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METHODOLOGICAL CONCEPT FOR THE DEVELOPMENT OF SOIL AND WATER CONSERVATION PACKAGES IN SMALL SCALE FARM AREAS

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Different degradation processes are destroying the natural resources of the African highlands. Among these processes is the by man accelerated water erosion one of the most important destructive process. Large efforts have been made in different parts of Africa to protect soil and water, by applying traditional soil and water conservation (SWC)-measures by farmers and by implementation of new introduced SWC-measures by governmental organisation and NGO's. Nevertheless, the achieved progress in soil and water conservation is low. African heighlands are loosing considerable quantities and qualities of the soil and water resources, an alarming situation under consideration of the growing population pressure.

The approach to soil and water conservation used in the past is subject of a critical review among concerned experts at present. Experts accept more and more the following elements as keys for an improved approach to soil and water conservation:

i participation of the community and the single farmers
ii low external inputs
iii use of integrated soil and water conservation packages

The term "integrated " has three important aspects.

The consideration of SWC in all parts of the land use (livestock management, arable farming, forestry, etc.) - land husbandry

The development and implementation of a concept which, in the context of the farm's environment and the degradation dynamic of the landscape, use all suitable measures (physical & biological & agronomic) in the most compatible manner possible so as to keep degradation processes at a level below those causing injury for sustainable land use. The most important question is the use of synergetic effects by combination of different single soil conservation measures.

The new added soil and water conservation elements should fit into the existing farming systems in the most suitable manner (integration of SWC-package in the existing farming system) and should initiate development processes.

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Subject of this presentation is a methodological concept for the design and participatory implementation of integrated soil and water conservation packages. This concept considers socio-cultural and technical aspects. The mains steps of the procedure are shown below. The procedure based on data collected from a ten years soil and water conservation research program and from several conservation trials in Ethiopia and Kenya. These data and information are transformed to key-figures and functions allowing the estimation of important elements for the assessment of the existing local erosion potential, the determination of the correct objectives for soil and water conservation measures, and the integrated design of soil and water conservation measures. The procedures combine soil conservation, socio-economic, and agronomic aspects. Steps and important elements of the proposed procedure are demonstrated on basis of an example from Wolayta area (South-West of Ethiopia) representing small scale farming on steep slopes with a maize dominated crop rotation.

The presented procedure is an attempt to close the existing gap between existing knowledge about designing and implementation of single soil conservation measures and missing experiences in designing and implementation of integrated soil conservation packages suitable for the African context. The presented procedure will be subject of revisions and improvements after tests in trials and pilot projects.

PART TECHNICAL AND NATURAL SCIENCES	PART SOCIAL SCIENCES

1. Survey on key natural resources

Preliminary data-collection on key natural resources (e.g. information on soils, topography, hydrology, vegetation cover, land use etc.) in view of an assessment of the range of degradation status and dynamics. The survey includes methodological elements of Participatory Rural appraisal.

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2. Evaluation of social and economic potentials and limitations for SWC

Through and informal survey which includes methodological elements of Participatory Rural Appraisal social and economic potentials and limitations for soil and water conservation are evaluated. This evaluation addresses potentials and limitations on for levels: (1) plot and farming system (2) overall household strategies and decision making (3) community organisation and development (4) relation to the overall economic and political development.

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3. Formulation of demands towards soil and water conservation methods

On the basis of the evaluation of the social and economic potentials and limitations for soil and water conservation (see step 2) demands are formulated towards the development and testing of measures. These demands are mainly include aspects which are thought to increase the social and economic acceptance of measures (e.g. importance of short term productive effects of the measures).

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8. **Supporting soil and water conservation measures**

Additional measures which support and enhance the effects of the core measures (see step 4. to 6) are selected, designed and tested as components of an integrated package. These measures might as such not have a high acceptance, but through treating them as additional and supporting measures, aspects of not -acceptance can be kept on a minimal level.

9. **Design of points of breakage within the conservation system**

Implementation of perfect conservation systems are impossible due to limited resources. Therefore, to avoid erosion damages on productive land, breakages of conservation structures are designed on spots with low productive importance or low importance for the community.

10. **Implementation concept and participatory implementation**

The implementation of the suggested specific soil and water conservation package (see steps 4 to 9) is planned in a participatory way and the implementation is enhanced through assistance to the organisation of the target groups (single farm households and/or local community).

As all measures will be sub-optimal (mainly due to step 2 and 3), the measures are continuously further developed and adapted in the sense of conservation based rural development. This implies that during implementation one will draw back on steps 3 to 9 (iterative process).

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Integrated Pest Management

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INTEGRATED PEST MANAGEMENT[1]

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Introduction:

Agricultural pests are one of the most important limiting factors of crop production in Ethiopia. Although no comprehensive loss assessment studies have been undertaken, the annual losses are estimated to be 30% in the field and 15% during storage. This loss could be even higher than the above estimates, especially when there is pest outbreaks, such as, locusts, African armyworm etc.. Prevention or at least minimization of such loss is essential to satisfy food requirements of an ever increasing human population, raw material requirements of local industries and agricultural commodities needed for export.

There are several methods of pest control, however, none of them can provide an effective control or are free from undesirable effects when used alone. For example, chemical control which is commonly used today has several limitations; some of the most important ones are the following:-

- resistance development
- insurgence of secondary pest outbreaks
- environmental pollution
- residue problem

In light of these problems, Integrated Pest Management (IPM) program is adopted in many countries to deal with serious agricultural pest problems.

Integrated Pest Management:

Integrated Pest Management is defined as "a pest management system that utilizes all suitable techniques and methods in as compatible a manner as possible and maintains pest populations at levels below those causing economic injury."

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[1] Paper presented on training programme "Improved food production through the adoption of locally available technology" organized by CRDA from November 24-26,1993, in Addis Ababa

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A Classical Example of IPM

There are several successful examples of IPM in many countries. A classical example is the case of cotton pests in Canete Valley, in Peru. Prior to 1949-50, cotton pests were controlled by the use of arsenical and nicotine insecticides and hand picking of insects and infested fruit. However, after that period cotton pest control was solely based on the use of broad spectrum insecticides. This has led to resistance development and the control measures used had failed to provide satisfactory control.

As a result, by 1956 nearly 50% of the crop was lost despite 12 applications of insecticides. In 1957, a pest management system that utilized chemical, cultural, biological and regulatory control methods were developed and implemented. Seven years after the initiation of the program the pest problem was put under control and the natural balance between beneficial and harmful insects were maintained.

1. Cultural Control

This method involves purposeful modification of farming operations to reduce crop damage. The various cultural practices that could be adopted to reduce pest populations are briefly discussed as follows:

1.1 Optimal growing conditions

Damage by insect pest is more severe on crops suffering from moisture stress, unfavourable temperature, nutrient deficiency, etc.. Pest problem is particularly severe on plants grown on marginal land. Growing crop under optimal condition is, therefore, essential to minimize crop damage.

1.2 Timely sowing/planting

Early sowing or sometimes late sowing may help to protect crops against certain insect pests either by avoiding their breeding period or passing the vulnerable stage of the crop. Early sowing of maize has been shown to prevent stalk borer damage.

1.3 Timely harvesting

Timely harvesting has been found to prevent damage caused by maize weevil and Bean Bruchid on maize and beans respectively.

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1.4 Deep ; Ploughing

Some insect pests, such as, locusts lay eggs in the soil. Many species of Lepidoptera, Coleoptera and Diptera spend their larval and pupal stages in the soil. Deep plowing exposes these insects to hot sunlight and predators and there by reduce their populations.

1.5 Closed season

This refers to a practice of avoiding crops in the field for a limited period of time to reduce the population of insect pests that feed on them. A close season for cotton growing has been found to prevent population build up of Pink Bollworm. In East Africa, avoiding bean growing during the dry season has also helped to avoid bean fly infestation.

1.6 Crop rotation

Growing one kind or closely related crops continuously in the same field encourages build up of pest population that attack these crops. Crop rotation is useful to prevent damage caused by insect pests that have specific host plants. The inclusion of pulse crops in the rotation would not only help to reduce pest population but also contributes to the improvement of soil fertility. Crop rotation is considered effective, particularly against beetle larvae that may take a year or more to develop.

1.7 Weeding

Weeds compete with crops for sunlight, moisture and soil nutrients. In addition, they harbour insect pests that are destructive. An effective weed control is known to assist in the control of certain insect pests. Studies in Nigeria have shown higher percentage of damage to cow-pea and soybean when they are grown in weed infested fields.

1.8 Use of trap crops

Many insect pests prefer certain crops either for feeding or egg-laying. Growing trap crops in main fields would reduce crop damage by attracting insect pests. Since insect pests concentrate on trap crops, these can be sprayed with pesticides. African bollworm damage on kidney bean can be minimized by planting maize in strips in kidney bean field.

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1.9 Inter-cropping

This refers to a practice where more than one kind of crop is grown in a field. Inter-cropping may limit pest infestation in one or more ways:-

a. by acting as a barrier, or a hazard, or a camouflage,
b. by diverting the pest away from the crop at risk,
c. by benefiting natural enemies of the pest.

The International Rice Research Institute (IRRI) studies have shown low level of corn borer damage where maize and groundnuts were inter-cropped.

1.10 Crop sanitation

Some insect pests use crop residues either for breeding or passing the dry season. For example, the stalk borer larvae pass the dry season inside maize stalk. Destruction of the stalks would help to reduce stalk borer damage. It is also useful to destroy weeds, crop residues, rubbish, roughed plants, fallen fruit, etc. to reduce crop damage.

2. Physical Control

This refers to the physical elimination of the pest or physical alteration of the environment to make it unfavourable or inaccessible to the pest.

The most commonly used physical method of control is hand picking. This method is particularly useful in small farms, backyard gardens, etc. and where there is no shortage of labour.

Banding on fruit trees is also commonly used against caterpillars and ants which climb the tree by crawling up the trunk.

Cultivated crops may be surrounded by deep furrows on trenches in which crawling insects may be trapped and destroyed. Metal barriers are also extensively used for this purpose.

3. Host Plant Resistance

Plant resistance is defined as "those characteristics which enable a plant to avoid, tolerate or recover from the attacks of insects under conditions that would cause greater injury to other plants of the same species."

The sources of resistance can be classified as anti-xenosis (non-preference), antibiosis and tolerance.

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3.1 Anti-xenosis (non-preference):- refers to the characteristics of the plant that makes it unfavourable for the insect for egg laying, feeding or shelter. Some crop varieties are less attractive to insect pests because of their texture, colour, odour or taste. Non-preferred crop varieties have been found to frequently escape infestation, and even when insect pests are caged on them, they tend to lay fewer eggs and produce smaller populations than on susceptible hosts. For example, pubescent varieties of cotton are generally regarded resistant to aphids.

3.2 Antibiosis:- is defined as an adverse effect of the crop upon the insect. This may be caused either by the presence of a specific chemical or by the lack of a specific nutrient. For example, some European Corn Borer resistant varieties of maize are known to contain biochemical growth inhibitors at various stages of thier development.

3.3 Tolerance:- refers to a resistant mechanism when host plants suffer little actual damage despite infestation by large population of pest species. Generally, a healthy vigorous plants tolerate insect attack by healing quickly and showing compensatory growth.

An example of host plant resistance in Ethiopia is the control of cotton leafhopper by using cotton varieties of the "Acala" type.

4. Biological Control

This is defined as deliberate introduction of living organisms, such as, parasites, predators and/or pathogens to reduce pest populations to a level where serious damage is not caused.

Biological control is most effective against introduced pests, particularly on perennial crops. The main advantage of biological control is that long lasting control is obtained once bio-control agents are introduced.

The disadvantages of this method include that they are host-specific, requires high expenditure and long time for research and development.

The first successful biological control was recorded in California toward the end of the 19th century. Citrus industry was seriously threatened by the cottony-cushion scale, and many farmers were forced to abandon citrus production. To control the pest, a small lady beetle known as vedalia was introduced from Australia and releas ed on scale infested trees. Within a year, an effective control was achieved throughout citrus growing areas of California.

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In Africa, the most successful example of the biological control programme is the control of Kenya coffee mealybug, accidentally introduced from Uganda. This was successfully controlled by a parasitic wasp introduced from Uganda.

5. Regulatory Control

These methods involve the issuing of laws and regulations to prevent the introduction of dangerous pests from other countries and their establishment.

Regulatory control is based on quarantine of plant materials. Planting materials such as seeds, cuttings, whole plants, etc. imported from other countries are required to have phyto-sanitary certificates, which ensures that they are free from pests. These materials are inspected at the port of entry i.e. air ports, sea ports, border crosing points by qualified quarantine inspectors to ensure that they are free from dangerous pests. If dangerous pests are found on the materials they are either treated, destroyed or returned to the country of origin. Some times the planting materials are kept in quarantine isolation for a specified period of time to check that no symptoms develop.

In the past 10-20 years, several serious pests have been introduced into the country. Some of the most important ones are Trogoderma, vegetable leaf miner, scale insects and Bean Bruchid among insects; coffee berry disease, groundnut rust, potato late blight and maize streak virus among diseases, water hyacinth, parthenium, etc. among weeds. In addition to the losses they cause, the country is spending millions of dollars for their control. the quarantine service needs further strengthening inorder to prevent the introduction of such pests and others which are likely to be introduced. In particular, special attention needs to be given to prevent the introduction of greater grain borer which is causing considerable loss on maize in Tanzania and Kenya.

6. Chemical Control

Chemical control involves the use of toxic substances called pesticides. This method of control needs to be used as a last resort when other methods of control could not provide the desired degree of control.

6.1 Pesticide formulations

A pesticide formulation is made up of the active ingredient and one or more inert ingredients. The active ingredient is the poisonous portion while the inert ingredients are generally non-poisonous portion which are added to dilute, emulsify, increase

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the sticking ability or increase the dispersion of the active ingredient. The most commonly used formulations in the country are the following:-

a. Dusts:- the active ingredient is mixed with an inert powder such as clay, talc or volcanic ash. The percentage of the active ingredient in the mixture is usually less than 10%. They are applied as they are without mixing with water.

Eg. Bendiocarb 1% dust
Propoxur 2% dust

b. Wettable Powders (WP):- These are prepared by mixing the active ingredient with a powder and a wetting agent that helps the pesticide to spread out and coat the target surface. They have a higher concentration of active ingredient than dusts. They must be mixed with water before application.

Eg. Carbaryl 85% WP

c. Emulsifiable Concentrates (EC):- these are liquid formulations containing the active ingredient, a solvent and an emulsifying agent. They must be mixed with water before application.

Eg. Malathion 50% EC

d. Ultra Low Volume (ULV):- the active ingredient is dissolved completely in an organic solvent. The percentage of active ingredient is usually very high. These are applied as formulated without mixing with water, but they require special equipment such as ULVA sprayer.

Eg. Fenitrothion 95% ULV

e. Granules (G):- the active ingredient is coated inside or outside coarse particles. The percentage of active ingredient is usually very low. They are applied as they are without mixing with water.

Eg. Cypermethrin 10% G

6.2 Selecting a pesticide

Several factors have to be considered when selecting a pesticide. Some of the most important ones are the following:-

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a. Effectiveness against target species
b. Availability of application equipment
c. Safety to applicator
d. Safety to the environment
e. Phytotoxicity
f. Persistence
g. Shelf-life
h. Cost
i. Legal status

6.3. Calibrating spraying equipment

There are different methods of calibrating spraying equipment. The method most commonly used is the following:-

a. Measure out an area of 100 square meter on the crops to be sprayed.
b. Fill the equipment with water or an appropriate material and treat the area measured.
c. Determine how much was applied by refilling the equipment to its original level. This would give the amount of material required to treat the area measured. From this, the amount of material required per hectare can be calculated

1 hectare = 10,000 square meter

6.4. Pesticide safety

Pesticides are toxic substances that are a potential hazard to man and the environment. therefore, they should be handled with utmost care.

Preventing undesirable effects caused by pesticides involves the use of protective clothing, proper application techniques, correct storage, transport, etc.. It also involves understanding measures that should be taken in case of accidents.

It is always necessary to read the label carefully for safety instructions before starting mixing and applying pesticides.

Adequate safety measures have to be taken when handling and applying pesticides. Liquid pesticides should be poured carefully without splashing. similarly powders and dusts should not be allowed to puff up into the face by standing upwind and by keeping the package close to the mixing container. During application, the applicator should spray with the wind and avoid walking on the spray drift and on crops that were sprayed.

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Weed and Weeding Methods

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EFFECTS OF WEED AND WEEDING ON CROP YIELD

DEFINITION OF A WEED

"Weed is a plant growing where it is not wanted by humans." It can be another crop plant or a wild species. Weeds are unwanted because they interfere with crop or animal production or are irritating to humans in other ways.

HOW WEEDS INTERFERE WITH PRODUCTION

COMPETITION

Light, water, and nutrients are essential elements for plant growth. Any area can sustain only a given amount of plant bio-mass, whether crop or weeds. When any of these essential elements are limited and unable to supply the needs of both weeds and crops in an area, competition occurs, plant growth suffers, and crop yields are reduced.

