Krishi Suthras for Krishi Mithras

Reliance Foundation
Reliance Corporation Park-Thane, Navi Mumbai, Maharashtra
www.reliancefoundation.org

National Institute of Agricultural Extension Management (MANAGE)
(An Autonomous Organization under the Ministry of Agriculture and Farmers Welfare, Govt. of India)
Rajendranagar, Hyderabad 500 030, Telangana, India
www.manage.gov.in

Krishi Suthra for Krishi Mithras

Editors: Sri. B.G. Mahesh, Dr. B. Renuka Rani and Dr. Cherukuri Sreenivasa Rao

Edition : 2022. All rights reserved.

ISBN : 978-93-91668-64-8

Citation: Mahesh B.G., Renuka Rani B., Cherukuri Sreenivasa Rao (2022). Krishi Suthra for Krishi Mithras. Hyderabad: National Institute of Agricultural Extension Management (MANAGE).

This e-book is a compilation of resource text obtained from various subject experts presented inputs during the National Workshop on Krishi Suthra for Krishi Mithras at MANAGE in 2018. This e-book is designed for researchers, academicians, extension workers, research scholars, Community Resource Persons, Farmers and students to get input on natural resources, soil health, seeds, nutrients, pests, diseases and Post-Harvest management. Neither the publisher nor the contributors, authors and editors assume any liability for any damage or injury to persons or property from any use of methods, instructions, or ideas contained in the e-book. No part of this publication may be reproduced or transmitted without prior permission of the publisher/editor/authors. The publisher and editor do not give a warranty for any error or omissions regarding the materials in this e-book.

Published for Dr P.Chandra Shekara, Director General, National Institute of Agricultural Extension Management (MANAGE), Hyderabad, India by Dr Srinivasacharyulu Attaluri, Program Officer, MANAGE and printed at MANAGE, Hyderabad as an e-publication.

SANJAY AGARWAL
SECRETARY

सत्यमेव जयते

भारत सरकार
कृषि एवं किसान कल्याण मंत्रालय
कृषि, सहकारिता एवं किसान कल्याण विभाग
Government of India
Ministry of Agriculture & Farmers Welfare
Department of Agriculture, Cooperation & Farmers Welfare

FOREWORD

The agricultural extension system aims at providing required knowledge and skills to farmers so that they run their farms more efficiently and lead a quality life. In India, Agricultural extension services are being provided by Department of Agriculture and Family Welfare, Krishi Vigyan Kendras under the umbrella of ICAR, State Agriculture Universities, Civil Society Organisations, Private Sector, etc.

Kisan Mitras are trained resource persons who work with farmers to help them shift towards agro-ecological approaches to sustain their farming. In this regard, as a first step, MANAGE and Reliance Foundation have jointly developed a simplified and user-friendly training material on Agricultural livelihoods that serves as a standard, uniform and reference material for Krishi Mitras (service providers) on Agriculture livelihoods across the country.

I appreciate Reliance Foundation joining with the National Institute of Agricultural Extension Management (MANAGE), ICAR organisations, Universities and civil society organisations and brought out this training material to build capacities of the Krishi Mitras working with resource poor farmers. I am sure that this publication would help the farmers and provide a strategy to ensure timely, need based quality and affordable agricultural extension services to the farming community. I request all the readers to spread the spirit and culture of agriculture through extension services in the farming sector.

Sanjay

[Sanjay Agarwal]

April 4, 2019

Office : Krishi Bhawan, New Delhi-110001, दूरभाष / Phone : 23382651, 23388444 फैक्स सं० / Fax No. : 23386004
E-mail : secy-agri@gov.in

PREFACE

Despite a wide range of reform initiatives in agricultural extension in India in the past decades, the coverage of access, and quality of information provided to marginalized and poor farmers is uneven. The importance of agricultural extension in transferring relevant knowledge and information to farmers as well as in translating policy directions into action is well known.

In this context, developing a pool of Krishi Mitras (Community Resource Persons) on agriculture livelihoods within the community would ensure timely, need based, local and affordable agricultural extension services to farming community. Thus, it is imperative that these Krishi Mitras are equipped with simplified, user-friendly and handy training material that is very easy to understand and comprehend by Krishi Mitras.

The National Institute of Agriculture Extension Management (MANAGE) and Reliance Foundation in partnership with domain experts from 13 Organizations like Krishi Vigyan Kendras (KVKs of ICAR), Central Research Institute on Dry-land Agriculture (CRIDA, Hyderabad), NGOs like Watershed Support Services And Action Network (WASSAN), Centre for Sustainable Agriculture (CSA), JATTU trust, MYRADA, BASIX have attempted to develop this field guide "Krishi Sutra" meant exclusively for Community Resource Persons for offering need based extension services to farmers.

"Krishi Sutra" is organized into nine chapters that include institution building, soil and water conservation, soil health improvement, use of quality seeds, crop nutrient management, management of insect pests and diseases, seed production and storage; and post -harvest management. To enable quick understanding and learning of Krishi Mitras , the content is simplified as much as possible by using pictures and sketches. It has also been developed in rich Indian vernacular mediums of Hindi, Telugu, Tamil, Kannada, Odiya, Marathi and Gujarati for a wider reach and impact.

I appreciate the efforts of Mr. Mahesh Gangadhraiah, Program Integrator, Reliance Foundation and Dr. B. Renuka Rani, Deputy Director, MANAGE, in documenting this Krishi Suthra. I hope " Krishi Suthra" will help all Krishi Mitras to offer need based services to the farming community across India benefitting millions of farmers in the near future.

(V. Usha Rani)

Reliance Foundation

MESSAGE

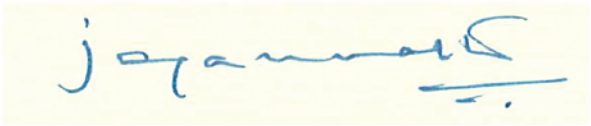
The agricultural sector in India is facing rapid changes and unprecedented challenges. The knowledge intensive nature of the sector is more evident now than ever before. Extension services have been transforming in response to various challenges and developments.

Agriculture extension workers have a critical role in helping farmers through technical and non-technical services. They have the opportunity to bring innovation to the doorstep of the farmers as well as in nurturing the native innovations towards taking agricultural economy on a sustainable growth path.

Even though rapid strides have been made in the last few decades in agriculture extension, gaps still exists and role of all the stakeholders in enabling the extension cadre becomes crucial. Reliance Foundation has been at the forefront of working with farming community and also in bridging the vital information asymmetry over the years.

In an effort to further this cause, Reliance Foundation has joined hands with MANAGE to develop a source book for agriculture extension workers (*Krishi Mithras*). The book compiles available and recent literature on development in the agricultural extension practices adopted by various practicing agencies in India. The user friendliness of the content and its presentation will help practitioners and extension workers to access knowledge on the nuances of agriculture extension.

I congratulate the authors for their dedicated efforts in bringing out this volume and the contributors whose work has shaped this. It goes without saying that this handbook will be of immense use to extension workers and the development community at large.



Jagannatha Kumar

CEO, Reliance Foundation

Acknowledgement

MANAGE and Reliance Foundation are grateful to following organisations and persons for their efforts and contribution in developing the field guide.

Dr. B.B. Kapadia, Programme Coordinator, Krishi Vigyan Kendra, Targhadia, Rajkot (Gujarat)
Dr. Nikhil, Programme Coordinator, Krishi Vigyan Kendra, Dist. Seoni, (Madhya Pradesh)
Dr. Alok Kumar Deshwal, Programme Coordinator, Krishi Vigyan Kendra, K.G.N.M.T, Kasturbagram, Dist. Indore (Madhya Pradesh)
Dr. Atul Purushottamrao Kalaskar, Programme Coordinator, Krishi Vigyan Kendra, Ghatkhed, Amravati, Chirantan Madhuban Colony, Camp Amravati (Maharashtra)
Dr. V.K. Sachan, Programme Coordinator, Krishi Vigyan Kendra, Chinyalisaur
Dist. Uttarkashi (Uttarakhand)
Dr. Senthil Kumar, Programme Coordinator (I/C) Krishi Vigyan Kendra Gandhigram Rural Institute Gandhigram, Dist. Dindigul (Tamilnadu)
Dr. Dasari Chinnam Naidu, Programme Coordinator, Krishi Vigyan Kendra Agril. Research Station, Amdalavalsa Dist. Srikakulam (Andhra Pradesh)
Dr. Ravi. C. Deshmukh, Programme Coordinator, Krishi Vigyan Kendra, (P.O) Box 58, Janawada Road, Dist. Bidar (Karnataka)
Dr. P.K. Sanigrahi, Programme Coordinator, Krishi Vigyan Kendra, Sujani, (P.O) Ghorlash, Deoghar (Jharkhand)
Dr. V. Maruthi, Programme Coordinator, Krishi Vigyan Kendra, Near Deer Park, Bhagyalatha Busstop**,** Hayathnagar Research Farm, Hyderabad (Telangana)
Dr. Khoobhi Ram Sahu, Programme Coordinator, Krishi Vigyan Kendra**,** Adarsh Krishi Upaj Mandi Campus, Basantpur, Dist. Rajnandgaon (Chattisgarh)
Dr. S.S. Burbak, Ex-Director Research, Maharana Pratap University of Agriculture & Technology, Udaipur (Rajasthan)
Dr. S. T. Tailor, SMS – Agriculture extension KVK, Indore (Madhya Pradesh)
Dr. P. T. Patel, Professor- Sardar Krushi Nagar, Dantiwada Agriculture University, SK Nagar, Banaskanta (Gujarat)
Dr. Bhagwan Kapse, Jan Jagrithi Prathistan, Aurangabad (Maharashtra)
Dr. S.M Hussain, Professor, PJTSAU, Hyderabad (Telangana)
Dr. Sanjeev Reddy, Professor, Agri Engineering, CRIDA Hyderabad (Telangana)
Mr. G. Chandrasekar, Centre for sustainable Agriculture, Hyderabad (Telangana)
Mr.Ramchandrudu, WASSAN, Hyderabad (Telangana)
Mr. Peri Naidu, JATTU Trust, Andhra Pradesh
Mr. Vijay Kumar, MYRADA, Tamil Nadu
Ms. Seema Shastri Shankar, Senior Executive, Basix, Hyderabad (Telanagana)

MANAGE and Reliance Foundation extend their sincere gratitude to scientists from Krishi Vigyan Kendras, Agricultural Universities, Agriculture Departments for their timely and technical support in making this document very meaningful.
Special thanks to NGOs like CSA, WASSAN, JATTU TRUST, BASIX, MYRADA for their relentless help in building the field guide.
Authors would like to thank all the internal scientists of MANAGE and team members of Reliance Foundation for their continuous support in shaping the field guide.

