

A TRAINING ON AGROFORESTRY PRACTICES THAT PPROMOTE SOIL PRODUCTIVITY AND CONSERVATION

This training guide is prepared by
**Cameroon Gender and Environment Watch
(CAMGEW)**

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This training is more practical with trainees learning-by-doing. This guide is prepared to give additional knowledge to trained persons on organic vegetable cultivation practices for the sustainable management of their farms.

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SECTION I:

INTRODUCTION

Cameroon Gender and Environment Watch (CAMGEW)

CAMGEW is a not-for-profit organization created in October 2007 with authorization number N° 000998/RDA/JO6/BAPP to look for a solution to environmental and women's issues in Cameroon. CAMGEW works locally and thinks globally, integrating gender in solving environmental problems in Cameroon. CAMGEW from 2012 to 2017 planted 64000 bee loving trees in the Kilum-Ijim forest and trained 818 bee farmers in honey production and bees wax extraction. She has also distributed more than 695 beehives to trained bee farmers. She has organized more than 1000 bee farmers into 5 Oku White Honey cooperatives located around Kilum-Ijim forest. 572 farmers have been trained on agroforestry techniques. As of December 2017 about 987 women have been trained on business skills and 907 women received financial assistance in form of loans. 24 teenage boys and girls have been trained on dress making, shoe making and hair dressing. CAMGEW has also developed 3 tree nurseries with more than 150.000 trees. CAMGEW believes that the future of our mother planet-earth is in the hands of men and women, young and old and also that this planet can be sustained by putting social and environmental justice at the centre of development

WHY AGROFORESTRY TRAINING FOR MBORORO WOMEN

Despite the fact that mbororo women and their families have access to organic manure for farming they are still face with problems of erosion caused by wind and water. They still need fuel wood, fodder for their animals, fruits, medicinal plants, shade trees for crops and animals, other crops to balance their diet and sale to make money. CAMGEW has seen the need to do training on agroforestry to enable women tackle these challenges and also fight against poverty and unemployment. Mbororo women are a treasure to our nation and need to contribute in nation building. CAMGEW has identified their potentials as follows

AGROFORESTRY AND ITS LINK TO CROP CULTIVATION

Agroforestry is a collective name for land use systems that combine trees with crops and/or animals on the same unit of land. From the name “agroforestry” one could think of agriculture and forestry. In another sense, we could think of how a natural forest can be transferred to the farms to enable farmers avoid soil erosion, get firewood, green manure, shade, wind breaks and variety of products from farms like it is done in the forest.

Agroforestry creates farm micro-climate (humidity, sun intensity and wind) thereby helping farmers to get high farm yields. farms need agroforestry systems to conserve soil nutrients and avoid water and soil losses. This could be done by creating various tree canopies in farms like it is found in a natural forest to enable crops benefit from shade, soil conservation and micro-climate necessary for healthy growth. farmers can plant various appropriate tree canopies of benefit to them and this will improve lives of farmers. Water and soil are two of the most important resources for farmers around the world. The soil and water of any community must be conserved for the present and future generations. Soil nutrients are tampered with by erosion in farms and this reduces fertility. Farms with no shade and mulching promote evapo-transpiration leaving farms dry.

Agroforestry systems come to integrate trees, crops, people, and/or animals on the same piece of land in order to get higher productivity, greater economic returns, and more social benefits on a sustained basis. This can be done by planting appropriate trees and crops together with in the same field. By planting the correct trees and shrubs on their farms, farmers can improve the quality of their farmlands, develop organic fertilizer to conserve soil, increase income generating opportunities and establish sustainable supplies of high-protein animal forage, food, fuel, medicines and building materials. Not only does agroforestry provide useful and marketable products, it diversifies the timing of production so that farmers do not receive their entire year’s income at one time only from one crop. It can improve the yields of agricultural systems, while also diversifying the products from the system. Animals are confined and fed with fodder harvested from farms. Ultimately, the use of agroforestry leads to food security, soil and water conservation, and long term sustainable agriculture. Agroforestry system fulfills economic, social, and cultural needs of the individual owners and provides biological conservation, carbon sequestration, and other valuable benefits to society.