The effect on the crop may be difficult to see. This is one reason why farmers, extensionists, and policy makers may not realize the damage weeds are doing to the crop. At other times, the crop will appear visibly stunted, perhaps yellow as a result of nutrient deficiency, or completely shaded under weed growth.

In an average situation, where weeds are not removed from the crop, the farmer can expect a 30% yield reduction.

The following reductions due to delayed weeding have been reported in Institute of Agricultural Research experiments:

Cereals	Pulses	Others
44% - maize	50% - lentil	62% - coffee
30% - sorghum	30% - chickpea	73% - cotton
35% - wheat	20% - faba bean	30% - peppers
18% - barley	36% - haricot bean (up to 90%)	tomato (up to 100%)
30% - teff	15% - field pea (up to 67%)	
	50% - soybean (up to 75%)	

1. Effect of Off-season Weed Growth

Where moisture is not a limiting factor in the system, weeds growing on fallow land can have a positive effect on nitrogen conservation. This is particularly important in systems where inorganic fertilizers are not used, as on many small farmers in Ethiopia, but where organic sources supply the nitrogen which is recycled in the system. In this instance, weeds should be controlled before crops are planted but where organic sources supply

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the nitrogen which is recycled in the system. In this instance, weeds should be controlled before crops are planted but their residues not removed from the system unless they are noxious like Digitaria abyssinica. In addition to adding nitrogen to the soil when weed residues are plowed under before seeding, weeds will also protect the soil by helping to prevent erosion. This strategy is useful to manage annual weeds which are normally not too aggressive, but perennial weeds are difficult to control and are often too competitive during the crop season.

2. Competition During Crop Growth

Crops are generally more sensitive to limitations of light, water, and nutrients at three growth stages, early growth, during fruiting and flowering, and during ripening. Of these three sensitive stages, damage done by weeds when both weeds and crops are small is most common and serious. This early stage is usually referred to as a critical period. With experimentation we can show definite crop yield reductions if weeds are present during this period (See Figure 1). The actual number of weeks in the critical period depends on the crop, weeds present, and environmental factors.

3. Parasitic Weeds

Weeds such as Striga spp., Orobanche spp., and Cuscuta spp., live as obligate (total) or semi-parasites on specific crop plant hosts. They remove water and nutrients directly from the crop host, which weakens and stunts the crop and produces a very low or no yield. These weeds are very difficult to control.

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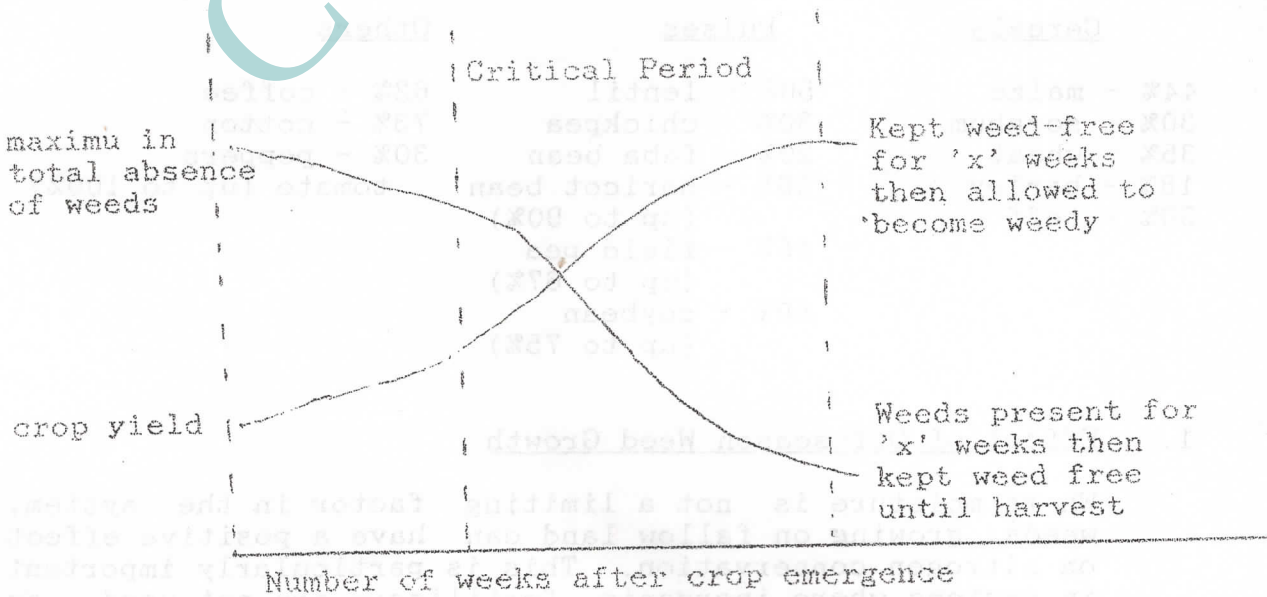


Figure 1 The concept of critical period of weed competition (Adapted from Stephens, 1982)

4. Factors Modifying Competition

Factors related to the crop:

- Species - determines rate and extent of root and canopy development; therefore, spreading rate of ground cover.
- Variety - same as species.
- Cropping system - determines the mix of crop species as well as the timing of their growth in relation to each other.
- Density and distribution - the greater the density, the more competitive the crop. If the density exceeds a certain population, the crop will compete with itself and yield will be reduced. Generally, when the crop plants are planted equidistant from each other at an optimal density, they are more competitive with weeds and less competitive with other crop plants.
- Duration - the amount of time the crop is present in relation to the weeds whether or not thinning takes place. The earlier the crop plant emerges compared to the weeds, the greater the advantage it has of using the limited resources.

Factors related to the weed:

- Species - determines rate of growth, and extent of root and canopy development.
- Density and distribution - the more dense the weeds, the greater the competitive effect on crops. The more even their distribution, then the greater will be the competition in any given area.
- Duration - the longer the weed is present, the greater its impact on the crop. If the weed emerges first, the competitive advantage will be for the weed.

These factors interact . They are affected by soil, climatic (rainfall, temperature) conditions, and altitude. This ultimately means that the competition encountered by a crop will change from one place to another depending on all the factors present in any given location (Figure 2).

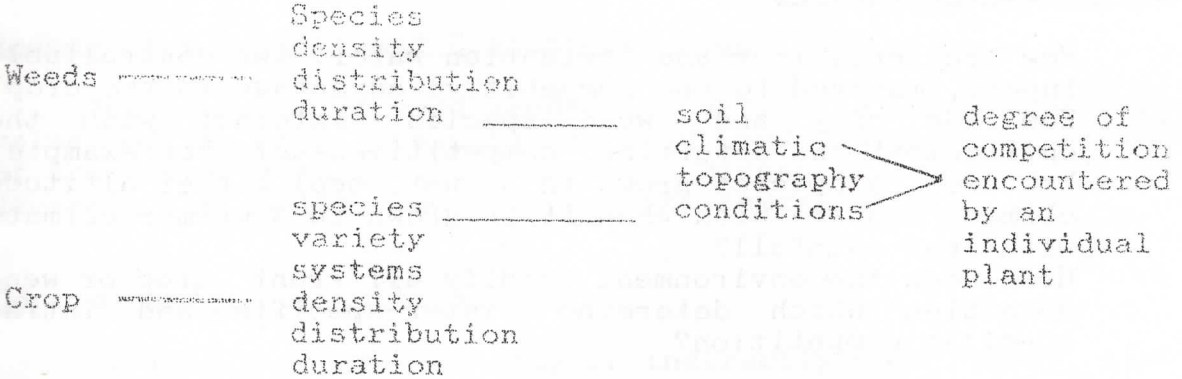


Figure 2. summary of factors affecting the amount of competition present in any given situation

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5. Questions Pertinent to Agricultural Systems

Questions pertinent to agricultural systems can be raised considering Figure 2. Once these relationships are understood for a given farm or field, recommendations for variety choice, spacing, population, inter-cropping combinations, etc., can be made with weed control and other production needs in mind.

Duration:

- At what stages of growth (critical period) does competition occur which will affect crop yield?
- Is relative time of emergence of the crop and weeds critical in determining effects?

Density and distribution

- What effect is there on competition between crop plants (intra-specific) and between the crop and (inter-specific) when choosing crop population densities and spacing?
- What weed densities of the various species or species combinations cause crop yield reduction?

Species or Variety:

- How do crop species or varieties vary in their competitiveness with weeds? How is this modified when different crop populations and spacings are used?
- How do different weed species compare in competitiveness?

Cropping systems:

- What combination of crops and timing of establishment of the crops offer a competitive situation to weeds?
- What cultural practices related to the various crops, when combined in a cropping system, provide a disadvantageous situation for weed growth?
- If an agro-forestry system is used, what species and spacing combinations offer a competitive advantage to the crops?

Environmental factors:

- How are fertilizer and irrigation water, two controllable inputs, managed to the competitive advantage to the crop?
- How do crop and weed species interact with the environment and determine competitiveness? For example, how does a species grown in a wet, cool higher altitude climate compare with when it is grown in a warmer climate with less rainfall?
- How does the environment modify different crop or weed densities which determine inter-specific and intra-specific competition?

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Limiting Land Farmed

The availability of labour or capital for weeding, may be a problem and limit the area the farmer prepares and plants. This situation occurs in areas where rainfall is high and plants grow fast or in areas where rainfall is limited but growing conditions favor vigorous weed growth. When rainfall is low and variable, competition for water can be serious; therefore, early and complete weeding is necessary.

If the farmer cannot accomplish this on an extended area, he may limit the cultivated area and concentrate his labor.

Harvest Problems

Weeds may interfere and/or contaminate the harvested crop.

Weeds as Pest Hosts

Weeds may provide a habitat or serve as an attractant, alternative host, or feed for insects, diseases, birds, rodents and others.

Allelopathy

Some weeds (and crop plants) secrete toxic chemicals which cause crops to grow poorly. In some cases, for example when the residues have not had enough time to decompose before seeding the crop, toxins from decomposing weed residues may inhibit crop germination or growth.

Interfering with Irrigation and Reservoirs

Weeds may reduce water flow and increase consumptions.

Harm Humans and Animals

Certain weeds can be poisonous if eaten by animals or may interfere with their digestion. They can cause irritation, skin rasher, or punctures (by thorns) to humans.

Reduce Crop Quality and Contaminate Seed

The presence of weed seeds, in particular, can reduce the value of the crop. Cuscuta in noug seed can cause rejection of the crop for an overseas market. Bidens in cotton lint can decrease the quality and increase the removal cost.

Control and Input Costs Wasted

Obviously weeds directly or indirectly cost money, time and labor to control. In addition, the yield increases when using inputs such as fertilizer, water from irrigation, improved seed, and others will not be realized if weeds are not adequately controlled. Therefore, an indirect cost of

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production is the cost of these inputs which may be potentially wasted if weeds are not controlled.

WEED CHARACTERISTICS

Importance of Understanding Weed Biology

- Identification
  To help choose the correct control measure, especially when herbicides are used.

- Germination time
  To help in timing cultivations, fertilizer application, planting time, and herbicide application.

- Factors affecting survival.
  To help in choosing and timing cultivations for desiccation of seeds and perenniating organs (underground tubers, rhizomes, stolons, bulbs, etc.)

- Period of growth and food storage
  To assist in the timing of herbicide application and cultivations.

- Nature and Position of perenniating organs in the soil
  To assist in choosing the depth of cultivation for desiccation or control.

- Competitiveness of the weed
  This will help to indicate conditions which are more suitable for the crop.

- Seed dormancy
  Understanding dormancy can indicate whether dormancy can be encouraged (no soil disturbance) or to break dormancy (increase soil disturbance).

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Life Cycle

Annuals - Complete their life cycle in one season.
Perennials - live for a number of years or seasons.
Biennials - Complete their life cycle in two growing seasons.

Many weeds, whether annuals or perennials, have vigorous fast growth and can produce seeds or vegetative reproductive parts quickly.

Reproduction

Annuals - can have many small seeds and be self - fertile.
Perennials - can produce by vegetative means and by seed.

Vegetative reproductive parts include: tubers, rhizomes (below-ground stems), stolons (above-ground stems), bulbs, storage roots, corns, spreading roots, and tufts.

Dormancy

Seeds and vegetative parts can survive for long periods and still germinate when growing conditions are favorable. Most weed seeds have a discontinuous germination pattern. This means that, unlike crops, they do not germinate all at once. Both dormancy and discontinuous germination help weeds survive over time.

Dissemination

Weed seeds or capsules:

- have burs, hairs, and other structure that help attach them to animals and humans;
- have winged or feathery parts and are light weight to aid transport by wind;
- are light weight and have bladders to float in water;
- can be transported in soil on equipment, tools, or with transplants, straw, hay, crop waste, crop seeds;
- can be a contaminant of compost and sewage; and can be eaten by animals, carried, and spread in manure.

Not Easily Controlled

Noxious weeds,those difficult to control, have one or more of the following characteristics: fast life cycle; produce a large amount of seed; perennial growth; parasitism; difficult to remove (irritating to touch, hard to pull or cultivate so they regrow, look like the crop).

SHIFTING WEED POPULATIONS

After a major disturbance in nature, a succession of species predominate. Agricultural systems are similar, but there are frequent changes in the wild or natural species that occupy a field due to continued disturbance. Nearly all management practices will affect weed flora, encouraging some species while destroying others. The following factors will have an effect on what species are encouraged or discouraged.

- Crop choices - life cycle of weeds and crops, competitive ability of the crop, cropping patterns, crop combinations, and rotations.
- Agronomic practices - land preparation timing and method, time of planting, crop population, fertilization practices, drainage, weeding practices, treatment of harvest and weed residues, and fallow or off-season treatment of land.

The repeated use of any one weed control method or series of agronomic practices will permit the build-up of species that are not controlled by that method.

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INTEGRATION OF PRODUCTION AND WEED CONTROL MEASURES

Any single weed control method will encourage some species while destroying others. For example, slashing destroys tall growing annuals but does not kill low-growing annuals or creeping perennials. Herbicides selectively kill some species but not others. Handweeding cannot readily remove weeds which are difficult to pull out entirely; weeds which resemble the crop plant; and weeds which re-root easily if not removed from the field. To ensure adequate weed control by avoiding selectivity when using only one method, choose a weed management system which is integrated. Agronomic practices also exert a selective pressure which affects the weed species. Therefore, weed control and other production practices must be varied in order to have an integrated approach to weed management. These general integrated methods are suggested: rotate crops, rotate and integrate weed control methods, and rotate and (or use herbicide combinations (if used). Crop rotation assumes that crops have unique agronomic practices associated with them, so that, by rotating the crop the farmer is also varying the environment and changing the selective pressures on weeds.

WEED CONTROL PRINCIPLES AND METHODS

Prevention

1. Plant clean seed and use clean soil for transplants.
2. Use seed screens or traps in irrigation canals.
3. Prevent weeds from seeding or spreading in the field.
4. Clean tools and equipment before cultivating a new field.
5. Livestock will spread weed seed in manure. Try to restrict the animals' movement.
6. Quarantine.

Eradication

Eradication is the elimination of all weeds and weed parts from an area (usually a single noxious species). In most cases, this is uneconomic and not practical. It is possible to attempt this method if the weed is noxious newly introduced, and has a limited distribution.

BASIC APPROACHES TO WEED CONTROL

Physical

The method removes weeds using physical or mechanical means: machine tillage with tractors or animals, moving, hand pulling, hoeing, flooding, mulching, and burning.

Cultural

These methods involve any agronomic or management practice which enhances the crop's ability to compete with weeds: selection of a competitive crop or variety, manipulation of crop population and distribution, inter-cropping, fertilizer placement method, planting time, and crop rotation.

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Biological

This method uses a biological agent other than man to control weeds. Multiple host agents are those that can control a variety of weed species and are largely non-specific. Examples are goats, sheep, geese, and fish.

Specific host agents are insect or disease organisms that affect a single host species.

Chemical

Herbicides will selectively control weeds; however, to use them effectively requires specific conditions which may be more limiting than for other control methods. The correct herbicide must be selected for the particular crop and weed spectrum present and it must be applied using a uniform application at the correct rate at the correct time under specific environmental conditions.

POSITIVE AND NEGATIVE ASPECTS ABOUT WEED CONTROL MEASURES

Physical Methods

1. Hand weeding

This may be the only practical method available to small farmers. Other than requiring labour, it usually requires no further cash outlay. It may be the only method that can be used to weed broadcast -seeded crops where herbicides are not available.

Hand weeding is intensive and slow compared to other methods.

Handweeding is usually delayed until the weeds are easily seen and can be grasped. Yield losses can occur before weeds are removed. If weeds are simply piled up after pulling, some species may re-root and grow again. Some weeds are not easily removed by hand weeding. Perennials, parasitic weeds when they are young, and others.

2. Mechanical weeding with animals or tractors

In order to use most methods of mechanical cultivation the crops must be planted in rows that are spaced wide enough for the animal, tool and farmer to pass without damaging the crop. The use of animal-drawn cultivators can make weeding faster and easier. Mechanical cultivation may be difficult to perform effectively in bad weather. It cannot be used on steep land. Sometimes the farmer must wait until the crop is large enough to see before cultivating, which may cause some yield reduction.