CONTENTS

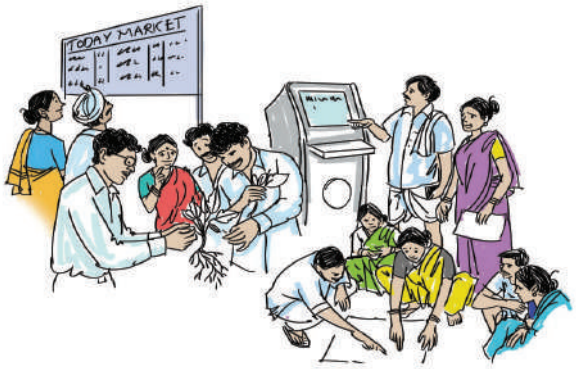
Agriculture Extension

What is Agricultural extension?

Agricultural extension is known as the application of scientific research and new knowledge to agricultural practices through farmer education

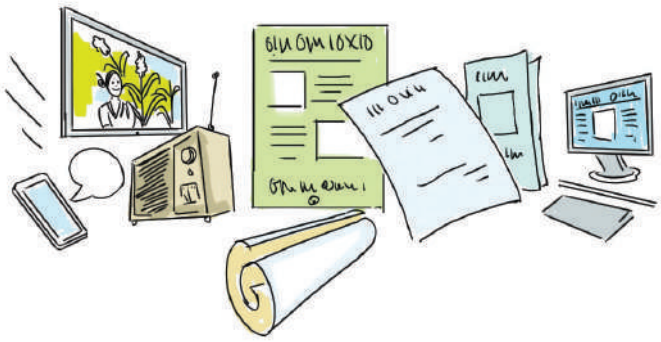
Why Agricultural Extension?

Agricultural Extension strengthens the capacity of rural farmers and stakeholders by:



- ➢ Creating awareness
- ➢ Providing latest development in practice and information
  - Crop, weather and market price advisories
- ➢ Providing Trainings, demonstrations, exposure visits
- ➢ Facilitating linkages with Agri, Agri allied departments , other development stakeholders for knowledge and farm inputs
- ➢ Facilitating market linkages
- ➢ Documentation and sharing of Indigenous technical knowledge (ITK)
- ➢ Access to banking and credit facilities
- ➢ Business planning
- ➢ Continuous monitoring and evaluation, enumeration, survey

How is Agriculture Extension done?



Mass media

Leaflets, pamphlets, posters, radio, television, websites and text or audio messages via mobile phones

Demonstrations:

A demonstration provides farmers an opportunity to observe, at first hand the differences between recommended crop practice and traditional practices.

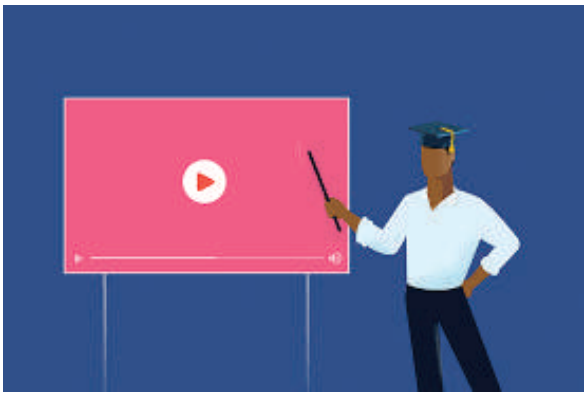
Farmer field schools:

The Farmer Field School is an adult education – experiential methodology which evolved from the concept that adults learn optimally from observation and experimentation.

Videos:

Different types of videos include documentary, institutional, instructional, farmer learning and participatory.

Videos help bring first hand experience to farmer door-step or hands and a much cheaper cost and faster pace. It can be repeated at any time and any number of times.

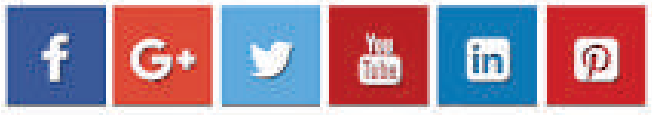


ICTs:

Different ICT applications includes web-portals, call Centers, mobile apps, community radio, digital videos, audio and video conferencing and e-learning platforms.

Social Media:

Social media includes web-based tools and media that allows users to personally and informally interact, create, share, retrieve and exchange information and ideas in virtual communities and network.

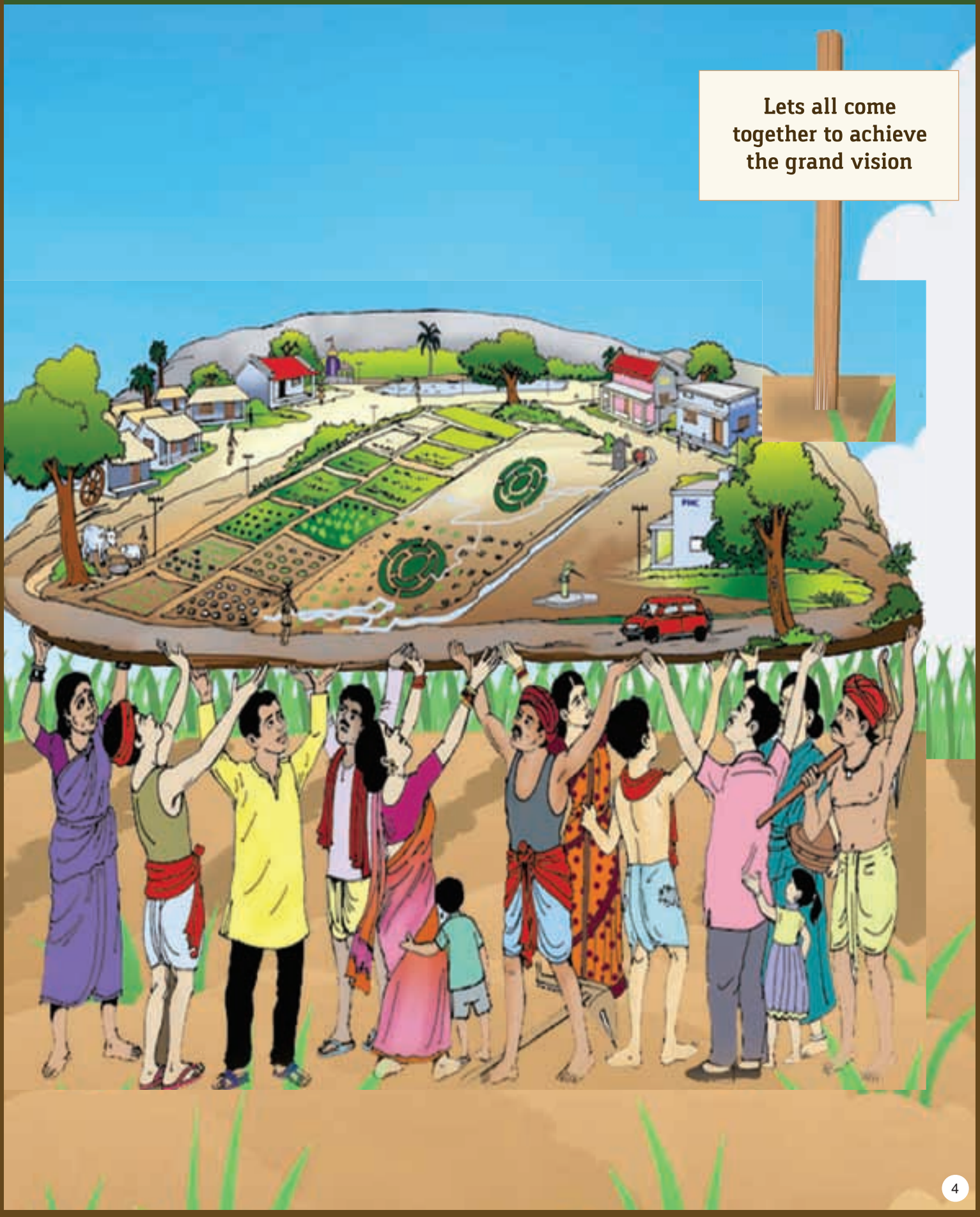


CHAPTER 1
INSTITUTION BUILDING

1. INSTITUTIONS

Institutions are regularized patterns of behaviour that emerge from underlying structures or sets of rules in use and are maintained by people's practices

Why Institution?



Why Institution?

Alone I scare
Together we walk
Towards what we aspire

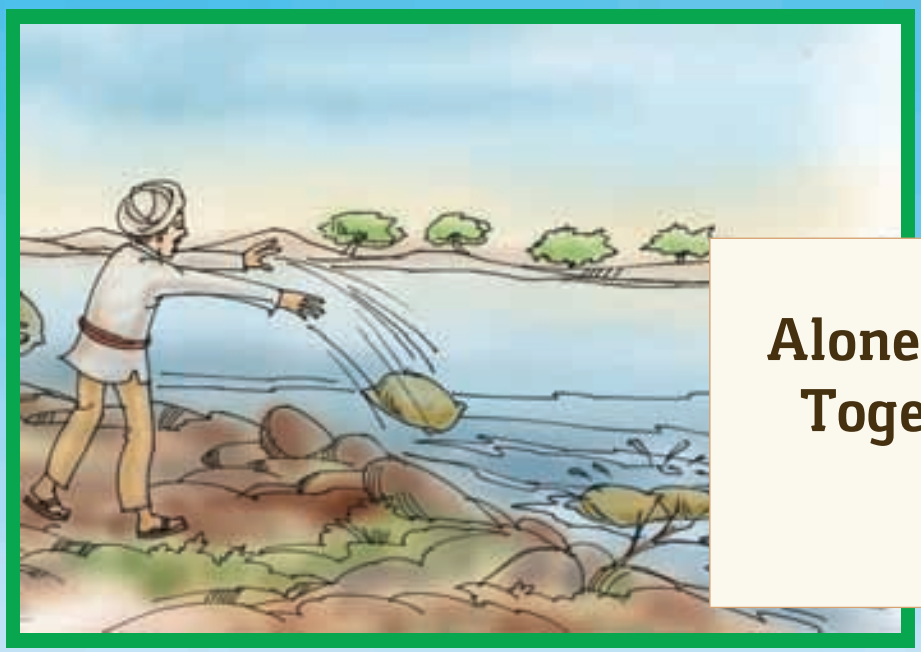
Why Institution?

