PRINCIPLES AND PRACTICE OF CONSERVATION FARMING

Editors:
Nderitu, J. H.[1]; Tum, J.[2]; Mwanzia, P[2].; Kimani, L.2;
Nkanata, L[2]; Kimotho, P[2]; Akivaga, F[2].

[1]University of Nairobi, P. O. Box 30197, Nairobi, Kenya
[2]Association For Better Land Husbandry
P. O. Box 61, Village Market, Nairobi, Kenya

Telephone: 522292 Fax: 521484 , Nairobi, Kenya

ABLH report, October 2001

Preface

Conservation farming is a production model to assure sustainable use of the environment by affordable means. It is essentially a basket of choices. Resource poor farmers cannot afford the fertilizers and other agri-chemicals that are currently recommended as par of the high technology solutions to the ills of farming. NGOS have promoted low cost solutions from the onset. There has to be an affordable beginning and an income improvement before purchase of a agro-chemicals becomes possible, whether the agro-chemicals are desirable or not

Vegetable gardens based upon composted deeply dug beds have become popular with small scale farmers, and the use of a mix of rock phosphate and green manure in main field cultivation to improve plant nutrition is gaining ground. Some farmers have adopted various natural pesticides for pest and disease control. In water management, irrigation is out of reach for most, but organic recycling(e.g. composting) increases water holding capacity and assures longer, stronger crop growth. Diverting water into man made basins(mandala gardens) and the use of drip feed irrigation from barrels to bring seedlings are two water management techniques that have proved popular. In soil conservation the use of contour cultivations, ground cover, various barriers and ditches are made as a means of gaining water for crop growth and improved yield.

Conservation farming approach encourage crop and enterprise diversification and, production by a set of practical and affordable techniques that provide soil rehabilitation and the maintenance of environmental qualities(sustainable) at low cost

Farmers are trained in a basket of choices in conservation farming and provision of advisory materials. Once conservation farming methods are known, and farmers adopt and use them successfully then it is time to disseminate and encourage replication. Highly trained farmers are encouraged to offer extension services to other farmers and also carry out on-farm research on technologies from National and international research centers and their own indigenous knowledge

Acknowledgement

The editors wish to express appreciation to all the members of staff of Association For Better Land Husbandry(ABLH) for their assistance in many ways while compiling this manual

Table of contents: **Page**

1. INTRODUCTION.

Conservation farming employs friendly farming techniques that help rehabilitate and sustain the environment. Emphasis is on natural ways of soil fertility management such as use of manures, composts, mulches and agroforestry techniques wherever possible. The thrust - first and foremost - is to encourage natural ways of fertilization and soil protection in order to assure product quality and a sustainable environment. Consequently, synthetic fertilizers and pesticides are only used when absolutely essential. Necessary aspects of this mode of farming are :-

(i) Good organic matter management as a basis for plant nutrition and sustainable land use;

(ii) Use of integrated pest management, including safe, effective and judicious use of chemicals; and

In adopting an integrated pest management (IPM) and Integrated Crop Management (ICM) approach, conservation farming as described in this document - is NOT against synthetic fertilizer and pesticide use *per se*, but is advocating reductions in such use to conserve natural resources.

The principles and methods employed result in practices which :-

- Coexist with, rather than dominate, natural systems;
- Sustain or build soil fertility;
- Minimise pollution and damage to the environment;
- Minimise the use of non-renewable resources;
- Protect and enhance the farm environment with particular regard to conservation and wildlife;
- Consider the wider social and ecological impact of agricultural systems.

The basic characteristics of conservation farming are :-

- The enhancement of biological cycles, involving micro-organisms, soil fauna, plants and animals;
- Sustainable crop rotations;
- The extensive and rational use of manure and vegetable wastes;
- The use of appropriate cultivation techniques;
- Minimal use of fertilizers and chemical pesticides.

Part 2. Land preparation techniques

2.1. Raised beds

Raised beds are made by adding manures to the farm and digging about 1/2m below the ground. Horticultural crops do well in the raised land that has been dug deeply.

Advantages

- Raised beds are easy to make
- There is a good crop on raised beds during the first season
- There is no water logging as compared to double digging during long rains season

Disadvantages

- Manure is added every season as compared to double digging
- Raised beds dry up during the dry season compared to double dug beds

2.2 Deep soil Preparation (Double digging)

The purpose of double dug planting beds is to build up a deep layer of loose, well-composted topsoil, which allows intensive growing of vegetable crops. Deep, well-composted topsoil allows closer spacing of plants than normal and continuous growing of crops where watering or irrigation is possible. Several double dug beds close to the homestead can provide a family with fresh vegetables throughout the year. It is better to have a number of double dug beds (5-10) in order to plan your rotation of crops well.
Essential requirements for a vegetable garden are shading, mulching and compost. A protective hedge of flowering legume trees and bushes, which give a light shade, mixed with local fruit trees, create the ideal climate for vegetable growing. Hedges and trees can act as a live fence.
A double dug bed should be planted with the plants closer than normal because the roots spread downwards much more easily. Plants which are closely spaced also keep down the growth of the weeds. The plant leaves also protect the soil from the sun, wind, and rain. Once dug, every effort should be made to avoid stepping on the loose soil and therefore compacting it again. Leave a space of 0.3m to 0.5 m as a path between two beds. Always weed and harvest the produce while standing on the path.

<u>These are the steps to making a double dug planting bed:</u>

1. Select the site. It is best near the homestead or a water source.
2. Each bed, when completed, should have an area of 10 square meters. Therefore, measure out a bed 1.5 m wide and 7 m long. Sometimes you may prefer a narrower bed of 1.3 m wide and 8 m long.
3. Measure out a 1 m length of plot and dig about 30-35m deep that represents the top soil.
4. Remove the soil you have just dug and take it to the end of the bed. Put it outside of the bed on the far side. You need a shovel or wheelbarrow for this. Make sure that you have removed all the topsoil. You will know this when your tool hits a harder layer at

the bottom or when the soil changes colour from dark to brown or reddish brown, depending on the soil type.

5. Then dig this hard compact subsoil deeply. Strike it with a long heavy fork several times. When the whole strip is completed, level out the loose subsoil (**this is why it is called Double Digging).**
6. If you have plant materials, then place a layer of materials to be composted slowly in the hole.
7. Measure out another 1 m strip and dig a 1-foot deep soil. Then put this soil into the first strip to fill it. Then repeat by digging deep another foot to loosen the soil, apply a layer of materials for composting. Measure out another 1 m and fill the previous strip with the topsoil.
8. Repeat this to the end strip, which you fill with the topsoil from the first strip.
9. Apply about 4 wheel-barrows of compost on top and mix well with the soil. Then level out the whole area making sure you do not step on it at all.
10. The finished bed is then raked off and mulched in preparation for planting.
11. When finished the bed is higher than normal ground level
12.. There should be a path of 2 feet between double dug beds.

Advantages

1. Double dug beds do not need to be dug again for three or four planting seasons.
2. Easy weeding, just uprooting the weeds
3. Good aeration
4. Deeper root penetration thus healthy crops
5. Good water retention especially during the dry season
6. Lasts for three seasons with good soil fertility without incorporating organic matter
7. Higher yields than conventional land preparation
8. Diverse crops can grow in double dug beds
9. High yields of horticultural crops
10. Double dug beds should be made where water logging is not a major problem.

Disadvantages

1. There is water logging during long rains and crops do not perform well

Note: After three yeas soil fertility is reduced and the soil becomes compact making root penetration difficult. To renew the bed, so that it can be used for another three years use the same soil moving procedures.

2.3. Mandala garden:

This is a double dug bed prepared in a circular manner with an inlet for water preferably harvested from the house roof behind the kitchen. Plants are then grown in several lines all round. Water is collected and retained in the mandala rings. This is best for the dry regions or dry seasons where crops/ vegetables can remain green for a long time without necessarily watering.

Advantages

1. Different horticultural crops perform well in mandala gardens
2. Family members can harvest at night because it is near the house
3. Kitchen water throughout the year
4. There is no theft of the horticultural crops because it is near the house
5. a major recommendation for kitchen gardening

Disadvantages

1. Mandala garden can become waterlogged if initially double dug
2. If not fenced the crops can be destroyed by sheep, goats and chicken

2.4. Mazimbuko garden

Mazimbuko gardens are made in soils that are not deep and have small stones in the farm. It is made by digging deep to remove the soil and the stones. Then farm is added dry grass, manures, green manures, and water, ash and soil respectively The stones are removed and put at the periphery of the farm.

Advantages

2. The soil in Mazimbuko gardens has good soil with enough fertility for crops for three seasons

Part 3 Soil conservation

3.1. Soil conservation

Soil conservation should be an integral part of the conservation farming system.
All relevant measures must be taken to prevent soil erosion in order to retain the structure and fertility and thus the sustainable character of the operation. A suitable soil conservation measure, appropriate to specific local conditions of climate, soil, slope, and land use, should be employed. Some of these measures are given below: -

(a) Agronomic measures.
- (i) Agroforestry;
- (ii) Contour cultivation and planting;
- (iii) Contour ridging;
- (iv) Contour strip cropping;
- (v) Crop residue mulch and trash lines;
- (vi) Green manuring/cover crops;
- (vii) Utilization of manure and composts;
- (viii) Vegatative barriers (e.g. nappier grass).

(b) Structural measures.
- (i) Bench terraces;
- (ii) Bunds and narrow-based channel terraces;
- (iii) Cut-off drains;
- *(iv) Fanya juu;*
- (v) Infiltration ditches;
- (vi) Terracing.

Wind erosion should be reduced by the use of such practices as windbreaks, cover crops, minimum cultivation and late cultivation of crop residues.

3.2 Terracing with an A-frame

It is important to protect slopes and hillsides by planting all crops on ‘contours’ - rows running across slopes and around hillsides. It is important too to construct contour canals or barriers running across slopes and around the hillsides. In rocky places, the rocks can be made into rock walls, which slow down the flow of the rain water and hold back the soil. Where there are no rocks, level canals can be dug to absorb the rain water. Grass barriers on the upper side of canals hold back the soil.
In order to make level rows a tool can be used called the A-frame. The A-frame is easy to make and use. Plus, it is one of the most important tools in the world - because it can save our soil.

Step by Step Construction of an A- Frame

Materials:

- three poles, 2 ½ m long
- three 2 inch nails
- about four meter of strong string
- a fist-sized piece of rock
- two pegs about ½ m long

Method:

- First, cross two poles at the top and tie them together securely. Use one of the nails to help fasten them.
- Tie the third pole across the other two to form the letter A. Tie both ends.
- Tie a length of cord to the top of the A and let it hang down below the crossbar.
- Tie the rock to the end of the cord, below the crossbar.
- Now the A - frame is almost complete but before it can be used to mark contours, a point must be found on the crossbar which will indicate when the two legs are in a level position.
- Stand the A - frame upright and drive one of the pegs into the ground next to each leg of the A - frame.
- With a pencil, piece of chalk, or charcoal mark the point where the string passes the crossbar.
- Move the A - frame so that the placement of the legs is reversed.
- Again mark the point where the string passes the crossbar. Usually the marks will be at different points. If the ground is level, the two marks should be at the same point.
- Mark a third point halfway between the first two. This is the point on the crossbar which will indicate when the two legs are in a level position.
- In order to keep the mark from being erased, cut a notch there.
- When the weighted string hangs directly in front of this cut notch, then the two legs are in level.
- Now the A - frame is finished and is ready to mark level contours on hillsides.

Using an A - frame

- Study the area of your field on which you want to construct contour barriers. It is good to start near the top of your field.
- First, cut a supply of stakes. These are used for marking level lines where the ditches will be dug or the rock barriers will be constructed.
- Drive the first stake at the edge of the field near the highest point. You will begin marking the contour lines at this point.
- Place one leg of the A-frame just above and touching the first stake. Adjust the other leg so that the string passes the level position point you notched on the crossbar.
- With the string passing exactly the point of the level position, drive another stake into the ground just below and touching the second leg of the A-frame.
- Now pick up the A-frame and move it along, placing it so that one leg of the A-frame touches the stake you just drove into the ground.

- Continue across the field this way. Now you have a level line of stakes which tells you where the first contour barrier will be constructed. But one contour barrier is not enough.
- A hillside must be protected with one contour barrier every 1½ meter of difference in elevation. On steep hills, the barriers will be close together. On gentler slopes, they will be further apart.
- Continue marking level contour lines across the field until you reach the bottom of the slope.
- If the field is rocky, use the rocks to construct rock barriers along the level lines marked by stakes.
- Then using a hoe or shovel, dig canals along the line marked by stakes. Be sure to follow the line of stakes. Remember these stakes mark the level lines across the field. The canal should be half a meter deep.
- Plant grass along the top of the canal. A tall thick variety such as elephant, napier or guinea grass is best.
- When the heavy rains come, the grass barriers will catch the soil and prevent it from being washed down the slope.
- As the soil is caught behind the grass or rock barriers, terraces will gradually build up.
- As the terraces build up, not only is the soil saved, but the fields become easier to work because they are more level.

Part 4. Nursery and tree management

4.1 Nursery Management

What is a nursery?. A nursery is an area of land dedicated to raising seedlings. Nurseries are prepared for both vegetables and trees. The crops usually raised in nurseries are mainly those with very small seeds.

Why have s nursery at all?. There are several reasons for raising plants in a nursery, the most important being:-
i) To enable plants to grow strong before transplanting them
ii) To protect young seedlings from damage by livestock and adverse weather effects
iii)To save time , space and other inputs

When does one start a nursery?
The best time to start a nursery is about 2 months before rains depending on the crop or the time when one has timed to have the crops in the field. This gives time to get all planting materials before rains start(this applies both for trees and vegetables)

Types pf nurseries:-

1. Raised nursery- for use in high rainfall areas

Advantages
- Easy to make
- Able to raise enough healthy seedlings

Disadvantages
- When a lot of rain there is water logging and seedlings rot due to dumping off disease

2. Sunken nursery – used in drier areas

Advantages:
- Can have seedlings at the right time of planting
- Less water is used to raise the seedling because you concentrate water into the hole

3. Movable nursery- seedlings may also be raised in wooden flats, boxes and plastic containers if land is scarce

Advantages

- Can move seedlings anywhere you want to plant
- Less damage of seedlings during transplanting
- The boxes of seedlings can be moved to a safer place when there is a lot of rains or animal damage
- Have less pests and diseases because they are movable from one place of unfavourable to favourable conditions

Sitting of the nursery:- the following considerations may be taken into account:-
i) availability of water
ii) protection from wind
iii) security from livestock
iv) for vegetables the site should not have the same family of crops grown there to prevent soil borne diseases
v)close to shade
vi)Place where there is no water logging
vii)raised bed

To prepare the nursery bed:-
Select a flat area and free it of weeds. A good nursery is 1M wide and of desired length. It should be slightly raised for good drainage unless otherwise. Loosen the top soil with a jembe and apply well decayed manure and mix it well. The surface of the bed is leveled with a wooden plank. The nursery is then well watered before sowing

Sowing:-
What you need to know about seeds:-
i) vegetable seeds:- These seeds are easy to germinate but require to be dressed with a chemical to prevent soil and seed borne diseases. Make sure you obtain clean certified seed each time you start a nursery. You may think that soving seed will save costs but but you may end up in losses due to seed borne diseases

ii) **Tree seeds -** some tree seeds may not germinate and require to be treated by soaking in water or scratching the outer coat. However, small seeds like those of fruit trees and cypress may not require to be treated. *Calliandra* and *luceana* have seed coats and may require to be treated.

It is also important to know the spacing of all the seed. However, most spacing will be be given. For ver small seeds, it would help to mix them with sand to ensure good spacing. Seeds should be covered lightly. Mulch with grass or straw but remove immediately after germination.

Nursery management

The following tips will help you get a good crop establishment:-

1. After sowing water the bed using a watering can or a tin with fine holes. Avoid over watering, it may cause compaction. The best time to water is early morning and late afternoon when the rate of evaporation is low.
2. During hot weather construct a simple shed over the nursery.
3. Seed dressing with chemicals will help to prevent damping off and stem rot disease
4. If there is thick germination, thin to avoid weak seedlings. Remove the shading gradually to get the seedlings used to full sunshine
5. Fence off the nursery to prevent attack by livestock
6. Weed the nursery to keep it free from competition and plants that may host pests and diseases
7. You may need to use pesticides in case of diseases and pests

Whatever you do use pesticides wisely, safely and carefully.