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3. Delayed tillage or stale seedbed

The seedbed is prepared well in advance of sowing. Weeds are allowed to germinate. A second shallow tillage kills small emerged and germinating weeds. This can be repeated if there is sufficient time.

4. Blind tillage

The field receives a shallow tillage after the crop is planted but before it emerges.

5. Minimum or zero tillage

Many problem weeds, usually associated with annual crops, only survive in disturbed or tilled soil.

6. Mowing, slashing or cutting

Removing the majority of the above-ground portion of the weed will help to control many weed problems, such as competition for light or interference with harvest. The portion of the plant remaining can protect the soil from erosion. This method is suitable for controlling weeds in pastures, ditch banks, on field edges, and between the rows of some perennial crops. It does not completely eliminate competition from weeds in perennial crops.

7. Flooding

This is suitable for crops, such as, rice which can withstand flooding.

8. Mulching

This weed control technique is most often used on high value crops on small areas. Besides weed control other benefits include soil moisture conservation, reduced erosion, and reduce soil moisture conservation.

9. Burning

This method is used to get rid of undesirable crop residues which may harbor diseases as well as weed seeds.

CULTURAL METHODS

1. Crop competition

A farmer's selection of a crop is governed by many factors; economics, biological, preference of a variety disease resistance or tolerance, as well as, competitiveness with weeds. Therefore, unless there is a serious weed problem, other factors may determine crop choice.

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CHEMICAL METHODS

Advantages to herbicides are:

- possibly the only solution to a serious weed problem;
- potentially less expensive than other weed control methods;
- may be faster than other methods;
- weeds are controlled early during the critical period, when other methods may not be effective;
- maximum cropping of land may be encouraged because of a lower labor requirement;
- less labor is required compared to other methods; and
- can be combined with other weed control techniques to make an integrated program.

Disadvantages include:

- risk of ineffective weed control and injury to crops;
- spray drift may injure non-target organisms;
- possible herbicide residues may be left which would injure the subsequent crop;
- expensive and uses limited foreign exchange;
- lack of trained farmers and extension personnel leading to misapplication problems;
- lack of protective clothing, proper storage and mixing facilities which may increase the chances of accidents and harm to humans and animals;and
- requirement of purchase, operation and maintenance of spray requirement may not be met and lead to faulty application.

VEGETATION MANAGEMENT

The goal of weed control is to limit their negative effects to the point of acceptability. The strategy is to create conditions favoring desired plants (crops) while suppressing unwanted plants (weeds). Vegetation management leaves as few niches as possible for weeds (for example, by using a competitive crop variety which is closely spaced), and disrupts available niches so weeds cannot invade, (for example, using cultivation, herbicides, etc.)

The extent of vegetation management in each situation will vary depending on many factors, such as, crop and weed species, but also on economic factors, such as labor availability, market price, cost of control measures, etc.

For example:

- an expensive, intensive weed control program would not be warranted in a low value crop.
- If a high value crop is following a low value crop, then better weed control in the current low value crop would be an investment in the future.

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- A one time, expensive weed control treatment to eliminate a noxious weed may be worthwhile when costing the control over the next several years when the beneficial effect is still being realized.

GENERAL INFORMATION ABOUT CHEMICAL WEED CONTROL

TYPES OF HERBICIDES

Herbicides can be classified using several systems. They can be classified as selective or non-selective; foliage applied or soil applied; contact or translocated; plant type controlled; by time of application; or by family. The most common classification system is by family. Each family has distinctive characteristics, but within a family their use and plants which they kill varies. The most commonly used families are:

1. Hormonal herbicides (Phenoxy, Benzoic acid, Picolinic acid)
2. Triazines, ureas and uracils
3. Acid amides
4. Carbamates
5. Thiocarbamates
6. Dinitroanilines
7. Bipyridyliums
8. Substituted glycine
9. Double ring grass killers ("graminicides")

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Application of Herbicides

Calibration method (knapsack sprayers)

1. Measure out 100m. Length,
2. Fill sprayer with water,
3. Measure swath width,
4. Record the time spent spraying 100 meter length
5. Repeat the operation and find mean figure
6. Measure water volume used over 100 meters by spraying into container for time spent spraying (eg. 2 liter)
7. Calculate area sprayed
   i.e swath width X 100 meter
   e.g. 1M X 100 meter = 100 meter square
8. Calculate spray volume/ha.
   i.e $\frac{10,000 \text{ X water vol. sprayed (lts)}}{\text{area sprayed (meter square)}}$ = spray volume (lt)
   e.g $\frac{10,000 \text{ X } 2}{100}$ = 200 l/ha
9. Calculate herbicide volume required for 10 leter water
   i.e herbicide needed for 10 leter water = $\frac{10}{\text{water vol/ha.}}$ X rate of use (ml)
   e.g. herbicide 3 l/ha = $\frac{10}{200}$ X 3,000 = 150 ml

TIME OF APPLICATION

- Pre-sowing or pre-transplanting
- Pre-emergence
- Post-emergence

HERBICIDE PLACEMENT

- broadcast
- band application
- direct sprays
- spot sprays

WEED CONTROL IN SPECIFIC CROPS

MAIZE

Critical Weed-fee Period

Maize should be kept weed free following the methods stated below, from 10 days after emergence to just before flowering, when the tips of the tassel are visible.

Land Preparation

Create a weed- free seedbed with good tilth

Competitive Cropping and Good Husbandry

Choose an accurate planting method, proper spacing and optimal population density

Number of Weedings

A general rule is to weed the crop every three weeks if weeds are present, for up to three times.

Shilshalo or Inter-row Cultivation with Animal Drawn Implements

This mechanical removal of weeds can be practiced in either broadcast or row-seeded maize. In row-seeded maize the practice is usually called inter-row cultivation.

Hoeing and Handpulling

These two methods can be used instead of, or to supplement inter-row cultivation or shilshalo; however, they are more tedious and time consuming to perform.

Cultivation Using Tractor Drawn Implements

Shovel or sweep cultivators or rotary hoes are the most useful, efficient tractor drawn weeders.

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Mulching

In higher rainfall areas, it may be feasible to use the residues from the pulled weeds which have not produced seed to mulch the maize within the rows.

Cutting and Mowing

This technique is useful when it is too wet to cultivate or handweed effectively and/or when it is later in the season and weeds need to be controlled to prevent seeding.

Herbicides for use in Maize

1. alachlor
2. alachlor + atrazine
3. atrazine + metolachlor
4. cyanazine + atrazine
5. 2, 4-D many brands

WHEAT AND BARLEY

Critical Weed-free Period

Wheat and barley are most sensitive to weed competition and suffer greatest yield reduction up to their 3 - 6 leaf stage. This is approximately between 2 and 4 weeks after emergence.

Land Preparation

Conventional tillage

When using conventional tillage methods, both barley and wheat require a smooth seedbed which is free of weed and crop residues. If possible, plant on land previously planted to a legume or oilseed crop.

Stale Seedbed

Land is prepared using conventional ploughing during the short rains. Weeds are allowed to germinate between the two ploughings, then are destroyed by the second ploughings.

COMPETITIVE CROPPING AND GOOD HUSBANDRY

Use clean seed and choose a population and spacing conducive to high yields. If broadcasting seed use the following rates: bread wheat, 75 kg/ha; durum wheat, 150 kg/ha; food barley, 125-150 kg/ha; malting barley, 100 kg/ha.

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Number of handweedings

Two handweedings has shown to be the most economic practice and produce the best results in most areas. In drier areas only one handweeding may be needed. The first handweeding should be done 2-3 weeks after emergence (at early tillering stage) and the second 4 - 5 weeks after emergence (at stem elongation stage).

Herbicides used in wheat and barley

1. barban
2. bentazon
3. bromoxynil + MCPA
4. bromoxynil + ioxynil + mecoprop (CMPP)
5. chlortoluron
6. diclorprop (2,4-DP)
7. diclofop-methyl
8. difenzoquat
9. flamprop isopropyl
10. MCPA
11. Mecoprop (UCPP)
12. Pendimethalin
13. terbutryne
14. 2,4-D amine

Prevention

Sow clean, weed-free seed. Do not harvest the crop with the weeds.

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TEFF

Critical Weed-free Period

Teff is initially very sensitive to weed competition because it is a very small seeded crop. Keep the crop free of weeds between 15 cm (at early tillering) and pre-heading stage. This period is approximately 3-7 weeks after emergence.

Land Preparation

Land should be well-prepared with a smooth seedbed free from growing weeds. This is very important, because good land preparation can control early weeds when the crop is very small and sensitive weed competition and before handweeding or post-emergence herbicides can be used.

Competitive Cropping and Good Husbandry

On black soils the recommended seed rates is 30 kg/ha and on other soils use 25 kg/ha.

Number of Weedings

The number of required weedings depends upon the severity of the weed infestation and crop vigor. In many cases, one handweeding when the crop is 15 cm. tall (approximately 3-4 weeks after emergence)has been shown to be most economic when the weed infestation is moderate.

Cultivation or Hoeing

Because the crop is broadcast seeded and very sensitive to disturbance. This is too difficult to do and is discouraged.

Roguing

Roguing is a type of handpulling when the weed are large.

Herbicides used in teff

1. dichlorprop
2. MCPA
3. 2,4-D amine

Rotation

It is important that teff be preceded by a crop which had good weed control

Prevention

It is very important to use clean seed, without any weed seeds.

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Method of Farmers Based Crop Trial In Identifying Adaptable Variety

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METHOD OF FARMERS BASED CROP TRIAL IN IDENTIFYING ADAPTABLE VARIETY BEFORE EMBARKING ON A WIDE SCALE SEED ASSISTANCE SCHEME

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MENGESHA BEKELE

NOVEMBER 1993.

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Methods of Farmers Based Crop Trial in Identifying Adaptable Variety Before Embarking on a Wide Scale Seed Assistance Scheme.

1. Back Ground

1.1 Introduction

It should be recognized and taken into account that farmers are the most important, valuable and decisive resource to promote agricultural development. The development begins with the human being, with his interest, initiative and decision making. The human potential is the only one capable of generating technologies and more qualified individuals. Therefore, priority must be given to the members of farmers families with material resources and training, so that they will be able to fully utilize the potential of their environment.

1.2 Farmers problem in seed assistance scheme.

Ethiopia suffers from food deficits as a result of low productivity in general and shortage of quality seeds and planting material in particular. Improved varieties of seeds/planting materials, although in small quantity, are available in some areas. However, their accessibility to the farming community is the main problem. This problem is not only limited to improved varieties but it extends to local cultivars as well, particularly in areas suffering from drought. Lack of seed, during planting time succeeding dry periods, was clearly shown in the studies made in four Administrative regions (Hararge, Bale Gonder, Gojam) by the Catholic Relief Services(CRS) in 1984. Another study, conducted by OXFAM in 1988 in North Wollo region also showed lack of seed as the most serious problem. To alleviate the problem of lack of seeds, one could purchase seeds from un-affected areas having different agro-ecological conditions

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and introduce to seed deficit areas. However, the result could be negative effect as the new introduction of the seed to deficit areas. Moreover, movement of seeds/planting materials from one region to another may also encourage the dissemination of noxious weeds and dangerous insect and diseases.

Efforts made, so far, so in the production of improved seeds contributed only a small portion to the national seed requirement. Even the small quantity produced could not reach the vast majority of the farmers; due to a number of problems, for example the lack of suitable varieties for the different agro-ecological conditions, lack of transport for timely delivery and high prices. Therefore more than 95% of the seeds planted in the country originates from the farmers themselves. Despite of such a high share of contribution; little or no emphasis have been given to improve conditions regarding the seed requirements of the small-holder farmers. It is high time for creating mechanisms that will enable farmers to produce and distribute better quality seeds in their own localities. Therefore this manual focuses on methods of farmer-based crop trials in identifying adaptable varieties before embarking on a wide scale seed assistance scheme.

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1.3 Strategy for use of endogenous and Self-reliant Development

1.3.1 Generating of appropriate technologies:-

. Agricultural research continues generating technologies in favor of small farmers. By obtaining technologies with these characteristics, all farmers will have real opportunities to improve their farms and to increase production. Inaddition to traditional research by product disciplines investigations should be carried out on integrated and diversified systems of

agricultural, forestry and livestock production. Being self-sustainable and less risky, these are more adequate for the circumstances of small farmers. Research should be aimed at producing technological innovations that can be adapted to diverse circumstances of human beings and the physical environment. In addition, this transformation should be achieved fundamentally on the basis of use of the available resources that farmer actually possess.

1.3.2 **Training of all the members of rural families (men, women, youth and children).**

The rural families basically can promote their own development, other agents or factors can merely contribute towards this achievement. However, in view of their lack of training, they are able to do so at present. The logical conclusion is that there will be no development unless the families are trained so that they are encouraged to solve their own problems. Therefore, it is important to train the members of rural families, for the following purposes.

. To develop their human potential

. To expand their knowledge, productive and managerial abilities in order that they will be able to:

. diagnose the real causes their problems, especially those that can be solved by themselves.

. improve farm management, and identity and utilize fully their most abundant resources

. diversify and integrate agricultural and livestock products, in order to fully utilize their resources,

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. increase yield per unit of land, capital and time, thereby reducing its unit cost.

. reduce losses during the production process, harvest and in subsequent stages.

. Raise the productivity of family labor force(men, women and youth).

. Encourage a change of atitude and values(self-confidence, greater ambition, receptivity to change, desire to progress, responsibility in personal, family and community development etc.

1.3.3 **Organizations of the farmers**

The farmers need to purchase inputs, to produce and to market their surpluses efficiently. For this reason and in view of the weakness of governmental services, farmers must become organized in order to establish their own mechanisms for the reception (from the outside) and provision (to wards the inside) of services; these will allow them to gradually reduce their dependence on external services (from the state and private enterprises, and to act together for their common goal.

1.4 **Objective of method of farmers based trial**

. Improving productivity in staple food crops grown by small-scale farmers.

. generate information by farmers appropriate for small producers.

. generate and transfer of technologies integrated among researchers, extension agents and farmers.

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- solving/addressing constraints in staple food production, before moving on to other agricultural problems and/or production opportunities.

- not waiting for the "perfect" technology before trying to small-scale farmers.

- Help the farmers take the first step toward increased productivity and a better understanding on field experiments.

- Identification of drought resistant and short season crops which are known to many farmers in the area.

- Identification of past and present methods of cultural and improved management of the crops and improved technology development and transfer in to the area with regards to crop development.

- To find ways and means in which farmers themselves could actively participate in trials and development activities.

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2. Types of On-Farm Trials

On-Farm trials may be grouped into several categories. In this paper one kind of on-farm trials which is more relevant for the manual will be discussed. This grouping is simply based on who manages and monitors the trials.

2.1 On-farm Agronomical Surveys

This involves close observation and monitoring of farmer activities. However, this method is time consuming and requires a good background knowledge of the environment. Similar results could be obtained by close observation and interviewing farmers.

2.2 Researcher Managed On-Farm Trials

Trials implemented in farmers' fields but are managed and monitored by the research worker. The farmer in this case undertakes to provide security for the trials. These types of trials are useful for fertilizer investigations,because with no fencing or buildings, they can be moved to new land at any time.

2.3 Farmer Managed (at agreed level) and Researcher Monitored On-Farm Trials

This type of trial represents an evolution in trial development and, because of the much closer farmer involvement. It directly addresses farmer problems and therefore it is necessary to discuss all issues with the farmer. The farmer is the primary target, and a greater degree of the feedback information is required. Such trials are useful to test recommended fertilizer treatments, recommended cropping systems and crop varieties, because the trial is supervised by the research workers.

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2.4 Farmer Managed (at all level) but Researcher Monitored On-Farm Trials

These are trials carried out in farmers' fields with management at farmer level but monitoring by research workers. These trials represent a final evolutionary stage in one direction, in that the farmer is sufficiently impressed, and tries the new technology under his own management using his own inputs. At this stage problems may arise if his management is less than optimal. To avoid this routine monitoring of the farmers' activities by the researcher is required, otherwise, there is the risk of losing valuable information.

3. Materials and Methods

3.1 Deciding where to locate trials in fields

Obtaining the best possible site is not the key factor in locating a trial in farmer's fields but the researchers should rather aim at obtaining the most representative.

In locating trials in farmers' fields the research team working in non-terraced, sloping, rainfed areas must be aware of what is located uphill of their trial. Because, runoff from fertilizer use, herbicides, other pesticides, or stored animal manure may influence the results. The researcher should not select the farmer's most inaccessible field unless it is the only field the farmer is willing to let him use.

3.2 Determining blocking technique to be used

3.2.1 Border guard rows

The purpose of marking border rows in field trials is to buffer the harvestable mid-plot rows from the confounding effects of neighboring varieties or treatments. The number of border rows vary with distance between rows, crop type and type of treatments. For example, pesticide spraying trials requires greater number of border rows than do variety, or fertilizer trials.