My voice goes unheard, our voice will make a difference

Why Institution?

One person to another
Bond that draws us together
When challenges are bigger,
Let's bridge the gap together!

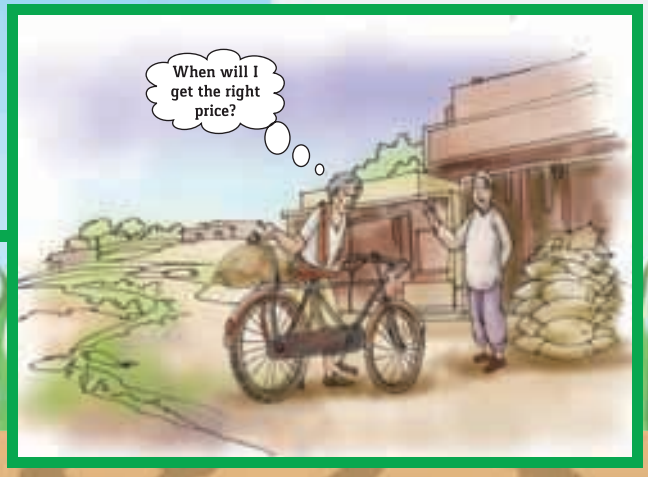
Why Institution?



Alone we can do so little
Together we can do so much

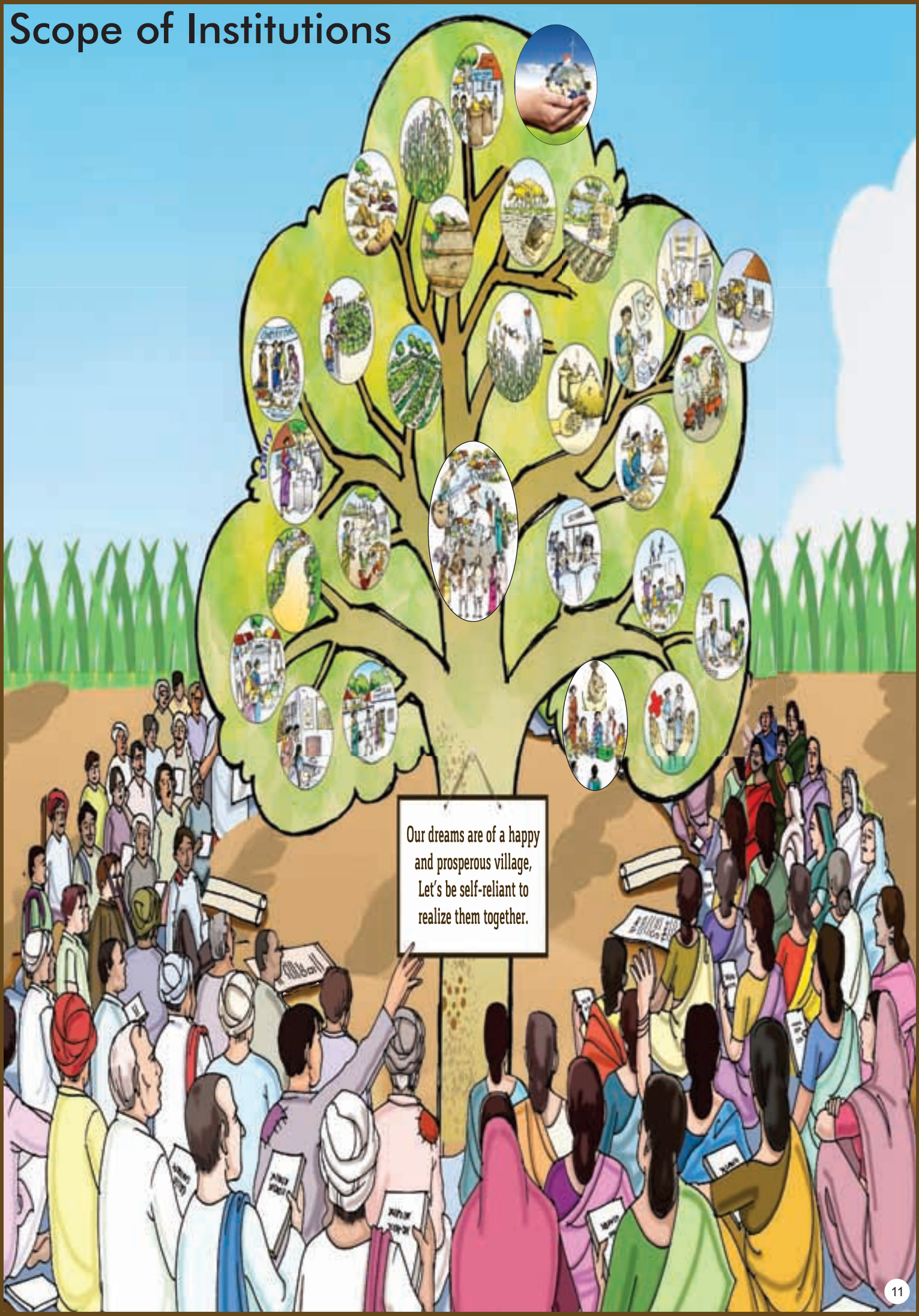
Why Institution?

Agriculture is our country's pride
Farmers have lost their glory
Let's write an opposite story
Let's come together and strive
So that our produce gets
the right price.



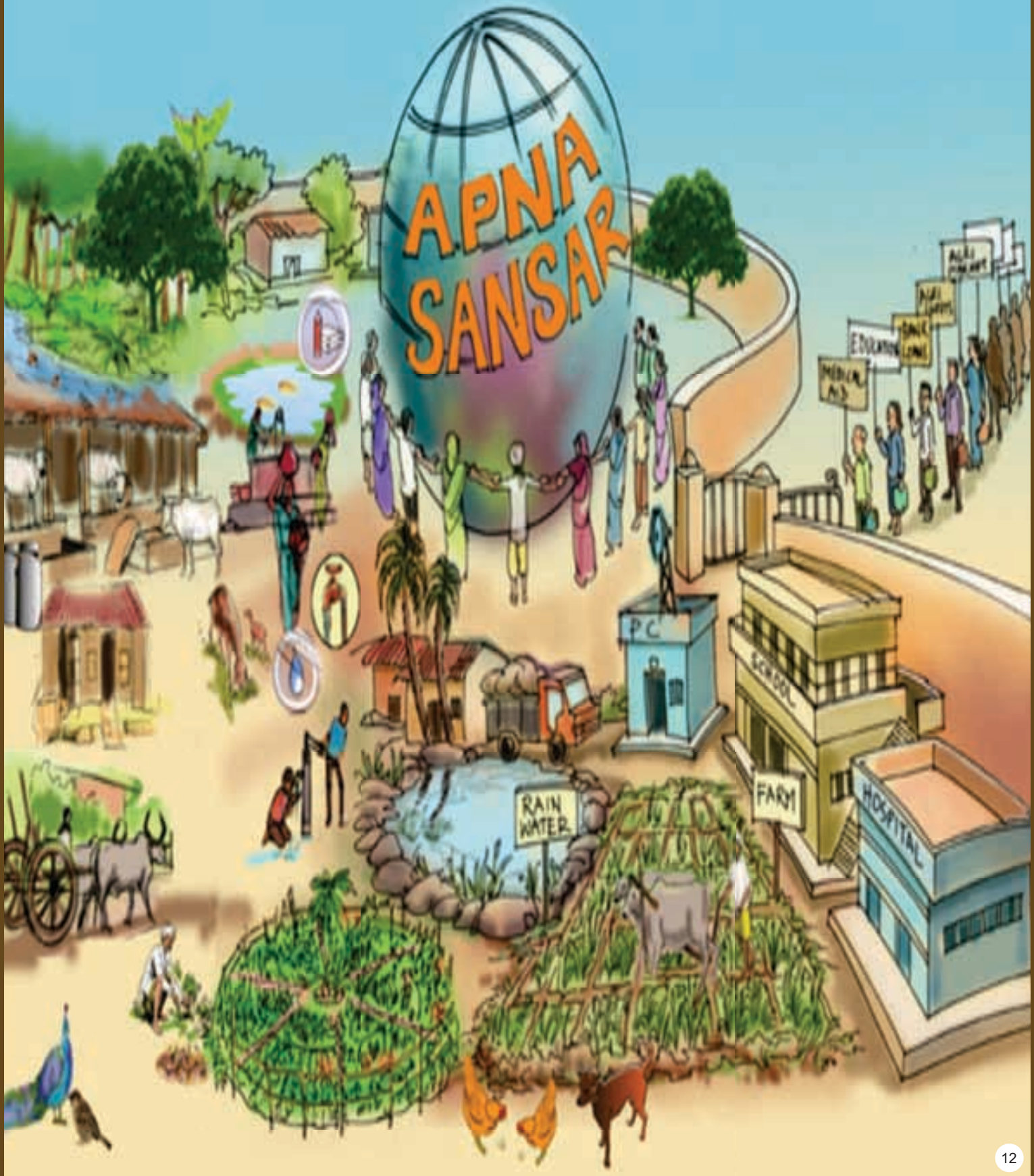
Institution is our strength
Our participation will fulfil our dream
We together are better
Our village will be self-reliant and brighter