Agroforestry systems can be categorized as follows:

- Structural basis:** referring to vertical stratification or tree canopy layering.
- Functional basis:** referring to the major function or role of the system like windbreaks, shade provision, soil conservation, etc
- Socio-economic basis:** referring to either management for subsistence, commercial or intermediate. This will determine management inputs, scale and intensity.
- Ecological basis:** referring to soil conservation practices for sustainable management practices to improved organic matter of the soil and nutrient cycling

SECTION II

AGROFORESTRY TECHNIQUES FOR CULTIVATION

A) WINDBREAK

Windbreaks are one of many agroforestry technologies that increase overall productivity of land and environmental quality. Windbreaks incorporate many useful multipurpose species and management practices that will return additional income to the producer. Windbreaks slow the wind at low level and divert the force of the wind to higher altitudes. Farmers plant windbreaks for four main reasons:

- ♣ To minimize damage to crops,
- ♣ To protect plant flowers from wind (because fruits develop from the flowers, production can be increased by protecting flowers from heavy winds),
- ♣ To minimize soil erosion by wind and
- ♣ To minimize the amount of moisture the winds evaporate from soils.

The species composition of trees and shrubs used in windbreaks vary greatly, but the basic design of windbreaks stays the same. There tends to be a time of the year, often during the dry season, when strong winds cause the most damage. It is those strongest winds which must be addressed first. Windbreaks should be planted perpendicular to the wind. It may be necessary to plant windbreaks on multiple sides of fields because the wind often changes direction during the year. Communities can work together, analyze their farmlands, and identify major areas where massive windbreaks can be established to benefit the entire community, OR individual farmers and families can create smaller windbreaks on their own individual plots. Desirable characteristics of windbreak species includes: ability to withstand strong winds, deep spreading root system to add stability to the windbreak by making the trees less susceptible to wind.

B) LIVING FENCES

A living fence is an animal-proof barrier composed of trees and shrubs planted at close spacing around the perimeter of the farm. Not only do living fences reduce the need (and cost) for standard fencing, but the trees and shrubs utilized in living fences can produce tangible benefits such as food, fuel wood, fodder, and other raw materials. Families who normally pay others to build fences see a major savings in never having to pay anyone to construct or fix their fence - but this is not to say that maintaining a living fence is not labor intensive. Farmers face the greatest difficulties during the first few years when establishing a new living fence. Replanting is often necessary to fill in gaps where the previous year's seedlings did not survive. Farmers must also be sure to begin pruning the trees when the seedlings are in the nursery, and there is always pruning work to be done to maintain the fence. However, once the living fence is established, farmers can develop their field inside the safety and security offered by the permanent protection, and they can utilize the many products from their living fence.

Desirable characteristics of trees used in living fences:

- **Tolerate minor "injuries":** living fences are susceptible to frequent injuries from pruning or animals and should tolerate them well.
- **Fast growing:** provide benefits to families as soon as possible.
- **Compatible with crops:** cannot have adverse effects on other tree species or crops they are associated with.
- Produce useful products like fodder, green manure, & fuel wood
- Protection- stiff branches, thorns, spines, nettles, or irritating latex to keep animals out.
- **Vegetative propagation:** ensures fast establishment while reducing the chance of spreading to pasture and cultivated areas.

C) ALLEY CROPPING

Alley cropping is the planting of strips of 'green manure' trees among crops. These green manure trees serve the vital role of producing nitrogen-rich organic matter (mainly in the small, easily degradable leaves) which is harvested and mixed into the soil, ultimately increasing soil fertility. Despite the fact that the rows of trees reduce space for planting, experience shows that because of the increased soil fertility and crop production has increased. For example, a field of intercropped with leucaena and Calliandra trees will produce massive quantities of , fuel wood, organic fertilizer and high-protein animal forage, all at different times of the year.

Design: Spacing among the rows of trees and among the trees themselves is highly variable. One of the major considerations is that the rows should run east to west - following the path of the sun to ensure that there is not too much shading among rows. Spacing between rows ranges from 4 to 20 meters, depending on the farmer's preferences.

Harvesting: The rows of trees are often harvested at 50 cm to 1 meter height. Branches are used for construction and fuel wood, and leaves are mixed into the soil as an organic fertilizer, though leaves of some species like leucaena are also collected and used as high protein animal forage (after which the manure can be added back to the soil).

Overview: One of the most promising agroforestry technologies in the humid and sub humid tropics is alley cropping. Alley cropping is a system of growing food crops between parallel hedgerows of (usually leguminous) shrubs and trees. The hedges are pruned periodically during the growing season to provide biomass and to prevent shading of the growing crops.