When are seedlings ready for planting?

Transplant when seedlings are 15-20 cm and having 4-6 leaves. This should be done in the morning or evening to avoid transplanting shock. For tree seedlings these are transplanted into polythene bags or any container Just before this harden them by stressing them for a while so that they are able to cope with the environment.

4.2 Tree and woodland management .

Trees and woodland play an important role in maintaining the ecological balance in farms. They provide habitat for animals including pest predators. Mature trees and woodland may also have an amenity and recreational value. Individual trees and ancient woodland play a vital part in preserving landscape and species diversity. It is recommended that :

a) The retention and management of trees in accordance with local custom and woodland practice.
b) Replanting programmes integrated with existing woodland and trees, and using indigenous and local shrubs and trees.
c) Natural regeneration, coppicing and other traditional management practices.
d) Fencing of newly planted or regenerating woodland against stock.

Clear felling of woodlands and felling of mature specimen trees that are not endangering safety should be restricted.. Traditional boundaries such as hedges help to maintain a diverse ecology, provide a habitat for many beneficial animals and insects and shelter for livestock...The retention of hedges using traditional methods and materials is recommended.

Part 5. Soil Fertility management techniques

5.1 Soil management.

The soil must be managed with the aim of developing and protecting an optimum soil structure, biological activity and fertility. Management must therefore ensure the following :-

a) A regular input of organic residues in the form of manure and plant-remains in order to maintain the appropriate level of humus, biological activity and plant nutrients.

b) A level of microbial activity sufficient to initiate the decay of organic materials and breakdown of non-soluble minerals into simple nutrient salts capable of being absorbed by the plant roots.

c) Conditions conducive to continued activity of soil micro-organisms and other soil-stabilizing agents and the improvement and stabilization of the soil structure by the incorporation and mixing of organic matter.

A protective covering of vegetation, e.g. green manure or growing crop, to protect surface-living organisms and soil structure from damage by exposure to dry conditions, heavy rain or strong winds. Appropriate cultivation for crop production to achieve :-
i)Deep loosening of the sub-soil to break plough or compaction pans.

ii) Minimal disruption of the soil profile.

iii)Timeliness of cultivation or grazing to ensure appropriate tilth and to avoid damage to existing soil structure.

The monitoring of organic matter levels, available plant nutrients and nutrient reserves in the soil by means of regular soil analyses. Maximum use of composting as a regular and integral part of soil management. Burning of organic matter e.g. slash-and-burn, straw burning is restricted

5..2 Manure management and application.

5. 2.1 The management of livestock manure and crop residues produced on the holding, and materials brought-in, should aim to achieve maximum recycling of nutrients with minimum losses.

5.2..2 Manure management should aim at maintaining and increasing the fertility of the soil and biological activity within it by natural processes.

5.2.3 Sufficient quantities of organic material should be returned to the soil to increase, or at least maintain, its humus content and fertility on a long-term basis.

5.2.4 The amount of brought-in manure must be regulated so that self -sufficiency in soil fertility is achieved naturally and according to regional conditions.

5.2.5 Management and handling of manure and compost must minimize nutrient losses.

5.2.6 As far as possible, care should be taken to keep/bring the soil pH to a level appropriate for the site, crop type and land use. If necessary it can be adjusted by liming.

5.2.7 The total amount of manure added, averaged over the rotation, must not exceed the quantity which could be produced on the farm unit if it were a self-sufficient livestock holding. Exceptions can be made by the certification body for isolated intensive crops and farms where an extra need for nutrients and soil organic matter can be proven.

5.2.8 Adequate provision must be made for the storage of manure and slurry prior to application. Manure and slurry stores must be able to :-

a) Hold organic matter for sufficiently long periods for complete rotting-down before use - to avoid carry-over of pests, diseases, soil acidity problems, etc.
b) Cope with the volume of production of manure/slurry on the holding.
c) Enable flexibility of application timing by provision of adequate storage.
d) Prevent liquid effluents from manure/slurry from entering watercourses and ground water.

5.2.9 Care must be taken when storing and spreading manure/slurry to avoid run-off and the pollution of watercourses and ground water. Attention must be paid to the capacity of the ground to absorb the manure/slurry at the time of application. When conditions appear unfavourable and pollution seems likely to occur, application must not take place. i.e. timing of manure application should be done such that leaching is avoided.

5.2.10 Heavy metals and other metallic elements are naturally present in the soil and some are essential, in trace amount, to plants and animals. It is however necessary to maintain a correct balance and the concentration in the soil should not be increased beyond acceptable levels by the application of manure, fertilizers and mineral supplements.

5.2.11 Heavy metal levels in manure should not exceed the levels specified for manure. Manure must not be added to the soil where the addition would lead to the heavy metals in the soil exceeding the levels specified.

5.2.12 Maximum permitted heavy metal levels in the topsoil (on a dry matter basis):

	in the soil		in the manure	
	mg/kg	kg/Ha	mg/kg	kg/tonne
zinc	150	336	1000	1.000
Chromium	150	336	1000	1.000
copper	50	110	400	0.400
lead	100	220	250	0.250
nickel	50	116	100	0.100
cadmium	2	4.4	10	0.010
mercury	1	2	2	0.002

5.2.14 Recommended.

a) The storage of compost and manure indoors, or under some form of cover such as plastic sheeting, banana leaves, etc., to prevent leaching of nutrients during periods of heavy rainfall.
b) Applications of composted manure and slurries onto fertility building crops, grassland and cultivated land.
c) Avoiding the spreading of manure next to ditches and watercourses and within fifty metres of boreholes and wells.

5.2.1.5 An analysis of the soil may be required by the conservation farming from time to time to ensure that soil fertility and structure are being maintained.

5.2.17 The records on type of manure, Source., dates of application and quantity used should be kept

5.3. Fertilizers.

5.3.1 Artificial fertilizers, though permitted, must be regarded as supplements to, and not replacements for, nutrient recycling within the farm. These should be judiciously used as top-ups.

5.3.2 All organic and mineral fertilizers, and particularly those rich in nitrogen (e.g. dried blood) – as well as artificial fertilizers - must be applied in such a way as to have no adverse effect on the quality of crops (nutritive quality, nitrate content, taste, keeping quality and plant resistance) and the environment.

5.3.3. It is recommended that organic fertilizers such as Rock Phosphate, Cofuna and Biofix be used

5.3.4 The records must be kept of type of fertilizer, source, dates of application and quantity used.

5.3.4. Good to understand behavior of plant nutrients. E.g N is mobile, volatile and carried by heavy rains. It provides the deep green colour and additional plant vigour. P is fixed and never moves. It is good at planting and for rooting.

5.4. Composts

5.4.1. Importance of composting

Composting manure change the organic wastes into dark, crumby material called humus. Using compost is a good low cost way of improving soil fertility and productivity of many soils. The humus loosens soils and make cultivation easier. It conserves soil moisture, improves air circulation in the soil, provides balanced plant nutrients, reduces erosion by binding soil particles together, supports millions of microorganisms, neutralizes soil acidity, protects soils from poisons and above all, humus extends the growing season by keeping the soil moist and warm

5.4.2. Methods of making compost

The aim of making compost is to convert large amounts of vegetation e.g crop remains, garden weeds , kitchen and household wastes, hedge cuttings, garbage and animal manure and beddings into valuable humus. This conversion takes place in nature all the time. By managing this process, the farmer is able to quicken it and maximize losses through volatilization, even evaporation, leaching, etc. When properly made , compost is immediately available to plants. It allows the farmer to get a good crop without the use of expensive chemical fertilizers or in combination with chemical fertilizers

Materials
Materials needed to make compost are:
i)Manure- mixture of animal droppings or dung, urine, straw, remains of fodder and other beddings
ii)Dry or mature vegetation
iii)Green plant material, kitchen waste and garden weeds
iv)Topsoil or old manure
v)water
vi)wood ash

5.4.3. Compost site
The location is important as it eases the labour of transporting materials for composting or the ready compost heap near animal houses, water and other materials- but not too far from where it will be used.

5.4.4. Preparation for composting
Bulky materials such as maize stalks, banana stems, hedge and tree pruning should be chopped into small pieces

Tools

Farmers make small and medium sized compost heaps as compared to large municipal compost heaps. They need the following tools:-

i)Folk jembes
ii)panga
iii)spade or shovel
iv)watering bucket or water tin
v)wheelbarrow or any manure transporting equipment
vii)Dry sharp pointed stick

5.4.5. Making a compost heap

The steps of making a compost are as follows:

i)Measure out the area where the compost will be placed. Suitable sizes are 1m by 2m or ½ by 3 or 11/2m wide and any convenient length. Too small compost do not heat up or decompose properly
ii)Dig the area you have measured and remove the topsoil to a depth of 1/2m. You will need this topsoil. Lay large materials, branches and brushwood at the bottom to help in aerating the heap
iii)Put down a layer of dry chopped vegetation about 10-15cm
iv)Add fresh animal manure 6-10cm
v)Add a layer of fresh green materials such as weeds, kitchen wastes etc-10-15cm
vi)Add a good sprinkling of topsoil
vii)Add another sprinkling of wood ash
viii)Water the layers thoroughly
ix) Repeat the process starting with dry vegetation and ending with watering
x)The completed heap should be 1m-11/2m high
xi)Finally, cover it with a slightly thicker layer of soil(3-4cm) and a dry grass/banana mulch
xii)Drive the sharp dry stick into the pile. This will help to monitor the condition of the on-going decomposition. It will feel hot after 3-4 days. If it develops white mould it means the heap is dry and needs watering. This can be done routinely every third or fourth day. The heap is left for 3 weeks
xiii)In the meantime the temperature rises to 60-70%, this temperature is good for killing weeds, pests and diseases

5.4.6 Turning of compost heap

After 3 weeks, the heap is turned. Start with the top which becomes the bottom of the new heap. Cover it again with mulch. Leave it for 2-3 weeks. Turn it again if needed. Turning the heap more frequently encourages faster decomposition. The C/N ratio of a good compost heap should be 25-27. Compost contains all the essential plant nutrients which are Nitrogen, phosphorus, potassium, iron, calcium, sulphur, magnesium, carbon, manganese, copper, cobalt, boron, zinc, and molybdenum

5.4.7. Types of composts

Fully composted material has the followingcomposition:
Air = 25%
Minerals = 45%(nitrogen- from green materials, phosphorus- from bacteria, potassium- from ash, iron, calcium- from ash and the dry vegetation, sulphur, magnesium, manganese, copper, cobalt, boron, zinc, molybdenum, carbon)
Water = 25%
Organism = 5%.

5.4.7.1. Trench Compost:

Dig a trench 60 by 60 cm by 60 cm deep. The length can vary. Remove the topsoil and put aside.

1. Prepare 2 layers of composting materials as required (from composting notes). This heap will be above the ground level.
2. Cover the top with the topsoil and dry vegetation to preserve moisture.
3. Crops are then planted along the edges of the trench as the material s rot. After a while, the materials will be fully composted and crops can then be planted within the trench as well as along it.
4. Proven good for nappier grass.

5.4.7.2. Basket compost:

Compost materials are layered in a circular hole whose diameter depends on material availability. Crops are then grown all round the basket.

Advantages

- Easy to make
- Conserves water in the basket
- Useful during dry seasons
- One method of water harvesting

Disadvantages

- Slow decomposition which is only realized after the first season
- It is normally ready during the first season

5.4.7.3. Boma compost

Use dry vegetation in the animal boma as beddings. In such a case, the manure containing plenty of beddings is composted by adding a sprinkling of topsoil and wood ash only. Water may be added depending on how the boma manure is already wet due to the presence of urine

5.4.7.4. Pit compost

In dry areas, the drying effects of the environment and the lack of water may encourage the farmer to compost in a pit of 1-11/2m deep. Topsoil is used to cover the material. Planting is done on top or edges of the compost. The compost is not turned. The growing crops sends roots into the decaying compost during the growing season. Subsequent crops can use the same humus over several seasons.

5.4.7.5. Trench compost or fertility trench

Similar to basket composting but the compost is done in a long trench ½m deep. The trench may again be used to grow the crop over several seasons. It is suitable in dry or rocky areas

5.4.8. Using compost

Ready compost is dark brown, has a damp feel. It smells like forest soil. It crumbles easily. You will not recognize the original material. It should contain soil-about 20-25%. This compost is ready for use. The quantities that can be used are:-

- 15 kg or 1 debe full in a furrow of 3m long
- 1 kg compost in 1 planting hole
- 3 kg compost in 1 sq metre
- 10-15 tons compost(2 lorry loads) in 1 hectare of land

Compost may be used in intermittent years, i.e a farmer does not need to apply compost with every single planting. A lot of compost remain in the soil and feed the following year's crop. However, a careful rational program is necessary in order to get the most benefit from composting

Caution:- Do not use row compost since it may contain life pathogens that may be harmful to the crops

5.5. Green manures

Green manures are fast- growing plants(legumes and non-legumes) placed on a piece of land to improve soil fertility and protect the soil from erosion. They are normally low, spreading plants that grow fast and cover the soil surface quickly after planting. During or after the growing season, the green manure plants are slashed and incorporated into the soil, where they decompose, releasing nutrients and improving soil structure. Examples of green manure crops are :-

- **Food legumes:-** Bambara groundnuts, chickpea, cowpea, green grams, groundnut, lablab, pigeonpea
- **Fodder legumes:-**clover, lablab, Lucerne, lupin, stylo, sunn hemp, velvet

Advantages

- Some types of green manures provide food or fodder as well as conserving and improving the soil
- Green manures suppress weeds by shading them out. Some legumes reduce the number of striga weeds in the field. Sunn hemp is especially good at this
- Relatively little labour is needed, compared to other ways of adding organic matter
- Green manures are cheap to plant and easy to manage
- Seeds of green manure crops are easily available

Disadvantages

- The benefits of green manures may be long-term rather than immediate
- It can be difficult to incorporate green manures into an existing cropping system
- Some green-manure crops such as velvet bean and lablab bean may compete with the main crop for light and nutrients. It is important to select green manures carefully so they do not interfere with the main crop.
- Some green manures may attract new pests and diseases which attack the crops
- Some green manures may become weeds by seeding and growing in the crop field in the next season
- Green manures may not be successful in the dry season, especially in drier areas
- If a green manure legume has not grown in the field before, the soil may not contain the bacteria it needs to fix nitrogen and inoculation of seeds may be necessary

5.6. Mulching

Mulch is dry, vegetative material used to cover the soil. It helps reduce evaporation and retain moisture, reduce soil erosion and provide plant nutrients as the material decomposes. Mulch can be dry materials you can find nearby e. g grass, maize or sorghum stalks, maize husks and wheat straw. Mulch is spread on the soil, with a layer of 7-15cm deep all over the bed, or around the growing plants. Do not put on so much of mulch that bury the plants or shade them out. Use dry materials that do not rot easily

Mulch can be used in the fields before and after planting, as well as around young crop plants. It is especially useful for high valuable vegetable crops, and for growing crops in dry areas, during dry-season cropping, and in places where soil is easily eroded by heavy rains

Advantages

- Mulch keeps the soil underneath moist longer than bare soil
- It controls soil erosion by cushioning the impact of raindrops and by slowing runoffs
- It suppresses weeds by shading them out
- It leads to healthy crop growth
-

Disadvantages

- Mulching is labour intensive
- It can introduce pests and diseases into a field
- Dead plants for use as mulch may not be available
- Grass mulching is done where termites are a problem. Use banana leaves where termites are a problem rather than grass mulch

5.7. Legume inoculation

Biofix is a legume inoculant from the university of Nairobi, Kabete Campus. The direction for use as follows:-
i)Add 30g Gum Arabic(or sugar) to 300 ml clean warm water to soda bottle and shake to dissolve. Fill a debe can(or any other container) with 15Kg of large sized legume seeds

ii)Transfer the 15Kg legume seeds from the debe or any other container into a clean basin

iii)Pour Gum Arabic/sugar solution onto the legume in the basin

iv)Using both hands, mix the legume seeds with the Gum Arabic/sugar solution until all the seeds are wet.

v)Using the right type of Biofix for the legume seeds, add the inoculant onto the wet seeds

vi)Mix the legume seeds and the inoculant thoroughly using both hands until all the seeds are uniformly covered with the inoculant.

vii)Protect the inoculated seeds from direct sunlight by covering the basin with paper clothe or gunny bag and keep under shade

viii)Plant the inoculated seeds as soon as possible in well prepared moist bed.