Scope of Institutions



Vision

Holistic, Self Reliant And Sustainable Institutions

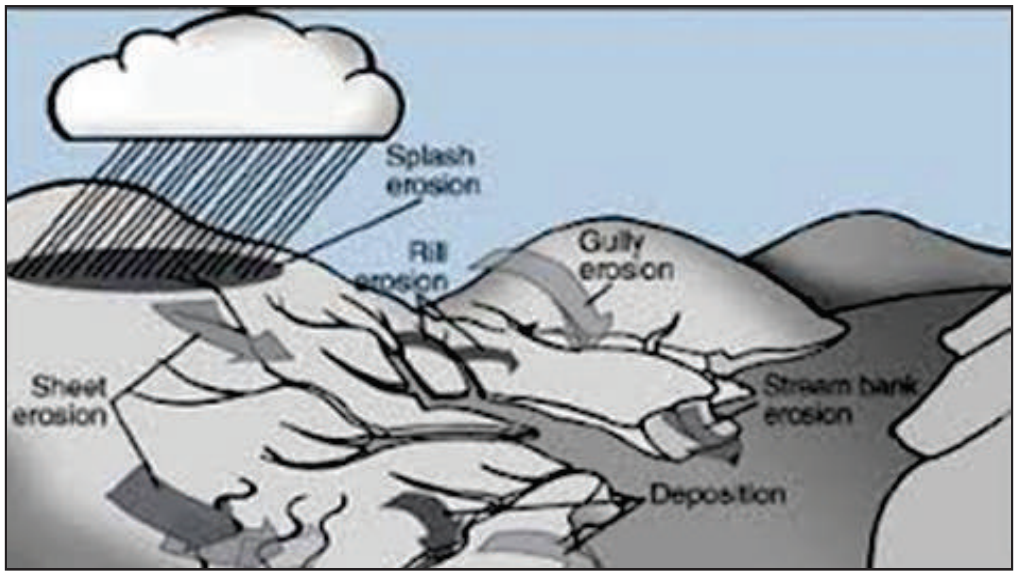


CHAPTER 2
SOIL AND WATER CONSERVATION

WHY:

- Soil health is very important for better crop productivity
- Soils are degraded due to uncontrolled run off
- So prevention of soil erosion is very important
- Water availability at critical stages is very important for crop productivity
- Drought and unseasonal rains lead to water scarcity
- Conserving water is very important to meet water requirement of crops, animals and human beings during lean periods

IF SOIL NOT CONSERVED



Erosion leading to reduced soil depth, unfertile and waste lands

MAJOR SOIL AND WATER CONSERVATION MEASURES

- Conversion of waste lands into productive lands
- Trenches in hilly slopes to control runoff
- Contour bunds and farm ponds in agriculture fields
- Works across drainage lines
- Water harvesting
- Plantation

NOTE: Type of measures depend on the location

1.WASTE LAND DEVELOPMENT

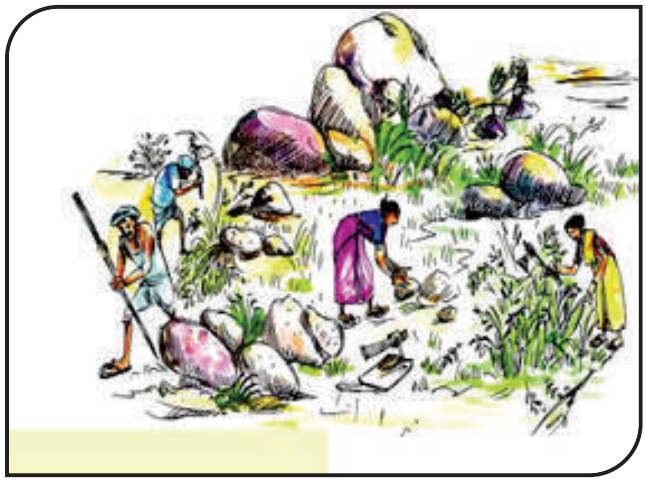
What: Transforming waste land into productive land

Why:

Eefficient use of land for producing food, fibre, timber, manures,fuelwood while improving microclimate and biodiversity in a location

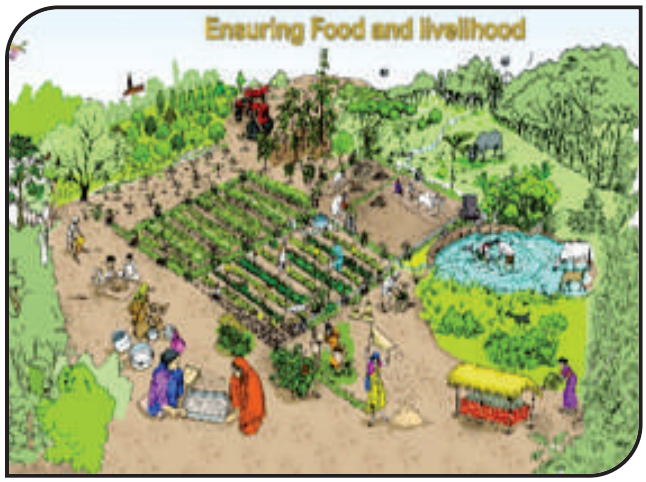
HOW:

Bush clerance



Removal of boulders

Removal of stones

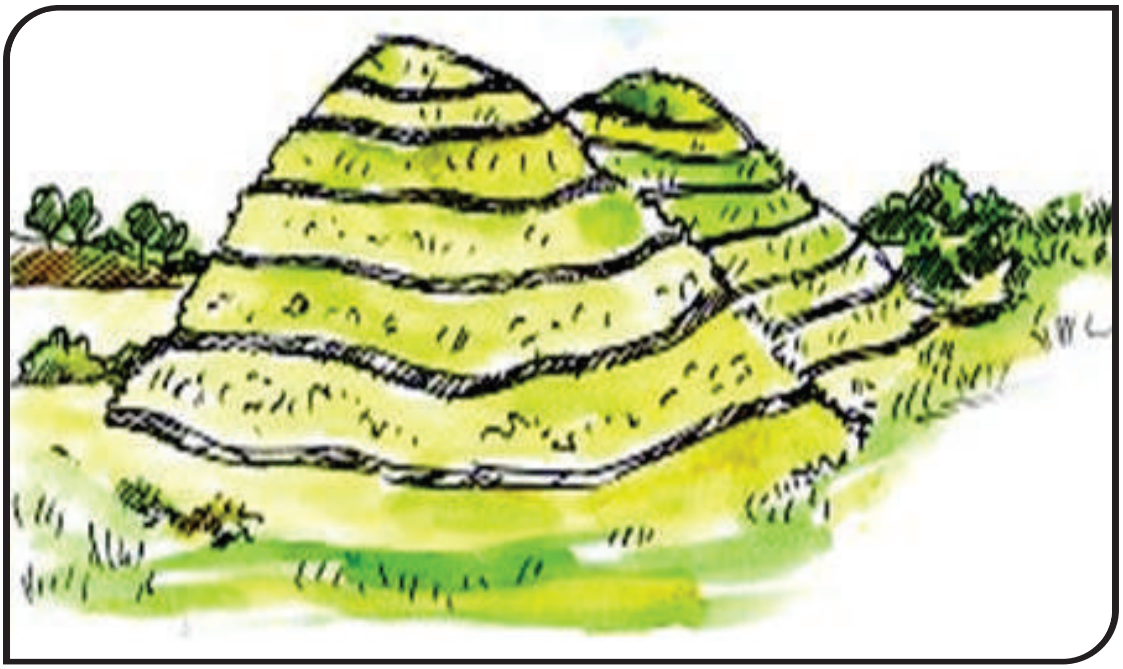


Land brought into productive use

2.TRENCHES IN HILLY SLOPES

A. Continuos contour trenches:

What: Trenches dug continuously on the hillocks, undulated common lands in a village



Where: Hillocks, undulated common lands, near forest in a village

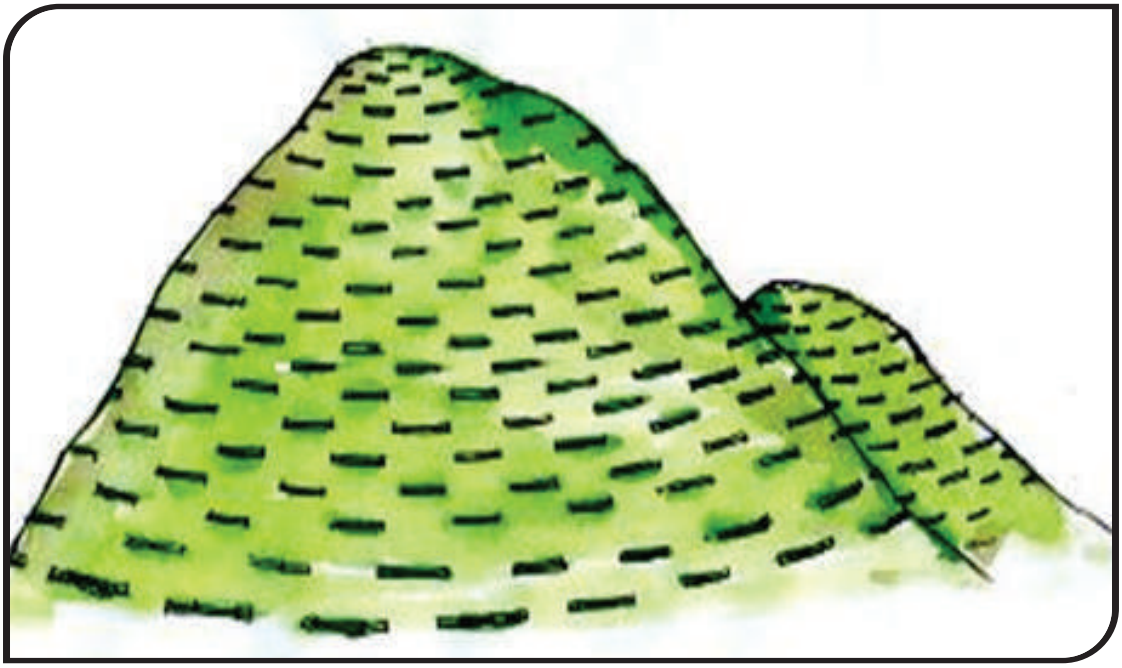
Why:

- To prevent soil erosion at ridge areas and to harvest rainwater
- To check runoff
- To promote plantation/ vegetation