Many farmers in developing countries do not have access to commercial fertilizer. Even if they did, they do not have the money to buy it. In equatorial regions, the rows of trees should be planted in the east-to-west direction, NOT north-to-south. By planting the rows east-to-west, the sun is able to shine inside all the rows of the field. If the rows are planted perpendicular to the path of the sun, then the crops will not receive enough sunlight. The species of trees planted should be able to coppice (resprout and grow well after cuttings).

Throughout the growing season, on a rotational system of 3-4 weeks, the branches, branchlets and leaves of these trees are cut and dropped around the crops growing between the tree rows. They quickly degrade, adding large amounts of organic matter & nutrients to the soil. On degraded soils, this brings important and sustainable increases in harvests (Agus et al., 1999). Moreover, this is sustainable - it continues to increase harvests year after year. In many instances, once the growing season is ending and the dry season is about to begin, the trees are

allowed to grow tall, since there is now no problem of shading out the crops. By the beginning of the next rainy season, the trees may be 3-4 meters tall and should be cut back. The wood can be used for fuelwood or construction, and the leaves should be plowed back into the land as "green manure".

D) TERRACES & CONTOUR PLANTINGS

Contour planting is an agroforestry technology that can minimize soil erosion on hillsides by up to 50%. Contour lines refer to a set of points on a hillside that are all at the same altitude. Contour plantings are vegetative strips that follow contour lines. They minimize hillside erosion by creating living terraces that encourage the infiltration of rainwater into the soil while slowing the speed of water washing down the hillside. As more upland soils erode and degrade, and the demand for food crops increases, farmers are forced onto more marginal lands, including very steep hillsides. It is common to see a farmer planting his crops up and down a steep hillside throughout much of the world, even though it is obvious to everyone that the bare soils on those hillsides are eroding away, creating deep gullies. Farmers who want to sustainably work these lands therefore construct terraces, often comprised of stones from the field. The eroding soil backs up behind them and, over time, these terraces become flat, looking like a series of giant steps down the hillside. The problem is maintaining these terraces in times of heavy rain. In the tropics, it can rain as much as 250 cm in a single night, and with the increasing numbers of hurricanes and cyclons, the potential for damage is enormous. Heavy rains can cause a large area of soil to break loose above or within stone walls, eventually stressing or crashing into the next terrace and continuing the chain reaction to the bottom of the hill. And so the "living terrace" was developed. Here, a double row of trees, similar to some alley cropping arrangements, is planted on the contours of the hillside.

As the land is worked, stones, weeds, and other debris are continually thrown behind the rows of trees, forming a wall that helps catch the eroding topsoil. Many of these terraces have tall grass, such as vetiver or napier, which are planted in combination with the trees. This further strengthens the terrace and can be continuously harvested as fodder for livestock, as organic matter to be added to the soils, and for other purposes. In this way, there can be a stone terrace, backed by trees and tall grasses, strengthened by hundreds of thousands of tree roots. In areas of heavy rain, soil build-up behind these terraces is as much as 30 cm (1 foot) per year - rich topsoil that would otherwise have been washed away. The terrace is also providing a steady supply of organic fertilizer and humus from the leaves of the trees, as well as forage for animals, and a sustainable supply of firewood that can be used or sold. The greatest benefit is often the creation of a sustainable supply of water that is guided and captured into the ground during the rainy season and made available during the dry season.

E) FIREBREAKS

Firebreaks are necessary in the dry season to prevent fires from getting into farms. Many farms are surrounded by bushes or dry vegetation in the dry season and it is always difficult to clear all this vegetation surrounding the farms. It becomes more complicated when the surrounding land to the farms are owned by different persons. In order to prevent bushfires from entering our farms, firebreaks must be made.

Bushfires is always caused by cigarette smokers, poor honey harvesting or carelessness from farmers cultivating around our farms who set fire to burn vegetation in their farms.

There are two ways to make firebreaks. One way is through clearing a path that separate our farms from nearby bushes or vegetation. The path cleared should be clean with no vegetation on it and could be above 3 m wide. Firebreaks could be created by planting thick evergreen vegetation at the borders of the farm that will prevent fire resulting from nearby land to enter the farms.