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3.2.2 *Slopes and other Problems in Fields*

Once the researcher and the farmer have agreed as to where the trial will be placed in the field, the researcher must determine how to lay out the trial. If a significant change in slope is encountered. blocks (reps) of treatments must be located along the slope/ gradient, not up and down the gradients. The same blocking technique must be used when obvious soil type differences are encountered. In addition a number of other factors need to be considered. Forexample, field corners, over-hanging trees, footpaths, exposure to domestic or wild animals, etc.

3.2.3 **Plot Location**

When allocating the plot location in on-farm experiments, all treatments of any given trial need not always be located together in one farmer's field. If space is limited, or if the designed trial is too large to fit into a given farmer's field, the treatments can be separated spatially. The reason for separation of treatments may be due to flooding problems, soil type difference and major slope changes. If one of these cut across a trial corner or several treatments, the trial should be separated so that some treatments do not fall into the less representative areas.

3.2.4 **Row Spacing and Planting Distance**

Trials, especially during the initial phase, should generally minimize changes in spacing without first

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examining the reasons behind current farmer row spacing and planting distance. There are often very sound reasons why current spacings are used, i.e by animal type or plow width used in land preparation. Changing such traditional methods without verified improvements, may discourage the interest of farmers in collaborating any further.

3.3 Layout Techniques

The mechanics of trial layout are often determined by a combination of the number and complexity of treatments and replications.

Frequent farmer-researcher interaction is indispensable to this process, otherwise, misunderstandings may arise when farmers are ignored or over-looked during the implementation of the trials.

After selecting an appropriate place in a farmer's field for the trials location, the field team should use a simple methods of insuring that trials can be lay out with right angled corners using string.

4. On-Farm Trial Data Collection

Four catagories of data are to be collected for on-farm trials. The four data types to be collected are as follows.

4.1 Environmental Information

This involves the physical and biological environment of the area, the farm and the field on which the trial is planted. This includes cropping history, weather

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conditions, soil characteristics, location of the field in relation to the homestead, position in the topography and any other relevant factors which describes the farm and field where the trial is conducted. All factors which may affect the crop response should be noted, such as presence and direction of slope, soil type fertilization/ commercial or organic/, and any irrigation history. This information is largely taken for trials planted on an experiment station, but should also be collected for all on-farm trials in all stages in the trial sequence.

4.2 Primary Experimental Data

This is the data on selected variables which reflect the response of the experimental material to different treatments. These are measurements from trial plots of biological and physical variables directly related to the trials objectives. This will be a measurement of productivity or yield, but may include other measurements which will aid in understanding and interpreting any differences. Such variables could include agronomic characters such as stand count, plant height, days to flowering, days to maturity (harvest) etc...

4.3 Secondary Experimental Data

This information would include data or observations on time of planting, rate and date of fertilizer application, time of irrigation, moisture stress periods, pest incidence, interference or damage caused by wild or domestic animals etc... This information is used to help interpret primary experimental data and which relates to the whole experiment.

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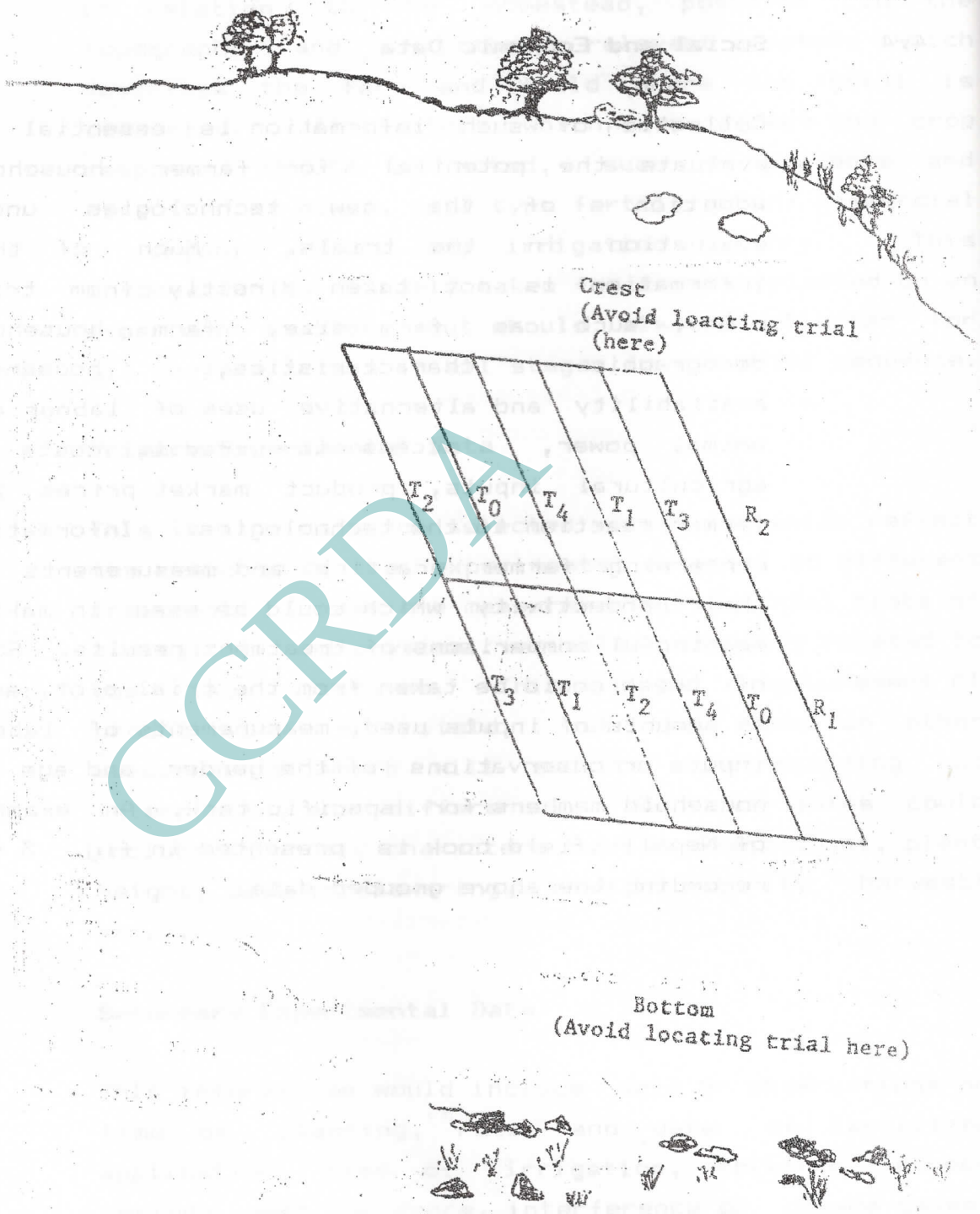
4.4 Social and Economic Data

Collection of such information is essential to evaluate the potential for farmer household adoption of the new technologies under evaluation in the trials. Much of this information is not taken directly from trial plots, such as farm size, farm household demographic characteristics, household availability and alternative uses of labour and animal power, access to credit, costs of agricultural inputs, product market prices and farmer reaction to the technologies. Information concerning farmer practice and measurements of their productivity which could be used in making meaningful comparisons of treatment results. Some of these could be taken from the trial plot, such as amounts of inputs used, measurements of labour inputs or observations of the gender and age of household members for specific task. An example of Nepali field book is presented in fig. 3 for recording the above grouped data.

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Fig. 1

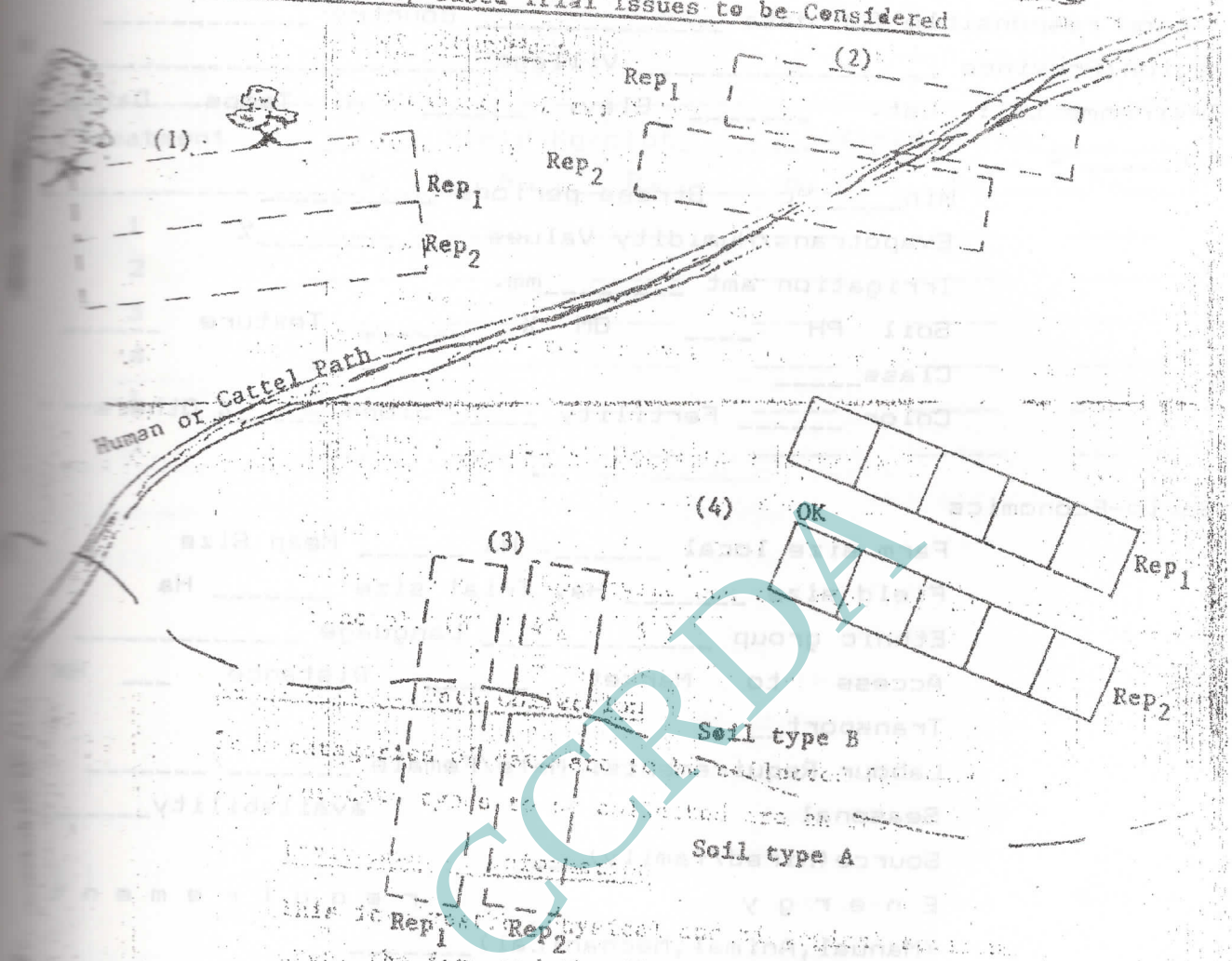
Trial Layout under Changing Slope Conditions



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Fig. 2

Additional Crop-Based Trial Issues to be Considered



1. Trees providing excess shade and compete for water and nutrients
2. Human or cattel path
3. Inproper blocking across major soil differences
4. Appropriate trial location

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Fig. 3 On-Farm Agronomic Trials Field Book /Nepali Example/

Person responsible for data _____ Country _____
Region/Province _____ Village _____
Environmental: Lat. _____ Elev. _____ m. Temps. Daily max_____ °C

Min_____ °C Stress periods _____
Evapotrans/Humidity Values _____ %
Irrigation amt _____ mm.
Soil PH _____ OM % _____ Texture _____
Class_____
Color _____ Fertility _____ Slope _____ % Others_____

Socio-Economics

Farm size local _____ Ha _____ Mean Size
Field size _____ Ha, Trial size _____ Ha
Ethnic group _____ Language _____
Access to Market _____ Distance _____ Km
Transport_____
Labour Requirements: Male/Female _____ / _____
Seasonal availability_____
Source(hired/family)_____
Energy requirement (Manual,Animal,Mechanical)_____
Cash requirements (prices of key inputs)
Fertilizer
_____ $/Kg
Seed _____ $/Kg Pesticide _____ $/Kg or lit.

Trial Details:

Previous Crop Management_____
Tillage/land preparation_____
Cultivars _____

Plot design _____ Reps _____ Plot size _____ m^2
Harvested area _____ m^2

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Treatment	Yield Kg/plot			Yield Qt/ha		
	R_1	R_2	R_3	R_1	R_2	R_3
1						
2						
3						
4						
1						
1						

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Fig. 4 (Cont...)

Plot Record Form

Site: _____

Farmer's Name: _____

Site Map (Sketch) _____

Crop Type _____

Crop Variety _____

Previous Crop _____

Date of Land Prep. 1st _____ 2nd _____ 3rd _____

Planting Date _____

Compost used (if any) Volume _____ M^3 _____ Weight _____ t.

Date Transplanted _____ Fertilizer type _____ Rate _____

Seed germinated: Yes _____ No _____

Planted in row: Yes _____ No _____

Stand at emergence: Good _____ Poor _____

Flowering (50%) date: _____

Pest Occurrence (Insect, Weeds, Disease, Rodents, Birds)

Degree of Lodging _____ % Date _____

Plant Height at Harvest _____

Harvest area _____ m^2 Harvest date _____

Sun dried straw/stalk Yield _____ Kg/m^2 or plot

Grain Yield, Kg/m^2 _____

Calculated Grain Yield Qt/ha _____

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Note: This record sheet is taken from Nepail field book, ar
for our condition, it could be modified withou
affecting the quality of data to collected.

Coefficient of Variation (CV)

This indicates the degree of precision by which the treatments can be compared and is a good indicator of the reliability of the experiment. It expresses the square root of residual (error) as a percentage of the overall mean for the experiment. The higher the value of the coefficient of variation the lower is the reliability of the experiment. Experimental stations may accept an upper limit of 10% for the coefficient of variation. Levels of 20-25% or more can be acceptable for on-farm trials. Researchers should however seek to identify the main sources of variation leading to the high coefficient of variation for on-farm trials. Not with standing that researchers wish to obtain low values, the non-uniformity of small farmers fields and looser experimental management are important factors and usually account for such higher CV'c.

Reporting the Results of an On-Farm Trial

6.1 Introduction and Objectives

Under this title the researcher need to discuss farmer problems he is addressing, the causes of the constraints, interactions with other problems, and relative importance of the constraint in the farming system. He should comment on farmer recognition of the problem, the priority they give it and their assessment of the causes, and also briefly describe pertinent facts about the farming system which help to explain the problem. The target group or agro-ecological zone at which the trial is aimed and possibilities of extending the results to other similar target groups and areas should also be included.

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The objectives of experiment including the hypothesis being tested which should directly address the background Information. That is past and present work on the problem in the research institutions where the researcher is working, present recommendations related to the experiment, other relevant information at other institutions in the country and outside of the country should also be included.

6.2 Materials and Methods

Location, proposed duration, experimental design used, number of replications per site, plot size, treatments, non-experimental variables are to be clearly discussed.

6.3 Results and Discussion

Results should be presented by farmer target group or recommendation domain. By using the analysis of variance/ADV/ significant differences between treatments could be analysed.

If there was damaged or lost data, the method used to handle it should clearly be noted. Tables containing physical response and also tables containing other relevant data should be presented. It is also necessary to discuss the physical response table, and how various treatments perform in comparison to the control plot. Whether or not the control plots represent typical farmer yields, variation in yield across sites, and how treatments respond at different sites, should be discussed.

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6.4 **Farmer Assessment**

Discuss which treatment(s) the farmer prefers and why, report the farmers detailed assessment of all the developments and cultural practices involved in the trial and also what the farmer does.

6.5 **Economic Analysis**

An economic analysis should be considered for any trial designed to determining or verify recommendations for farmers. The types of analyses to be conducted are: partial budget, dominance, marginal rate of return and minimum return analyses.

7. **Farmers evaluations at different stages of Trial**

Farmer evaluation are not a substitute for careful agronomic and economic evaluation of technology. It is an essential complement which provides information on how farmers weigh agronomic, economic, and socio-cultural considerations to arrive at their own conclusions about the usefulness of a new technology.

7.1 An agricultural research program proceeds through several different stages which can be broken down as follows:

Diagnosis = identification of objectives, needs and problems

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Planning and Design	=	setting priorities among problems; definition of potential solutions; formulation of strategy to test solutions; design of prototype technology.
Experimentation	=	Testing and evaluation of prototype technology, resulting in developed technology.
Adaptation and validation	=	development technology is further tested, and adapted to many location-specific circumstances, resulting in recommendations for use.

7.2 The application of farmer evaluations at different stages in research

Stages of Research:	Farmer Evaluations:
Diagnosis: Identification of objectives, needs and problems	Identify farmers' criteria for choosing among currently available technologies to understand their decision-making.
Planning and Design: Setting Priorities among problems; identifying potential solutions; design of prototype" technologies; & strategy to test there.	Identify farmers reactions to "prototypes", to obtain criteria for identifying which prototypes to " test.