B. STAGGERED CONTOUR TRENCHES

What:

- Trenches dug in staggered manner with interspace
- Trenches are below one another in contour lines



Where:

- Larger areas with minimum budget
- Lreas with hard soil, rocky strata

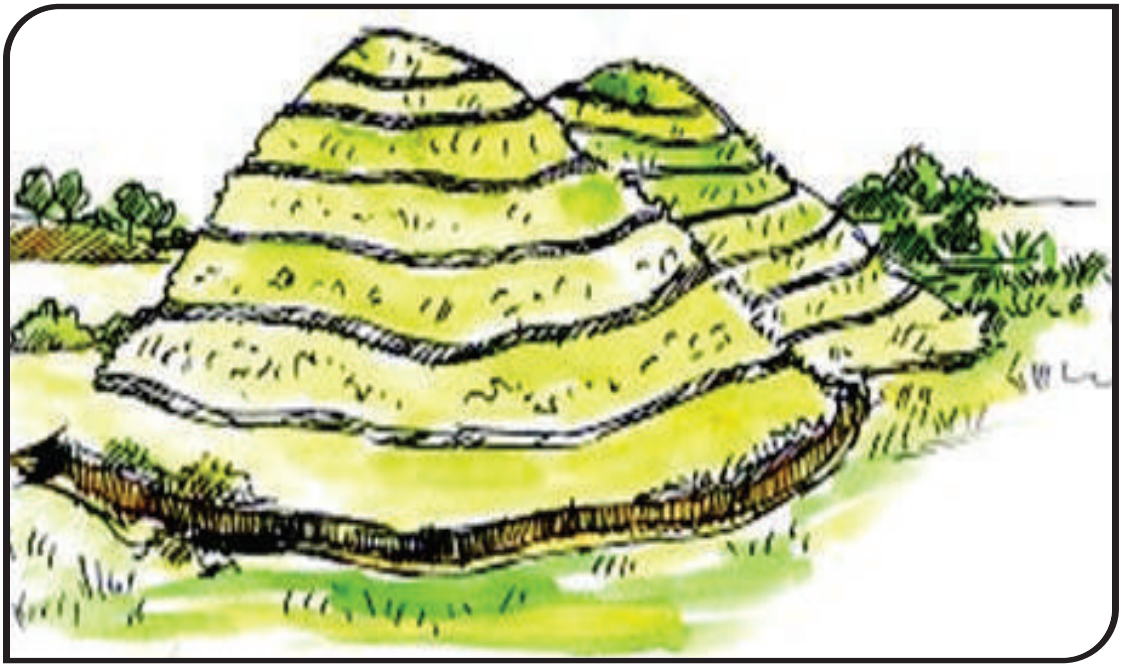
Why:

- To prevent soil erosion at ridge areas and harvest rainwater
- To check runoff
- To promote plantation/ vegetation

C. WATER OBSORPTION TRENCHES

What:

- Normally a continuos contour trench
- Border zone between private land and hillock



Where:

- Foot hills of hillock
- Covers the entire bottom line of the hillock

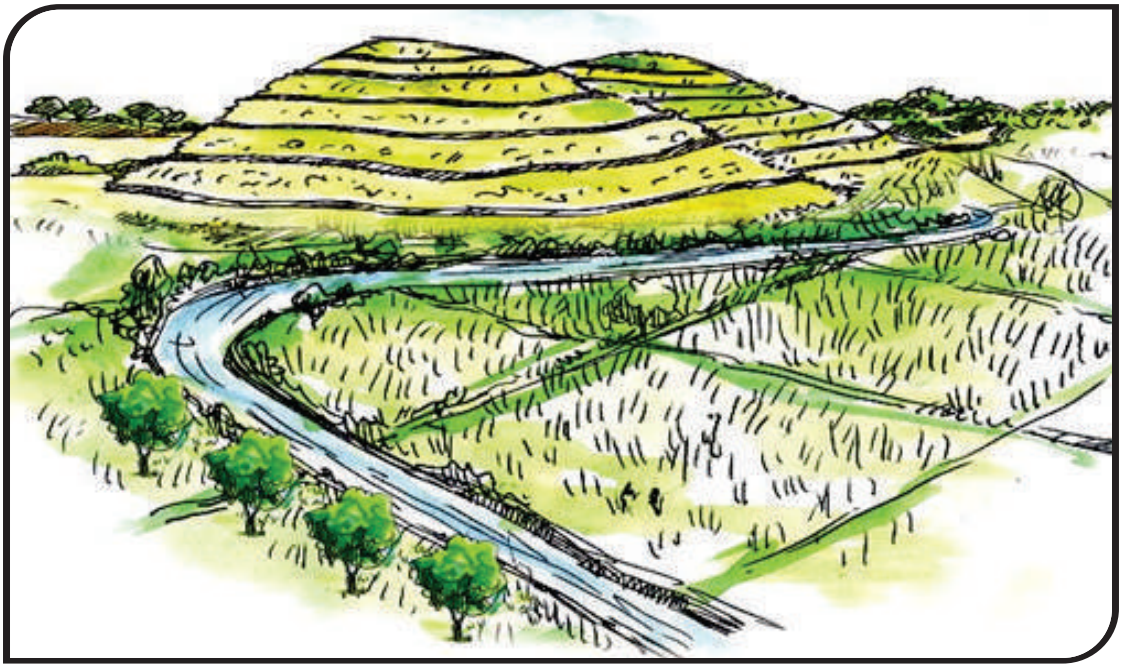
Why:

- Enables prevention of flooding
- Enables obsorption /recharging of runoff water
- Allows water to flow in a regulated manner through outlets to reach normal drains
- Also prevents entry of stray animals to plantation/forest areas – in such cases the Dimensions Are Quite Bigger

NOTE: Depth and outlet depends on the soil types, slope and area of hillock

D. DIVERSION DRAINS

What : It is artificial channel linking runoff source like hillocks, forests, Flat lands and drainages with a water harvesting structure or natural drain to conduct runoff safely to a suitable point



Where:

Just below the hillocks between private and common land

Why:

To divert the runoff away from the protected area

How:

- Map of the identified site is prepared with the following details-
- Hillocks /forest lands with huge runoff
- Agriculture lands likely to be damaged due to floods
- Potential route/directions to channelize the flood water
- The diversion drawn should be linked to the stabilised outlet to deliver runoff in proper way
- Identification of potential use /users of this water

3. WORKS IN AGRICULTURE FIELD

A. CONTOUR BUNDS

What: Earthern bunds constructed along the contours of the land across the slope

Where:
In agriculture lands with slope of 6% marginal sloping (2-6%)

Why:
- Soil and moisture conserved due to which productivity is enhanced
- Crops in these lands can withstand dryspells for a longer period

Note:

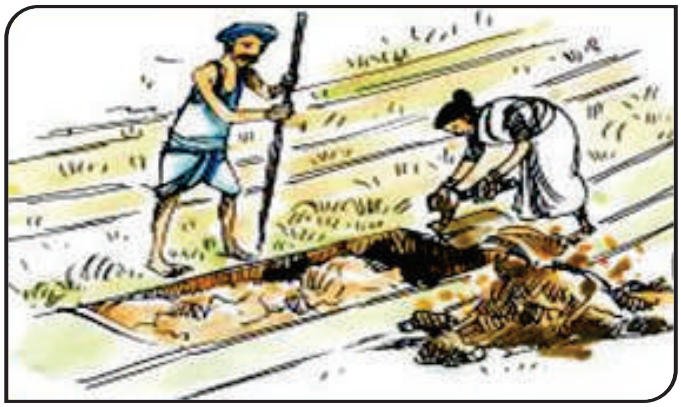
Ensure outlets are constructed at proper location to prevent breaching of bunds, stagnatation of water and damage to agriculture land.

Need based multipurpose plantation (timber, fruit, fodder etc) can be undertaken on bunds if the size of bunds is more.

HOW (ALL TYPES OF TRECNHES AND CONTOUR BUNDS)

Contour survey

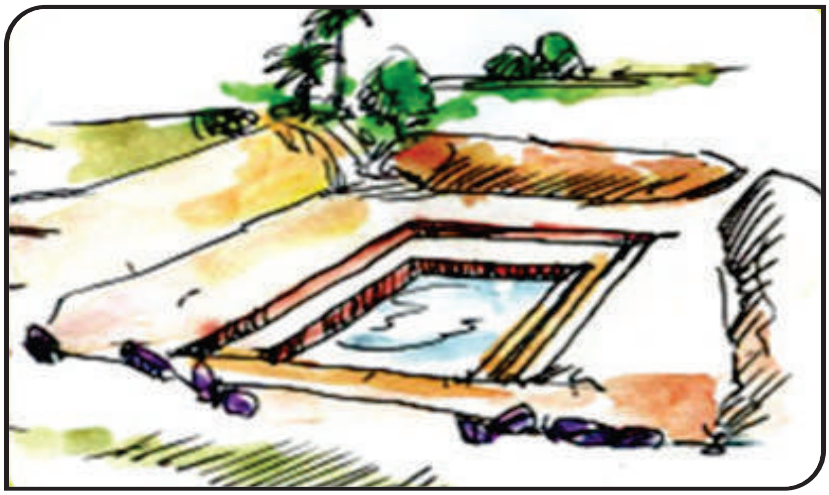
Giving mark out/ layout



Digging trench and keeping soil downstream side

B. FARM PONDS

What: It is a pit dug in the field to harvest rain water or to recharge ground water as an option to store water from diversion drains where ever it is possible



Where:

Private agriculture lands

In common lands close to private agriculture lands

Why:

- Harvest rain water
- Recharge ground water
- Critical irrigation for the crops and livestock
- If the recharge is low, then fisheries could be an option based on number of months

Water Is Retained

Note:

- Size of farm ponds depend on the rainfall
- Map the micro catchment to assess the potential of run off (volume of water to be stored)
- Identifying the appropriate site
- Proper inlets and outlets needed

4. WORKS ACROSS DRAINAGE LINES

A. Loose boulder structures

What:
Structure made out of stones in series with proper interlocking arrangements

Where:
In common lands across the drainage lines (most commonly 1st order drainage lines and 2nd order drainage lines sometimes)