5.8. Rock phosphate+tithonia

Soil fertility can be improved by increasing the levels of phosphorous and nitrogen through cheaper and natural resources, that is both affordable, available and environmentally friendly.
When preparing the soil for planting apply rock phosphate at a rate of 400 kg per acre(100 g per m^2.and tithonia pruning at a rate of 2,400 Kg per acre(600 g per m^2). Combining rock phosphate with tithonia is a low input technique for the improvement of soil fertility and farm yields. Well composted manure or any organic compost can be used instead of tithonia

5.9. Agroforestry

Agroforestry is a collective name for land use systems and technologies whereby woody perennials(trees, shrubs, etc) are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence.

Improved fallows as an agroforestry systems is being adopted in various regions of the country. Improved fallows entails the use of plant species in order to achieve the benefits of natural fallows within a short time or smaller area. The main improved fallow trees(shrubs) are *Sesbania sesban*, *Crotalaria* and *Tephrosia vogeli*i. Advantages of improved fallows include:-

- Elimination of the tree-crop competition characteristic of agroforestry systems
- Increases soil organic matter which affects both physical and chemical fertility
- Nutrient input, mainly N through biological nitrogen fixation
- Retrieval of leaching minerals from the subsoil and making them available to crops
- Reduced soil erosion
- Improved activity of soil microorganisms(arthropods, earthworms, nematodes)
- Weed control

5.10. Top dressing fertilizers

5.10.1. Liquid Manure:
Materials: chicken, (free from saw dust), rabbit or cow dung manure, a drum or *debe*, a strong sack or gunny bag, a strong pole and a rope.

1. Put about 50 kg of manure for one drum of water (one type or mixture) in a sack
2. Half fill the drum with water
3. Tie the mouth of the bag with a rope and suspend it in the drum by the strong pole placed across the diameter of the drum (continued in next page in No. 4, 5 & 6 af for plant tea).

Advantages
- Animal wastes are easily available on the farm
- There are no costs involved in preparation of the liquid manure

Disadvantages
- Animal wastes(cow dung, or cow urine, chicken waste, rabbit waste) cause crop phytotoxicity when applied on the leaves and stems., especially during dry periods

5.10.2. Plant tea:
Materials: Chopped fresh plant leaves. Place these into a drum of water (not necessarily in a bag)

4. Let this stand for three days and every day thereafter, stir the contents of the drum by lifting the pole several times.
5. After 15 days he water will have turned blackish. Remove the bag.
6. Dilute the contents of the drum 1:2 and put small quantities at the foot of the plant slightly away. Do not tough the leaves with this!

Advantages

- Materials available in every farm
- Farmers do not spend money
- Farmer can prepare plant tea by himself/herself

Disadvantages

- Some Plant teas can be phytotoxic to plants e.g. those from eucalyptus and cypress

5.11. Ridging and manure application

Cultural practice of ridging and application of manure in the furrows before planting is recommended. It is also a soil conservation measure

Part 6. Planting and cropping system

6.1. Crop rotations.

6.1.1 Rotations must be as varied as possible and aim to :- (a) Maintain soil fertility, (b) reduce nitrate leaching, and (c) reduce weed, pest and disease problems.

6.1.2 Whilst there cannot be a definitive rotation, the following guidelines should be observed in line with good agricultural practice :-

a) A balance should be achieved between fertility building and exploitative cropping.
b) Crops with differing root systems should be included.
c) Rotations should include a leguminous crop at least once in every four crops to provide a balance of nitrogen in the soil for use by subsequent crops.
d) Plants with similar pest and disease susceptibility should not be grown consecutively.

6.1.3 Rotations should :-

(a) Minimize the time that the soil is left uncovered, by means of maximum use of green manure where appropriate.
(b) Maintain or increase the organic matter levels in the soil.
(c) Vary weed susceptible crops with weed suppressing crops.

6.1.4 Horticultural crop production should make a maximum use of legumes and green manure catch crops.

6.1.5 Choice of species and varieties for conservation farming should be adapted to the soil and climatic conditions and resistant to pests and diseases.

6. 1.6 The records must be kept of previous crop, type of seed used, variety and source and date of planting.

6.1.7. Things to consider in rotation are:- i) the plants should be of different family; ii) plants should be of different rooting depth; iii)plants should be of different rooting depth; iv) rotate leafy and bulb plants

6.2. Five or nine maize hole

There is higher yields from 5 or nine maize hole plots than the conventional planting pattern. The remarkable increase in maize yield suggests that the technique has the potential to increase food security and improve farmers' income

How to prepare nine maize hole:

1. Measure 2feetx2feet holes, leaving a space of 2 feet between each hole

2. Dig up the top soil and put it on one side: remove the sub-soil placing it on the other side of the hole. The hole should be 2 feet deep
3. Mix the top soil with one debe full of compost(15-20Kg) or well decomposed manure. In the next seasons the amount of compost can be reduced to 2-4Kg per hole
4. Place dry and green plant materials in the bottom of the hole. This improves the moisture conservation and releases nutrients when decomposed
5. Fill the hole with the mixture of top soil and compost. The sub-soil is then mixed with some compost and spread between the holes, including a thin layer on the surface of the hole
6. Sow nine maize seeds in the hole(five seeds in drier regions)
7. Beans or other short season crops can be planted in the space between the holes.
8. After the maize crop, other crops like beans, kale or tomatoes can be planted in the hole

6.3. Multiple cropping

Multiple cropping is the practice of planting several different crops on the same plot of land at the same time. It is common among small-scale farmers in Kenya. Crops, livestock and trees can all be integrated into a small farm, making it much more productive. Such integrated farming is particularly relevant for small farms or fields

The integration of many farm enterprises gives farm families several advantages. More crops can be planted in a small space. The production of crops is usually spread over a longer period of the year, allowing for better vegetative cover to protect the soil, but also spreading out the harvest throughout the year.

The appropriated crops, crop combinations, planting times and planting patterns will vary from place to place, depending on the local climate, soils, topography, water availability, pests and diseases, socio-economic conditions, and other factors. An example of a typical combination of five to twelve different crops:

- **Cereals:** Sorghum, millet, maize
- **Legumes**: beans, pigeonpeas and cowpeas
- **Root crops**: cassava, potatoes
- **Trees for forage, fallow and construction:** Calliadra, Luceana, Sesban , Gravillea

Advantages

- Multiple cropping reduces the risk of total loss form drought, pests and diseases. Usually at least some of the crops can escape disaster and produce a yield
- It optimizes production from small plots, so can help farmers cope with land shortages
- Including legumes in the cropping pattern helps maintain soil fertility by fixing nitrogen in the soil
- Multiple cropping yields different types of produce, resulting in a balanced diet for the family
- It suppresses weeds. As the planting density is high, weeds cannot compete with the crops

- Different types of crops can be planted to take advantage of different seasons. For example, crops that require a lot of water can be grown in the wet season, intercropped with drought-resistant crops that can be harvested in the following dry season

Disadvantages

- The presence of crops in the field throughout the year allows crop pests to survive more easily. Some pests can shift from one crop to another, for example aphids can move to cotton during dry season
- The large number of different crops in the field makes it difficulty to weed
- It may be difficult to introduce new technologies such as row planting, modern weeding tools, and improved varieties

5.4. Crop diversity (Crop screening)

This involves introducing high value crops with niche markets which ideally require minimal external inputs and can store or be processed relatively easily. In the main these are horticultural crops to meet growing domestic demand and export markets. Carrots, chillies, climbing beans, passion fruits are some of the crops that can be successfully introduced into the market. Those crops also perform very well on double dug or raised beds

Part 7. Pest and disease management

7.1. Weed management

7.1.1 Weed control must primarily be approached by use of a number of preventative cultural techniques limiting their development, e.g. suitable rotations, composting and early seedbed preparation.

7.1.2 General weed management techniques

1. Crop rotations
2. Varying weed suppressing with weed susceptible crops.
3. Thoroughly rotted manure and plant wastes.
4. Hygiene - in the field and on machinery.
5. Pre-sowing cultivations.
6. Stale seed-bed techniques.
7. Variety selection for vigour and weed suppression.
8. Pre-germination, propagation & transplanting.
9. High seed rates.
10. Under-sowing.
11. Utilization of green manure.
12. Raised beds and no-dig systems.
13. Mulches.
14. Mixed stocking & tight grazing.
15. Re-cleaned seed.
16. Pre-emergence and post-emergence mechanical operations (e.g. hoeing, harrowing, topping, hand weeding, slahing).
17. Plastic mulches.
18. Steam sterilization - greenhouse soils only.
19. Solarization.

7.2. Pest and disease management.

7.2.1 Conservation farming must be carried out in a way which ensures losses from pests and diseases are minimized - with minimum use of chemical pesticides. This should be done following a thorough evaluation of the situation taking into account :-

(i) Previous experience of pest incidence and crop susceptibility,
(ii) weather,
(iii) regular crop monitoring to identify and assess pest and disease levels with laboratory diagnosis if necessary,
(iv) trapping of pests where appropriate,

7.2.2 General pest and disease management techniques

(1) Mechanical and Physical Practices.

(a) Digging out eggs/larvae;
(b) Hand picking;
(c) Removal of infested plants;
(d) Selective prunning;
(e) Burning infested vegetation;
(f) Scarecrows;
(g) Sound devices;
(h) Wrapping of fruits and pods;
(i) Painting stems and trucks with lime or other materials;
(j) Application of ash, salt and other natural pesticides.

(2) Cultural Practices.

(a) Crop rotation;
(b) Mixing crop varieties;
(c) Use of resistant varieties;
(d) Antagonistic/trap plants, e.g. Tagetes spp. Mustard, asparaagus, sesame; Crotalaria spp. Act as trap/antagonistic plants for nematodes;
(e) Use of clean stock;
(f) Inter-cropping;
(g) Correct choice of adjacent crops;
(h) Timely sowing and planting;
(i) Green manure/cover crops;
(j) Mulching;
(k) Over-planting or varying seeding rates;
(l) Fertilizer management;
(m) Selective weeding;
(n) Water management;
(o) Changing time of harvest.

(3) Integrated Pest Management(IPM)

This is the best combination of cultural, biological and chemical measures that provides the most cost effective, environmentally sound and socially acceptable method of managing diseases, insects, weeds and other pests under the circumstances in which they work. The guiding rules of IPM are:

a) only the pest should be killed by the control methods used
b) no part of the environment, plant or animal should suffer undue damage from the control methods
c) cultural methods, which prevent infestations, are preferred to chemical controls that cure infestations. Spraying and dusting are the last resort of crop protection, not the only means

d) planting of well adaptive native varieties should be undertakes to compensate the environment for plants cleared to make room for crops.

(4) Biological control agents

The natural enemies of pests and diseases should be protected and encouraged through proper habitat management (hedges, nesting sites, etc.), according to integrated pest management, and biological control systems.

7.3. Integrated Pest Management(IPM) and Integrated Crop Management(ICM)

WHAT IS IPM:?

IPM is the best combination of cultural, biological and chemical measures that provides the most cost effective, environmentally sound and socially acceptable method of managing diseases, insects, weeds, and other pests under the circumstances in which they work. IPM is designed to:

(a) Prevent insect numbers from increasing to levels where they destroy quality or yield of crops.

(b) Develop protection methods that use the existing natural controls.

(a) Combine cultural practices with carefully chosen sprays in a way that supports existing natural controls.

The quiding rules of IPM are:

1.Only the pest should be killed by the control methods used.

2.No part of the environment, plant or animal, should suffer undue damage from the control methods used.

3.Cultural controls, which prevent infestations are preferred to chemical controls, which cure infestations. Spraying and dusting are the last resort of crop protection, not the only means.

4.Plantings of well adaptive native varieties should be undertaken to compensate the environment for plants cleared to make room for crops.

NB: Natural forces limit insect populations more effectively than spray programs.

BASIC COMPONENTS OF AN IPM PROGRAMME:

A) **PREVENTION- INDIRECT MEASURES** :

These Limit or Prevent The Initial Build-Up Of Pest Infestations:

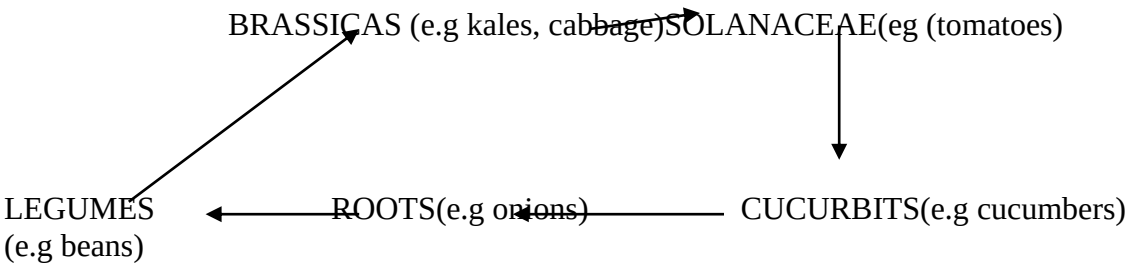
1. Location:

Crops and varieties should be grown in appropriate locations where they fit to climate, soil, and topography. This gives the crops optimal growing conditions from the start.

2. Crop rotation:

Growing different crops in a rotation reduces the build-up of certain pests especially those in the soil e.g. nematodes, root feeders and certain fungal pathogens. Rotation also reduce weed problems and increase the range of weed control methods that can be used,

including a better choice of herbicides to manage perennial weeds. The following is a suggested rotation program:



For intensive French bean production, a viable rotation is to have two F. bean crops and one cereal crop.

3. Cropping pattern.
Avoid planting alternative host crops alongside each other to reduce weed and disease or pest pressure.

4. Resistant varieties.
Use of disease and pest resistant varieties reduce the need for frequent application of crop protection products.

5.Ploughing.
Ploughing inverts the soil burying crop residue and and weeds. Birds pick up weed seeds, grubs and pupae exposed from deeper soil levels.

6. Crop hygiene.
The field should be kept free of weeds and crop residues should be destroyed (burn or take to animal pens). This reduces the build-up and carry-over of pest populations from one crop to another and survival of some pests to the next season is reduced.

7. Manuring & good fertilizer practice.
This adds fertility in the soil and helps produce healthy, disease resistant plants.

8.Irrigation
This reduces pest incidence e.g. flooding Riceland checks weeds. It however affects the survival of some soil inhabiting natural enemies.

9. Habitat management
Protection of natural habitats within the farm environment conserves many of the natural enemies of pests. Careful management of the margins of farm land and growing tree crops or hedges provide habitat, cover and refuge for beneficial insects and other animals

e.g. in rice paddies, field buds provide important refuges for predatory spiders which help control several important rice pests; and for snakes which control rats.

10. Trap crops
A pest can be attracted away from a valuable sensitive crop by another crop which suffers less damage if attacked e.g. Maize sown in rows every 10-15m across cotton fields attract bollworms during critical periods of crop development. Limited spraying then controls bollworms attracted to the maize.

11. Intercropping (barrier planting)
Growing two crops side by side creates obstacles for pests that can slow or even halt their progress across the field. This can be because barrier plant is too high or distasteful e.g. Cabbage moths avoid the scent of tomato plants. Also intercropping maize with beans improves soil fertility and reduces weeds.

12. Livestock
When allowed to eat crop residue or to forage, cattle and poultry add manure and reduce insect population by eating a good part of it.. Keep them in an enclosed place to be able to collect the dung+urine

13. Carry over of weed seeds and pathogens can be reduced by appropriate harvesting, seed cleaning and storage methods..

B) OBSERVATION- DECISION TOOLS:

These help to determine WHEN and WHAT action to take.

1.Crop monitoring

Management of any crop needs routine inspections to asses how well plants are growing and what actions need to be taken on cultivation's, fertiliser use, weed, pest and disease control, as well as when to harvest. Monitoring for pests is an important part of the need to "walk" through a crop.

2. Area – wide management

IPM requires collaborative decisions within a national or more localised area to provide effective control of pests. Some of these decisions need to be taken centrally by governments in relation to:

- Quarantine regulations and legislation.
- Provision and training of advisory services.
- Establishment of resistance management strategies against highly mobile pests and diseases on major crop systems.

Other decisions can be made by farmer associations.

NB: Many indirect prevention measures help to reduce pest pressure, but are unlikely to be sufficient on their own to eliminate the need for some form of intervention.