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Experimentation: Testing & Evaluation of prototype technology resulting in developed technology.	Identify farmers' criteria for choosing among alternative technologies being tested, to select the most promising ones from the farmers' point of view.
Adaptation and Validation: Developed technology is further tested, resulting in recommendation for use.	Verify farmers' reactions obtained earlier, by comparing new tenchnology to current practices, to ensure acceptable recommendations.

8 Conventional expectations of farmer-researcher relations

Definition of researcher role	Definition of farmers's role
1. Research is the expert	1. Farmer is the layman.
2. Researcher is a social superior	2. Farmer is social inferior
3. Researcher represents modern agriculture	3. Farmer represents backward, traditional agriculture.
4. Researcher asks questions.	4. Farmer gives answers.
5. Researcher makes decisions.	5. Farmer complies with researchers' decisions.
6. Researcher is supposed to teach and convince the farmer that new technology is better than existing practices.	6. Farmer is supposed to learn from received wisdom of researcher.

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9. Key expectations for successful farmer evaluation.

9.1 Researchers and farmers are experts in their own different fields of knowledge and experience.

9.2 Both types of knowledge merit mutual respect

9.3 The farmer's agricultural practices, and whole way of life, are respected by the researcher.

9.4 The farmer needs to under stand the technology that is being tested, and therefore has the right to ask questions, he is entitled to explanations and justification of the research.

9.5 The researcher is motivated to learn from the farmer who will, therefore, teach as well as learn.

9.6 The farmer will be responsible for decisions that can make or break the success of the result.

10. Seed production Scheme

10.1 Attempts to manage the seed problems.

Improved crop variety is one of the key components of the recommended crop productivition technologies. Unfortunately, in Ghana, the supplies of certified seeds have not been adequate, more with sorghum. This problem has become more serious as the number of farmers increase rapidly wishing to participate in the production Test plot (PTP) project or to adopt the improved crop production technologies on their own. Inadequate availability of certified maize and sorghum seed has forced extension officials to work out alternative means to supply improved seeds to farmers.

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One of the most practical options has turned out to be the selection of the well-managed PTPs as seed multiplication plots and this option has been implemented in all three regions of the Northern zone.

In the upper East region, while seeds harvest from PTPs art being used as the extension system have attempted to improve the quality of seeds in two ways. For maize, they tried to make use of farmer who has had the experience of producing seed maize for the Grain and legumes Development Board (GLDB); the farmers was asked to multiply the foundation seed obtained from GLDB, which in turn, purchased the commercial seed from him. There experiences are valuable, showing what can be done at the local level to meet the demand of the seeds of improved varieties under the absence of certified seeds in the market supplied by the seeds under the supervision of the extension system may not be ideol for the production of the seeds of very high quality. Still in the absence of very high quality seeds available in the market, the attempts to extension system to supply reasonable quality seed of improved varieties to farmers is commendable.

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0.2 Secondary seed Multiplication Scheme (SSMS)

The experiences on Secondary seed Multiplication at a village level in Ethiopia are limited or even non-existent. There is a proposal to establish and expand SSMS. The SSM units could be at the level of a village, a peasant association or service co-operative or individual farmer.

The participants on SSM units are the following:

a) Farmers: they are expected to be the main actors in defining the problem, in finding solutions and

in carrying out the plans. If farmers are not given an active sole to play, the scheme will not be effective and sustainable.

b) Development Agent (DAS). DAS are expected to ensure community participation and will also be responsible for the over all field implementation of the scheme. To be successful in the SSMS, a development agent must communicate effectively with the local people, must have sufficient knowledge in seed production, and must stay in the community for a better follow up of the scheme.

c) Female farmers participation they will have more role for encouraging and ensuring the participation of women in the SSMS. They can participate in cleaning seed and selling of all aspects.

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5. Coefficient of variation (CV)

6. Reporting Results of on-Farm Trial

7. Farmers evaluations at different stages of Trial.

8. Conventional expectations of farmer-researcher relations

9. Key expectations for successful farmer evaluations.

10. Seed production Scheme.

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Crop Diversification & its Effect on Yield & Soil Fertility

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Crop diversification and its effect on yield and fertility

1. Introduction

    1.1 The role of rainfall and temperature in crop production

2. Major crops grown and their climatic adaptation

    2.1 Climatic adaption of crops in Ethiopia

    2.2 Present situation

3. Potential cropping systems

    3.1 Mixed cropping

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4. Summary and Recommendations

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Inter-Cropping and its Effect on Yield

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Inter-Cropping and Its Effect in Yield

1 Introduction

2. Multiple cropping systems

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4. Summary and recommendations

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Storage, Post Harvest Handling and its Effect on Overall Crop Products

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STORED PRODUCTS, PESTS AND THEIR CONTROL IN ETHIOPIA

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CCRDA

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1. INTRODUCTION

Ethiopia has a great agroecological diversity and therefore has a wide range of crop pests and diseases. A large number of food and cash crops grow in this country. These include cereals (teff, sorghum, maize, barley, wheat) pulses (faba bean, field pea, chickpea, lentil, haricot bean, grasspea), oil seeds (figger seed, linseed, sesame, rapeseed, sunflower, groundnut), horticultural crops (enset, potato, sweet potato, vegetables, fruits) and cash/industrial crops (coffee, cotton, sugarcane).

Average yield of crops in Ethiopia is low mainly due to poor technology, including crop protection. Pests and diseases are reported to have damaged about 30% of crops produced worldwide. Storage pests are known to cause 5-10% crop loss and 20-80% damage 2-4 months after crops are stored. Storage pests affect both quantity and quality of crops thus affect their value. For example, experimental results show that crops damaged by storage pests lose about 80% iron, 82% calcium and 92% ascorbic aid contents of certain grains.

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2. PESTS AND DISEASES

Records show that a large number of pests and diseases mainly attack stored products in Ethiopia. The commonest pests are shown in the following table:

Name of insect	Crop(s) attached
BRUCHIDS	Legumes
Beans bruchids (several species)	
WEEVILS	
rice weevil	Sorghum, Maize
maize weevil	Maize, Sorghum
sweet potato weevil	Sweet Potato
OTHER BEETLES	
red flour beetle	Sorghum, Maize, Wheat
lucujid beetle	Wheat, Maize, Sorghum
MOTHS	
Angoumois grain moth	Maize, Sorghum
tropical warehouse moth	Maize, Sorghum, Wheat
potato tuber moth	Potato

Grain mould is important in pits commonly found in eastern Ethiopia several species of rats cause heavy losses on stored cereals in many parts of the country.

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3. PEST CONTROL

To most non-specialists, "pest control" is synonymous with "pesticidal control". However, this is not right. On the contrary, insecticides are used as a last resort (except for combatting outbreaks of migratory pests on a standing crop). This can be seen later in this section.

The options available for pest control depend on several factors such as the origin of the pest (whether it is introduced or indigenous), habit of the pest (sedentary vs. migratory; wide vs.

limited host range; flying vs. non-flying, etc.), size of the crop area, importance of the crop, etc.

3.1 Regulator Methods

These refer to legislation to enforce quarantine of plant material. Propagating materials (seeds, cuttings, whole plants) imported from abroad are required to be accompanied with a phytosanitary certificate stating that they are free from pests and diseases. pests can be controlled by fumigation, dusting or dipping the material in an appropriate pesticide solution, depending on the type of the material. These materials are inspected by a trained quarantine officer at the port of entry, and if he/she finds dangerous organisms, the whole consignment may be destroyed. Sometimes imported materials may be grown in isolation (quarantine) under strict observation before they are released for research or for use by the general public. This is Particularly important to intercept seed-borne diseases.

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Plant quarantine is a very important aspect of pest control. This is because new pests in a new place are more devastating than in their original home because its natural enemies (parasites, predators, pathogens) are usually left behind. Mealybugs, scale insects, etc. can be examples of this. The cassava mealybug (Phenacoccus Manihoti) was accidentally into west Africa from South America in the early 1970's. It quickly spread and affected most cassava-growing countries of western, central, southern and eastern Africa in less than a decade. The vegetable leafminer

(Liriomyzatrifolii) was inadvertently introduced into Kenya in 1977 with chrysanthemum cuttings from Florida, USA. By 1979 it was reported to be found in Tanzania and by 1983 it reached Ethiopia. This is a quarantine insect in many countries. More recently, the greater grainborer (prostephanustruncatus) was reported to have been introduced to Tanzania with imported grains from the USA and is becoming a major threat to maize production. Unfortunately, most countries in Eastern Africa do not have strong national quarantine regulationsto control migration of pests.

3.2 Physical Methods

These are pest control methods by used putting physical barriers such as nets and bags to prevent pest damages. Physical methods are very costly and have little relevance to Small-scale agriculture.

3.3 Mechanical Methods

These involve actual removal and killing of pests. Mechanical methods are particularly useful against certain insects in subsistence farming. For example, egg batches of the cotton leafworm (Spodopters littoralis (Boisd)) are hand-picked and destroyed not to damage the cotton. Hand-picking and killing of caterpillars of the orange dog (Papiliodemodocus) on citrus and of flower beetles (Coryna and Mylabris spp.) on beans are recommended in some tropical countries.

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3.4 Cultural Methods

Cultural methods refer to the various practices the farmer himself undertakes to reduce pest damage. This may include several practices such as adjusting planting/harvesting dates and plant populations, inter-cropping, observance of closed season, crop hygiene, and crop rotation. These are briefly discussed as follows.

3.4.1 Timely sowing

Adjusting sowing dates is essential to avoid the breeding period of pests. By the time the pests are mature enouth to damage crops, the vulnerable crop stage is already passed. For example,early sown maize crops will escape damage by the maize stalk-borer (Busseola fusca (Fuller).

Another aspect of adjusting planting dates is that it helps to avoid building up of pests in an area where the same crop is planted repeatedly. For example, heavy damage by B. tabaci on cotton is believed to be at least partially due to staggered planting.

3.4.2 Time harvesting

Prompt harvesting is known to prevent maize and beans from damage by maize weevil and been bruchids, respectively,

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3.4.3 Optimum plant density

Pest management practices show that plant density can affect pest and natural enemy biology. For example, bean fly infestation on haricot bean is less severe in more densely-planted crop than thinly-planted ones.

3.4.4 Observance of closed season

Some pests have limited host range and therefore cannot survive in the absence of their host plants. A good example is the effective control of pink bollworm (Pectinephora gossypiella) on cotton by a strict observance of closed season (dead season) in Eastern Africa. When no cotton is grown during the off-season, the pest is deprived of a carryover site for the next season, and thus is kept below economic levels.

3.4.5 Trap-cropping

Trap crops are used to divert pests from the main crop. They are usually preferred over the main crop for feeding and/or egg laying. Here the trap crops are grown either as peripheral bands or strip-planted at appropriate intervals. Pest population thus concentrates on the trap crop the main crop thus suffering little damage. In Ethiopia maize strip-planted with haricot bean and lupin (Lupinus albus) with chilies (Capsicum spp.) contained much greater numbers of Heliothis armigera and resulted in less pod damage. Hyacinth bean (Dolichos lablab) planted around cotton is known control, to some degree, Heliothis from cotton in Zimbabwe. Another importace of trap crops is that of planting strips of the

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same crop species in the borders earlier in the season so that the pest population concentrated on the strips can be either hand collected and destroyed or the strips can be sprayed with effective insecticides.

3.4.6 Crop rotation

Crop rotation may be useful in the control of insects that have limited host range and those that inhabit and breed in the soil. White grubs (Heteronychus licas (klug) and Schizonycha spp.) that attack sugar cane and cereals are examples of this.

3.4.7 Crop sanitation

Cleaning crop fields after harvesting and burning crop residues to destroy overwintering pest population are important cultural practices. Currently, however, this practice is being challenged on the grounds that will hosts and crop residues can play an important role as reservoirs of parasites. Moreover, farmers have other uses for crop residues. Sorghum and maize stalks are used for construction purposes and therefore the farmer may not be willing to burn stalks.

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3.4.8 Cropping patterns

Cropping patterns can influence pest population in several ways. Intercropping is a common practice in a peasant agriculture in Eastern Africa and elsewhere in the tropics and pest outbreaks under this condition are less frequent than in moncultures.

In some instances intercropping systems may cause a delay in the onset of pest attack as was shown for stalk-borers in Kenya. It is not uncommon for peasant farmers in tropical countries like Ethiopia to grow mixtures of several crops in one field. This creates crop heterogeneity and genetic diversity within a crop, which may impose a physical restriction on a potential pest.

3.5 Host Plant Resistance

Host plant resistance can have negative impacts on pests in three major ways. These are: antixenosis (or non-preference) antibiosis, and tolerance. A brief description of each of these mechanisms is given below.

3.5.1. Antixenosis (non-preference)

This refers to the innate qualities of the plant that makes it unsuitable for the insect for oviposition, feeding or shelter. Differences among plant varieties in morphological and physiological characteristics such as excessive pubescence or presence or absence of extrafloral food sources can influence pest/host interactions very dramatically. Resistance of pubescent varieties to the potato aphid (Aulacorthum solani) and to leafhoppers and of nectariless cotton to plant bugs are examples of antixenosis.

3.5.2 Antibiosis

Plants with this type of resistance mechanism have deleterious effects on the pest feeding on them.

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3.5.3 Tolerance

Tolerant plants are those that suffer little damage in spite of supporting a pest population adequate to severely damage susceptible hosts.

There have been only a few cases where host plant resistance has been used effectively against insect pests in Eastern Africa. The cotton leafhopper (Empoasca lybica De Berg) was a common cotton pest in Ethiopia. But it has been a lesser threat because of more resistant cotton plants varieties such as "Acala". In West Africa host plant resistance combined with minimum insecticide applications how proved to give effective control of some cowpea pests.

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3.6 Biological Control

Biological control refers to the use of living organisms for the control of insect and mite pests. This particularly refers to the deliberate introduction of natural enemies (parasites and predators) from abroad. Broadly speaking biological control also includes the use of pathogens (bacteria, fungi, viruses, protozoans and nematodes) and botanicals.

Biological control using parasites and predators is usually more successful against introduced pests especially on perennials. The effective control of the Kenya mealybug (Planococcus Kenyae) by Anagyrus spp., introduced from Eastern and Central Africa is one of a few examples of successful biological control in this region.

Effective control of the cassava mealybug (Phenacoccus manihoti) which one is controlled or are they the same? in Western and Central Africa is achieved by introduction from South America of the specific parasite Epidinocarsis lopezi.

3.7 Use of Insect Growth Regulators (IGR)

IGR's are substances that interfere with the growth and development of insects. These have been identified, synthesized and used against some insects in recent years. These compounds do not give immediate kill and thus do not prevent pest damage on a standing crop.

3.8 Use of Sex pheromones

These are substances that attract the opposite sex for mating. Synthetic sex pheromones can be spread in the field for mate confusion or used in mass trapping. Their practical use is limited to pest monitoring and forecasting.

3.9 Sterile Insect Technique (SIT)

Insects (males or females) are mass reared in the laboratory, sterilized (by radiation or chemosterilants) and released in the field. These mate with the wild population and produce sterile progeny. This technique has no use under our produce sterile progeny.

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3.10 Insecticides Control

Insecticides have long overshadowed all other methods of pest control because of their quick effect. However, several drawbacks attributed to insecticides have been observed over the last few decades. Some examples follow.

3.10.1 Resurgence of target pests

Flare-up in target pest population following insecticide application can result from one or combination of two things. First, high selection pressure caused by insecticides results in insect population that are resistant to pesticides. These surviving pest populations multiply at a very fast pace thus requiring higher and higher dosages until it becomes uneconomical to produce a crop. The African bollworm (Heliothis armigera) is a notorious example of an insect developing rapid resistance to pesticides. Secondly, insecticides indiscriminately kill natural enemies (parasites and predators) which otherwise check pest outbreaks especially under traditional agriculture such as the one practised in Ethiopia and other developing countries.

3.10.2 Secondary outbreaks

Sometimes insects that were innocuous or minor pests can attain major pest status following insecticide applications against major insects. For instance, in Ethiopia, the use of DDT on cotton early in the season is reported to cause outbreak of the cotton aphis (Aphis gossypii) tobacco whitefly (Bemisia tabaei) and red spider mite (Tetranychus cinnabarinus).

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3.10.3 Residue hazards

Insecticide residue hazards, especially those of persistent ones, can affect humans when foods from chemical-treated crops are consumed. Moreover, they may drift or drain into streams and other waterways from which the wildlife, domestic animals and humans get their drinking water.

All the shortcomings of insecticides mentioned above aside, they are not available to the small farmer, cannot afford them and he may not have the know-how to use them.

3.11 Integrated Pest Management (IPM)

IPM can be defined as the judicious selection and use of compatible pest control options to keep pest populations below damaging levels. IPM is based on adequate knowledge of the ecology and dynamics of the pest ad its natural enemy populations. The emphasis here is on optimization of control tactics rather than attempting to eradicate the pest.