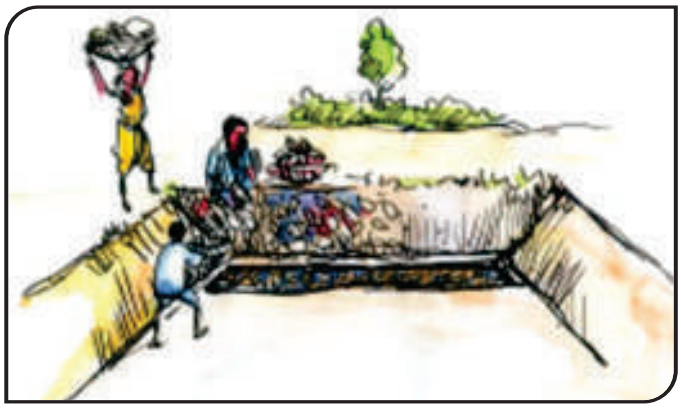
Why:
- To prevent gully formation at ridge areas
- To reduce velocity of runoff

Note:
Depending on site and local conditions stones/wood logs/stick/gunny bags fillwe with sand can be used

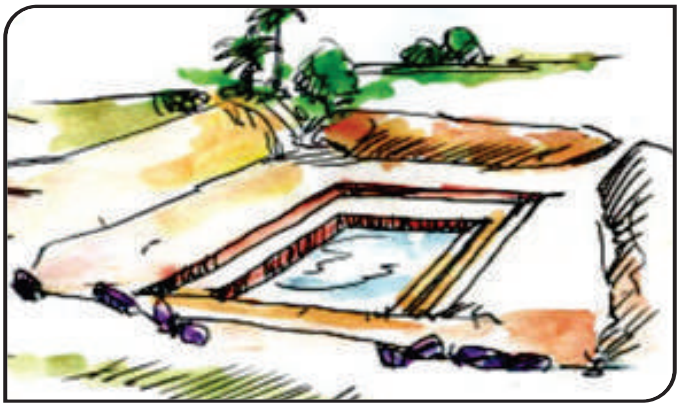
HOW: PROCESS

Markout/ layout for farmpond

Digging farmpond and keeping the soil with proper berm



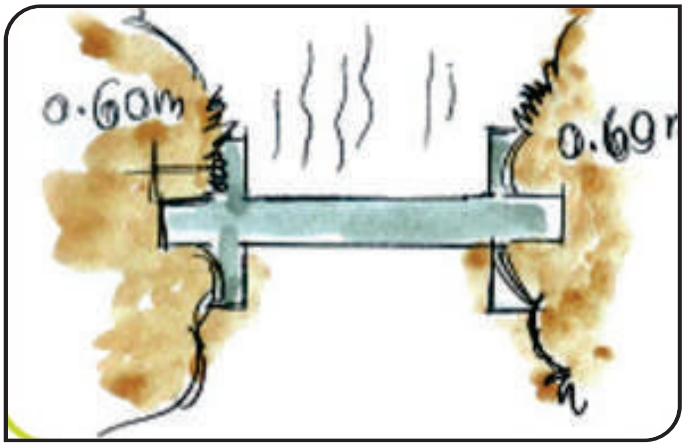
Constructing stone revitment



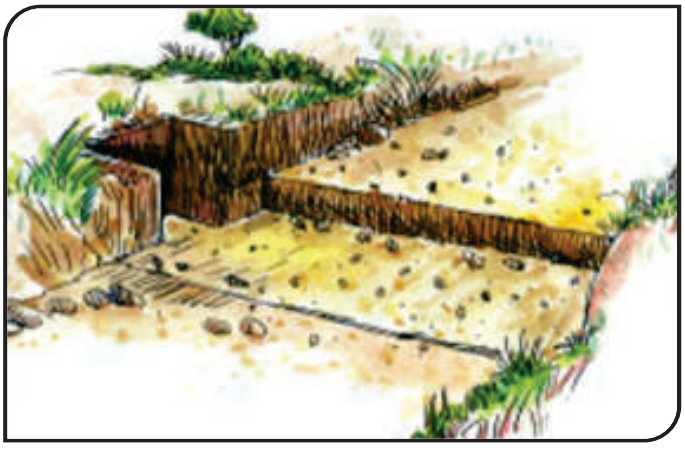
Another model of farm pond

HOW: PROCESS

Measuring the gully width



Plan /layout- Gabion earth work

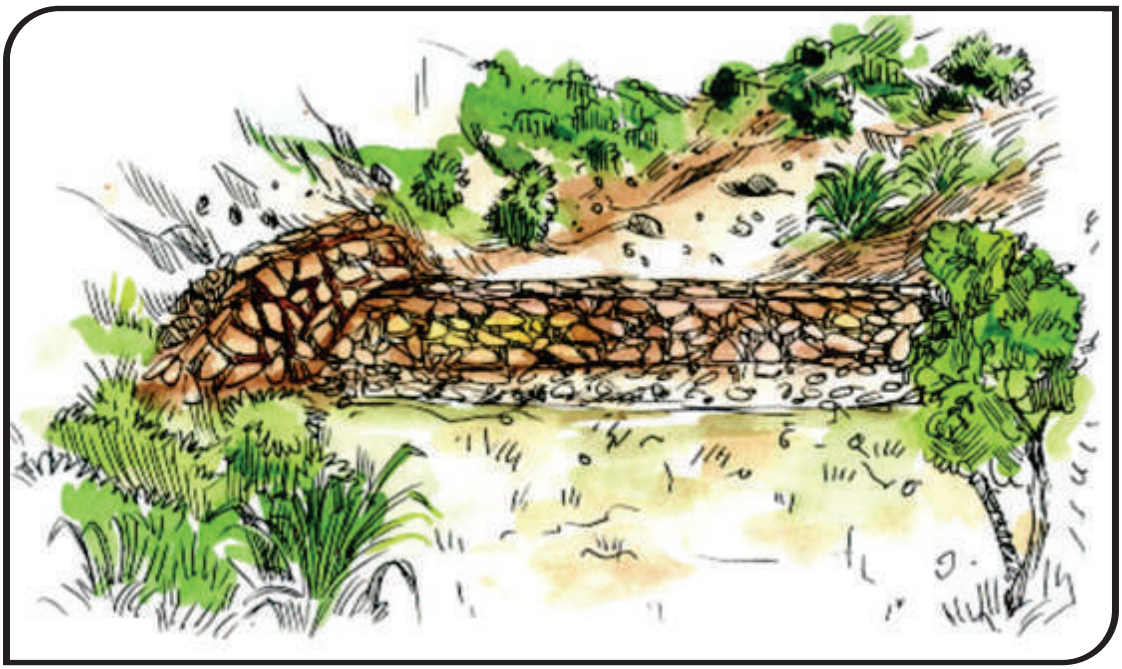


Head wall extension to embankment

B. ROCK FILL DAMS

What:

Are structures constructed in series using stones interlocking each other



Where:

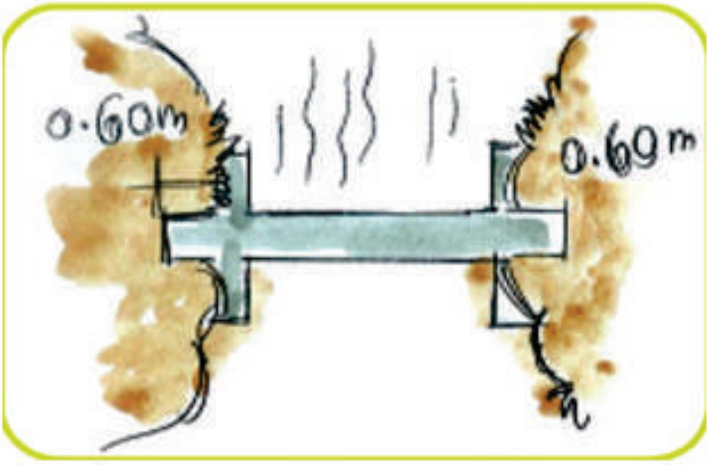
In common lands, forest lands in between agriculture lands across the drainage lines (both1st and 2nd order) where gullies are already formed and are deep

Why:

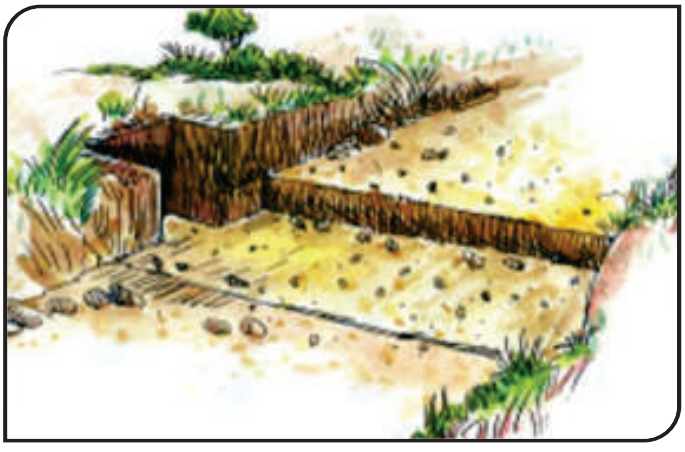
- To Prevent Gully Formation
- To Prevent Gully Expansion (Width And Depth)
- Reclaim Gullies

