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STOP 4

INTENSIVE PRODUCTION OF ANNUAL CROPS ON SMALL LEVEL PLOTS

THE CORN PATCH
&
VEGETABLE GARDENING IN PERMANENT RAISED BEDS

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STOP 4
INTENSIVE PRODUCTION OF ANNUAL CROPS ON SMALL LEVEL PLOTS

PRINCIPLE

SMALL INTENSIVELY CULTIVATED PLOTS OF ANNUAL CROPS CAN YIELD HIGHER RETURNS PER HOUR OF WORK THAN LARGER, POORLY TENDED FIELDS. THE EFFICIENT PRODUCTION OF FAMILY FOOD REQUIREMENTS FREES TIME TO PLANT AND CARE FOR PROFITABLE PERENNIAL CROPS, WHILE OFF-FARM INCOME CAN BE PUT TO MORE PRODUCTIVE USES.

1. INTRODUCTION

1.1 Objectives

The primary aim of STOP 4 is to provide alternatives to upland farmers who only have slopes steeper than 55%, and are cultivating corn and other annual crops primarily for home consumption rather than as a cash crop. Its benefits are equally applicable to other farmers

1.2 Rationale

To secure a harvest of corn in the uplands requires six or seven operations per harvest using 40-60 man-days work: land clearing, one to two ploughings, a harrowing, planting, fertiliser application (sometimes), weeding, and harvesting. With only one furrow covered per operation, the distance walked per hectare is 13.333 km per operation– or a minimum of 80 km travelled per harvest! Two ploughings to just 15 cm depth, loosens and turns over more than 4,000 tons of soil. Erosion on sloping land causes soil losses of 360 - 1,000+ tons/ha/yr, equivalent to a reduction in soil depth of 3-10 cm per year. This decreases corn yields still further and damages the potential of the land to plant tree crops, which need deep soils to store the sufficient moisture to survive during extended periods without rain.

Upland households consume 600-1,000 kg shelled corn a year. Yet farmers cultivating corn on upland slopes often manage to produce only 400 kg shelled corn. Despite the enormous effort involved, the net result is a shortfall of over 200 kg of corn, and high soil losses through erosion. The extra corn has to be purchased at P16 to P18/kg. The value of the shortfall ranges from P2,000 (for a bachelor farmer) to P9,600 for larger families – with the average about P3,600. As a result they have to seek off-farm work to buy the balance needed. At P80-100/day this can amount to an average of 36-45 days work. This implies that 76-105 days are spent just to produce food to feed the family, without any generating any income. Higher monthly food requirements cost even more labour (see Case Study on page 5).

With such inefficient use of manpower, it is obvious why there is widespread poverty in the uplands. Spending less time on household food production means off-farm income can be used to improve the family welfare. Many upland farmers have discovered that planting fruit trees and bananas frees them to earn cash elsewhere, and they can buy their household staples and pay for other services things with the income from selling fruits.

1.3 Strategies

When land is too steep to meet STOP 1 specifications, extension workers should:

- Recommend planting bananas and fruit tree seeds followed by field-grafting of scions.
- See if multi-storey tree cropping and/or mushroom culture is possible near the house.
- Identify small areas of flat to gentle slopes, covering 600 to 1,200 m^2; and give assistance to set up *Corn Patches* and *Vegetable Gardens on Permanent Raised Beds*.
- Properly demonstrate the effectiveness of seed-fertiliser technology packages. If farmers see that a modest investment in inorganic fertilisers can secure their subsistence food requirements, they are more likely to apply the considerable savings in time and labour to managing more profitable perennial crops and earning off-farm income.

2. THE CORN PATCH - GROWING CORN FOR HOME CONSUMPTION ON SMALL PLOTS

PRINCIPLE

BY USING IMPROVED SEED-CHEMICAL FERTILISER TECHNOLOGIES TO CONCENTRATE THE CULTIVATION OF CORN FOR HOME CONSUMPTION ONTO VERY SMALL AREAS BETTER SOILS, MARGINAL LAND ON STEEP SLOPES AND ACID SOILS CAN BE PLANTED WITH TREE CROPS OR LEFT UNDER FORESTS.

2.1 Improved seed-fertiliser packages

Improved varieties of corn have been developed to give high yields when combined with inorganic fertilizers. The yields to be derived from applying the recommended basal dressing and side-dressings of fertilizer need demonstrating over two seasons to show that the family needs for corn can be obtained from very small areas with correspondingly less effort (Fig 1).