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Abate in Ethiopia studied population dynamics of the red scale, Aonidiella aurantii, and its natural enemies. He concluded that white oil sprays timed to coincide with breeding peaks of the pest in September-October and March-April can reduce frequency of spray from previously used average of about 10 to 2/per year. In addition to reducing insecticide usage and application costs this practice gives better chance to natural enemies and may eventually lead to total abandoning of insecticide spraying. Early planting

of resistant varieties at a high plant density has been reported to reduce insecticide and application costs. This practice gives to natural enemies more opportunities and may eventually lead to total abandoning of insecticide spraying. Early planting of resistant varieties coupled with high plant densities has been reported to reduce bean fly (Ophiomyia phaseoli) infestation of bean in some parts of Ethiopia.

4. SPECIFIC EXAMPLES OF SOME STORAGE PESTS IN ETHIOPIA

4.1 Maize and Rice Weevils

Maize and rice weevils (Sitophilus zeamais and S. oryzae, respectively) are serious pests of stored cereal grains. Damage is caused by the larva that bores a thin tunnel towards the inside of the kernel making the characteristic circular holes. Infestation usually starts in the field.

4.1.1 Life cycle

The adult chews and makes tiny holes in the seed into each of which it deposits a white oval egg. The holes are then sealed with a secretion after the eggs are laid. The minute larvae hatch from the eggs and feed inside. The full-grown larvae are legless (like other weevil larvae), whitish and about 4 mm long. Pupation takes place within the kernel. The adult is a small dark brown weevil (with light brown spots on the back) and about 4 mm long.

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4.1.2 Host range

Maize, rice, sorghum, wheat, barely and many other stored cereals grains are liable to be attacked by these weevils.

4.1.3 Control measures

Cool and well-ventilated storages provide unfavorable environment to these and many other pests of stored grains. Stores must be free from weevils and crop (seed) residues. Only clean seeds should be stored. Maize varieties with unexposed ears are likely to escape infestation in the field and therefore can minimize the chance of infestation in storage.

Grain treatment with 5 ppm (0.5g a.i./100kg seed) pirimiphos-methyl and 5 - 10 ppm methacrifos gives satisfactory control.

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4.2 Angoumois Grain Moth (AGM)

AGM (Sitotroga cerealella) is another common pest of stored grain. Infested seeds are characterized by very small holes on them. Infestation may start before harvest.

4.2.1 Life cycle

The eggs are oval-shaped, pink and laid on the surface of the grain. A female pest lays up to 100 eggs. Upon hatching the dirty white, elongated larvae bore into the grains and feed inside. The full-grown larvae are about 8 mm long. Pupation takes place in a frail cocoon inside the seed. The adult is a straw-coloured small moth with a wing span of about 15 mm. It is distinguished from

other moths attacking stored grain by a longfringe of hairs on the hindwings. The adult does not feed. The total life cycle is completed in about 5 weeks.

4.2.2 Host range

Maize and wheat are preferred hosts. AGM also attacks other cereals (including sorghum and barley) and dried fruit in storage.

4.2.3 Control measures

Similar control measures for weevils can be used.

4.3 Bruchids

Three species of bruchids are common in Eastern Africa. These are: the bean bruchid (Acanthoscelides obtectus (Say)), the cowpea bruchids (Callosobruchus chinensis (L.) and C. maculatus (F.)). The first type attacks beans, while the last one cowpeas and C. chinensis attacks both crops. The Mexican bean beetle (Zabrotes subfasciatus) has been recently found in Ethiopia and it is common in Eastern and Souther Shewa.

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4.3.1 Life cycle

The eggs are pointed (dirty white in A. obtectus and white in the other two, and are laid stuck on the seed coat. Each female lays 40-90 eggs (Callosobruchus is more prolific). The aggs are hatched in 5-6 days. The larvae bore into the seed and feed inside for about 3 weeks and pupate there. The pupal period lasts about a

4.4 Red Flour Beetle

The red flour beetle (Trifolium castaneum) is the most dangerous attacking pest stored foodstuffs throughout the tropics. Infestation can be detected by the appearance of adult beetles on the surface of the grain. The damage is more serious on previously damaged grains (mechanically or by other pests). Both the larvae and adults can damage grains.

4.4.1 Life cycle

The small, cylindrical, white eggs are laid scattered in the produce. Each female can lay 400-500 eggs in its life time. Larvae are yellowish-white and measure about 6 mm when fully grown. They feed and develop inside the grain till pupation. The pupa is also yellowish-white, but turns brownish as it progresses in its development. The dorsum (upper part of the body) is hairy and has two spine-like processes. The adult is flattish, oblong, reddish-brown and measures about 3-4 mm in length.

The entire life cycle, from egg to adult may take about seven weeks, depending on the ambient temperature.

4.4.2 Host range

Maize, sorghum and wheat are preferred hosts; it may also feed on a wide variety of stored food stuffs.

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4.4.3 Control measures

The grain must be adequately dried. Mixing shelled grain with neem seed powder at about 5-10% proportion (by weight) can give good protection. Similar treatment with pirimiphos-methyl (4.5 ppm) is also effective.

4.5 Tropical warehouse moth

The tropical warehouse moth (Ephestia cautella) is a dangerous pest of stored produce in Ethiopia and elsewhere in the tropics. Its damage is recognized by the characteristic webbing in the grain and on the surface, with pupal co-coons in between surfaces.

4.5.1 Life cycle

The whitish round eggs turn pale orange towards hatching. They are laid through the holes in the bags. Each female moth may lay up to 250 eggs during its life time. Larvae are greyish white and measure about 2 cm in length when fully grown, numerous dark hairs can be observed interspersed along the body. The pale brown pupae are enclosed in cocoons in crevices or in between adjacent bags. The adult moth is greyish and about 13 mm long. The entire life cycle may be completed in 40-60 days, depending on the surrounding temperature.

4.5.2 Host range

Maize, sorghum, and wheat are preferred hosts. It also attacks a wide range of crops, including beans, nuts, groundnut, and dried fruits in store.

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4.5.3 Control measures

Store hygiene is an important aspect of controlling tropical warehouse moth. Treating bags or containers with neem seed powder or pirimiphos-methyl can also be recommended.

4.6 Potato Tuber Moth

The potato tuber moth (PTM) or potato tuber worm (Phthorimaea operculella) is the major pest of potato in shores as well as in the field. The larva bores the tuber and causes damage by directly feeding and/or by paving the way for secondary infection by fungi or bacteria.

4.6.1 Life cycle

Eggs are minute, oval, yellow and laid singly in tubers in storage near the eye. Each female may lay 150-200 eggs. Larvae are pale greenish, measuring about 10 mm in length when fully grown. Pupation occurs just under the surface of the tuber. The adult is a small moth (wingspan 15 mm) with narrow fringed wings, forewings are greyish-brown with dark spots; kindwings are dirty white. Depending on temperature, one generation may take 20-30 days.

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4.6.2 Host range

PTM is a polyphagous insect recorded on a wide range cultivated and wild plants. Potato and tomato are preferred hast plants in Ethiopian. Other hosts include tobacco, eggplant, Datura and many other solanaceae.

4.6.3 Control measures

Store hygiene and use of clean (uninfected) tubers are recommended. Tubers should be stored under a cool condition. Covering stored tubers with a layer of dried leaves of lantana is known good protection against PTM in other parts of the world.

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TRAINING PROGRAMME ON IMPROVED FOOD CROP PRODUCTION & MANAGEMENT

METHODS AND STRATEGIES FOR CONSERVATION OF PLANT GENETIC RESOURCES

By Regassa Feyissa[1]

CCRDA

November 24 - 26, 1993

1 Plant Genetic Resources Centre/Ethiopia (PGRC/E)
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1. What are Plant Genetic Resources?

Plant Genetic Resources are the potentially useful characteristics in plants that can be transmitted genetically. They are the sources of wide variation of plants life upon which all other forms of life on land depend for subsistence. Plant genetic resources cover a wide range at both the evolutionary and ecological level. Ecologically the variation ranges from the components of very early ecosystems to the modern agricultural materials. At the evolutionary level it covers a wide range of variation from wild ancestors to the modern cultivars.

2. The need for Conservation:

Variability in plants has become a base for food and other human welfare for millennia and it continues to provide the genetic bases for development of plant characters useful to humanity. These heritage of humanity remains an asset and a tool to promote local, regional and national economies in all nations of the world. It is a key to a sustainable agriculture and have a major role in world trade. However, from what we see these rich heritage is ill-used and the pressure is rather increasing being supplemented in many of the cases, by human greed. The problem is getting sever in so many aspects as being a great challenge to humanity and thus, areas of immediate concern are tremendously increasing.

The basic need for genetic resources conservation mainly arises from two processes of human interaction with his environment and changes in natural ecosystems.

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2.1 Human Interaction:

2.1.1 Destruction of species due to the pressure exerted by humanity on natural ecosystems:

Todate, of 31 million hectares once found on earth, 56% have been logged or cleared. Home of at least half the planet's species, tropical forests have been reduced by nearly half, their original area. In Ethiopia the forest once estimated to cover 40% of the total area of the country has now reduced to 3%. In Benin, Cote d'Ivoire, Western Ecuador, El salvador, Ghana, Haiti, Naigeria and Togo, forest have all but disappeared.

Out side the tropics also there are arid land scape which are found to be the house of the worlds greatest concentration of threatened plants. Among these are South Africa, where four fifth of existing there plants are found nowhere else. Unfortunately, 13% of these - more than 2,300 species are reportedly, threatened. In the United States of America about 3000 species, in which one in eight is a native plant, are considered in danger of extinction. More than 700 species are estimated to disappear without effective major taken to save them.

2.1.2 The loss of variability due to spread of agricultural technology:

The modern varieties are widely diffused to accompany the spread of technology based agriculture, but at the expense of narrowing and totally displacing the variabilities in crop/plant.

Infact, the wide spread of introduction of a handful high yielding crop varieties has promoted food production over a few decades, but eliminated many traditional lines well adapted to local ecosystems. These local varieties with wide range of adaptation to local environmental conditions could have been used to develop high yielding, locally appropriate crops. In Indonesia, for instance, 1500 local varieties of rice have been disappeared within the past 20 years. Amazingly enough, nearly three fourths of the rice planted today in Indonesia descends from a single maternal plant.

Uniformity, is not essentially undesirable. To some extent uniformity is the basis of all agriculture in which a given type of plant is favoured and other suppressed or eliminated. But, intensification of homogenizing farming systems have pushed uniformity to dangerous level. Such high level of agricultural uniformity may leave fields vulnerable to pest and disease outbreak that can violet the entire agricultural system of a nation.

2.1.3 Changes in Natural Environment

The genetic resources of indigenous crop/plant species has been disappearing or threatened to disappear due to changes in environment. Natural calamities such as drought and other stresses create or accelerate selective elimination of genotypes in populations or cause crop failures which may result in complete wipe out of genetic material.

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The awareness and the expansion of the above mentioned and other problems, mostly caused by human in its relations to ecosystem and changes in environment have initiated the universal need to protect and maintain the existing variations. There is no doubt that this rich heritage to humanity would no longer be available if not protected to day.

3. What should be conserved:

It is difficult to predict the future value of even, the plant genetic resources in current use and impossible to foresee the arising needs and demands of humanity on those, which we are not in a position to use today. But, one thing is true: when humanity is destructing its ecosystem, it is evident that humanity is also affected together with the ecosystem.

As a matter of fact, there is no basic evidence to discard one or another genetic material, since there is no means of telling when and which genetic material may truly be useless. Therefore, all genetic materials covering a wide range of variabilities that exist today must be conserved.

4. Methods of Conservation:

Basically there are two methods of conservation, viz. in-situ and ex-situ.

4.1 In-situ (Dynamic) Conservation:

It is the conservation of the centres of natural variabilities in which all the existing variations are maintained inherently unchanged. It involves the maintenance of genetic resource with due regard to the natural ecosystem and permits continued evolution and is dynamic in its nature. Both domesticated and wild plants can be conserved in-situ. For crops, in-situ conservation includes the continuing cultivation of crops by farmers in the system where these crops have been evolved. The crops have been co-evolved with diseases, pests, weeds in which certain mechanisms of co-existence is developed through time.

In-situ is normally defined by geographic area rather than by species, therefore, what is conserved often includes both known and unknown species. Knowledge of minimum habitat size, the abundance of species, and the dynamics of the populations is needed.

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In-situ permits the study of species in the context of their natural environment. It provides a natural reservoir of plant genetic resources, many of which may yet be unidentified and of unknown future value.

In-situ conservation is appropriate for many wild species, including the wild relatives of crops/plants (particularly trees) for which no adequate ex-situ methods are available. Species continue to evolve with the dynamic forces of their habitats; and this does not occur ex-situ.

4.2 Ex-situ (Static) Conservation:

Ex-situ conservation involves different means of preservation with little or no regard to natural ecosystem. It is effected through maintaining organisms outside their original habitats in botanical gardens, field gene bank and storage facilities, both modern and traditional.

5. Strategies for conservation:

Effective conservation activities are always hindered by the lack of qualified or problem versed personnel, by the lack of information on the biology of species to be conserved, by the lack of appropriate facilities and also due to lack of mechanisms which integrate conservation programmes with other development efforts.

Basically the strategies of conservation depend on the nature of the material to be conserved, on the objective and the scope of conservation.

The nature of the material is defined by the length of the cycle, the mode of reproduction, the size of individuals and the ecological status-whether wild, weed or domesticated.

The over all objective of conservation is the long-term support of agriculture in general and plant breeding in particular. It includes research, introduction, etc. that determine the degree of integrity, which is essential or desirable to maintain.

The scope of conservation is the time scale over which maintenance is projected and the area or space to which it relates.

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5.1 To establish a strong and sound conservation system the following conditions should be fulfilled.

5.1.1 Important to survey, document and collect wild species, relatives of cultivated crops, medicinal plants, horticultural crops and associated with them knowledge;

5.1.2 Important to study the status of the existing environmental condition and its impact on the ecosystem; survey the level of ecological degradation and the rate at which genetic erosion occurs; quantify the domination of certain species by others to keep it in balance; survey and record the magnitude of the existing genetic diversity in PGR. Knowledge of conservation biology is also required.

5.1.3 Information on biological resources serving as a primary data essential for survival management of the species is required. Such information include:

- information that help to establish knowledge on the occurrence, abundance and distribution of endangered plant species;
- information on where such species occur and such information is essential for conservation planning and management;

5.1.4 Comprehensive documentation including the following is required:

- survey and mapping of broad habitat type interms of topographical features, soils, vegetation and micro-climates including ecological data and lists of species with their known or potential economic, ecological, cultural and medicinal value;
- indexed inventory for species of actual or potential economic significance and endangered species found in a critical need of conservation;
- review of collections and indexing of historical and scientific literature already available and keeping the documents up-dated with current facts and information;
- maintenance of records of all significant events like changes in land use policy which may likely affect the habitat.

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5.1.5 The integration of conservation and development programmes is required.

This include:

- integration of conservation programmes within other national development policies and sectoral plans.
- setting of priorities and strategies of option for effective conservation and sustainable use and development of PGR;
- establishing mechanisms where by both ex-situ and in-situ conservation systems are initiated and effected as a national goal of development;
- developing environmental impact studies that can be undertaken and become a prerequisite and mandatory on every major development project. This should be made as a legal requirement and confirm to standardized codes of conduct in the country. The studies need to be undertaken from a multidisciplinary approach, taking in to account the ecological, economical and cultural aspects of the area or the problem to be studied.

5.1.6 Community Participation including the following prerequisites is required:

- coordinated and systematised environmental education, be it at grass root or formal educational level;
- it is important that sustainable public education and awareness campaign programmes are developed to teach the importance of nature conservation and its relevance to the concerns of all groups of the community at all levels.

At present there are enormous growth of conservation literature, but there are few information materials designed to persuade people regarding the relevance of conservation to development. Hence, the effort to create awareness of the maintenance of ecological, life-support systems and genetic diversity is made without sufficient documentation to convince people. Some of the available information on genetic resources are not documented fully enough or described with sufficient precision.

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C O N C L U S I O N

Any conservation effort is unlikely to succeed without a national strategy and policy guidelines. The designed national strategies should aim to achieve the following functions:

- develop mechanisms and methods for effective conservation, and sustainable use and development of PGR;
- develop a system where by both ex-situ and in-situ conservation activities are established and strengthened as a national goal of development in which PGR conservation can be integrated within other national development policies and sectoral plans;
- develop concerted cooperative programmes among in-situ and ex-situ conservation practices that can be run by government agencies, NGOs and communities, inorder to align the activities and investments with over all national, regional and local goal for PGR conservation development;
- treat the public polices that invite the loss or miss-use of PGR, especially in development policies and with regard to forestry, agriculture, energy and other natural wealth;
- reform or design policies governing the balance between state, community and private ownership's control and access to forests and range lands.

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TRAINING PROGRAMME ON IMPROVED FOOD CROP PRODUCTION AND MANAGEMENT

COMMUNITY BASED MANAGEMENT OF PLANT GENETIC RESOURCES

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CCRDA

November 24 - 26, 1993

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THE FIVE PRINCIPLES OF PLANT GENETIC RESOURCES CONSERVATION

1. Agricultural diversity can only be secured through the use of diverse strategies for its conservation and development.

   No single strategy can alone preserve and protect the diversity that took so many human cultural efforts and environmental changes to produce it. Different conservation systems should be applied in such a way that they complement each other and provide insurance against the inadequacies of short comings of any one method.