C) INTERVENTION – DIRECT MEASURES:

These reduce the effects of economically damaging pests populations to acceptable levels.

They include **mechanical, biological** and **chemical** control measures which may be applied individually or in combination, taking into consideration costs, benefits, timing, available labour force, machines/tools and control agents, as well as ecological and environmental effects.

1. Cultural and physical control

These include:

- Weed control by manual methods or tractor cultivation.
- Insect control by hand picking of egg masses or larvae.
- Removing infected plant debris.

Before including such methods in IPM recommendations their impact on yields (e.g. through root disturbance) and their requirements for family labour inputs need to be critically assessed. Recommendations must be practical. Also, possibility of integrating appropriate cultural techniques with judicious use of crop protection products should be explored (e.g. instead of replacing manual weeding entirely by herbicides, it may be better to use band treatments to control weeds close to the crop plants, but continue to hoe the central part of the inter-row space).

2. Biological control

This involves use of beneficial insects, mites, nematodes, etc and it works best when crops are grown in controlled environments (e.g. glasshouses and plastic channels) to ensure consistent report. Successful cases in open field conditions are like predatory mites against spider mites. Biological products are however often unreliable or not efficient enough in the field to be commercially used on their own. There's increasing interest in other biological products such as viruses, fungi and bacteria but they require similar technical expertise as chemical agents in relation to formulation, field application and resistance management.

Classical biological control (i.e. introduction of a predator or parasite for the control of a particular pest species) and inundative control (i.e. repeated mass release of a control agent) narrows down the number of candidate chemical control agents for IPM.

Bacillus thuringensis, a bacterium that occurs naturally, has been mass cultured and used to control pests (e.g. mosquitoes and caterpillar pests in vegetables, vineyards and orchards) has been one of the most successful biological control. The spectrum of activity is narrow compared with synthetic chemicals, and this is useful in IPM strategies.

3. Chemical control

With the present knowledge, the use of chemical control agents represents in many situations the most important and widespread means of achieving effective and reliable reduction of pest (disease, insect, weed and rodent) infestations. As such it's necessary to **reduce unnecessary exposure to crop protection products, improve standards of work practice and hygiene, limit residues in the environment, and harvested crops and avoid potential problems of pests resurgence and pesticide resistance.** Judicious

application of chemical products to minimise the risk of adverse effects is integral with the principles of IPM.

Make full use of naturally occurring beneficials by maintaining untreated refuges (e.g. hedgerows, field margins, or "island" habitats) where natural enemies live. Improved application techniques allowing lower use-rates of chemical controls offer some way of reducing exposure of beneficials. Avoid spray drift into refuges to reduce product contamination.

When should crop protection products be used ?

The severity of pest infestation varies and it's therefore better to monitor pest populations or the damage they cause before deciding to use a crop protection product when a certain threshold has been reached. This threshold is usually called the "economic threshold". It is defined as the pest population level that causes losses greater than the cost of controlling the pest.

"Action threshold" depends on the pest pressure and the stage of crop development when it occurs i.e. there is no need to control pests in a crop during the final stages of the crop because the yield is not affected.

How can a crop be monitored ?

Examining a crop by walking in the fields takes time but is an essential part of IPM. Farmers need to know what to look for , how frequent and over what part of the crop development. " Pest scouts" help in assessing pest populations.

Which products can be used in an IPM program ?

In developing an appropriate strategy of chemical control in IPM programs, it is essential to review the known product characteristics and costs of locally available products; then select those products which provide the most cost –effective treatment with minimal undesirable side effects (careful advice is needed in this).It is important to determine whether fewer applications of a more **selective**(less likely to affect natural enemies and non target organisms but are not widely available) but more expensive compound are actually more cost effective than a cheaper **broad – spectrum** compound which requires more applications.

Most commercially available products have a broad spectrum of activity. When reviewing the choice of such compounds in IPM programs it is important to distinguish between *intrinsic toxicity* and *bio-availability*. The toxicity of some broad spectrum compounds against natural enemies can be reduced by " behavioural selectivity" which limits their " bio-availability" against non-target organisms. For example:

- Where pesticides are highly systemic within the plant, localised treatments may keep contact between the active ingredient and non-plant eating organisms to a minimum.
- Compounds with translaminar penetration of leaves combined with fast degradation on the leaf surface can also be "selective".
- Products with short persistence or bio-availability can also be "selective" even though there could be an initial impact on beneficials.

- If care is taken in terms of use-rate applied and timing of the application(e.g. seed treatment) then the exposure of non-target organisms can be reduced.

In any IPM system the possible side effects of all crop protection products used should be taken into account e.g. ranking in terms of most toxic in insecticides or harmful in fungicides. It is also important to note that populations of beneficial species can recover quite quickly, even when broad spectrum products are used, particularly if they are easily degradable, by migration and recolonisation of sprayed areas at field margins. Such considerations should be taken into account when choosing a product.

The impact of broad spectrum products can be limited physically e.g. selective treatment with non-persistent pesticide in orchard crops). Part of a crop area is left untreated to allow natural enemies to survive and recolonise the treated areas. Another example is **band treatment** of fruit tree stems to prevent certain pests climbing into the upper canopy, or to restrict movement of predators so that beneficial insects can survive in fruit tree canopies.

- Take care of beneficial insects.
- Do not spray flowering crops when bees are busy pollinating.
- Do not spray field margins with insecticides and avoid drift onto hedgerows.
- Where possible, use selective products.

What use rate should be recommended ?
Ideally, the **minimum effective use-rate** of a product should be employed against a particular pest to provide adequate control. Use-rate moderation is likely to be most feasible where **partial pest resistance** of the host plant increases the susceptibility of the pest to chemical control agents.

7.3. Use of pesticides.

7.3.1 Conservation Farming emphasizes maximum use of integrated pest management techniques. Practices that protect and enhance the farm environment - with particular regard to conservation and wildlife - are encouraged.

7.3.2 Use of chemical pesticides is permitted ***IF, AND ONLY IF, THIS IS ABSOLUTELY NECESSARY!*** i.e. ***as a last resort!*** When used, this should be judiciously, effectively and safely done. Reduction on use of chemical pesticides is advocated in order to conserve natural resources and minimize pollution and damage to the environment.

7.3.3 Growers should scout for pests and diseases on a regular basis in order to reduce the frequency of spraying - which should only be done when there is an immediate threat to the crop.

7.3.4 Chemicals permitted in the scheme are given in appendix 3. All other chemicals registered by the Pest Control and Products Board (PCPB), but not included in the appendix are restricted, i.e. permission is required before they can be used. Or banned(Table 1)

While selecting the permitted pesticides, consideration was given to :-

(i) Chemicals approved by the Pest Control Products Board;
(ii) Toxicity class;
(iii) Approval by Governments worldwide;
(iv) Environmental compatibility;
(v) Effect on natural enemies;
(vi) Development of pest resistance;
(vii) Existence of carcinogenic effect;
(viii) Availability in the market;
(ix) Current usage by farmers.
(x) Type of formulation;
(xi) Specificity to particular pest; and
(xii) Range of pests, e.g. nematodes, mites, insect pests.

Pesticide products with low human and eco-toxicity, and low phytotoxicity (impact on the plant) are to be preferred.. Natural pesticides are allowed(Table 2). Nicotine is prohibited

7.3.5 When the use of pesticides is necessary :-

a) They must be used in accordance with the manufacturer's instructions - as per the label.
b) They should be used as responsibly as possible. Applications should be targeted and timed to achieve their full potential. Where possible, applications should be confined to the insect hot-spots or disease foci.
c) They should be chosen to avoid resistance build-up. e.g. rotation of pesticides for specific pests or diseases.
d) Where a choice exists, a product which will be safest to handle, and has least environmental impact, should be chosen.
e) The application of the chemical must be as efficient as possible, both in timeliness and in targeting.
f) APPROVED PRE-HARVEST INTERVALS - AFTER APPLICATION OF CHEMICALS - MUST BE ADHERED TO IN ORDER TO ENSURE THAT MAXIMUM RESIDUE LIMIT LEVELS ARE NOT EXCEEDED.

7.3.6 Samples may be taken and will be analyzed for the detection of prohibited chemicals and determination of maximum residue levels.

7.3.7 Pesticide containers and packaging materials must be safely disposed of. These must be kept out of reach of children and livestock and should never be used to contain water for human or animal use, food or feedstuffs. Where these are buried, this should be away from watercourses.

7.3.8 Spray operators, and any supporting staff, must :-

1. Receive, and always adhere to, complete instructions on precautions to observe before, during and after application.

2. Have personal protective equipment including :-
   - (i.) Respirator; with disposable filter, dated on installation and changed regularly,
   - (ii.) goggles,
   - (iii.) overalls; fully buttoned-up,
   - (iv.) gum boots,
   - (v.) impermeable gloves.

3. Be trained in - and always observe - proper disposal of pesticide waste and containers, hygiene and safety precautions.

7.3.9 Spray application machinery and implements must be appropriate to the job, regularly calibrated and serviced so as to apply chemicals accurately and avoid repairs during actual spraying operations.

7.3.10 Record sheets detailing each pesticide application to a particular crop and/or plot must be maintained The sheets must provide a complete treatment history for the crop together with a record of the pre-harvest interval following the last application. Pesticide application data should include :-

a) Product name.
b) Dates of application.
c) Pest(s) being controlled.
d) Quantity used and application rates.
e) Weather conditions.
f) Spray operator.
g) Pre-harvest interval.

7.3.10. Why some chemical preventions fail

1. poor timing of insecticide application
2. Improper selection of insecticide
3. Unfavourable weather conditions
4. Low rate of application
5. Equipment failure
6. Operator negligence

Note: Timing of application is the most important and probably the least attended of these factors

7.4. Safe use of agricultural chemicals

Agricultural chemicals help us increase production and quality of our produce. They can however be poisonous to both people and livestock. They can also destroy other useful animals and plants as well as the environment. It is therefore necessary to learn how to work with them safely without harming ourselves, livestock, crops and the environment.

A. WHAT TO CONSIDER WHEN BUYING AGRICULTURAL CHEMICALS.
There are many agricultural chemicals in the market and we should have the necessary information inorder to get the right chemical to solve our problems. Information must be obtained on:

- Recommended products, and if possible, dose rates, dilutions, timing and frequency of application, e.t.c.
- Methods of application.
- Precautions to be taken.
- Cost per unit area.

When buying the chemical, we should make sure that:

- The container is not damaged
- The container has a clear label
- The quantity of chemical bought should be used in one season.
- The chemical should be wrapped in plastic bags and should be kept away from food products at all times e.g. when being carried home.

B. HOW TO STORE AGRICULTURAL CHEMICALS ON THE FARM

1) Keep agricultural chemicals away from food items. Small quantities of chemicals should be kept in lockable boxes or cupboards. The chemicals must be kept away from children to prevent accidental poisoning.
2) Some agricultural chemicals easily catch fire and others produce poisonous gas when the temperature rises. These chemicals should be kept away from direct heat, fires, lamps and stoves.
3) The store/cupboard/box for the agricultural chemicals should always be kept clean and locked.
4) Stored agricultural chemicals should be checked regularly to make sure they are not expired.

C) TAKING CARE WHEN APPLYING AGRICULTURAL CHEMICALS:
Before using any agrochemical, make sure that you read and understand all the information on the label. The label should be taken care of and make sure it is not damaged. The information on the label includes:

- Manufacture and expiry date. Check these to avoid buying expired chemicals.
- Warning on how poisonous a chemical product is. Four colours are used:

(a) **A GREEN** colour shows that the product is not dangerous if properly handled.
(b) **A BLUE** colour shows a good amount of care is required when handling the product.
(c) **A YELLOW** colour shows that the product is moderately poisonous and must be handled with care.
(d) **A RED** colour which means that the product is very poisonous and must be handled with great care.

SAFETY PRECAUTIONS WHEN HANDLING THESE HIGHLY TOXIC PRODUCTS MUST BE STRICTLY OBSERVED:

- Directions on how to use the chemical product. This tells us the amount of chemical to be applied per given area and how often the chemical should be applied.
- This information is shown for every crop or livestock being treated. It also specifies the pests against which the chemical is effective.
- Quantity of chemical in the container is shown on the label and is useful when applying the product.
- Information on how we should take care during application of the chemical product; how we can prevent poisoning and how to handle a victim of poisoning.
- Information on the pre-harvest safety interval.
- Information on re-entry interval after treatment.

D. MIXING AGRICULTURAL CHEMICALS:

When applying agricultural chemicals always use the correct type of equipment. The equipment should be in good working order to avoid accidental spillage. The parts of a knapsack sprayer should be well maintained to prevent leakage. Avoid over-filling the sprayer.

Never use bare hands to scoop or stir the chemical. Measures should be used to scoop powders and stirring should be done using a stick.

Select a safe place for mixing the chemicals away from dwelling houses, sources of water, livestock and buildings where farm activities go on.

Use clean water for mixing chemicals, which should be filtered to prevent blocking of sprayer.

Wear protective clothing such as gloves, face masks, boots and apron as recommended on the label.

Follow the correct mixing procedure to have an effective solution e.g.
-Powders should be mixed out of the wind.
-Don't spray when the wind is too strong.
WARNING:
-Never use equipment used for application or mixing of chemicals for domestic purposes.
-Empty containers should be destroyed and should never be re-used for domestic use.

E. APPLYING AGRICULTURAL CHEMICALS:

Apply when it's not windy to prevent the chemical from being blown on to other crops, on the person applying it and on any other place where the chemical is not required. When applying, ensure the wind carries the drift away from you.

Don't spray when it's rainy to prevent the chemical being washed away.

Keep children and livestock away froms prayed fields.
<u>WARNIG</u>: **Children should never be allowed to apply agricultural chemicals.**

i) Conservation farming is being practised, efforts must be made to reduce the risk of spray-drift contamination.

ii) If you known or suspected spray-drift contamination must be notified to the certification body without delay.

G. USING PROPER PROTECTIVE CLOTHING:

Wear protective clothing when applying chemicals to cover arms, legs, head, face and shoulders. This prevents the chemical from coming into contact with skin and the eyes. It also prevents the person from breathing in any of the chemicals.

The following pieces of clothing are necessary for protection.
- **GOGGLES**
- **GUMBOOTS**
- **FACE MASK/SHIELD**
- **PROTECTIVE TROUSER**
- **GLOVES**
- **HAT/CAP**

Read the instructions on the label so that you can dress in the correct way for each type of chemical
Alternative clothing's are:
- Plastic bags to cover the body, hands, head and feet.

- Old clothes to cover the body
- Normal hats
- Handkerchiefs to cover the mouth and the nose
- Ordinary shoes

-Wash the clothing after every use. Plastic bags should only be used once.
-Always prevent any sort of direct contact with the pesticides.

- GUMBOOTS:

These should be made of rubber or neoprene because they do not absorb pesticides. They should be long enough to reach the knee or just below it. Other materials such as leather or canvas are unsafe because absorb pesticides.

- PROTECTIVE TROUSERS:

These should be worn to cover the boots inorder to prevent the chemical from flowing down the trousers and entering the boots.

- OVERALLS AND APRONS:-long sleeved.

Wear these on top of the ordinary clothes to get good protection from chemicals
Wear apron to cover the front and the sides of the body and it should be made to reach at least below the knees. It should be made from liquid proof material to prevent the overalls from soaking a lot of pesticide.

Wash the protective clothing regularly after every use in clean water and soap and then rinsed in a lot of water before being dried.
Never use torn overalls and aprons since they cannot give us full protection.

- PROTECTION OF EYE AND FACE:

Use goggles when mixing agricultural chemicals, filling tanks and when cleaning equipment. These protect the eyes from splashes at the time of opening the chemical containers, or when pouring mixed liquid pesticides. A face shield gives better protection. The goggles and face shields should be regularly cleaned with soap and plenty of water.

- GLOVES:

These should be worn if recommended on the label and they should be long enough to protect the whole hand and wrist.
Gloves made from leather or cloth are not suitable because they absorb pesticides.
Gloves should be washed both inside and outside then turned inside out to dry. Wash after every use with clean water and soap and then rinse with a lot of water before drying.
Make effort to read the instructions on the use of gloves for each type of pesticide to protect yourself properly.

- RESPIRATORS AND DUST MASKS:

These should be worn when applying very poisonous pesticides or dusty (powder) ones. They should also be washed regularly after use.
Change the cartridges when a bad smell passes through them or when breathing through them becomes difficult.