2.2 Identifying areas suitable for the Corn Patch

One or two blocks of land covering a total of 600 m^2 (e.g. 30 m x 20 m) are needed. The crests of hills and gently sloping land protected with properly contoured and spaced hedgerows or other cross-slope barriers are ideal. If these land units don't occur on the main block of land small blocks can usually be found in the vicinity of the farmer's homestead, among coconut trees on flat land.

2.3 Inputs and expected outputs from the Corn Patch

- A requirement of 50 kg of shelled corn a month for food = 600 kg per year.
- Average yields of hybrid corn (GSI47) on loam soil = 5,280 kg/ha which translates into a harvest of almost 700 kg from 1,200 m^2, (or use open pollinated HYVs).
- Table 1 shows the inputs required to harvest 600 kg corn. Note the low amount of labour involved. An outlay of about P1,800 gives P10,800 worth of corn (@ P18/kg) if the farmer has to buy it for food. 1 kg of fertiliser gives 12-13 kg more corn.
- Table 2 shows the inputs needed to get 300 kg corn from 600 m^2 in one season. 5-6 days of off-farm work each season will provide the funds to buy the inorganic fertiliser needed to grow half the family's food supply.

Table 1. Inputs and outputs to produce corn for home consumption (purchase price of P18/kg)

Inputs	Per hectare	Per 1,200 sq m	Cost/ 1,200 sq m
Seed corn	18 kg	2.16 kg	P205
Average yield	5,280 kg	698	
Fertiliser			
Complete	200 kg	24 kg	P432
Urea	200 kg	24 kg	P432
Labour	60 man days	7.2	P720
TOTAL COST			**P1,789**
Average yield	5,280 kg	600 kg	**Value = P10,800**

Table 2. Inputs and outputs for 600 sq m per season

Inputs	Per 600 sq m	Cost/ 600 sq m
Seed corn	1.08 kg	P103
Average yield	349	
Fertiliser		
Complete	12 kg	P216
Urea	12 kg	P216
Labour	3.6	P360
TOTAL COST		**P895**
Average yield	300 kg	**Value = P5,400**

Including time spent to get cash to buy the fertiliser, the total mandays per year to secure the family's subsistence food supply is reduced to about 20 days (down from 75-105 days) freeing 55-85 days for more productive uses

2.4 Demonstrating the corn patch

The extension technician must personally deliver the seeds and fertilizers at the relevant stages to ensure the inputs are not misplaced, or sold, and *must be present* at*:*

- planting to ensure the farmer plants the seeds of improved corn at the recommended spacing; and
- at the application of the top dressings and side dressings of fertilizer to ensure the correct amounts are placed. Reducing the recommended amounts will lower yields.

2.5 Proposed planting schedule

The block shown below represents a 1.2 ha farm with 1,200 m^2 of flat land (10%) allocated for corn production for home consumption. The rest is given over to bananas and other fruit trees.

A (600 m^2)
B (600 m^2)

By rotating the positions of the crops from season to season, and ploughing in the crop residues it should be possible to maintain soil fertility and high corn yields. The sale of beans grown on the adjacent plot may be used to offset the cost of the fertilizer.

Season 1	Plant area A (600m^2) with *corn* and area B with *beans*
Season 2	Plant area A (600m^2) with *beans* and area B with *corn*
Season 3	Plant area A (600m^2) with *corn* and area B with *beans*

However, once the bananas and fruit trees start bearing fruit, the farmer may find that he can increase his income still further by converting the corn patch to bananas and buying corn for his family to eat – as farmers have discovered elsewhere in Southern Mindanao.

Figure 1 The farmer on the left, with a large corn field on a steep slope, wonders how his neighbour is able to grow enough corn for consumption and still have time to grow bananas, fruit trees and vegetables to earn cash. The answer is by having a Corn Patch!

2.6 Comparing traditional corn production with the Corn Patch

Scenario 1

Traditional cultivation of corn (based on field data from Davao Oriental)

- Farmer needs 800 kg corn a year for home consumption.
- Currently plants 7,500 m^2 of flat land each season with native corn.
- Each harvest takes 54 md labour @ P80/day, and 18 carabao days @ P 100/day.
- Total cost for two seasons = 108 md or P8,640 plus P1,800 for carabao hire. Cost of corn production = P10,440
- Harvesting 300 kg shelled corn per harvest, or 600 kg a year, leaves a shortfall of 200 kg which he has to buy at P18/kg (P3,600), requiring 45 days work off- farm.
- Total outputs for 800 kg corn = P14,040 equivalent to 780 kg of corn.
- Net savings from growing corn by traditional means = 20 kg of corn (or P360).