2. Agricultural diversity can be protected well when it is in use only.

   The value of diversity is in its use. Only in use can diversity be appreciated enough to be saved. And only in use can it continue to evolve thus retaining its value.

3. What agricultural diversity is saved depends on who is involved and consulted.

   How much is saved depends on how many people are involved. Farmers, gardeners medicine makers, religious leaders, carpenters. All segments of community need to be involved to insure that the total needs of community are met. The more involvement, the greater the potential to conserve.

4. The need for diversity is never-ending and our efforts to preserve this diversity can never cease.

   Because extinction is forever, conservation must also be forever. We must continue to utilize diverse conservation strategies, involve as many people in the process as possible, see that diversity is actively used and insures the survival of the farm community - for as long as we want agricultural diversity to exist.

5. Agricultural diversity can not be saved without saving the farm community. Conversely, the farm community can not be saved without saving diversity.

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Communities as genetic resource curators

Farming communities have always implemented conservation methods todate known to the formal sector, as ex-situ and in-situ conservation strategies. They have been preserving or conserving variations in their gardens, back yards, fields and in their traditional storage facilities which form a complex of communal gene bank system. In this principle of maintaining crop/plant diversity under traditional gene bank system, the ex-situ seed preservation is supported by the local facilities such as bins, pots and holes underground etc. to keep seeds of various crops for different purposes. The ex-situ preservation under this facilities has usually complemented the in-situ conservation in the fields, gardens, back yards and community forests. Local communities have therefore, been active curators of genetic resources in which they are always able to maintain diversity at their gardens and in their fields improving crop security and stability, thereby lowering the risks of food shortage. They traditionally intercrop varieties and species in which new variation often created as a result of crossings within the mixtures. This has always given them an advantage to widen the diversity in their crops and adapt the newly formed variations to meet certain morpho-agronomic and physiological characters of their interest.

Naturally local farmers are the experts on the traditional varieties and their knowledge of these varieties and the diversity they have created in it has been serving as a basis for modern agriculture. Through use and evaluation they have established the genetic value of their varieties as a dependable source of genes with characters they require to meet their needs. Usually, the potential in a variety to resist pests and pathogens as well as the quality of palatability and storability is well defined by the farming community, particularly by women farmers. The identifications of genetic characters they have established in their varieties are often associated to the morphology, physiology and use value of the varieties and special names that reflect the behaviour of those genes are given to their varieties. Varieties with thigh enzymatic activities are for instance given names expressing good fermentation and baking quality. Similarly varieties resisting birds, pests and microbes are given names indicating the mechanisms of resistance and special substances in the seed, which is responsible for the resistance. The role of polyphenols in different sorghum varieties as related to the above mentioned traditional facts is one of the examples indicating that many of the findings established by modern agricultural science are originated from or are based on the already existed traditional agricultural knowledge.

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THE ROLE OF LOCAL COMMUNITY IN CONSERVING AND UTILIZING GENETIC RESOURCES (IN BOTH Ex-situ and In-situ)

In-situ

- the world's healthy ecosystems are still found predominantly in areas under the control of local communities;
- survival of protected areas depends on the support of local communities, rather than on fences, fines and even force;
- many species little known to science or industrial technology are already managed by local communities;
- many off - site efforts, including gene banks, botanical gardens and zoos are necessary, but protection of habitat is the single most effective means of conserving diversity but with full participation of local communities.

Ex-situ

- traditional agro-ecosystems contain source of a sustainable, diversity based mode of agriculture;
- local farmers usually mimic the species diversity of natural systems and grow varied crops together;
- such multiple cropping on the worlds small farms still accounts for as much as 20% of world food production;
- all high technology forms of crop breeding are dependent on the diversity promoted and maintained by local farming community.

COMMUNITY SEED BANK AND THE COMMUNITY

Community seed bank is not simply a store where seed is kept for distribution or marketing, nor a sophisticated temperature and humidity controlled seed storage facility. It is a system in the process of community agriculture which includes village level facilities, a garden or field where traditional varieties are safe

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guarded, communal or farming forests where wild relatives of cultivated crops survive. Through this system of theirs, farmers have been playing a key role in the creation, maintenance and promotion of crop genetic diversity. With the help of traditional skills they have developed over centuries, they have been selecting crop varieties to meet their specific needs such as quality, resistance to pests and pathogens, adaptation to soils, water regimes and climate, etc. Under this system, local farmers have also established their own communal seed networks to facilitate seed supply among families including the exchange of seeds through local markets. Community Seed Bank therefore, is a system composed of all the above mentioned and other seed related communal activities that have been existed since the start of the local farming system. It is among the major strategies in maintaining genetic diversity in crop/plant species and serves as a back-up for local self-sufficiency in seed, to improve indigenous sustainability.

POTENTIAL USE OF COMMUNITY SEED BANKS

Community seed banks are repositories of locally adapted species, including the enhanced landraces that could provide a sustainable supply of planting material and minimize dependency on poorly adapted and high input varieties. The low-cost community level seed storage facilities can help to preserve the famine mitigating traditional varieties which at the same time serve as a base material for farmers to select special lines to meet their changing needs. However, community seed banks are often understood and operate as a community based stores used for distribution of seed and grain to the local community on loan basis. In some cases, the community seed banks are designed as an income generating activities in which monoculture farming system accompanied with various chemical inputs are exercised at the expense of the poor farming community. Infact, the community seed bank system is not inviting the negligence of improved varieties there by stagnating the development in rural agricultural system by strongly biasing it towards the use of low-yielding mixed populations of landraces. But, the purpose behind it is to increase the number of options in using crop variabilities and to decrease vulnerability to famine and crop genetic erosion.

This can be realised through selection, enhancement and use of the potential genotypes including landrace population and at the same time maintain the landraces as a back up in sustaining the agricultural system. The endangered plant species and economically and ecologically useful types should also be included in the system as parts of community managed environment protection and species conservation schemes. The species would cover various wild trees, shrubs and grasses of traditional use to the communities as food, feed, medicine sources, for fuel and construction.

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Successful community seed bank programmes can be established if only activities are integrated in to the national regional or area specific development programmes. Sustainability can also be achieved when only the programme is designed under the decision and cooperation of local people who are in a better position in identifying problems and setting priorities of species and varieties of their interest for conservation and utilization. Overlooking this fact and disrupting the system as a result of its poor recognition by mainly formal sectors and unwise approach to it would cause an irreversible disorder in the life of the local farming community. There are already enormous evidences where unconscious and unwise approaches to the functions of traditional farming systems and knowledge at community level has exposed the farm community to both nature and human-induced constraints. Some of such incidents are the indiscriminate distribution of seeds of wrong or unknown adaption to the farming community, imposition on farmers to use materials of narrow genetic base and monoculture farming system, unconscious and, uncareful distribution or use of chemical inputs such as pesticides, herbicides and fertilizers, and introduction of unfit exotic forest species to the local ecosystem. Such approaches have certainly disturbed the local ecosystem and sustainability in food production.

The multi-optional approach supported by concerted actions, exercised by the Plant Genetic Resources Centre/Ethiopia (PGRC/E) would probably serve as an example of the best solution to encounter contradictory problems in food security and maintenance of genetic variability. Here, as a national genetic resources conservation and development strategy, the formal sectors (scientists) are jointly operating with the informal sectors (Farming communities) to alleviate the problems in conservation and sustainable food production.

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THE COMMUNITY STRATEGY FOR SEED CONSERVATION

Activities at Community level

1.	SURVEYS	Socio-ecological survey of the community land area based upon Consultation with farmers, medicine-makers, wood cutters, herders etc. Include plant-users in survey and monitoring exercises, covering locally and globally important species.
2.	COLLECTIONS	Organise a series of community-based collection expeditions covering a range of crops throughout the entire growing season.
3.	CONSERVATION	Where possible farmers are supported in maintaining small plots for endangered

cultivars and store under cool, dry conditions within the community and monitored by local people knowledgeable about the species. Duplicate sample can be kept at national gene banks where it exists.

4. REGENERATION With a decline in viability, sample is either grown out or (if possible) a new sample is collected from the original site. The community may cooperate with regeneration programmes, and they do it effectively better than the formal group.

5. DOCUMENTATION Information is recorded in most useful local language using locally-understood land descriptions and personal names for the benefit of further investigation and regeneration.

6. EVALUATION Information collected from the local community regarding the immediate usefulness and long-term value of the crop is documented.

7. UTILIZATION Evaluation information is shared with community users and samples may with the information directly be passed to the community members to may improve production.

Existing Gaps Affecting Communal level genetic resources conservation

- modern and indigenous conservation and utilization systems are not integrated;

- knowledge of natural environment possessed by local communities is under estimated;

- indigenous knowledge is disappearing at the rate faster than the natural environment it self;

- the loss of traditional management systems for medicinal plants, traditional varieties of crops and other life forms developed and used by local people are among the greatest threats to biological diversity;

- the indigenous practices in conserving biodiversity is disappearing due to the displacement of native cultures and cultivars by expanding influence of the global commercial economy;

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- legitimate historical claims of local community and free recognition of traditional resource right is missing;

- benefits from resources in areas under community conservation (protection) usually flow to national coffers and in most of the cases the communities are not benefiting or are given minimum share. But local communities have born the cost of living with pollution, habitat degradation and with wild life attacking their crops and life stocks, without any or unfair compensation.

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Small Scale Agricultural Tools and Equipments

Small Scale Agricultural Tools and Equipments

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SMALL SCALE AGRICULTURAL TOOLS AND EQUIPMENT

PREPARED FOR CRDA's TRAINING PROGRAMME

ON

IMPROVED CROP PRODUCTION THROUGH

THE

ADAPTION OF LOCALLY AVAILABLE TECHNOLOGY

CCRDA

Menker W/Kiross

RTPD

November, 1993.

Small Scale Agricultural Tools and Equipment

Ethiopia is a country rich in diverse agricultural traditions of equipment, food processing and preparations. These richness in the diversity in foods and agricultural traditions have maintained and provided the population it's means of existance for many centuries. The existance of these traditional equipment unchanged undeveloped or substituted for many years have contributed to the weak productive capability of agriculture.

The ever increasing population of Ethiopia is not matched by rate of improvement in agricultural production. The average yield of food grain is hardly more than 1.2 tons/hectare. This rate of production is not an incouraging reality of Ethiopian agricultural situation.

The development of efforts in agricultural production in Ethiopia concentrates mainly on the utilization of appropriate fertilizer, and to some extent on improved seeds. However, without proper seed bed preparation, harvest and post-harvest operations, it is not possible to obtain the possible production rate per unit area as achieved in those countries which have appropriately combined the fertilizing inputes with proper means of production. In Ethiopia, however, we are trying to increase production by mixing inputs with centuries old means of production. Such trend though seemed a short-cut for agricultural development, it can hardly provide sustainable and economically affordable system of production.

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thiopia to day is not even capable to furnish adequately the upply of the traditional implements to the peasant farmers to elp them satisfactorly perform their agricultural practices.

t is high time to accelerate the efforts of improvement of agri-ultural implements in five fronts:

- Facilitate the availability of the traditional tools and implements adequately.
- Make available improved equipment, to alliviate the bottle-neck agricultural activities and that reduces loss.
- Up grade the quality and capability for maintainance and production of traditional and improved equipment in rural villages.
- Develope national capability of research, development and popularization of improved technologies and
- Provide incentives for private sectors to involve in the production and promotion of agricultural equipment and services.

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raditional Tools and Equipment

lore than 95% of the tools and equipment used in Ethiopian agri-:ultural production are traditional. The existance of these equipment at the threshold of 21st. century is not without reason.

They have qualities that have attracted farmers. It is not reasonable to expect farmers to adapt new and improved technologies unless these equipment are of quality and standard that satisfy the socio-cultural and technolo-economic situation of the individual farmer and the community.

The effectiveness of the operation of agricultural activities are sacrificed due to lack appropriate means of production that are accessible to peasants. As the result, farmers are obliged to use the technologies of the B.C's to feed the multitude of Ethiopians in the last years of 20th. century.

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Soil Preparation Traditional Implements

Most farmers in Ethiopia own the traditional soil preparation implements. The most popular being the traditional plough known as "MARESHA". This soil preparation implement is used for performing activities of soil preparation preparation from ploughing to seed covering and weeding. The versatility of the traditional plough is one of the attractive qualities which protects farmers from investing on variety of implements for different soil preparation activities.

However, the performance of these implement to adequatly meet the quality standards of soil preparation activities is much to be desired.

Though the "MARESHA" has qualities of versatility, light weight, simplicity and affordability, the technical performance of this plough is the cause for poor soil preparation, in-effectiveness in weed controle and low productivity. Traditional plough requires 20 - 24 man hours and 40 - 48 ox/hrs/hectare for one ploughing operation demanding up to 240 man hrs. for the soil preparation of one hectar of land per one agricultural season. Despite taking all these time for the operation the effectiveness of the plough to attain a quality and weed free seed bed is very low.

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Weeding

Weeding is one of the major activities of agricultural operation. The activities of weeding is not only tiring, but also time consuming demanding upt to 70 man/hrs/hectare. Weed controle by cultivation is also difficult as row planting is not practiced in most peasant farms making mechanical weeding difficult to carry out. Some studies indicate crops in weed free fields can yield up to 40% more than fields infested with weeds.

The most common weeding method in Ethiopia is hand weeding though utilization of hand tools is also common.

Harvesting and Post-Harvesting Equipment

Harvest

Harvesting in Ethiopia is done for most crops by hand, sickle and by other traditional tools known as konchera, jegra or mencha. Harvesting with sickle also takes up to 137 man hrs/hectare with considerable loss of products in the field.

Threshing and Shelling

The last agricultural activity performed in the field is threshing. Traditional threshing is performed by hand, hand tools or with the help of animals. This operation as it is in many other traditional farming operation is time consuming, tiring and wasteful.

Harvesting and threshing are the most important activities in agriculture. The loss is more apparent and felt during this activities as these are the operations which deliver the fruits of the efforts and the hard work of farmers during the seasons of ploughing, planting and weeding.

Farm Transport

Farm transport is the major agricultural operation in Ethiopia, be it in farms or in other transport activities. For every tone of goods transported by modern means of transport 140 tons of goods is transported by means of traditional transport. This reality indicates the magnitude of efforts required to develop the rural/farm transport in Ethiopia.

Storage

Many of the types of the traditional store hardly satisfy the technical requirements of a good store. However, the amount of agricultural crops surplus for storage in peasant individual farms are decreasing due to shortage of cultivable land and the low productivity of peasant farms. At present, a type of ideal improved store is not yet available to provide to farmers as better option.

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Improved Agricultural Equipment

Efforts to improve the traditional implements in Ethiopia has history of many decades. The outcome of these endeavour has not been very rewarding. This was mainly due to the protracted and uncoordinated, un-institutionalized implement development activities. The research institutions, development organizations, establishments of higher learnings are among the organizations who tried to develop and promote improved agricultural implements.

The Rural Technology Promotion Programme of the Ministry of Agriculture has takeled these problem more pragmatically and has been able to come up with different options of agricultural implements and equipment. These equipment are designed and are made to be used by small farmers individually and in groups or through their organizations.

The most successful achievement of Rural Technology Promotion Programme (RTPP) is the field of agricultural equipment is, the development, promotion and production of post-harvest technologies. These are mainly corn shellrs, wheat and barly threshers, multi-crop threshers (for tef, wheat and barly.) The type and capacity of implements and equipment is indicated in page 8 and 9 of this paper.

Promotion of Agricultural Equipment

Promotion of agricultural equipment is as complicated as that of development of the technology.

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It requires thorough understanding of:-

1. the need of farmers
2. the technology
3. socio-economic environment
4. the benefit from the point of the farmers and
5. sustainability and maintainability.

It is very important to realize that imposition of the technology on farmers will never be successful and infact it will help them to reject the technology even if it is the best.

However, it is important to realize that without improved equipment in agriculture, achievement of agricultural development is un-attainable goal.

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Agricultural Equipment Development by the Rural Technology Development Programme.