- HEADGEAR:

Wear a waterproof wide brimmed hat or a hard hat, which is fitted with a plastic sweat band. The hat should be regularly cleaned after use.

G. CARE IN GETTING RID OF EMPTY CHEMICAL CONTAINERS:

The following are some of the recommended ways of getting rid of the containers: -

- Plastic containers: Clean them three times with a lot of water and then make holes in them and burn or bury them deep in the ground. Making holes in them prevents people from using them.
- Metal containers: Wash with a lot of water first (three separate rinses) then make holes in them and bury them deep in the soil.
- Cardboard and paper containers: Burn these in a fire made in an open place away from crops and buildings used by people. Avoid breathing the smoke from burning chemical containers because it's poisonous.
- Glass containers: Break these into small pieces and then bury them deep in the ground.

Remaining agricultural pesticides remaining after mixing should be diluted and buried deep in the soil far from water sources to prevent water contermination. The hole should be at least 45cm deep.

When agricultural chemicals are accidentally spilt, sand, soil or sawdust should be used to absorb the chemical. These materials should then be swept away and buried in deep holes. If the affected area is concrete or wooden, it should be washed with water and soap.

H. CLEANING OF THE EQUIPMENT AFTER USE:

Clean all the equipment that has been used in handling agricultural chemicals i.e. sprayers, buckets, stirring rods, funnels e.t.c.

I. <u>FOLLOWING THE RULES OF HYGIENE:</u>

- Avoid eating, drinking or smoking when handling agricultural chemicals.
- Never suck or blow blocked nozzle or filter with your mouth to clear them. Use a piece of soft grass stem to unblock them.
- After applying the chemical, the person should:-

-Wash all the clothes used in spraying.
-Wash the body thoroughly with soap and water.

- If agricultural chemicals are accidentally spilt, the spill should be cleaned up immediately.

7.5 10 common sense practices for controlling pests and diseases

1. Field hygiene: Early ploughing in or burning of weeds and stubble directly after harvest as these often harbour pests and diseases. Any diseased plant material should be burnt.

2. Plant the best quality seed. This means that the seed should be a) disease free b) certified when possible

3. Select crops, which are best suited to the soil and climate. A crop not growing in an area does not mean that it cannot be grown there. But this is a good indication.

5. Control weeds. Grass and weeds compete strongly with crops for moisture and nutrients and they frequently harbour or attract insects which may later attack the crop and may also serve as disease reservoirs

6. Select plots of land that are fertile and well drained. Substantial land will produce substandard yields while poorly drained areas will invariably result in sparse stands, damping off and seed decay problems

7. Use only the best quality fertilisers. Soils tests will indicate what fertiliser combination is needed and whether liming is necessary. Promotion of vigorous plant growth: through use of manure, compost, fertiliser and irrigation to improve growth as well as helping the plant to resist diseases.

8. Use of disease resistant cultivars if they are available

9. When harvest is completed, destroy the remains of annual crops as soon as practical
8. Rotate crops. Planting the same crop year after year results in severe soil borne diseases and insect or nematode infestations. It prevents a build up of pests and diseases, which reduce, crop yields. The reasons for this are as follows:

a) Different crops have different insect pests, diseases and nematodes. Growing crops from the same family in succession encourages multiplication of insects, nematodes and diseases common to these crops. Crop rotation discourages this.
b) Crops differ in their nutrient requirements. Leafy crops such as vegetables require higher nitrogen while seed and fruit crops e.g grains need more potassium.
c) Different crops take up nutrients from different depths. Some e.g lettuce have shallow roots while others e.g beans and tomatoes have deep roots.

10. Follow recommended planting dates. This helps crops to mature before diseases strike.

11. If you buy plants, they should be disease free.

7.6. HORTICULTURAL INSECT PESTS AND DISEASES CONTROL

CROP	COMMON PESTS	RECOMMENDED CONTROL MEASURES		COMMON DISEASES	RECOMMENI
		Non-chemical	***Chemical***		***Non-chemical***
Soya beans	Aphids, white flies	Rotation, early planting, proper weeding	***Karate***	Fusarium leaf spot	As for pests
Carrots	Dusty beetle, caterpillars	Rotation, early planting	***Orthene, Karate***	Powdery mildew	Rotation, proper weeding
Tomatoes	Heliothis, RSM aphids, white flies	Rotation, timely planting esp. during the dry season	Dipel ZX WP Thuricide, Karate, Apollo	Blight, leaf spot, Fusarium	Rotation, regular picking
Sukuma	Aphids, white flies, cutworm	Rotation, weeding, regular harvesting	Orthene, Karate	Leaf spot, stem rot	Rotation, regular picking
Onions	Thrips, white flies, scales	Rotation, good weeding	Orthene, Karate	Leaf diseases, bulb rot, silvery leaf spot	Weeding, rotation
Cabbages	Cutworms, aphids, white flies	Weeding, rotation	Karate, Orthene	Leaf spot, stem rot	Rotation, timely picking
Eggplant	Aphids, white flies, RSM	Weeding, rotation	Karate, Decis	Blight, leaf spot	Rotation
Dania	White flies, aphids	Rotation, weeding, early planting	Orthene, Karate, Decis	Powdery mildew, leaf spot	Rotation
Sweet pepper	Aphids, white flies, Heliothis	Rotation, weeding, early planting	Orthene, Karate	Leaf spot, Fusarium	Rotation, weeding, timely pick

Spinach	Aphids, white flies, cutworms	Rotation, weeding, early planting	Karate (if necessary)	Leafs Alternaria	Rotation
Cucumber	Aphids,L/min or pumpkin flies	Rotation Staking Weeding	Orthene karate Apollo, omite	P/mildew D/mildew Leaf spots	Rotation Isolation
Squash	Aphids W/flies P/flies RSM	Rotation Weeding Regular harvest.	Orthene Karate Apollo Omite	P/mildew Alternaria Leaf spots	Rotation Isolation
Water melon	P/flies RSM Aphids W/flies	Rotation Isolation Weeding	Orthene Karate Apollo Omite	P/mildew Leaf spots Fusarium	Rotation Isolation
Leeks	Thrips W/flies	Weeding Rotation	Orthene Karate	Silvery leaf spot Alternaria	Rotation Isolation
Beetroot	Thrips W/flies Dusty beetle	Rotation Weeding Isolation	Orthene Karate	Leaf spot	Rotation
Hot chili	Aphids Giant roller W/flies	Rotation Weeding	Orthene Karate	Leaf spot Fusarium	Rotation Regular pick
Radish	Thrips Aphids W/flies	Rotation Weeding	Karate	Leaf spots	Rotation Timely pick
Lettuce	Aphids W/flies	Rotation Timely harvest Weeding	Orthane Karate	Leaf spots Stem base rot	Rotation Timely pick

Index:

CW =cutworm
RSM =Red spider mites
P/flies =Pumpkin flies
\+ =Very important
DM =Downy mildew
Note:

For tomatoes

- avoid long rains
- Don't plant near same family

7.7. Storage pest control

7.7.1 Pest control measures must be established and maintained to ensure that the premises are effectively protected against entry by wild birds and infestation by rodents and insects.

7.7.2 Pest and pathogen control should be achieved mainly by means of scrupulous cleaning procedures and hygiene.

7.7.3 In cases where further measures are required, control products used must not come into contact with the food products, and there must be no risk of contamination.

7.7.4 Substances used for rodent control must be properly labelled and stored under lock and key away from food when not in use.

7.7.5 Precise and up-to-date records must be kept of all pest control and fumigation measures taken.

7.7.6 Where fumigation of premises, plant or equipment is required, the treatment must be carried out under the supervision of a suitably qualified person or organisation.

5.5.7 Other control measures are:-

1) Carbon dioxide, Nitrogen, freezing and vacuum treatments for fumigating crops, raw materials, sacks and containers.

2) Mechanical/electrical/pheromone traps, barriers, sound and light to protect premises against entry and infestation by birds, rodents and insects.

3) Derris or Pyrethrum sprays and fogs for insect control.

4) Static bait traps using licensed poisons for rodent control in locations where there is no risk of contamination.

Part 8. Farmers own research for development

Conventional top-down research and development models are based on expensive external inputs which continue to be offered to farmers who find them unacceptable and/or unaffordable. These models have no mechanisms to incorporate farmers' skills and knowledge although experience has shown that farmers do have their own ideas and innovations with which they might experiment. Farmers also actively challenge and adapt innovations introduced by other actors such as farmers, researchers and extensionsists.

The instigation of on-farm research is important in helping to relate technical research to the practical needs of the farmers. Futhermore, the involvement of farmers in undertaking research adds a practical dimension to the assessment of what aspects are, and are not, of value to the smallholders. Active participation of farmers in the prioritization of commercially useful research activities is considered indispensable. To enable direct activity-related action in support of farmers' perceived needs it is necessary to:

- Create a demand for research by encouraging farmers to demonstrate, to themselves and others, the added value of testing out novel ideas and adapting existing methods to local situations
- Assure supply of research by encouraging research institutes to move beyond the production-supply side towards a more demand-led research programme that accommodate farmers in areas such as appropriated conservation farming techniques, low-cost affordable inputs to concentration of high value crops on small farms

Advantages

- The approach helps to build the farmers' confidence, tapping their potential for innovation and initiative
- It strengthens the links between indigenous and scientific knowledge
- It builds human capacity for self-reliance
- The approach helps in developing and testing the most suitable technologies for the community. For this reason, these technologies are likely to be adopted by quickly by other farmers
- Farmers participating on on-farm trials enables them to be involved in evaluating and selecting farm technologies right from the beginning.
- It develops farmers' analytical skills. After conducting one such trial with the guidance of outsiders, they will be encouraged to do further tests on their own
- It enables farmers to develop a sense of ownership of the technologies, since they choose which are to be promoted
- It provides researchers with valuable information about farmers' preference and problems they face

Disadvantages

- Farmers' organizations may find it difficult to get sufficient support from research stations and extension services to enable them to use this approach

- On-farm trials require considerable organizational skills, and may require literacy and numeracy. The farmer groups may lack these. Considerable guidance form researchers and extension staff may be needed
- Basic research skills are lacing in most of the farmers
- Record keeping is poorly done by most farmers

Part 9. Farmer to Farmer extension

Farmer's access to extension services and advice remains limited and generally the information delivered is inappropriate, There are too few researchers and extensionists that they are unable to cover the whole farming community. Farmer to farmer extension therefore refers to the process whereby farmers trained in a particular aspect of new innovation are able to pass and share their knowledge and experiences. If farmers are given opportunity, they make better extension workers to others. Other farmers become encouraged to adopt an innovation when they discuss and practice effectively. Farmers are enthusiastic when sharing their farming experiences. Adoptable technology on farming, once introduced , have to be disseminated effectively by farmers and there is no more effective way of technology transfer than one farmer showing another what works and what does not. Farmer to farmer extension has been carried out in different ways such as group exchange visits/ excursions, field days and demonstrations. The role of government and non-government extension service is:-

1. To identify and mobilize interested farmer trainers
2. To identify farmer groups and assess their training needs
3. To equip interested farmer trainers with a specialist tools
4. To provide backstopping during the training

The primary objectives of the farmer to farmer activity are:

1. To increase the accessibility of information and advice available within the farming community and reach a wide area
2. To stimulate the formation of critical groups of farmers that articulate the farmers' voice in discussions with external organizations.

Interested farmers/farmer groups to be trained in a particular aspect are only required to pay a small amount of training fee for the farmer trainer for services rendered to them

METHODS OF TRAINING ADULT LEARNERS.

1. Reasons for a trainer to know various training methods.

There are several motives why a trainer (NGO staff and /or farmer trainers) should be able to use several training methods for the adult farmer learners. They include:

- ☞ One training method can not be used for all training situations. It can be good for training one subject but inadequate in another situation. An example is, you can't train farmers on how to make a compost manure without necessarily demonstrating it.

- ☞ Knowledge of advantages and disadvantages of the various training methods enables a trainer to choose a better one in planning for the training.

☞ Use of various methods during a training session can encourage the trainees to learn better without getting bored and tired by one method.

Factors affecting selection of training methods.

The following variables influences the choice of training methods for training sessions.

- The training venue room available (big or small?).
- The number of learners/trainees in a given training session (large number or small?).
- Time available for the training (enough time or limited?).
- The skills of the trainer and the learners.
- Subject matter to be covered (is it long or short, theory or practical).
- The attitude of learners and the trainer towards the method.

2. <u>Types of training/teaching methods for adult learners.</u>

The following are three categories of training methods for adult learners.

(a). Presentation methods (examples are: Lecture method, demonstration method.)

(b). Interaction methods (examples are: group discussions, field trips / group exchange visits, role-plays, case studies etc)

(c). Independent study method.

Let us now examine each category of training methods in detail.

(a). **Presentation methods*<u>:</u>***

Presentation methods are used by a trainer for delivery of ***instructional information*** - where there is no participation by the learners.
In this method, the trainer passes over the information to learners by ***lectures, talking informally, writing on a chalkboard, use of demonstration etc.*** The learners on the other hand, watch and listen throughout.
It's advisable for a trainer using these methods to objectively obtain active participation or feedback from the learners. Failure to solicit this feedback can result to the trainer's talking voice becoming like traffic noise which the learners can quickly reject or ignore.

Let us therefore expound on a few of these presentation methods one by one.

(i). **Lecture method*<u>:</u>***

The lecture method is the most commonly used in transmitting information to adults.
It is usually used when addressing large groups of people.
The flow of the messages is one-way, that is, from the trainer to the learners.
Sometimes learners may be allowed to ask questions at the end of the presentation, but basically the learners are passive (quiet) during the entire lecturing session.

When to use the Lecture method.

☺ When giving information to a large number of people in a meeting/training session.

☺ When introducing a long series of activities to a large audience.

☺ When clarifying a point, explaining a problem, or directing learners on how to carry out a demonstration.

Things to consider for the benefit of adult learners when using a lecture method.

- The objective /aim of the lecture must be clear and specific, so that the learners will be able to follow the information presented. This will in effect avoid confusion.

- The lecture contents should not be too crowded for the time available. This will help the trainer not to rush to finish the material of the training due to shortage of time.

- The trainer should carefully introduce the training themes, provide evidence examples for arguments presented and conclude by a brief summary of the main lecture points.

- The trainer should complete the lecture presentation some minutes before the end of the scheduled session in order to allow the learners time to ask questions.

- During lecturing period, the trainer should give practical examples which are familiar to the learners.

- The trainer should speak boldly, loud and clear enough to be heard by everybody whether in a room, hall or field gathering.

- The lecture should be delivered in a language which the learners can understand easily, without the complications of difficult words/unfamiliar expressions. Avoid using *Sheng' language* with adult learners.

- The trainer should know his/her training subject matter well before attempting to start lecturing, lest you get ashamed before the learners.

- Where possible the trainer can use relevant training aids.

Likely problems when using the lecture method.

- ☞ If the trainer does not know the background of the learners, the lecture may fail to achieve its objective.

- ☞ Long lectures make learners to get tired, bored and may start sleeping and/or walking away, thus ignoring the importance of the message.

- ☞ The learners are denied the opportunity of feedback and/or asking questions especially in large meetings where every body may not participate.

- ☞ The trainer may be unclear or inaudible to most learners if the learning group is large.

- ☞ If training aids are not used, certain issues of the lecture may not be understood.

(ii). <u>Demonstration method.</u>

Like lecture method, demonstration method is another type of a presentation method.
The demonstration method differs from the lecture method in that, it seeks to make the learners practically apply certain skills and procedures in performing specified tasks.
This method is sometimes called 'teaching people how to do something' or 'teaching practical skills' to the learners by a trainer. It's highly used for training adult learners who do not read easily.
It can be used to train people in groups or to instruct one individual. For instance, the demonstration method can be used to train farmers how to prepare; double dug beds, seed beds, compost and harvesting of honey from beehives etc.

Types of Demonstration Methods.

There are two types of demonstration used in extension training – ***method demonstration*** and ***result demonstration.***

Method Demonstration:

Method demonstrations basically show farmers how to do something following step by step procedures. For instance, step by step procedure about how to plant seeds in a line, transplanting of crop seedlings, preparing a compost manure pile etc. The trainer here deals with those farmers who need practical skills of doing something by themselves.