RESULT: 153 man-days were spent just to get enough corn for home consumption.

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Scenario 2

What can happen if the farmer grows high yielding variety (HYV) of corn in a Corn Patch

- To get 400 kg corn a season he only needs to plant 800 m^2 of land with 1.5 kg HYV of corn, and apply 16 kg complete fertiliser as a basal dressing and 16 kg urea as a side-dressing.
- Labour costs: 6 man-days and 2 carabao per season = P680 or only 12 man-days a year
- Total cost for two seasons = P 1,360 labour + P2,650 seed-fertiliser package = P4,010
- BUT if the 6,700 m^2 of land no longer used for corn production are planted with 670 cardava banana suckers, to produce 20 kg bananas per hill @ P2/kg, then his income goes up by P26,800
- The 141 days of labour saved can be used to earn an off-farm income of P11,280.

RESULT: Only 12 days spent on corn production while freed land and time used to earn income of P38,080 to pay for fertiliser and improve family welfare, pay school fees, etc.

2.7 Environmental aspects

Concerns about the danger of ecological damage arising from using chemical fertilisers in the uplands should take into account the following:

- It has been pointed out that: “hardly anything is as destructive in terms of maintaining a balanced environment as the expansion of impoverished smallholder farming producing unfertilised arable crops on depleted soils in a tropical setting. Destruction of forests, eradication of wildlife, and serious soil erosion, are the accompanying phenomena”.
- The very small amounts of chemical fertilisers (<50 kg) used to restrict the production of annual crops to small plots (<0.1 ha) has to be offset against the loss of hundreds of tons of soil per hectare each year from current practices.
- Over-use by upland farmers is unlikely as inorganic fertilizers are expensive. The problem is to ensure that farmers apply the specified amounts to gain the full benefits of increased yields, as applying small amounts of fertiliser per hill are relatively ineffective.[1]

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[1] H Ruthenberg (1983): *Farming Systems in the Tropics*. OUP (page 363).

VEGETABLE GARDENING IN PERMANENT RAISED BEDS

PRINCIPLE

GARDENING HAS BEEN THE TRADITIONAL SOLUTION TO THE PROBLEMS FACING PERMANENT CULTIVATION IN THE UPLANDS THROUGHOUT THE HUMID TROPICS [2]. BY APPLYING INTENSIVE GARDENING TECHNIQUES, VEGETABLES CAN BE CULTIVATED SUCCESSFULLY IN UPLAND SITES EVEN ON POORLY DRAINED INFERTILE SOILS DESPITE INTENSE SUNLIGHT AND HEAVY UNRELIABLE RAINFALL

3.1 Raised bed vegetable gardening

As the name implies, the level of the soil in raised beds is higher than the surrounding soil. Upland farmers currently use *temporary beds* formed from ridges of soil, but these need to be built up every season because the impact of rain and cultivation flattens them out. The soil on and between the beds is frequently compacted by the farmer walking between the rows to tend to the crops. Standing water causes localized water-logging which lowers yields.

Permanent raised beds are surrounded by a framework or border, such as boards or bricks. This contains the soil and maintains the shape of the beds from season to season. As such they are ideal for a number of situations:

- On sloping ground and hillsides, where erosion can be controlled by a combination of terraces and permanent beds.
- On soils with a high clay content and tendency to become water-logged. Raising the height of the soil allows the surplus water to drain out of the soil.
- On subsoil or hard pans where root penetration is difficult. As most vegetable crops obtain most of their water and nutrients from the top 30 cm of soil, constructing raised beds can be used to artificially increase soil depth.