F) THE FOREST GARDEN

A forest garden is a sustainable agroforestry system that fulfills economic, social, and cultural needs of the individual owners and provides biological conservation, carbon sequestration, and other valuable benefits to society (Kumar and Nair, 2004; Hairiah, 1997; Torquebiau, 1992). Agroforestry requires farmers to think both horizontally and vertically, and a forest garden is a perfect example of this. A forest garden goes by many names including permaculture, stacked polyculture, analog forestry and 'the perfect acre.' This system gives the farmer products at different levels and time. There is no specific design or methodology for a forest garden, just a set of desirable characteristics and zones.

Major Characteristics of a forest garden

It allows people to sustainably meet their needs and produce a marketable surplus, by making maximum use of the land

- It incorporates the symbiotic relationships among plants, animals and microbes
- It avoids the risk of economic dependence on one, or a very few, crops
- It provides a continuing supply of food and other crops
- It allows nature to provide organic fertilizers and pest controls
- Properly managed, it produces fruits and vegetables of far higher quality than those produced through monocultures

With their ecological similarities to natural forest ecosystems, forest gardens act as insurance against pests and disease outbreaks. They also act as a buffer against deforestation of natural forests by providing an alternative source for goods and services that people would otherwise collect from natural forests. The multi-storied canopy structure is one of the most distinguishing features of forest gardens, especially in humid tropics (Kumar and Nair, 2004). About ten zones are distinguished in a typical forest garden.

Major Zones

Zone 1: The planting of "pioneer" or "fertilizer" trees that are initially planted to protect and support a forest garden like *Leucaena*, *Calliandra*, *Sesbania*, *Cassia*, *Acacia sp.* etc.

Zone 2: Ground crops that grow well in lower temperatures, higher humidity and partial shade. Examples include eggplant, wing beans, pepper, tomato, pineapple, etc.

Zone 3: Root crops that benefit from being planted close to the roots of the pioneer trees like ginger, yams, carrots, etc.

Zone 4: Vine/climbing crops. The trunks of the pioneer trees offer an ideal way to construct trellises for overhead crops such as passion fruits, pumpkin, water melon, etc

Zone 5: Various fruit and nut trees: shade-grown, bananas, papaya, guavas, citrus, & cacao.

Zone 6: Hardwoods for long-term investment like *Prunus africana*, Mahogany.

Zone 7: "Mini" livestock and poultry. Fodder from the garden can permit poultry and livestock (pigs, goats, cows, sheep, chickens, ducks, etc) rearing.

Zone 8: Marketable traditional medicinal plants grown in farms.

Zone 9: The production of biofuels, whether in shade-grown *jatropha*, coconut trees, or any other oil-producing plants. Though this is a new technology, such fuels and feedstock are being produced on a limited scale in many villages already.

Zone 10: Carbon credit market for carbon stored in these forests

A forest garden produces edible fruits, nuts, grain, rhizomes and tubers, leaves, and flowers, along with fodder, fuelwood, medicine, and construction materials. Forest gardens are also significant sources of minerals and nutrients contributing to food security of the owner (Wiersum,1997). As a result there is a growing interest in combining a forest garden with nutrition education as a practical strategy for improving household nutritional security for at risk populations, particularly women and children in developing countries. In experimental studies, the target families significantly increased their year-round production and consumption of vitamin rich fruits and vegetables compared to the families without forest gardens. Products from forest gardens usually are not contaminated by synthetic toxic chemicals and they can be more profitable than field crop agriculture due to lower production costs.

SECTION III

AGROFORESTRY SYSTEMS APPLICATION IN FARMS

A) AGROFORESTRY FOR LIVESTOCK MANAGEMENT

Agroforestry practices mainly concerned with the management of trees, forage and livestock for the benefit of man and environment. We have also learn that agroforestry seek to diversify farmers income from various products in the same land while not destroying the environment. In the above mentioned agroforestry techniques like alley cropping, fencing, contour planting, wind breaks and fire breaks the aim is to protect crops like and conserve the soil. Most of the trees used in these agroforestry techniques are good forages for various types of animals like goats, sheep, cattle, rabbits, etc. Grazing can enhance tree growth by controlling grass competition for moisture, nutrients and sunlight.