Result Demonstration:

Result demonstration method in training is used to show that a certain skill/technology is practical and beneficial to the farmers. Making comparisons is the main element here - examples are; crop yields between use of compost manure and no compost, Rock phosphate and no rock phosphate etc. This method aims at fulfilling to the farmers the age-old expression t

hat "seeing is believing." Farmers who are adult learners will only have confidence in and adopt a new skill or technology only when they 'see' tangible good results. Farmers' Own research falls under this type of result demonstration.

Purpose of the demonstration method.

- To involve learners in the process of learning by watching the demonstration.
- To give them an opportunity to *practice* the skills to improve their performance and to correct their mistakes on the spot.

Trainers' Preparations before the Demonstration session.

☺ Decide what is the objective of the demonstration

☺ Establish why is the demonstration method the most suitable training method for the learners and the usefulness of the skills to be passed over to the learners.

☺ Decide how much can be taught at one session. If it is a difficult or lengthy task, don't try to complete it all in one session.

☺ Breakdown the tasks into steps, and clearly indicate what key steps are to be stressed.

☺ Opposite each 'step' list the key points - i.e. suggestions to the learners which will help them to do each part of the demonstration task correctly. Examples are;

- *Reasons* for doing a step in a particular way and not the other.
- *What to avoid* so that things may not go wrong.
- *Suggestions for substitutions* i.e. alternative materials to use for the same purpose.
- *Hints*, practical ways to help the learners do the task more easily.

☺ Check to see whether you have included all the steps necessary and all key points which will be helpful to the learners.

☺ Make sure that all needed training aids and materials are ready. For example, tools, materials and supplies needed for the demonstration.

☺ Decide and prepare the demonstration space properly, e.g. tables, equipment, tools, farm site etc.

☺ Know when is the demonstration to be held – i.e. convenient date and time for the farmers to attend without problems.

During the Demonstration day- what to do.

During the demonstration day, the trainer should report early enough at the venue. In case a farmer is assisting in the demonstration, the trainer should supervise him/her but not dominate and also encourage the other learners to participate as much as they can. During the whole exercise, the trainer should also do the following:

Welcome the participants: Make them feel at easy at the venue site and be ready to learn.

Explain the demonstration purpose: Tell them what is to be achieved by the end of the demonstration and the stages that are to be followed.

Conducting the demonstration: The trainer should conduct the demonstration or be ready to help the demonstrator farmer. Speak with loud and audible voice for all to hear, proceed at a pace the farmers can follow, be ready to repeat explanations and answer questions from the learners. Concentrate on the key points and explaining them step by step in simple words. Involve the farmers who wish to practice the skills.

Summarising main points: Towards the end, summarise all key points of the demonstration, encourage the learners to ask further questions and answer them.

Conclude the demonstration: Mainly this is giving a vote of thanks to all participants and with few comments of follow up activities planned, if any.

Advantages of the demonstration method.

- Demonstration method can easily clarify issues better than lectures or written method.
- The learner is given an opportunity to practice the skills under the trainer's directions. Errors here are corrected immediately.
- The learners apply both the senses of hearing and seeing to learn better.

Disadvantages of the demonstration method.

- The demonstration materials and equipment may be too bulky or immobile to bring to the training venue, e.g. a big and heavy solar drier. The learners thus may be forced relocate for the demonstration.
- It may be difficult to arrange for all learners (if many) to see, hear and practice the demonstrated skills.
- The method is limited to training only in practical rather than in theoretical subjects.
- Result demonstration type can take a long time – e.g. a season for the crops to mature.

(b). <u>Interaction methods:</u>

Interaction training approaches require *full participation of the learners and the trainer* during a training session.
These methods provide continuous feedback between the learners and the trainer.
Examples of these interaction methods are:
(a). Group work and group discussions.

(b). Role – plays.

(c). case studies.

Again, let us expound on a few of these interaction methods one by one.

(i). Group work and group discussion method.

This method is very appropriate in training adult learners. This is because the learners are encouraged to relate the already acquired knowledge and experiences to new ideas and situations as arranged by the trainer.

As they work on a given task together, the learners get an opportunity to re-examine some of the views they have held over time or re-evaluate their ways of doing certain tasks - in this way they may accept alternative ways of doing things (they learn).
In this method, the trainer does the role of a *facilitator not a teacher.*
The group method is effective in teaching/training learning objectives which involve feelings, attitudes and beliefs.
The important advantage of group methods is that each member of the group is challenged to make a contribution, of which he/she gets immediate feedback on its quality. This encourages self assessment which facilitates learning.

Steps of guiding learners for a group work/group discussions in a training session.

- Clearly explain the purpose or task of the group and be sure the procedure is understood by all participants.

- If the number of participants in a training session is large, organise several sub-groups for same or different but relevant tasks.

- Ask each group to appoint a leader from among themselves to help the group to work in an orderly manner. There should be another member of the group to record and report the views of the group. When all groups have finished discussions, the trainer should re-assemble all learners so that the groups presentations can take place in order to share findings and discuss together with the trainer.

- If one member dominates the discussions, the group method fails. The group leaders and/or the trainer should carefully deal with such people so that others contribute.

- As each group starts to work, each member should be given a chance to express his/her views or play his/her role in the group task.

- The members of the group should agree to differ as they contribute. However, the trainer should reach an agreement to these views so that the finished task is viewed as the overall group accomplished task.

- After the groups present, the trainer should give concluding comments tactfully without arrogance critique. This will avoid discouraging the learners' further contributions.

Other group methods for adult learners include:

- **Field trips/Tours:** This is simply a learning group exchange visit that is well co-ordinated by the trainer. The trainer facilitates the learners to visit a given learning situation of interest. The purpose of the method is to observe and learn certain vital knowledge from a real life situation. Farmers like to visit others in different parts to see how they work, what they grow, kinds of problems faced and how they are tackled there in order to learn by sharing. Careful prior planning is a must for a successful field trip. The trainer should plan for the trip costs, time frame, and inform the learners about the purpose of the visit and the types of things to observe so that the learners don't get distracted and carried away by other exciting things outside the scope of the visit purpose. Field trips are appropriate methods for farmers to learn.

Things to do before the field day tour.

- Visit the area first to become familiar with the local conditions, the farms to be visited, the route and general road condition.

- Limit the tour to what is possible. It is better to do a short tour in which visitors can have a good look at the farms and share with the people of the area.

- Encourage the host farmers as you visit the area initially, to do all the explaining and to take charge of the tour. As a facilitator, the trainer here can only guide if need be.

- Arrange for food and drinks during the tour for the participants.

- Conclude the tour with a short summary of the main events and note any comments or conclusions reached.

- Finally thank all participants for their coming and taking part in the tour. Encourage them to apply the acquired knowledge and spread it to others after returning home.

- **Panel discussion:** Here three or four resource people discuss a topic in the presence of the learning group. Each of the panellists will give his/her views, while the other learners/audience ask questions or contributes other views. Adults feel very free to exchange views and thus learn in such an atmosphere.

- **Symposium:** Here again three or four resource people present papers on a given theme/topic. Although the learning interaction process is the same as in the panel discussion, more in depth information can be communicated by this method. The method is hence more structured than the panel discussion.

(ii). Role-play Method.

Role play is an interaction type of a teaching/training method in which an actual life situation is dramatised. Examples could be: how to contact a committee meeting.

The role play involves a small group out of all the class of members, who act in different play roles. The rest of the learners carefully watch and follow the drama and when its over a discussion session follows under the trainer's facilitation.

The method provides an excellent opportunity for the learner participation and involvement in the learning situation. However it can be disastrous if it is not properly planed for.

Things to consider when organising a role-play:

- Define what is to be achieved at the end of the lesson via the role play. The aim of the role-play session should be made clear to the participants, so that the role-players can portray situations accurately. This is important because if not, the role-play can easily turn into an entertainment which may later prove irrelevant to the training and learning objective.

- The actors should be selected on a voluntary basis. The trainer should not force them to act roles they either do not understand well or are unable to properly portray.

- The trainer should let the other learners(audience) to know what they are supposed to observe as they watch and listen during the role-play. This will enable easy discussion after the drama.

- The actors should be given enough time to discuss their roles before the actual performance of the role-play.

- The drama should not be allowed to be too long lest it might fail to give the desired impression. Care should be taken in determining how long it should be.

- At the end of the play session, the trainer and all the learners should discuss the performance within the context of the theme of the role-play. If there is a need for a repeat session, another role-play group should be given the opportunity to try.

How to facilitate the discussion after the role-play:

The trainer should ensure that the discussions after the role-play progresses *systematically* with the help of a sequence of *SPECIAL QUESTIONS.* They include:

☺ "What specific things or people did you ***see*** in the role play?" (Make sure that these objective elements were correctly recognised by the learners.)

☺ "What do you think was ***Happening?" (*** That is, did the learners recognise the specific dramatised/posed objective?)

☺ "Does this issue happen in ***our*** life?" (This question personalises the dramatised situation.)

☺ "If it happens, ***Why*** does it happen – what are the *causes* of this situation?" (This discussion will dig deeper and deeper as one ***"why?"*** leads to another *"why?"* concerning the contributory factors.)

☺ "What are the side-effects/results/complications of this issue in our lives?"

☺ "What are the ***possible solutions*** which we ourselves can carry out to normalise the situation?" (This question is mainly asked if the drama posed a problem affecting lives of people. The suggested solutions are later translated into an interaction plan).

Thus by using these questions and perhaps others in an inductive process, the learners discovers as much as possible within their *own thinking.* In this case, the learners discover their self-worth when they are taken seriously by the trainer and hence feel motivated. However, some of them cannot be self-discovered by the learners but have to come from outside e.g. the gospel message of Jesus Christ has to be preached to people.

(iii). **The case – study method.**

The case study method is a training approach in which the learners are presented with an issue/topic for discussion derived from previous events involving other people. It is a very effective training strategy for adult learners, so long as challenging and interesting case studies are selected for the learners.

The method emphasises the importance of facts, their analysis, synthesis and evaluation. The method is also vital in changing attitudes and provides a background in which other learner participants are encouraged to be actively involved in learning as they discuss the case-study – e.g. a farmer giving his/her experience of increasing soil fertility and crop yields after applying rock phosphate - organic fertiliser in his/her farm.

A case study can be real or imagined. It can be presented in a written form, in a speech, in a role play, in a drama, in a film or a slide.

After the case study has been given, a well facilitated discussion should follow so that the learners can analyse and discuss the key issues presented.

Importance of using case study method in training adult learners.

- To reveal the problems and issues to the learners found in a particular situation.
- To help learners understand the various alternative solutions to a problem.
- To help the learners to develop problem-solving skills for their own situations.
- To help the learners to learn through other people's experiences.

A good case study should:

- Be short and relevant to the learner's training goals.
- Be within the learner's knowledge and experiences.
- Pose a practical problem/issue to the learners.
- Have been pre-evaluated by the trainer and found to be relevant and simple.
- Contain clearly stated themes which generate active participation during the discussion, thus promoting efficient teamwork in the learning session.

(c). Independent study methods.

Unlike the presentation and interaction group of methods which involve the presence of both the learners and the trainer in a learning situation, the independent study methods require that the learners work on their own. For example in their farms (as they implement the acquired skills), on an independent learning activity they have chosen (like farmers own research trials) etc.

The trainer should ensure that some key issues are okay before allowing the learners to use this method. For instance, the learners should clearly know what to do, maintain high self-discipline as they work alone and that there is availability of learning resources in the learners' environment.

The method has great advantages to the learners because it permits them to study at their own pace, pursue a subject of their interest and achieve what they consider to be sufficient depth in knowledge and skill performance (e.g. educating farmers using ABLH newsletters, fliers). This is hard in a group training situation.

Use of training Aids and Materials during training.

Adult trainers should be able to select the right method for various training situations. Then next, they should be able to appropriately use the selected training aids well. The aids can be either audio (passing information by hearing) or visual (by seeing with eyes).

Training materials mainly include key training stationary – e.g. brown papers, mark pens, portable blackboard, chalks, masking tapes, exercise books, pens, plain cards, stickers, and other materials depending on the training objective. On the other hand, training aids refers mainly to tools/equipment needed for demonstration purposes during a training session – e.g. mark forks, Jembe, cutlass, etc. Training aids and materials used in a given training session will be influenced by the training objectives to be achieved.

Often, trainers tend to take too much time talking and explaining training issues while a good picture or a model or demonstrating certain items and skills could say it more accurately and in a much shorter time – and of course without boring the trainees!

Why use Training Aids during Training sessions?

- Proper use of training aids invites the participation of trainees and hence taps their experiences during the training session.

- The training aids make the learning session more real and meaningful. Real and meaningful learning situations greatly interest many adult trainees opening them to learn

- Since adult learners have very little time to spare for studies, thus training aids help them to learn as much as possible in the short time that they can spare. They will then hope to retain and remember what they learn for as long as possible.

- Studies done by Psychologists tell us that;

We learn	11% through <u>hearing.</u>
	83% through <u>sight.</u>
We retain	20% of what <u>we hear.</u>
	50% of what <u>we see</u> and <u>hear.</u>

<u>NB.</u>
The above information tells us that learning and retention is improved when more than one human sense is involved. This is particularly encouraged in adult training because as you get old, one or more senses may be weak. The use of several will re-enforce all the senses for better learning of the adult trainees.

Some Guides to the use of Training Aids.

1. **Operation of the training Aids.**
The trainer should be in a position to properly use/demonstrate specific training aids s/he has chosen to enhance the training effectiveness. If s/he does not, a person who knows to operate it should be available to assist.

2. **Proper planning.**
The trainer should check and pre-test all the selected training aids before they are used for the training session in order to ensure that they are in good condition. S/he must also establish beforehand that the training aids chosen serve the exact purpose of the training.

3. **Define the Training Aids.**
The trainer should define each of the training aids used and their respective purpose to the trainees before using them.

4. **Learners Participation.**
The trainer should encourage the adult learners' participation while using training aids.

5. **Visibility.**
All training aids being used in a training session should be visible to all learners, whether sitting or standing in a learning situation.

6. **Variation of the Aids.**
Varied types of training aids should be used where applicable and are easily available.

Principles governing selection and use of training Aids and materials.

The actual selection and consequent usage of any given training materials and aids will be determined by a number of training factors. The following are some of the guiding principles.

- **Real need for the training materials /aids.**

Trainers should note that, not all learning situations require usage of training materials/aids. It is always therefore good to determine in advance whether a real need exists for the usage of any training material/aid in a learning situation.

If a training material/aid is found worthy using in a learning situation, it is thus important to determine at what stage of learning the training material/aid is needed. Is at the:

- Development of the topic?
- The actual training of the topic?
- Summary and revision of the topic?

- **Appropriateness of the Training Materials/Aids.**

For the training session and its objective(s) to be effective and successful, the trainer should carefully select the appropriate training materials/aids s/he is going to use. The materials can not train by themselves but will make good training better.

- ***Availability of training Materials/Aids.***

The trainer has the responsibility to make sure that the needed training aid/material is:

- Available at the training site or
- Easily obtainable or
- Can easily be made from available local materials

Qualities of a good trainer.

A good trainer, and especially those involved in training adult learners, should portray the following qualities.

- Language used. The trainer should be able to properly use the language that all the learners will understand. Kiswahili or the local language dialect is recommended especially for rural communities.

- Communication. The trainers should have the ability of translating the technical language of specialists into words that are familiar to the learners. The need to learn and apply what words and phrases farmers use when talking about their farming activities is important to the trainers. Ability to communicate well is a key in training.

- Listening. Listening to the farmers during training is good. A trainer who does not listen to the farmers and engage in a dialogue with them is likely to be ineffective in his training. In his case, the learners know that the trainer is interested in them and they will be more likely to pay attention to what he trains on.

- Technical Knowledge. It is good for the trainer to have adequate working technical knowledge in the field of his/her training – e.g. bee keeping, conservation farming, solar drier making, simple food processing etc. Should understand the subject well.

- Adult Education. It is important for the trainers to be familiar with the main approaches to adult education. This is because most of the rural communities are adults, and they learn differently from the school children. This can be acquired through training of trainers.

- Commitment. The adult trainer should be committed to extension work with a sense of dedication and determination to get some extension activities (training of farmers) going when needed.

- An example to follow. This is more so to the farmer trainers. They should inspire confidence and trust in the farmers they train – i.e. set themselves an example and take the lead in initiating activities. They should be practising what they train on.