3.2 Advantages of gardening on Permanent Raised Beds

Because of the following advantages, properly managed raised garden beds can produce 1.4 to 2 times more vegetables per square metre than ordinary beds.

a) ***Soil compaction avoided***
Soil compaction can reduce crop yields up to 50 percent as it affects the movement of water, air and roots through the soil. Because there is no need to walk on a raised bed, the absence of compaction improves oxygen availability for plant roots.

b) ***Waterlogging prevented***
Sites liable to ponding can be made productive by raising the beds to prevent water-logging, which affects plant development by depriving roots of oxygen. This is an important factor when growing vegetables in minor valleys where clay soils may become saturated with run-off from adjacent slopes. Permanent raised beds can be planted during periods of heavy rainfall, whereas temporary beds need good weather for bed formation.

c) ***Soil depths increased***
Raised beds provide sufficient depth of soil for most vegetables. They are therefore very useful in areas where soils have become shallow due to erosion or other factors.

d) ***Soil conditions improved***
Raised beds enable the farmer to change the soil texture to suit the type of vegetable he wants to grow in a bed, e.g. by adding more sand or clay soil, or mixing in more organic matter. Small amounts of lime can reduce soil acidity and maintain it in the 5.8 to 6.8

[2] Garden cropping is distinguished by (1) production of small amounts of produce from a great number of different food crops: (2) small plots; (3) proximity to the house; (4) fencing; (5) mixed or dense planting of a great number of annual, biennial and perennial crops; (6) a high intensity of land use; (7) land cultivation several times a year; (8) permanence of cultivation; and (9) cultivation with hand implements.

pH range preferred by vegetables. Covering the beds with plastic mulch gives some control over soil moisture content. A small site can therefore have beds with different soil types to suit the range of vegetables to be grown.

e) ***Yields increased***
Plants can be spaced far enough apart to avoid crowding but close enough to shade out weeds. Higher densities are possible over a 1.0 m-wide bed than when the crop is planted in single rows separated by furrows. Good management may yield between 3-6 kg vegetables per square metre.

f) ***Inputs more efficiently used***
Expensive fertilisers, scarce manures and the limited supplies of compost, mulch, and water can be applied more efficiently as they are only spread on the cultivated beds.

3.3 Site Selection

Raised beds can be used on a wide range of soils because they have good drainage.

- Sandy loam soils are ideal for raised beds as they not likely to get waterlogged.
- The water-holding capacity of sandy soils can be increased by adding compost.
- The texture of heavy clay soils can be altered by adding sand and organic matter.
- On shallow soils where subsoil or hard pans prevent root penetration, raised bed constructed to a height of 30cm provide sufficient depth for most vegetable crops to extract their water and nutrients.

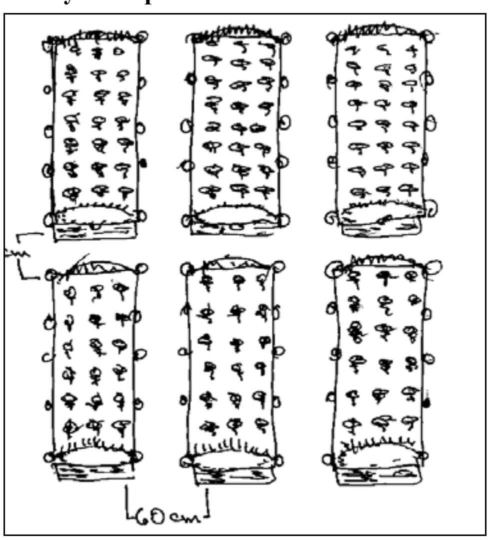
3.4 Bed Layout

a) Bed orientation

Plan the layout of the vegetable garden carefully. Beds constructed side-by-side and parallel to each other are easier to build, maintain and irrigate (see Figure 2). If space allows, beds for different vegetables should be aligned to the sun as follows:

- Align beds for tall crops requiring trellises (tomatoes, long beans, peas etc) in an East-West direction to get the optimum amount of light.
- Plant lower-growing crops on the south side of the beds so that the taller crops don't block the sun and align them in a North-South direction to allow direct sunlight to strike both sides of the beds.

Figure 2 Layout of permanent raised beds



b) Bed dimensions

The wider the bed, the lower the construction cost per square metre. Wider beds make better use of space as fewer pathways are needed. This can be important when the area of land suitable for vegetable gardening is limited.

i) **Bed width**
A bed width one metre (100 cm), but not more than 1.2 metres, reduces the need to step on the beds during crop management, and avoids compacting the soil.

ii) **Bed length**
A bed 1 m wide x 10 m long provides 9 sq m of usable space. Leave 0.6 m (60 cm) as a walkway between beds, makes for easy movement between beds. Mulch the spaces between the beds or cover them with slabs of carabao grass turf or stones to prevent them becoming muddy and slippery when wet.