	Capacity/ season	Status: Ready for manufacture and Distribution	Status: Under Verification
Soil Preparation Equipment			
1. Animal drawn mould board ploughs	8-10 ha.	X	-
2. Wooden frame harrow	20-30 ha.	X	
3. Single row maize planter	8-10 ha.		X
Harvest Equipment			
Engine driven self-propelled harvester for wheat & barley.	30-40 ha.	-	X
Post Harvest Equipment			
1. Thresher wheat & barley	1800 Qt.	X	-
2. Thresher Teff ,wheat & barly	1800Qt.	-	X
3. Sheller maize engine/PTO	10800 Qt.	X	-
Rural Transport			
1. Wheal barrow(w.b)	1w.b/ threshing field	X	-
2. Animal cart	1800Qt.	X	-
3. Damp cart	1800Qt.	X	-
Food Processors			
1. Enset scraper	48kg/hr	X	
2. Enset press	110kg/hr		X
3. Sugarcane press	36 lt/hr	X	

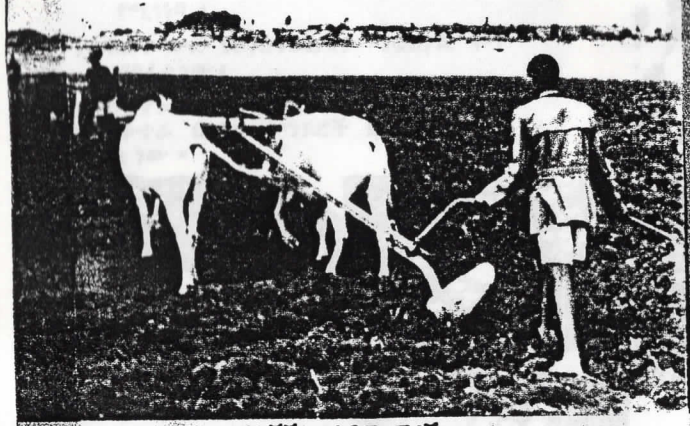
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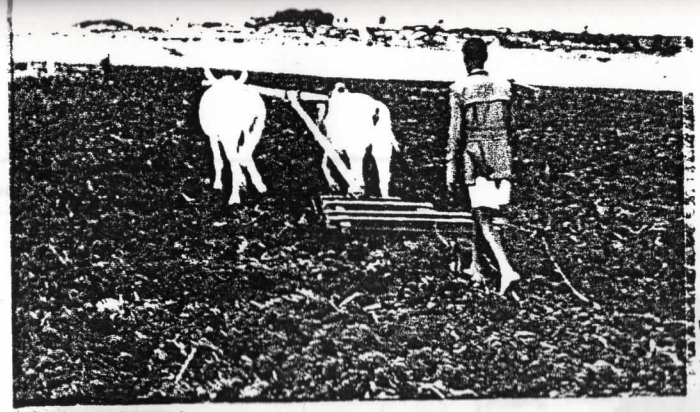
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በአንድ የኡርሻ ወቅት ከ7-10 ሄክታር ማረስ የሚያስችል
ዮተሻሻለ ማረሻ Mould Board Plough

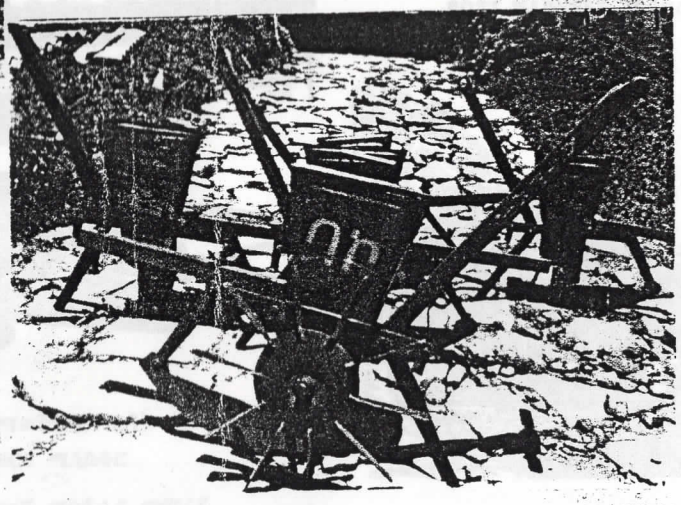


በአንድ የኡርሻ ወቅት 15-20 ሄክታር ማሳ ማዘጋጀት የሚችል መከስከሻ
Spike Tooth Harrow

መከስከሻ

- በአንድ ጥማድ በሬ የሚገ ተት ፣
- የታረሰ መሬትን ጓል ማፉ ራረስ ፣ ማስተካከልና ማለ ስለስ የሚያስችል ፣
- አረምን የሚቆራርጥና ከማ ሳ ወደ ውጭ የሚያወጣ ፣
- ዘርና ማዳበሪያን በተስተካ ከለ ጥልቀት መጠንና ሥር ጭት መሸፈን የሚያስችል፣
- በገበሬው አካባቢ ሊሠራና ሊጠገን የሚችል መሣሪያ ነው ።

- ዘርና ማዳበሪያ እንዳይባክን ፣ የሚያደርግ ፣
- በጥሩ ሁኔታ እንዲበቅል የሚያግዝ ፣
- አረምን በቀላሉ ለማረም የሚረዳና
- ዘር በተስማሚ መጠን ጥልቀትና ርቀት በመስመር መዝራት የሚያስችል መዝ ሪያ ነው ።



በመስመር ዘር መዝሪያ
በአንድ የኡርሻ ወቅት ከ15-20 ሄክታር በመስመር መዝራት የሚያስችል ።
Row Planter

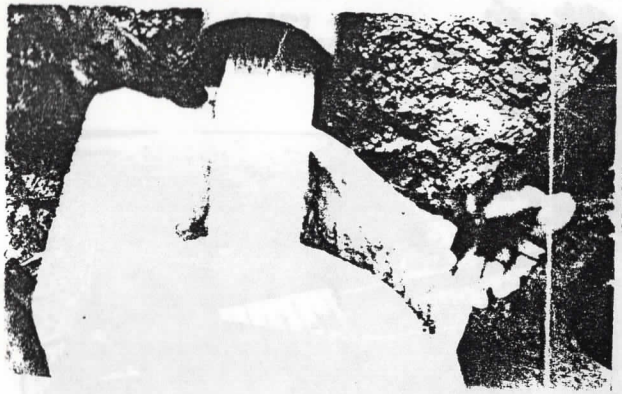
CRDA

የማከማቻ ጉተራ (ሳይሎ)

3. የጭቃ ሳር ጉተራ ፡—

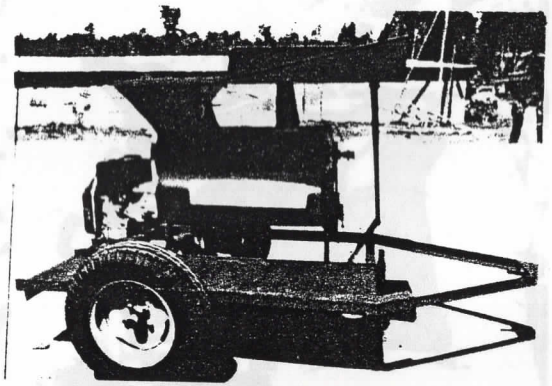
- እህል በአይጥ ፡ በተባይ ፡ በእርጥበት እንዳይ በላሽ የሚረዳ ፡
- ብክነትን የሚቀንስ ፡
- ምርትን ለረጅም ጊዜ በጥሩ ሁኔታ ማቆየት የሚያስችል ፡
- ለቁጥጥርና ለጥበቃ አመቺ የሆነ ፡
- ማንኛውንም የእህል ዓይነት ለማከማቸት ተስ ማሚ የሆነ ፡
- በአብዛኛው ከየአካባቢው በሚገኝ ጭቃና ሣር የሚገነባ ፡
- ብዙና ውድ የኮንስትራክሽን ማቴሪያል የማ ያስፈልገው ፡

ከቻይና የጉተራ አሠራር ቴክኖሎጂ የተገኘ የጭቃ ሣር ጉተራ በገበሬ መንደሮች በጠቀሜታ ላይ እየዋለ ነው ።





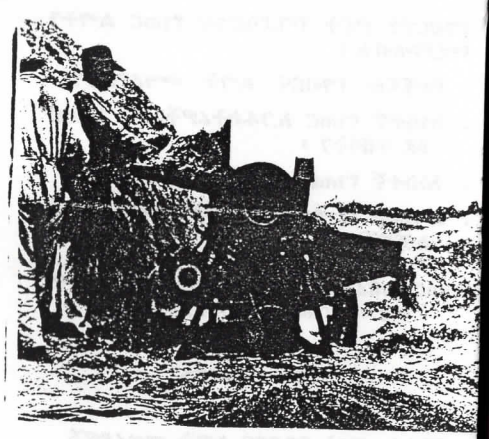
የጭቃ ሣር ጉተራ
ከ500-700 ኩንታል መያዝ የሚችል ጉተራ
Mud-Straw Silo



የበለጠ ለማወቅና ለመረዳት ፡
በግብርና ሚኒስቴር
የገጠር ቴክኖሎጂ ማስፋፊያ መምሪያ
የፖ.ሣ.ቁ 62347 አዲስ አበባ
ወይም በአካባቢዎ የሚገኘውን የገጠር ቴክኖሎጂ ማስፋፊያ ማዕከል ይጠይቁ ።

በገጠር ቴክኖሎጂ ልማት ፕሮግራም የሚዘጋጁ የድኅረ ምርት የግብርና ልማት መሣሪያዎች

POST HARVEST TECHNOLOGY



ባግብርና ሚኒስቴር

የገጠር ቴክኖሎጂ ማስፋፊያ መምሪያ

አዲስ አበባ 1985

MINISTRY OF AGRICULTURE
RURAL INFRASTRUCTURE MAIN DEPARTMENT
RURAL TECHNOLOGY PROMOTION DEPARTMENT
ADDIS ABABA, P. O. Box 62347

1993

በግብርና ሚኒስቴር

የገጠር ቴክኖሎጂ ልማት ፕሮግራም

ተግባራት

የግብርናን ምርት የሚያሳድጉና የገጠር ልማትን የሚያግለብቱ ፣

- የተሻሻሉ የግብርና ልማት መሣሪያዎችን ፣
- አነስተኛ የገጠር ኢንዱስትሪዎችንና ፣ የገጠር ዕደ ጥበባትን ፣
- አነስተኛ የገጠር የኃይል ምንጮችን ፣
- አማራጭ ማገዶዎችንና ማገዶ ቆጣቢ ቴክኖ ሎጂዎችን ፣

በገጠር በገበሬዎች ማህበራትና መንደሮች ማስተዋ ወቅ ፣ ማስፋፋትና ማዳበር ናቸው ።

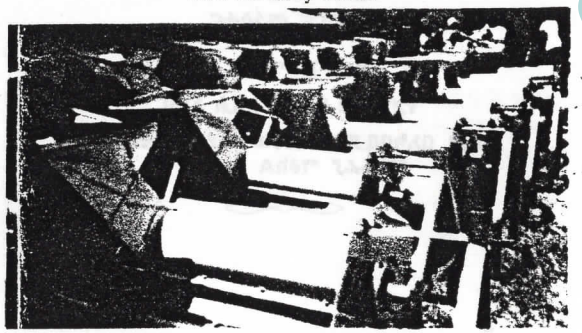
የድኅረ—ምርት የግብርና ልማት መሣሪያዎች

1. መውቂያዎችና መፈልፈያዎች

- የምርት ብክነትን የሚቀንሱ ፣
- ጊዜንና ወጪን የሚቆጥቡ ፣ ጉልበትንና ድካ ምን የሚቀንሱ ፣
- ጥራት ያለው ምርት መሰብሰብ የሚያስችሉ ፣
- በቀላሉ የሚገዛዙ መሣሪያዎች በገጠር ቴክ ኖሎጂ ልማት ፕሮግራም በሀገር ውስጥ በገጠር ቴክኖሎጂ ማስፋፊያ ማዕከላት ተዘጋጅተዋል ።



የስንዴና የገብስ መውቂያ
ከ5-6 ኩንታል በሰዓት የሚወቃ በሞተር የሚሠራ
Wheat and Barley Thresher



የበቆሎ መፈልፈያ
ከ40-50 ኩንታል በሰዓት የሚፈለፍል በትራክተርና በሞተር የሚሰራ
Maize Shellers

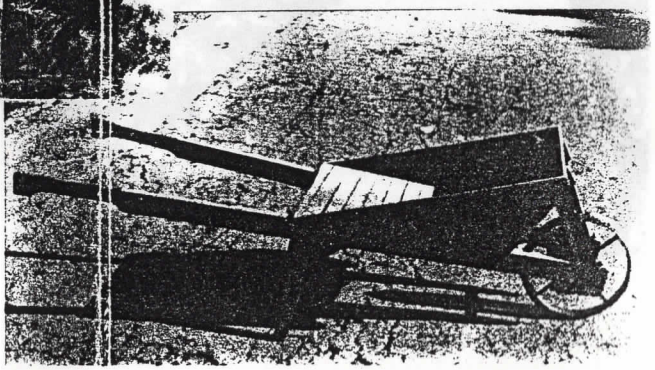
2. የማጓጓዣ መሣሪያዎች

የገጠሩን ኅብረተሰብ የማጓጓዝ ችግሮችን ለማቃለል ፣

- ዘር ማዳበሪያና እርሻ መሣሪያዎችን ወደ ማሣ ፣
- ምርቱን ከማሳ ወደ አውድማ / መውቂያ / ቦታ
- ከአውድማ ወደ ጐተራ ፣
- ከጐተራ ወደ ገበያ ፣
- ውሃ ወደ መንደር ፣
- ሸቀጣ ሸቀጦችን ከገበያ ወደ መንደር ፣ ከመ ንደር ወደ ገበያ ፣

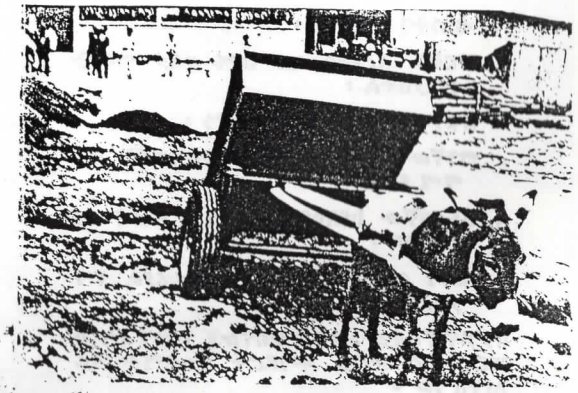
ለማጓጓዝ የሚያስችሉ በገበሬው አካባቢ ሊጠገኑ የሚችሉ የማጓጓዣ ጋሪዎች በማዕከላት እየተዘጋጁ ነው ።





የእጅ ጋሪ አንድ ኩንታል ማጓጓዝ የሚያስችል
Wheel Barrow

ገለባ ጋሪ
Tipping Cart



በእንስሳት የሚጐተት ጋሪ
ከ500 - 1500ኪ.ግ. ማጓጓዝ የሚያስችል ጋሪ
Animal Drawn Cart

ንግድ ማተሚያ ቤት

Organic Farming

Principles & Practices

CCRDA

LECTURE OUT LINE

PART 1

ORGANIC FARMING: PRINCIPLES & PRACTICES

1. INTRODUCTION

   .THE GLOBAL FOOD SITUATION

   .THE ETHIOPIAN CASE

   .WHY ORGANIC FARMING

2. ORGANIC MATTER AS COMPONENT OF ORGANIC FERTILIZERS

3. CHEMISTRY OF SOIL ORGANIC MATTER

3.1 FORMATION

3.2 SOURCES

3.2.1 PLANT MATERIALS

3.2.3 SOIL ANIMALS

3.2.4 FARM YARD MANURE

4. COMPOSITION & DECOMPOSITION PRODUCTS

4.1 PLANT MATERIALS

4.2 MICROORGANISMS

4.3 SOIL ANIMALS

CCRDA

5. METHODS OF STUDYING ORGANIC MATTER

5.1 SYNTHETIC APPROACH

5.2 DIRECT APPROACH

5.3 PHYSICAL METHODS

6. THEORIES WHY ORGANIC MATTER IS STABLE

1. THOSE BASED ON PHYSICAL PROPERTIES

2. CHEMICAL THEORIES

2.1 LIGNO-PROTEIN CMPLEX (WAKSMAN, 1930)

2.2 TANNIN-COMPLEX THEORY (HANDLEY, 1954)

2.3 POLYPHENOL-AMINO ACID COMPLEX

2.4 CHITIN-PIGMENT THEORY

2.5 BROWNING REACTION THEORY

2.6 POLYCYCLIC THEORY

7. CHANGES IN ORGANIC MATTER CONTENT OF SOILS

1. MATHEMATICAL EQUATIONS

2. ORGANIC MATTER TURN OVER

3. PRIMING ACTION AND ITS CAUSES

4. MAJOR COMPONENTS (N,P,S) OF ORGANIC MATTER

CCRDA

8. CONTRIBUTION OF OM TO SOIL FERTILITY

1. COLOR

2. AGGREGATION

3. NUTRIENTS

4. STABILITY

5. BUFFERING CAPACITY

6. MOISTURE

9. MANAGEMENT OPTIONS

9.1 CROP RESIDUE DISPOSAL AND NUTRIENT RECYLING

9.2 MULCHING

9.3 GREEN MANURING

9.4 ANIMAL MANURE & BIOGAS

9.5 ANIMAL SLAUGHTER HOUSE BY-PRODUCTS

9.6 COMPOSTS

9.7 NIGHT SOIL

9.8 WASTES (URBAN, INDUSTRIAL)

10. RECOMMENDATIONS

CCRDA

PART 2

1. EXPERIENCE ON THE USE OF CHEMICAL FERTILIZERS

2. CROP RESPONSES TO NPK FERTILIZER

3. CROP RESPONSES TO NPK FERTILIZER

3.1 BY SOIL TYPES

3.2 BY REGIONS

3.3 COUNTRY WISE

CCRDA