HOW: Process

Measuring the gully width



Plan /layout- gabion earth work



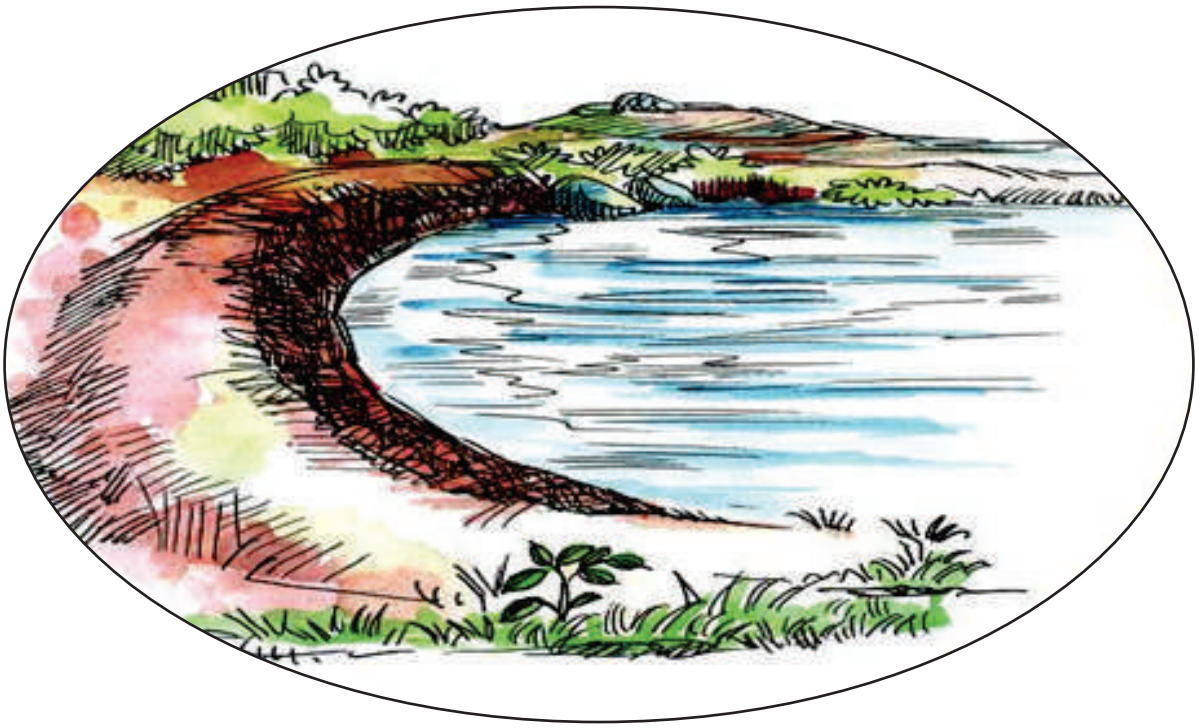
Head wall extension to embankment

5. WATER HARVESTING STRUCTURES

A. Earthen dams

What: dams constructed using soil

They are also called as gully plug/ percolation tank dpending on the size of the structure



Where:
Gully plugs are in common lands across drainage lines

Why:

To harvest rainwater for ground water recharge/irrigation

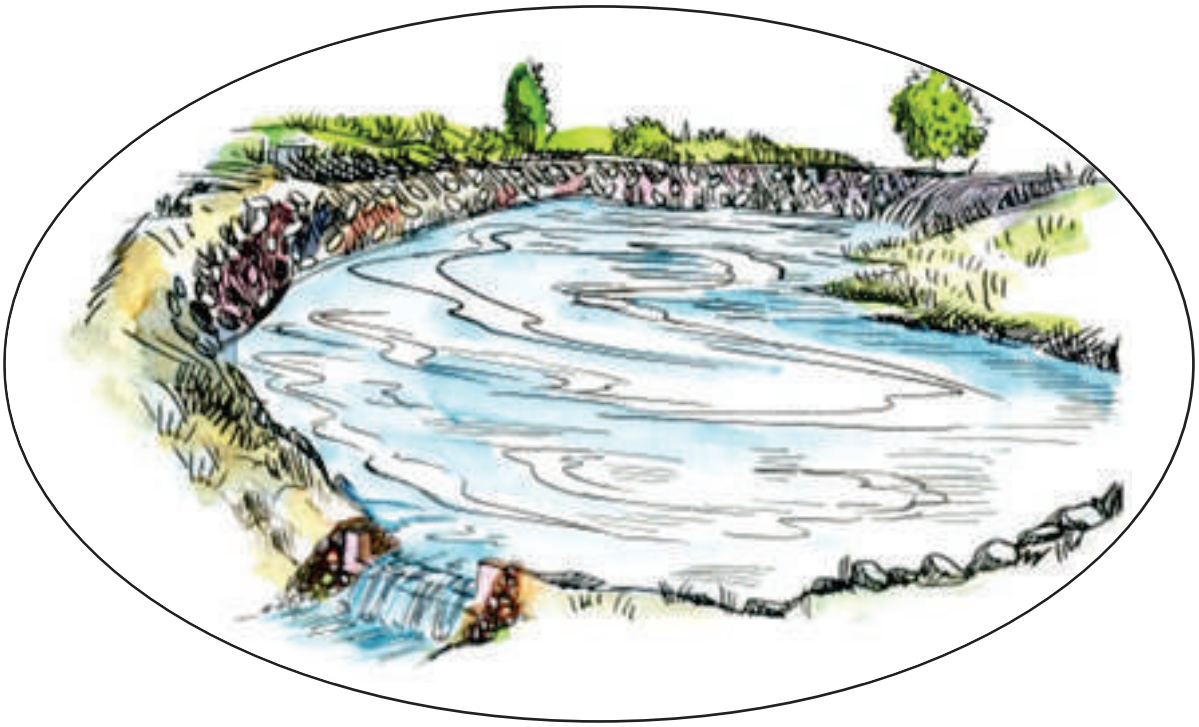
To prevent soil erosion and stabilize gullies

How:

- Cathment and drainage line survey using toposheet and engineering surveys
- Hydrological assessments (estimation of runoff and water flow)
- Identify appropriate site for construction of outlet /waste weir
- Earthern bund is constructed by dumping soils and ramming in layer by layer
- Pervious and impervious soils to prevent seepage (black soil)
- Side slopes to be maintained in earthern bunds both on both upstream and downstream
- Stone pitching is necessary on upstream

B. PERCOLATION TANKS

What: Percolation tanks are a combination of earthen dams with waste weir



Where:
Percolation tanks are constructed where land is available for submergence to create water reserviours

Why:

- To harvest rainwater on large scale
- To recharge ground water resources
- To irrigate agriculture lands through surface canals
- To support water based livelihoods like fisheries, livestock etc

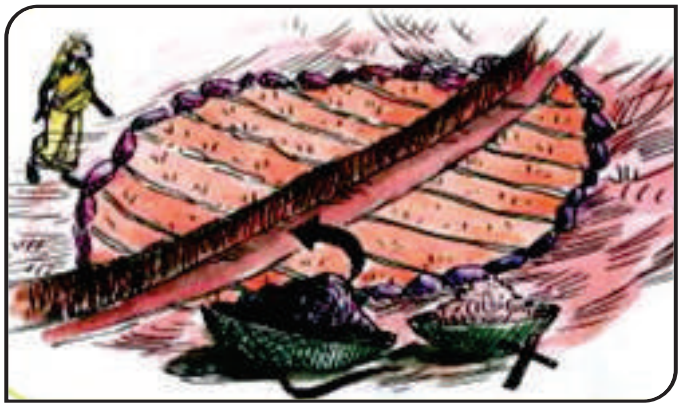
How:

- Cathment and drainage line survey using toposheet and engineering surveys
- Hydrological assessments (estimation of runoff and water flow)
- Identify appropriate site for construction of outlet /waste weir
- Earthen bund is constructed by dumping soils and ramming in layer by layer
- Pervious and impervious soils to prevent seepage (black soil)
- Side slopes to be maintained in earthen bunds both on both upstream and downstream
- Stone pitching is necessary on upstream

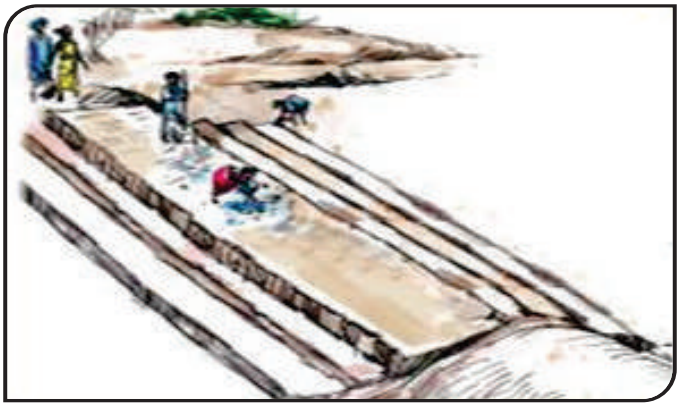
HOW: PROCESS (Gully plugs and percolation tanks)

Calculate the catchment area using

Marking/ Lay out



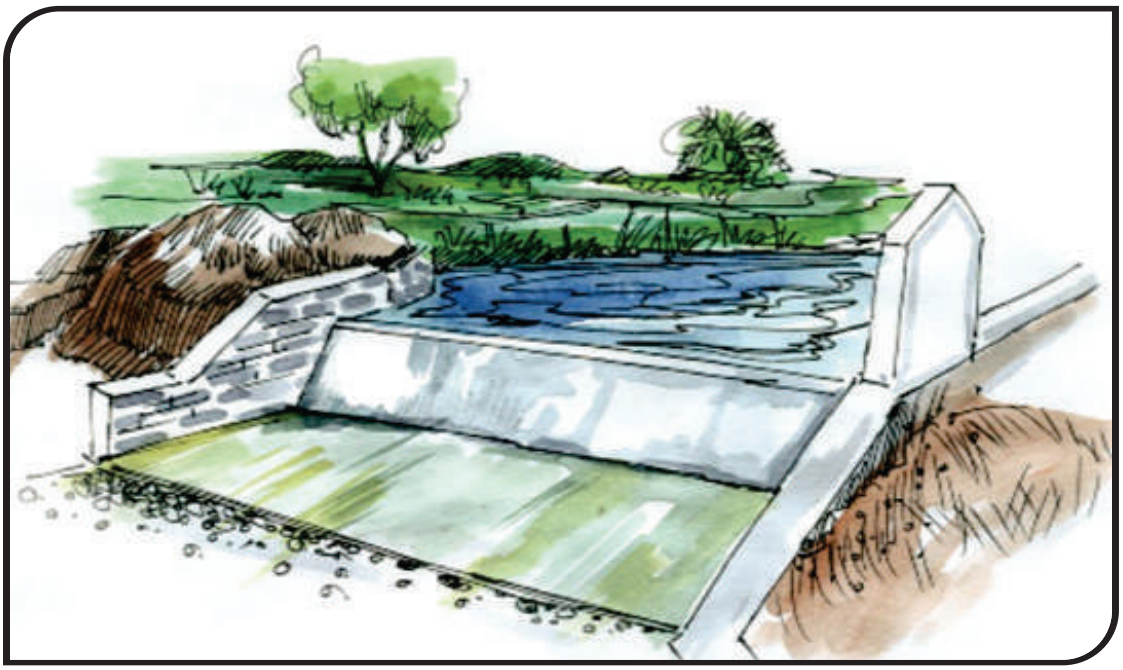
Fill key trench with impervious soil



Compact the earth in layers with water

B. CHECK DAMS

What: Constructed with stones and cement concrete. check dams impound/store water largely in drainage line/stream itlsef. sometimes water in retained upto two kilometers from the point of construction