Considering that livestock rearing can increase farmers income and also considering that allowing animals to move around unconfined can destroy our and other crops, it is therefore important to see how to manage livestock in such a way that forage in our farms can be used in feeding them. This brings us to zero-grazing or cut-and-carry system where animals can be confined in a fence that could be live or death and pasture harvested from our farms to feed them. Leaves of Luecaena, bananas, plantains and Caliantra used in alley cropping are rich in nutrients to feed animals. Elephant grass stem good in contour planting is good animal feed. Leaves of pear trees which are shade trees are good in feeding goats.

Families use walls, thorny branches, poles, or living fences to keep the cows, sheep, or goats enclosed. This protects them from other people, pests, and diseases, and it keeps them from wandering. Because animals are not allowed to graze in open lands, forage must be brought to them. This gives the owner an opportunity to select the very best food for the animals

- Animals could be confined and these leaves and stems harvested to feed them. Confining animals has the following benefits:
- Animals do not waste energy moving around and therefore grow faster
- Animals cannot contract diseases because they do not move from one place to another and even if disease outbreak occurs it will easily be identified and treated early enough
- Animals are not easily attacked by predators because they are in security
- Animal dung can easily be gathered for use as manure in farms
- Time is safe taking care of the animals than when they are astray
- Supplemental feeding like table salt can easily be given to animals to compensate for deficiency in micro-nutrients

Community members can cultivate more crops even in the dry season without fear that stray animals will destroy them. Animal waste as manure in farms: Animal waste (dung, urine and leftovers of forage) gotten from confinements is taken back to the farms to serve as manure to crops. This goes to improve on growth and conserve the soil. Proper livestock management can provide economic returns while creating a sustainable system with many environmental benefits. Animal rearing in confinements can add more income to farmers and diversify income sources thereby reducing economic risk of depending on a single crop for sustenance.

B) COMPOSTING FOR FARM IMPROVEMENT

Compost is a cheap and effective organic method that can be used instead of commercial fertilizers to improve the soil. Composting is a process that transforms organic materials into humus. This in simple terms is the bringing together of organic matter that is moist and allowing it for some time to rotten or biodegrade to ready-made-manure or humus for use in farms. Soil is composed of both organic and inorganic material. Humus is the organic matter component of soil. Many types of organic waste can be decomposed to create a valuable natural fertilizer that enhances the quality of your soil. Proper use of compost improves soil structure, texture and aeration, and increases the soil's water-holding capacity. It loosens clay soils and helps sandy soils retain water. Adding compost improves soil fertility and stimulates healthy root development in . The organic matter provided in compost is further broken down by macro-organisms like earthworms, millipede, centipede, etc and microorganisms like bacteria and fungi in the soil, keeping the soil in a healthy, balanced condition. It is for this reason that it is not a healthy practice to burn farms or use pesticides in farms because they kill even untargeted useful organisms in farms. Adding compost to gardens, nurseries, and crop fields adds natural strength to soil in the form of nutrient-rich organic matter along with plenty of beneficial microorganisms. When organic matter biodegrades, nutrients (Nitrogen, Phosphorous, Potassium, Aluminum, Magnesium, etc) are release to the soil. Adding chemical fertilizers is a short-term fix that actually causes long term problems, while adding compost to soil is a long term solution that causes no problems.

What Goes into Compost?

Proper composting relies on aerobic decomposition, which consists of: 1) carbon and nitrogen rich organic materials, 2) air, and 3) water. Carbon-rich materials are old brown or yellow fibrous vegetation like stalks and dry leaves. Nitrogen-rich material includes green vegetation and fresh manure. You can put nearly any organic waste into compost; just be sure it does not have any pesticides or other chemicals on it. Anything green or brown can be added. Crop residues, weeds, peanut shells, grass clippings, weeds (the high temperatures and decomposition will kill the weed seeds so they are not distributed when you use your compost), tree leaves, animal manure, fruit peels, egg shells, grounds, etc. You should also mix in soil and a little wood ash.

Putting Compost Together

The compost will begin decomposing more quickly if the materials you add are chopped into small pieces. Mix the compost pile regularly to maintain adequate aeration; the decomposition process will need plenty of oxygen or it will begin to smell badly. During rainy seasons, the compost can be arranged in a pile. During dry seasons, it is best to put it in a hole or pit to keep the moisture from evaporating.