- Reliability. The trainers should be seen to be reliable by the farmers who demand training skills from them – in terms of carrying out a standard training work and good relations with farmers. Should also be able to work alone with little supervision.

- Humility. The trainers must do the training with sensitivity to the wishes and feelings of the farmers. They should respect the farmers as people who have knowledge (ITK) and good ideas to contribute during the training.

for understanding of the Learners.

In any given training activity, there are four important elements of whatever is communicated in the training venue. These are:

- The **message** – the information or idea that is communicated;
- The **source** – where the message comes from;
- The **channel** – the method in which the message is transmitted;
- The **receiver** – the people for whom the message is intended to reach.

In ABLH, the above elements comprise of the following:

The **source:** Developmenta**l a**gency s the source through Technical extension services of the staff and allied collaborators and farmer trainers as the local resource people.

The **Message:** information about developmental agency keeping, conservation farming, simple food Processing, IPM, farm record keeping, business plan writing etc.

The **Channel:** This comprises the different adult training methods highlighted herein.

The **receiver:** This is mainly the small holder farmers who are working with developmental agency. The receiver could also be other farmers who are not necessarily working with developmental agency.

It is very important for any extension officer – whether an ABLH staff and/or a farmer trainer to have a good background of the receivers of their service – the farmers. It is not good to go to train a group of farmers about bee keeping when the trainer has not talked with the farmers to assess their background information on bee keeping. By talking with the farmers first, the trainer will be able to know, for example;

☺ What specific information the farmers want or need from the trainer.

☺ What information can those farmers make use of after training.

☺ How much do the farmers already know about the particular topic.

☺ The attitudes the farmers have concerning the topic – positive or negative?

☺ Should the farmers' attitudes be strengthened (if positive) or should an attempt be made to change them (if negative) during the training?

☺ What do the learners want to do with the skills after the training – i.e. the application.

In brief, a prior understanding of the learners (the receiver of the message) before the training is crucial to any trainer. One will be able to design the content of the training message to meet the need(s) of the learner. A balance should be achieved between what the receivers want to know and what the source feels the receiver ought to know. Again the trainer will establish the best communication channel that the receiver will understand and take notice of.

Pr About the Learner.

I repeat again, as a trainer, you can not prepare for an effective training session for farmers unless you first analyze their needs – their background.

Suppose you are asked to go and train a group of farmers about bee keeping in a certain village. You might go there with well prepared notes about bee keeping in general, only to find that the farmers specific need is only about harvesting and simple honey processing! What will you do? You will be forced to change your training topics and notes. If you don't, then you'll start training on things they already know and they will be bored and some may walk away! Clearly you will be wasting their time. As a trainer you may get confused and frustrated.

Let us now highlight some of the learners general characteristics that can affect learning if the trainer do not know them in time and act accordingly.

Broad Characteristics of the Adult Learners.

Characteristics and how they affect adult learning.	**What should be done.**
Physical Characteristics: ❑ *Defective eye-sight:* This makes the learner strain the eyes in looking at faint writing. This discourages learning.	❑ All illustrations and writings must be made very big and clear.
❑ *Defective hearing:* This makes the learner not to follow inaudible explanations.	❑ Speak boldly and audibly so that each person understands what is being said.

❑ *Stiff muscles:* This interfere with vigorous movements e.g. ice breaker exercises, field walks, practical demonstrations etc.	❑ Avoid exercise which involves vigorous movements if possible.
❑ *Sitting arrangements:* If learners sit uncomfortably, they may not learn well. Also if the sitting arrangement portray the trainer as the boss (chief) and learners as subjects (listeners) participation by learners will not be achieved.	❑ Try to make sure each learner sits comfortably on the chairs and/or on the ground in the field. ❑ Make the sitting arrangement be in a semi-circle – this promotes oneness and there is eye sight contact for all during learning.
Local Intellectual Characteristics: Adult learners have: ❑ Important and wide experiences in life.	❑ Integrate their experiences (ITK) into learning process. Don't ignore them.
❑ Rigid attitudes about the way they perceive knowledge. They don't easily change even after the training. They tend to say the old is better.	❑ Discuss with the learners about their different attitudes and the need for attitude change where possible.
❑ Talents and abilities which they may not be applying. ❑ Poor memory because of lack of constant practice.	❑ Encourage active participation, discussions and make the learners do things practically.
❑ Expectations to make immediate use of the knowledge acquired.	❑ Try to meet their expectations by addressing their training needs and making the training functional.
❑ Tendency to learn slowly and also very little at a time.	❑ Have short training content and train them by key points only. Avoid stories.
Social /cultural Characteristics: All adult learners have: ❑ Social responsibilities taking their time both in the family and in the community.	❑ Take individual responsibilities into account when training. Consider their busy schedules while making the training timetable.
❑ Most of them have strong personal ego or self esteem.	❑ Respect the way people feel about themselves. Don't look down upon them.
❑ Each has different attitudes and beliefs and is busy.	❑ Involve the learners in decision making about their learning.
❑ NB. If the above characteristics are not taken into account, the learner will simply stay away.	❑ Make learning an interesting experience.

INDUCTIVE LEARNING APPROACH FOR ADULT LEARNERS.

(THE LePSA APPROACH.)

Introduction.
AID agencies can deliver materials to communities like vaccines, water pumps, ploughs, farm implements et cetera,but they can't deliver attitudes. Outsiders can only *cultivate attitudes;* such cultivation is possible only through apt communication. The word communication implies a two-way exchange, as contrasted with the one-way delivery of a lecture.The first[dialoque] takes place *WITH people*, while the second[lecture] is *AT them. ''With''* can stand for the so called *Inductive approach* – the approach used by Jesus, Socrates and other soceity changers. On the other hand, the word *''AT''* can stand for the didactic, prescritive or lecture approach --- the way that mostof us received much of our trainings.

The acronym LePSA is a mnemonic, representing four important features of inductive or *''with''* approach to learning. These are:
Learner-centeredness
Problem- posing
Self-discovery
Action-oriented

THE **LePSA** LEARNING IN A COMMUNITY.

LePSA is not a new educational method. It is simply an acronym for remembering four important features of the inductive process.

1. The **L** in LePSA stands for a **LEARNER-CENTERED** teaching/learning situation. This means starting where the learners are at. How? ---by:

- providing for everyone to be seated in a circle, everyone having EYE-CONTACT with every one else.

- Seeing that everyone is comfortable in mind and body - a good learning ATMOSPHERE

- Taking time for greetings, news and generally building positive ATTITUDES.

- sing personal NAMES (i.e., ''Anna, what do you think?').

- Quoting the learners' personal OPINIONS (i.e., ''Anna says that . . . . . .'').

- Seeing that EVERYONE CONTRIBUTES something to every discussion.

- Seeing that the problem is often REFERRED BACK to the learners for concentrated discussions—‘‘buzzing like bees, in twos and threes.’’

- Eliciting and enhancing whatever AGREEMENTS develop.

- Using DISAGREEMENTS in a careful, constructive way to sharpen group thinking.

2. The **P** in LePSA stands for **PROBLEM-POSING.**

- Build each lesson around a SIMPLE, SPECIFIC, SENSITIVE, SOLVABLE PROBLEM [SSSS].

- DO NOT GIVE THE SOLUTION to the problem; that is for the learners to ‘‘self-discover’’ as much as possible.

- POSE or present that problem in a simle, clear, STIMULATING way. Use starters like a story, play, demonstration, picture, song, dance or other viable stimulating medium for the problem. Remember, do not give the solution.

- Make the posed problem a STARTER (or even ‘‘startler’’) of discussion or brainstorming.

- Stimulate the discussion with various TYPES OF QUESTIONS. These may be direct, open-ended, reflective, probing or ‘‘bounce,’’ according to the way they are phrased.

- Ensure that the LePSA discussion progresses systematically with the help of a sequence of SPECIAL QUESTIONS. In the text which follows these questions are marked with an asterix(*). Here are first three of those questions:

  * ‘‘What specific things or people did you **S**ee in the starter ?’’ (Make sure that these objective elements were correctly recognized.)

  * ‘‘What was **H**appening ?’’ (Find whether the specific posed problem was recognized as a problem)

  * ‘‘Does this problem happen in **O**ur place or situation ?’’ (This question personalizes the problem.

3. The **S** in LePSA stands for **SELF-DISCOVERY.** (It may also sometimes stand for ‘‘strungle-discovery.’’)

   - A further pair of special questions keeps the discussion progressing towards the learner’s self-discovery of:

* ‘‘**W**hy does ithappen--- what are the causes of this problem?’’ (The discussion will dig deeper and deeper as one ‘‘why ?’’ leads to another ‘‘why ?’’ concerning *contributory factors.*

* ‘‘**W**hat are the side-effects or *complications* ?’’

* ‘‘**W**hat are the possible *solutions* which we ourselves can carry out in the community?’’

- Through dialoque(using these questions in an inductive process) the learner discovers as much as possible within his/her OWN THINKING what are the multiple causes of and the relevant solutions to the proposed problem. (Some information can not be self-discovered; it must come from outside as input. Examples: the gospel message or the proper dose of chloroquin.)

- Such a discovery lesson will result in the learnee exclaiming ‘‘AHA!!!’’, and having a positive ‘‘aha-attitude’’ towards the posed problem.

- The learner also discovers his/her own SELF-WORTH when he/she is taken seriously by the teacher and the other learners. The more sense of self-worth a person has the more that person will be willing to take the risk of trying new ways to be healthy.

- This self-discovery of solutions and discovery of one’s self-worth is the match which ignites the fire of MOTIVATION.

4. The **A**in LePSA stands for **ACTION-ORIENTED.**

- Good teaching is helping people LEARN TO DO something.

- That ‘‘something’’ is to actually SOLVE the specific problem which was stimulatingly posed in the lesson.

- So the lesson is not complete until learners have made ACTION PLANS for implementing that solution in their own community.

NB

Note the sequence of special questions above , those marked with an asterisk(*). Notice the **emphasized letter** in each special question. Think of those single underlined letters in sequence and fill in the blanks below.

---------- ---------- ---------- ----------(This letter stands for three Qs)

In combination with the stimulating ‘‘starter,’’ these questions **‘‘SHOW’’** the way to getting the posed problem solved in that community, by that community. This is community based problem solving

Part 10. Animal integration-its role in conservation farming system

10.1. Beekeeping

Beekeeping is the art of managing bees in order to obtain honey and beewax for both food and income. Beekeeping can be carried out by men and women of any age. It is also an ideal activity for farmer groups as an income generating activity. Beekeeping requires little space and compliments other activities. The benefits for keeping bees are:-
i) Honey contains sugars(80-85%) that are easily absorbed by the body and acts as a very good source of energy giving human food. The honey has medicinal properties- used as a cough syrup and sweetening agent of drugs, treatment of wounds, ulcers, and sore throat. Honey has high market value for making local beer and also a food preservative hence good source of income. Honey is used to feed dairy cows that produce high milk when feed on . Also used to feed race horsed, donkeys, poultry, and fish. It is also used to treat cows for acetomenia disease.
ii) Pollination services- honey bees obtain nectar and pollen from plants and in return provide essential pollination services by transfer of pollen form one plant to another, therefore playing a great role of increasing the yield our agricultural crops.

iii) Bee wax- a substance bees use to make their combs and is secreted by specific wax glands on the abdomen of worker bees and is used in cosmetics, soaps, preserving leather and wood, shoe polish, ointments, making candles and electrical apparatus

iii) Propolis- Propolis is a resin that bees collect from plants. It is black and sticky. Bees use it to cover the inside of the hive and fill in the cracks. It is antibiotic and is used as a medicine. If you chew propolis it is bitter, but it is good for the throat and the chest.

In the beehive the mother is called the Queen and the father is called the Drone. The third type(or caste0 of bee is the Worker which is actually an immature female.

i) Queen bee(Diagram)

The queen is a sexually mature female. There is only one queen in the hive and her job is to lay eggs which hatch into other bees. She can lay up to 2,000 eggs per day. She may be hard to find in the hive but recognise her by her length. She is long and slender and her wings only reach half way down her back. She is far bigger than the numerous workers, but do not confuse her with the drones.

i)Drone (Diagram)

There can be several hundred drones in a hive. The number depends on the time of the year. In times of food shortage, the drones are thrown out of the hive by the workers. When a new queen starts life she mates only once with up to 10 drones outside the hive, high up in the air. Drones have very large eyes which are used to spot the queen during mating. The drones' major task is to mate. They have no sting. Drones look large and square and make a loud buzzing noise when they fly.

iii) Workers (Diagram)

Most of the bees in the hive are workers and they do all the work. Workers collect the honeny/pollen/propolis, feed the young and guard the hive. They have a sting. Workers can number up to 60,000 in a very strong colony(hive) of bees

iii) The young (Brood)
Diagrams

When the queen lays an egg it looks like a grain of rice. To see the eggs hold combs from the centre of the brood nest(at the centre of the hive) up to the light. The egg develops into larvae which looks like a white maggot. The larvae are fed on pollen/honey. Pollen is the powdery substance produced by the anther of flowers and is rich in protein. Pollen is the coloured substance seen on bees' legs and stored in the combs. The larvae is later sealed in the comb where it turns into an adult bee. During this changing process it is called a pupae. Thus there are three stages to adulthood: egg-larvae-pupae-adult.

Basics of beekeeping

Hives
A hive is the box or container where the bees live. Different types of hives are used in beekeeping. Here are some of:-
i) Pot hives(clay pots)
ii)log hives
iii)basket hives
iv)Kenya Top Bar Hive(KTBH)
v)Langstroth hives(uses frames

Log hives are made from hollowed out tree trunks
Basket hives are made from woven sticks which are smeared with mud

The Kenya Top Bar hive(KTBH)

You have copy exactly the measurements that is given. When it comes to bee management, it is important that all your hives are the same size.

Diagram

Both KTBH and mud/stick hive are an improvement of the traditional log and basket hives because with top bars combs are moveable. This allows management of bees. Top bar hives are not expensive or difficult to manage, which makes them more suitable for use by small scale farmers. It is important to shelter hives from heavy rains.

The mud/stick hive
Diagram

Sitting the apiary

An apiary is a place where hives are kept. Try and keep a limit of not more than 20 hives per apiary depending on the availability of bee forage. Bees forage in a radius of 3 Km from the apiary so if you want to keep more than 20 hives find another apiary site 3 or more Kms from away from existing apiary. Plant a good high hedge around your apiary using a shrub such as Keiapple. The hedge separates bees from people and animals. If you live in a hot area your hives will need shade as well as water. If you live in a cool area, such as highlands, only minimal shade is required or the bees will be cold and damp. An ideal site to set an apiary would be :
i) Away from human/livestock dwellings, roads and public areas
ii)Safe from strong direct sunshine, windy areas and theft
iii) Accessible to water and bee plants nearby
iv)way from swampy areas and smelly places
v)Near a good source of nectar such as forest/trees/nectar bearing crops

If you do not want to hang the hives, you can place them on stands. It is best to use this method for the mud hive as it is not strong enough to hang. The stand should be sturdy enough for the hive to be at waist height. Put the legs of the stand in cans of used engine oil to prevent pests getting into the hive. Hives on stands are more prone to attack by the honey badger. Putting a umber of hives under a shelter or into a beer house is also an option. Just make sure that the bees have a way of getting in and out to the hives. A bee house is useful because it can be locked to prevent thieves stealing the honey. A bee house can be a simple mud hut with holes in the walls for bees to come and go.

General apiary management

1. Keep the apiary clean: cut grass short and trim branches that reach the hives to prevent pests like ants from crawling into hives and disturbing the bees
2. Grease wires holding hives to keep off crawling pests-particularly ants
3. Do not make noise around the apiary, particularly machinery, as it can agitate bees
4. Supplement the bees source of nectar by planting certain plants around the apiary, i. E. bananas, sunflower, mango trees, citrus, coffee, eucalyptus, pawpaw, passion fruits, croton, Acacia, bottle brush,and calliandra etc. Trees will also give shade to the bees and provide a screen between them and people and animals.

5. Remove old combs from the hive. This helps to prevent wax moth damage.
6. Do not spill honey near the apiary. It will attract pests and cause the bees to fight with their neighbours(bees form other nearby hives)
7. Inspect hives regularly to monitor the progress of the bees and unsure no pests are attacking them
8. When the bees are making honey, inspect the hives once a week by opening them up. At another time inspect hives every month. Simply looking at the hives(without opening them) can be done almost daily.
9. Observing the bees for a few minutes can tell you a lot. Are the bees collecting pollen?(this is the coloured substance on the legs of workers). If they are, it indicates that the bees feeding the young. It shows that the bees are healthy and have laying queen

10.2 HONEY PRODUCTION.

10.2.1 Hive management and honey extraction methods should be aimed at preserving the colony and sustaining it. The colony must not be destroyed when the honey is harvested.