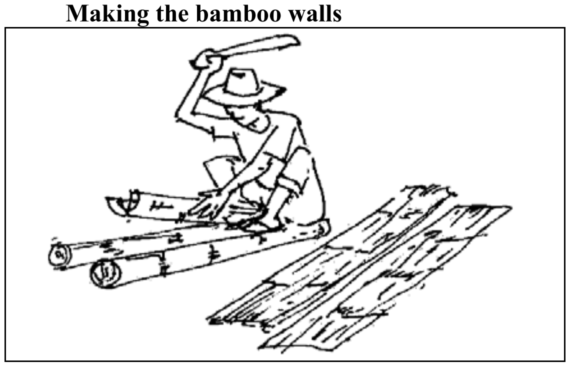
Warning: Beds higher than 45 cm constructed of flexible materials as such galvanized iron sheets or flattened bamboo sheets will extra require support posts as they lack rigidity.

3.5 Preparing a permanent raised bed

a) Making the walls

- Cut open a 10-cm diameter bamboo pole along its length and flatten it to form a bamboo strip (*san-san* or *tad-tad*) (See Figure 3).
- Repeat the process until there are enough pieces of *san-san* or *tad-tad* to make 22 metres of 30-cm high fence. (A 10-cm diameter pole gives a 30-cm wide strip).

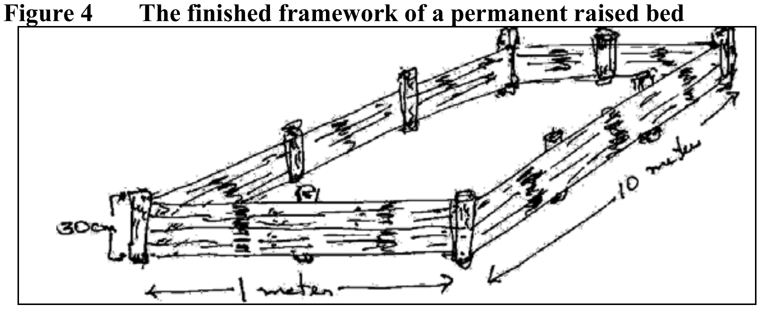
Figure 3 Making the bamboo walls



b) Setting the borders for the Permanent Raised Bed

- Decide on the orientation of the various beds based on para. 3.4 above.
- Measure out a 10 x 1 metre oblong on the ground.
- Hammer in stout 60-cm long pegs into the ground at each corner leaving 35 cm above the ground.
- Add additional pegs as needed between the four corner pegs, keeping them in straight lines between the corner pegs.
- Securely attach the flattened bamboo wall panels to the pegs.
- Prepare the soil (see 3.5 (c) below) and fill the framework to a depth of 35 cms.

Figure 4 The finished framework of a permanent raised bed



c) Soil Preparation

Raised beds can be used on a wide range of soils because they have good drainage. Sandy loam soils are the best for raised beds as they are less susceptible to waterlogging.

- A clay loam soil can be produced by mixing one part of heavy clay soil with one part compost or peat soil and one part coarse sand.
- For sandy soils, add more compost to increase the soil's water-holding capacity.
- Avoid working the soil when it is wet as this can damage the soil structure.
- Dig and loosen the soil as deep as possible.
- Mixing in a small amount of soil used to fill the bed with the existing soil avoids problems that arise from having layers of soil of different textures.
- Apply 0.5 kg of Complete fertilizer to each 1 x 10 metre bed.

Dangers of using composted manures.
Manure is high in soluble salts, which act to inhibit water uptake by plants, causing wilting and even foliar burn in extreme cases. Thoroughly water the soil mix to leach excess salts. A good soaking rain will do. This practice is especially important if plastic mulch is to be used as the beds become "leach-proof" once the plastic mulch is applied.

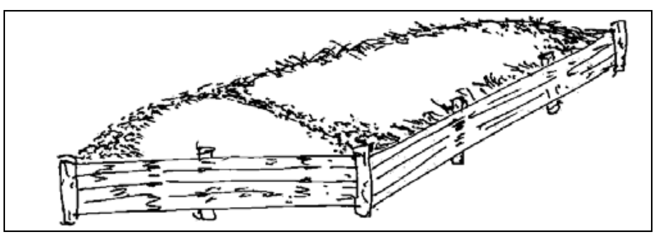
3.6 Preparing a crowned bed

A crowned bed has the center of the bed about 15 cm higher than the edges, to shed surplus water during heavy rain (see Figure 5).