The Internal Processes

In the presence of air and water, various kinds of fungi and bacteria feed on organic material and convert them into humus. As this takes place, heat builds up in the pile/pit. Properly made compost will reach 65-70 OC in 2-4 days due to the processes caused by bacteria; then it will cool down. This heat will kill pathogens in the soil and weed seeds. Mix it after a couple of weeks and it will heat up in the interior again. Continue this process. You will know the compost

is ready when it no longer heats up after being aerated. Finished compost is dark brown and earthy smelling.

Things to Avoid in preparing compost manure

- Do not let it get too wet.
- Do not add meat or bones
- Be sure it is mixed and gets enough oxygen.
- Keep the compost out of full sunlight.

C) MANAGING VEGETATION IN FARMS TO INCREASE PRODUCTION

Clearing of weeds in farms: There is need to always clear farms by cutting all grown weeds. The grass cut should be put directly under the stems of (mulching) where it rot gradually releasing (manure) nutrients to the soil. The cut vegetation placed under the stems helps reduce water evaporation from the soil and makes available much water to the crops. The pruned banana, plantain, luecaena, Caliandra, Acacia branches are placed on the floor of farms where they biodegrade and form manure for the farms. Luecaena and Caliandra are rich in nitrogen and good in soil improvement.

Once the branches are dry, they can be used as firewood and this reduces dependency on the natural forest for firewood.

D) REMOVAL OF UNFRIENDLY TREES FROM FARMS

Some trees like Eucalyptus, Pine and Cypress are not good in farms for many reasons. Eucalyptus trees grow rapidly into true trees at a wide range of elevations, soils, and climactic conditions. They sustainably produce fuel wood and timber suitable for many local construction needs, and they produce oil used in some medications and other products, BUT **Eucalyptus trees do not lead themselves to sustainable land management systems**. Many communities are suffering from the long term damage caused by massive eucalyptus plantings. At first, most communities were content with having a tree, which when harvested, grew back as two trees. These became four, and so forth. Throughout each coppicing, the root system, barely under the surface of the soil, continued to widen into fields where farmers once grew crops. Farmers quickly discovered that eucalyptus trees are causing problems with their roots by taking all available water and nutrients from neighboring trees and crops, and also with their leaves, which blanket the ground inhibiting new growth. Eucalyptus trees inhibit the growth of other vegetation. The lack of vegetation beneath these eucalyptus trees leads to soil erosion. Most plants and trees cannot grow in the understory of pine trees because of the blankets' of acidic pine needles exposing soils to erosion, and causing lakes and ground water to disappear with their aggressive roots. Pine trees which are planted throughout much of the world for their valuable timber present a similar problem. Beneath pine trees, you will rarely find a productive understory; you tend to find a blanket of acidic needles that inhibit the growth of everything. The needles are also a great fuel for forest fires. **Pine trees do have their benefits, but like eucalyptus trees, they do not lend themselves to sustainable land management systems**. These trees can leave soils in much worse condition than when they were first planted. Trees for the Future encourage communities to plant multipurpose fast growing (MPFG) trees that

not only produce useful products within a short time, but ALSO encourage the growth of field crops, vegetables, and other vegetation around them.

E) IMPROVEMENT OF SHADE IN FARMS

Shade is very important in farms to have high yields. Shades in farms reduce water loss, reduce wind speed and increase humidity in farms. To keep water, reduce wind speed and increase humidity farms must be stratified in the same way like natural forest. The farms must have very tall trees, tall trees, shrubs, some climbers and under storey which is grass or herbaceous plants. This is the way a natural forest or forest garden occurs. Taking into consideration our knowledge of agroforestry these trees must have diverse uses to , soil, animals and man. These canopies are made of trees or plants with different sunlight, humidity and wind speed needs that decreases to the underneath vegetation.

We can start building our shade in the farms.

Very tall trees: These trees are those that reduce the sunlight intensity, wind and rainfall before it falls on the next tree canopy. These trees should be made of hard wood like black plumbs, pear trees, Mahogany, schefflera, Kolanuts

Tall trees: these trees are those below very tall trees. They include Prunus, Accacia

Fairly tall trees: Caliantra, luecaena,

Shrubs: Plantains, Bananas

Climbers: Passion fruit, Pumpkins, Water melon, Okong-abong,

Herbaceous plants or under storey: Tephrosia, elephant grass stem, huckleberry, bitter leaf,

F) HOUSEHOLD WASTE MANAGEMENT FOR IMPROVED CULTIVATION

Household waste can play a big role to increase crop production. House waste in rural communities like around Oku is made of organic matter like pilings of potatoes, beans, corn, etc and a very little of inorganic waste. Proper waste sorting in households can provide much organic waste that can be taken to farms as manure.