10.2.2. Selective breeding may be practised.

10.2.3 Artificial insemination is prohited.

10.2.4. Permitted

1) Wing clipping of queens.

2) Biotechnical methods, formic acid fumigation and lactic acid sprays are permitted to control Varroa mite - no withdrawal period necessary.
3). Chemical medicinal treatments of the bees, only when the health of the colony is threatened

10.3. HONEY PROCESSING.

10.3.1 Honey shall not be heated, handled, or stored in such a way as to alter its taste, colour, smell and flavour.

10.3.2 When visually inspected, the honey shall be free from foreign matter such as dirt, scum, beeswax, or any other extraneous matter.

10.3.3. Honey shall not: -

1) Show any signs of fermentation or effervescence;
2) Contain natural plant toxins which may constitute a hazard to health;
3) Contain any added substances either in the form of additions or additives.

10.3.4 The acidity of honey shall not be changed artificially.

10.3.4 Honey shall comply with the requirements prescribed below: -

SPECIFIC REQUIREMENTS FOR HONEY.

	CHARACTERISTIC		***REQUIREMENT***
1	Relative density (S.G); Minimum		1.37
2	Moisture, percent by mass; maximum		20
3	Total reducing sugars, percent by mass; minimum		65
4	Sucrose, percent by mass; maximum		5
5	Total Ash, percent by mass; maximum		5
6	***Acidity:***	(a) Expressed as gluconic acid, percent by mass; maximum	0.2
		(b) Expressed as milliequivalent acid/ Kg honey; maximum	40
7	Fieche's Test		Negative
8	Pollen content		Be comparable with the standard
9	Diastase activity and Hydroxymethyl furfural (HMF)		*
10	Total water insoluble solids content, percent by mass; maximum		0.5
11	Aniline chlorine Number (to be performed in case Fieche's test is found positive); maximum		

* Determined after processing and blending. Diastase figure on Gothe scale should not be less than 8 provided the HMF content is not more than 40 mg/Kg. Honey with low natural enzyme content, e.g. citrus, shall have a diastase figure on Gothe scale of not less than 3, provided the HMF content is not more than 14 mg/Kg.

10.3.5 Honey shall be prepared in accordance with hygienic regulations and codes of practice for food industries; Public Health Act Cap 242; and Food Drugs and Chemical Standards Act Cap 254.

10.3.6. Honey shall be practically free from inorganic and organic matters foreign to its composition, such as insect debris, brood or grains of sand, when it is offered for sale, or is used, in any product for human consumption.

10.3.7 Pasteurization is prohibited .

10.3.8 Honey shall be packaged in hygienically clean, wide mouthed containers, acid resistant lacquered metal containers, or any other suitable material. The screwed caps for glass containers shall be of material that is non-corrosive and non-reactive to honey.

10.3.9 Honey may be designated by colour, and according to floral or plant source if the predominant part of the honey originates from the floral or plant source or sources so designated and if the honey has the characteristics of the type of honey concerned.

10.3.10 Honey may also be designated by the name of the geographical or topographical region if the honey was produced exclusively within the region referred.

Appendix 1. Banned/restricted pesticides in Kenya
(By the Pest Control Products Board)

No	Pesticide	Banned/restricted
1	Dibromochloropropane	Soil fumigant-banned
2	Ethylene	Soil fumigant
3	2,4,5 T	Herbicide –banned
4	Chlordimefon	Insecticide-banned
5.	Mixture of isomers of Hexachlorocyclohexane	Banned
6	Lindane(Pure Gamma-BHC(HCH)	Insecticide- restricted for termite control in building industry(banned for agriculture use)
7	Chlordane	Insecticide - banned
8	Heptachlor	Insecticide - banned
9	Endrin	Insecticide - banned
10	Aldrin	Insecticide - restricted for termite control in building industry (banned for agricultural use)
11	Dieldrin	Insecticide – restricted for termite control in building industry (banned for agricultural use)
12	Toxaphene (Campheclor)	Insecticide – banned
13	DDT	Restricted use in Public Health only for mosquito control in mosquito breeding grounds. Banned for agricultural use.
14	Captafol	Fungicide – banned 1989
15	Parathion Methyl and Parathion Ethyl	Insecticide - banned 1988

Numbers 1 to 13 banned in 1986.

APPENCIX 2. NATURL PESTICIDES

Pesticide	**Preparation of the pesticide**	**Pests/diseases controlled**
Garlic/onion	Chop some garlic or onion , soak in paraffin for 24 hours, mix with bar soap and water, then filter and spray	Aphids, diamond backmoth
Garlic/onion	Chop and boil in water for 20 minutes, dilute with soap water, filter and spray	Aphids, diamondback moth
Ash	Take any burned firewood ash from the stove and spread on the plants and soil	Aphids, cutworm, caterpillars Storage insects
Spider weed	Burn the dry plants, mix the ash with soap water and spray	Cutworms, aphids and caterpillars
Neem	Boil the leaves in water for 20 minutes, filter and dilute with soap water	Aphids, caterpillars, flies
Eucalyptus	Boil the leaves in water for 20 minutes, filter and dilute with soap	Aphids, soil pests
Eucalyptus	Place the leaves in grain storage as repellent	Storage insect pests, soil pests
Pyrethrum	Boil the flowers, filter and add soap water	All insects
Marigold	Harvest when flowering, place in a drum, cover with water, leave for 10 days, stir after three days, filter and add soap Companion cropping Mulching using marigold	Aphids, caterpillars
Tomato	Mulch kales with pruned tomato leaves acts a repellent	Aphids
Papaya	Boil the leaves, filter and add soap water	Aphids, caterpillars, snails
Sodium bicarbonate	Filter the ash, get the solution and add soap water	
Tithonia	• Boil the leaves, filter and add soap water Leaves in the banana or in the holes for bananas	Aphids, cutworms, snails, banana Banana weevils
Chillies	Boil chillies, filter and add soap water	
Coriander	Boil seeds and/or leaves, filter and add soap water	Aphids and catrpillars
Sour milk	Dilute 1:1 with water and spray	Aphids and caterpillars
Cow urine	Pour down termite holes, repeat every day	Termite holes
Lantana	• Boil the leaves in water for 20 minutes, filter and dilute with soap water • Dry leaves in store	Aphids, caterpillars, storage insects

APPENDIX 3. PERMITTED CHEMICAL PESTICIDES.

A. INSECTICIDES/ACARICIDES.

(i) HIGHLY ENVIRONMENTALLY COMPATIBLE				
No.	***Trade Name***	***Chemical Name***	***Toxicity Class***	***Action/Uses***
1	***Actellic***	Pirimiphos-methyl	III	Control of insect pests on stored produce.
2	**Apollo 50SC**	Clofentezine	IV	A specific acaricide, acting primarily as an against some motile stages with long residual residual control of mites in ornamentals and fr on predatory or beneficial insects.
3	**Dimilin**	Diflubenzuron	IV	Effective as stomach and contact poison, acti synthesis and interfering with formation of the activity, hence sucking insects are in general basis for selectivity in favour of many predator effective for control of caterpillars and leaf citrus, soya beans and other horticultural crops.
4	**Dipel 2X WP Thuricide W. P.**	Bacillus thuringiensis	IV	Biological insecticide for the control of le coleopteran larvae on field and horticultural pests, combined with safety to man and natur make it ideal for use in pest management. Tre plant attacked by insect larvae.
5	**Malathion WW** and **EC**	Malathion	II	A broad-spectrum contact insecticide and acaric wide range of insect pests in stores and field.
6	**Neoron 500 EC**	Bromopropylate	IV	Contact acaricide for control of mite pests on o vegetables and on field crops.
7	**Torque 50 W. P**	Fenbutatin oxide	IV	Miticide for control of mites on ornamentals, to vegetables. Relatively non-toxic to predacious a

A. INSECTICIDES/ACARICIDES CONTINUED.

(ii) ENVIRONMENTALLY COMPATIBLE				
No.	***Trade Name***	***Chemical Name***	***Toxicity Class***	***Action/Uses***
8	**Anthion 33EC**	Formothion	III	Systemic and contact insecticide/acari scales, thrips dipterous leafminers, ornamentals and horticultural crops.
9	**Omite 57E**	Propargite	IV	An acaricide for use on cotton, vegetables and other horticultural crop
10	**Orthene 75 S. P**	Acephate 75% w/w	III	***Systemic insecticide used for th leafminers, thrips, lepidopteran larva***
11	**Trigard**	Cyromazine	IV	***Insect growth regulator with s dipterous larvae e.g. American s flowers.***

(iii) LESS ENVIRONMENTALLY COMPATIBLE				
No.	***Trade Name***	***Chemical Name***	***Toxicity Class***	***Action/Uses***
12	**Bulldock 25 EC**	Beta-Cyfluthrin	II	Insecticide effective against biting an cereals and horticultural crops.
13	**Fastac 10 EC**	Alpha-cypermethrin	IV	A broad-spectrum insecticide effectiv pests, particularly Lepidoptera and soyabeans, tomatoes, vegetables. sucking Hemiptera, soil-dwelling L thrips, cottony scale and leafminer ca
14	**Cymbush** **Ripcord** **Sherpa**	Cypermethrin	IV	Contact insecticide used for control horticultural crops. Also controls hen dwelling lepidopteran pests.
15	**Decis**	Deltamethrin	IV	Insecticide effective by contact and i orders of insect pests on vegetables sunflower and ornamentals.
16	**Dynamec 1.8 EC**	Abamectin		Insecticide/miticide for the control of ornamentals.
17	**Gaucho**	Imidacloprid	II	Insecticidal seed-dressing with system of aphids, whiteflies, beanflies and we
18	**Karate**	L-Cyhalothrin	II	Effective against lepidoptera, coleopte horticultural crops.
19	**Mocap 10G**	Ethoprophos		A non-systemic non-fumigant soil-app effective against nematodes and soil horticultural and field crops.

20	**Pirimor 50 DG**	Pirimicarb	II	Specific aphicide for the control of ap horticultural crops.
21	**Sumicidin 7EC**	Fenvalerate	III	Broad-spectrum contact insecticide fo insects, including hemiptera, homop coffee, horticultural crops and orname

B. MOLLUSCIDES

(i) HIGHLY ENVIRONMENTALLY COMPATIBLE				
No.	***Trade Name***	***Chemical Name***	***Toxicity Class***	***Action***
1	**Slugit**	Metaldehyde	III	control of slugs and snails in ornamentals.

C. FUNGICIDES

(i) HIGHLY ENVIRONMENTALLY COMPATIBLE				
No.	***Trade Name***	***Chemical Name***	***Toxicity Class***	***Action***

1	**Alto 100SL**	Cyproconazole	III	Systemic and contact fungic rust in coffee and fruit trees.
2	**Alto Combi**	Cyproconazole + Carbendazim	IV	Systemic fungicide for the rusts, septoria spp on barl range of diseases on banana and vegetables.
3	**Anvil 5SC**	Hexaconazole	IV	A protectant and eradicant range of fungal diseases on
4	**Baycor 300EC**	Bitertanol	IV	Control of rusts, leaf spots o and other horticultural crops
5	**Baytan Universal 094FS**	Triadimenol + Fuberidazole	IV	A systemic and broad s fungicide for the control o early attacks of foliar diseas
6	**Baytan Universal 31.1DS**	Triadimenol + Fuberidazole+Imaz alil	IV	A systemic broad spectrum for the control of seed and early attacks of foliar diseas
7	**Cobox WP** **Cuprocaffaro WP** **Dimildex WP** **Microcop 50** **Perechlor WP**	Copper oxychloride	III	A protective fungicide use horticultural crops. Contr coffee, blights and spots in v

C. FUNGICIDES CONTINUED.

(i) HIGHLY ENVIRONMENTALLY COMPATIBLE CONTINUED				
No.	***Trade Name***	***Chemical Name***	***Toxicity Class***	***Action***
8	**Daconil WP**	Chlorothalonil	IV	Broad-spectrum protectant of diseases of horticultural c
9	**Delan 75WP**	Dithianon	III	Control of coffee berry dise and horticultural fungal dise
10	**Folicur 250EC**	Tebuconazole	IV	Systemic fungicide for the early and late blight in pota mildew on curcubits and bacterial blight on beans; ru on ornamentals.
11	**Funguran WP** **Kocide DF**	Copper hydroxide	III	A protectant fungicide and b horticultural crops.
12	**Plantvax 20EC**	Oxycarboxin	IV	Control of rust diseases in c beans and coffee and vegeta
13	**Previcur-N SL**	Propamocarb hydrochloride	IV	Systemic fungicide for cont Botrytis on ornamentals, po
14	**Raxil 2WS**	Tebuconazole		Seed-dressing to control sm
15	**Raxil Combi 6WS**	Tebuconazole+Tria zoxide	IV	Seed treatment for control o borne diseases.
16	**Rizolex 50WP**	Tolclofos methyl	IV	Control of soil borne funga ornamentals and potatoes.

17	**Saprol 20EC**	Triforine	IV	Systemic fungicide effectiv in horticultural crops and c storage diseases of fruit and of red spider mite populatio

C. FUNGICIDES CONTINUED.

(ii) ENVIRONMENTALLY COMPATIBLE				
No.	***Trade Name***	***Chemical Name***	***Toxicity Class***	***Action/U***
18	**Antracol 25EC** **Antrocol 75 WP**	Propineb	IV	A protective broad spectrum fu late and early blight on anthracnose, downy mildew, lea rust, anthracnose in fruit anthracnose in grapes; leaf spo ornamentals. It has some inhib mites.
19	**Bavistin 50 WP**	Carbendazim	IV	A systemic fungicide to contro diseases on bananas, cereals, vegetables.
20	**Cercobin F**	Thiophanate methyl	IV	Fungicide for use in cereals, fru
21	**Milraz 76WP**	Propineb + Cymoxanil	III	Control of late blight and earl potatoes; anthracnose down anthracnose, downy mildew in downy mildew on onions.
22	**Nustar 40EC**	Flusilazole	III	Systemic fungicide for control d grapes and citrus.
23	**Punch EC**	Fluzilazole + carbendazim	III	Broad-spectrum fungicide for co barley (barley scald, spot blotch
24	**Ridomil MZ**	Mancozeb+metalaxyl	III	Mixture of systemic and contac and late blight on potatoes, tor all crops; fungal leaf spot dise vegetables.
25	**Tecto F**	Thiabendazole	IV	Control of pre- and post-harvest fruits, flowers and ornamentals.
26	**Thiovit WP**	Sulphur	IV	Control of powdery mildew and crops, ornamentals, coffee, tea. ornamentals and kills predatory

C. FUNGICIDES CONTINUED.

(iii) LESS ENVIRONMENTALLY COMPATIBLE				
No.	***Trade Name***	***Chemical Name***	***Toxicity Class***	***Action/Use***
27	**Acrobalt mz**	Dimethomorph +	IV	Systemic and protectant fungicide fo

		mancozeb		potatoes and tomatoes.
28	**Dithane M-45 WP** **Pencozeb 80 WP** **Vondozeb 75 DG**	Mancozeb	IV	A protective fungicide used to c potatoes, tomatoes, onions, cucum and vegetables.
29	**Nimrod 25EC**	Bupirimate	IV	Systemic fungicide for the control horticultural crops and ornamentals spider mites.

All the above pesticides have been registered by the Pest Control Product Board for use in Kenya.

Key To Toxic Classes:

CLASS ***HAZARD***

II MODEARAELY HAZARDOUS
III SLIGHTLY HAZARDOUS
IV UNLIKELY TO PRESENT HAZARD IN NORMAL USE

REFERENCES

IIRR. 1998. Sustainable agriculture extension manual for Eastern and Southern Africa. International Institute of Rural Reconstruction(IIRR), Africa Regional Office, Nairobi, Kenya. 241pp

Njoroge, J. H. 1994. Field notes on organic farming. Kenya Institute of Organic Farming(KIOF).Nairobi, Kenya. 70pp

ABLH. 1997. Beekeeping: a beginner's guide. ABLH, Nairobi, Kenya. 37pp