To prepare a crowned bed:

- Drag soil towards the middle of the beds to form a ridge or crown along the length of the bed.
- Reduce the height of the crown by pushing the soil back towards the edges to form a uniformly curved surface 10-15 cm higher in the middle than at the edges.
- Wet the beds thoroughly to compress the soil surface. Several applications may be needed if the soil surface has previously dried out reducing the infiltration. The soil is sufficiently compacted if it resists forming a depression when an open hand is pressed down on the surface.
- Cover the surface with a 10 cm deep layer of mulch using either cut grass or leaves of *Flemingia*, *Rinsonii* etc.

Figure 5 A crowned permanent raised bed



3.7 Further actions to improve the site for permanent raised beds

The following actions may be needed to improve the site of the raised beds:

a) Divert run-off away from the site
Divert run-off water away from the beds with ditches (e.g. in minor valleys).
Action: If possible dig a large storage pond to water the vegetables during dry periods and stock it with fish.

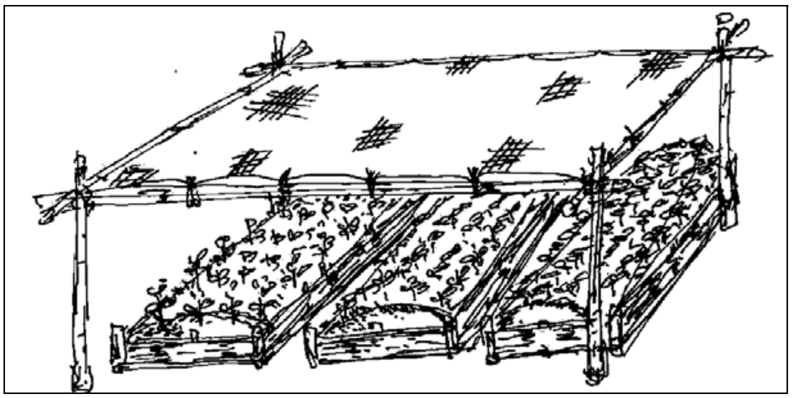
b) Avoid shade
Trees compete with the vegetable garden for nutrients and water as well as sunlight.
Action: Locate permanent beds away from trees on sites that receive at least half a day of full sun.

c) Reduce windspeeds
Hot, dry winds increase water use by plants and may dry out foliage.
Action: Plant a windbreak of shrubs to lower wind speeds and reduce plant stress. This can lead to earlier and increased yields.

d) Provide supplementary water
Due to the extra height above the ground, raised beds tend to dry out more quickly. Provide supplementary watering or, if not available, mulch the beds well to minimise evaporation of moisture from the soil surface.
Action: Locate the garden near a water source and/or mulch the beds.

e) Break up raindrop impact on flowers
Large raindrops typical of tropical storms can damage, and even break off, the flowers of some high value vegetable crops such as tomatoes.
Action: Erect a bamboo frame over the particular beds and cover it with sheets of plastic mosquito screening. This converts raindrops into a fine spray and protects the flowers**.**

Figure 6 Using mosquito screening to break up raindrop impact



3.8 Environmental issues

There are a number of problems associated with promoting organic farming in the acidic, inherently infertile soils of the uplands in the humid tropics:

- Fertilisers can be replaced by manures and composts in exceptional cases only. There are just not enough nutrients in the available organic matter to sustain a vigorous crop vegetation. For example, 10 tons of Ipil ipil cuttings are needed to apply the equivalent of 100 kg of nitrogen to the crop. This amount of material is simply not available to the average farmer.
- The very few economically viable systems of permanent upland farming that exist are found on very fertile alluvial or volcanic soils.
- Organic fertilizers are low quality fertilizers but, by improving soil structure and soil water-holding capacity, make applications of inorganic fertilizer more effective on sandy soils.
- Upland farmers need familiarizing with the circumstances when composts and manures, inorganic fertilizers or combinations of the two can be applied most beneficially. In particular, they should realize that to be effective on the mainly inherently infertile upland soils, between 12-30 t/ha/yr of organic fertilizers are needed (i.e. 1.2 – 3.0 kg/m^2/yr).
- Scarce amounts of manures and composts should be reserved for the intensive cultivation of vegetables on raised beds, in combination with inorganic fertilisers.

Finally, there is no pricing structure to pay upland farmers higher prices to compensate for the additional work used to produce organically grown fruits and vegetables.