Food leftovers could also be recycled by feeding other animals like pigs and its dung collected and used in farms as manure. All of us can accept that crops around our houses do very well even when no chemical fertilizer is applied and this is because of the continuous dumping of waste on empty spaces around our homes. This is done without knowing but the impact to food production is high.

G) DEVELOPING A NURSERY OF AGROFORESTRY TREES

In order to have a good farm that is ecologically, socially and economically sound with a good agroforestry system, a good nursery for and agroforestry trees must be developed. Improved seeds and collected locally available agroforestry seeds are nursed. A nursery is set with fertile soil that could be a bare root or polythene pot nursery where seeds are nursed directly. In some cases seeds are nursed in bare root nursery and when they germinate they are transferred to polythene pots that are filled with fertile soil.

The nursery needs to be fenced with a dead or life fence to prevent animal encroachment and must have a water source close to it to enable watering. Weeding must be done regularly to prevent competition between nursed seeds and weeds. There are some agroforestry seeds that can only be

nursery directly in farms because they cannot be transplanted. Compost manure could be prepared to use in bare root nursery and fill polythene pots. In the dry season a nursery must have shade to reduce the amount of sunlight getting into the nursery and must be watered regularly depending on the intensity of the sun and type of soil. Material needed for the nursery development include: wheelbarrow, spade, cutlasses, raincoats, rainboots, watering cans, buckets, dig axe, polythene pots, record keeping book, etc

H) CONTROLLING WATER RUNOFF IN FARMS

Water runoffs occur after rainfall and must be properly managed to prevent soil erosion in farms. To manage water erosion through runoffs in farms, we must do terracing and contour planting where necessary in farms. Some farms are on hills and are open to water soil erosion more than farm on flat land. Beds must be developed perpendicular to water runoffs and terracing done with contour planting. Trees and grass like elephant grass can be used to halt water runoffs and permit infiltration to the soil.

Water runoffs should be control when it is still outside of the farm than when it gets into the farms for prevention is better than cure. Contour development with stones, huge beds, planted trees or grass at the border of the farm from the topper part of the farm can prevent runoffs from getting into farms. Some farmers prefer to create a part for water runoffs in farms and channel all water to this path. This is good practice and could be bad where soils are weak and the force of the water takes off the soil and create gullies in farms.

I) DIVERSIFICATION OF FARMERS INCOME

Farms needs to be developed in a way that farmers do not only depend on for income but can grow other crops in the farms that will not hinder the growth of . Developing agroforestry systems in farms take into account the diversification of farmers' income and increase variety of farmers' food for a healthy living. We are going to look at various crops that can increase variety of food production

Shade trees: pears, oranges, plumbs, Kolanuts

Alley cropping: Bananas

- Planting of tubers in farms like coco yams, Irish potatoes,
- Planting of Climbers: partion fruit, pumpkin,
- Growing of vegetable: Huckleberry, bitterleaf,
- Rearing of animals like rabbits, goats, pigs, fowls, through zero-grazing system
- Planting of medicinal plants like *Prunus africana*,
- Planting of wood for timber: Mahogany,
- Carrying out bee keeping: there are some parts of our farms with hilly slopes where cannot do well, these areas could be used for bee farming and the bees will help in flower pollination and produce honey that can be sold or eaten by farmers.

J) IMPROVING SOIL FERTILITY IN FARMS THROUGH NITROGEN FIXING TREES

Some trees help in fixing nitrogen in the soil. Nitrogen is one of the 3 essential elements that that increase soil fertility. Some plants absorb nitrogen through their roots into root noodles and fix it to useful nitrogen for plants. Some organisms help these plants in fixing nitrogen like nitrogen fixing bacteria. These plants are leguminous plants. When you uproot these plants

from the soil you will find nodules on the roots of the plants. Examples of these plants are beans, Luecaena, Tephrosia, Calliandra, etc. The leaves of these plants are very rich in nitrogen and it is for this reason that these leaves are harvested to feed animals because of their nutritive value. When the leaves are cut and placed on floors they enrich the soil heavily with nutrients. Most of these trees are used in Alley Cropping.