **Erosion:** **Stoniness:** **Land use:**				
6* **Shape+** **Width m** **Length m** **Area:** **(W x L)**	**Slope: %** **Soil texture** **Soil depth:cm** **Erosion:** **Stoniness:** **Land use:**				
7* **Shape+** **Width m** **Length m** **Area:** **(W x L)** 8* **Shape+** **Width m** **Length m** **Area:** **(W x L)**	**Slope: %** **Soil texture** **Soil depth:cm** **Erosion:** **Stoniness:** **Land use:** **Slope: %** **Soil texture** **Soil depth:cm** **Erosion:** **Stoniness:** **Land use:**				

UDP Technician:______________________________ Signature:____________________________________

Cooperator: ________________________________ Signature ___________________________________

STEP 6: PREPARE MAP SHOWING LAYOUT OF SWC MEASURES