Where:

Across the drainge lines from third order streams onwards

Why:

- harvest rainwater
- recharge ground water resources

How:

- Cathment and drainage line survey using toposheet and engineering surveys
- Hydrological assessments (estimation of runoff and water flow)
- Identify appropriate site for construction of check dam
- Stabilise the bank of the stream by constructing earthern bunds to prevent breaching in the upstream side

HOW: PROCESS (check dam)

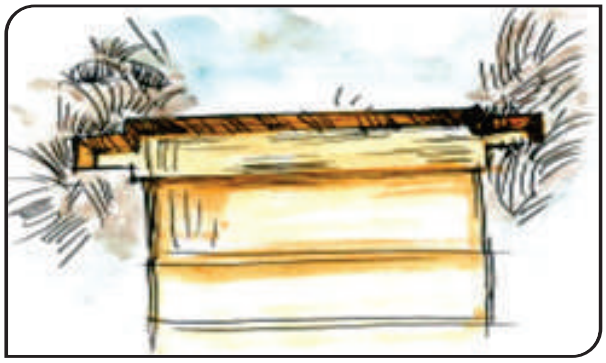
1. Map the area using toposheet

2. Site selection

3. Site clearance

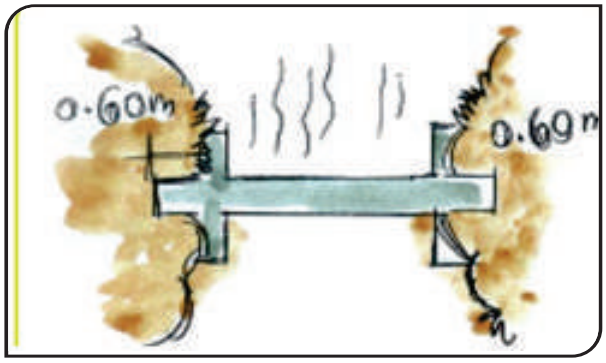
4. Measure average depth

5 . Measure width of drainage



6. complete earth work

7. Filling the foundation with cement concrete



8. Head wall extension into embankment

6. PLANTATION

What: It is an external effort to increase the availability of biomass in a given locality

Where:

- Common lands- forest, revenue lands, tank fore shore
- Private lands – agriculture lands
- Institutional lands- schools, avenues, govt offices etc

How:

- Soil conservation
- Moisture conservation
- Fuelwood, manures, timber, fodder, fruits , ntfp , shade
- Improving micro climate and biodiversity

Types:

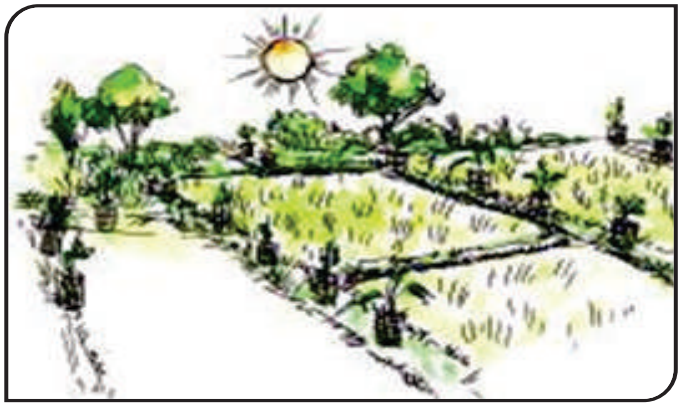
- Linear plantation
- Horticulture plantation
- Block plantation

A. LINEAR PLANTATION

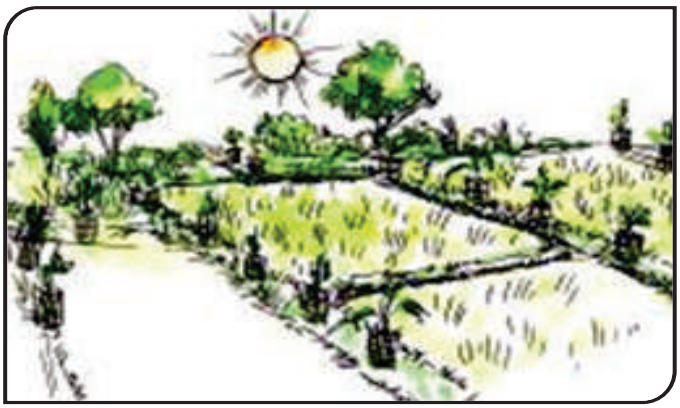
What: Plantation of multipurpose plant species along roads, canals, farm bunds they are tall growing and require water and protection for atleast three years

Along canal

Along roads



Fill key trench with impervious soil



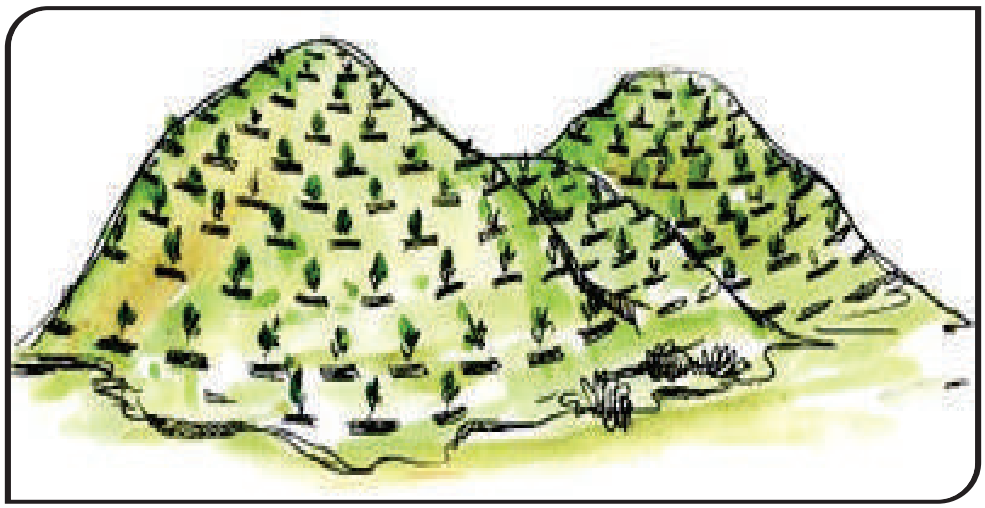
Bund plantation

Multi –purpose: Food, Fuel, fodder, manure, timber etc.

A. BLOCK: PLANTATION IN COMMON LANDS

Types: A. Hill afforestation

Where: Barren hills



Barren Hillocks

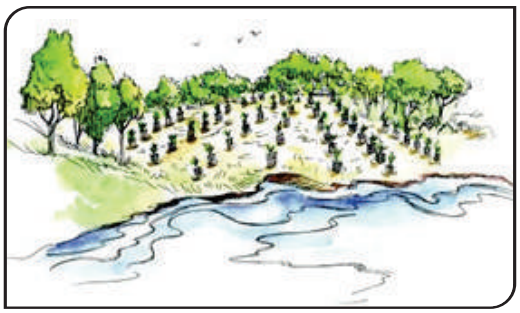
B. Plantation in public institutions

Plantation in school premises

Plantation in health centres

Plantation in government office premises

Plantation in the premises of religious institutions



Tank fore shore plantation

Plants that can grow in water logged condition

C. Horticulture plantation: plantation fruit crops in private lands

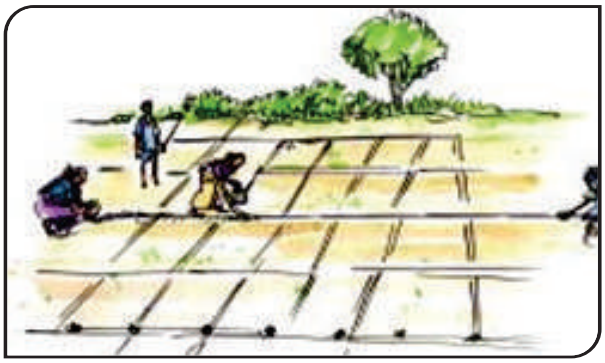
Crops: Mango, Guava, Cashew, Tamarind, Pomegranate etc

Why:

- Income to the farmers
- Availability of bio-mass for enhancing soil fertility
- Shade and shelter to the agriculture workers and farmers
- Protection for the crop
- Prevention of soil erosion due to wind blow

Fruit crops plantation

PROCESS OF PLANTATION



1. Marking

2. Pit digging

3. Procurement of plants from nursery

4. Transportation to field

5. Manuring and plantation

6. Basin preparation

7. Regular watering

8. Watch and ward

CHAPTER 3
SOIL HEALTH IMPROVEMENT

INTRODUCTION

Soil is basically composed of water and air in equal proportion (25 percent, minerals 45 percent and 5 percent of organic matter (microbes , plant residues and humus). Soil is a natural factory with microbes actively and very silently involved in breaking complex minerals and organic matter into readily available form of nutrients to plants. Health of soil is strongly determined by its organic carbon content that is directly correlated with organic matter and microbial load in the soil. More the organic carbon, better will be the infiltration, retention and resilience capacity to drought. Other factors that determine the soil health are soil pH, Electrical conductivity and nutrients composition in the soil. Thus maintaining soil health is important to sustainable crop production.

Organic manures are plant and animal wastes that serve as major source of crop nutrients. Organic manures are used in the fields since man began cultivating crops. Soil composition generally vary due to differences in the soil formation process. It is found that in soils generally one or more nutrients are deficit that would bring down the yields drastically.

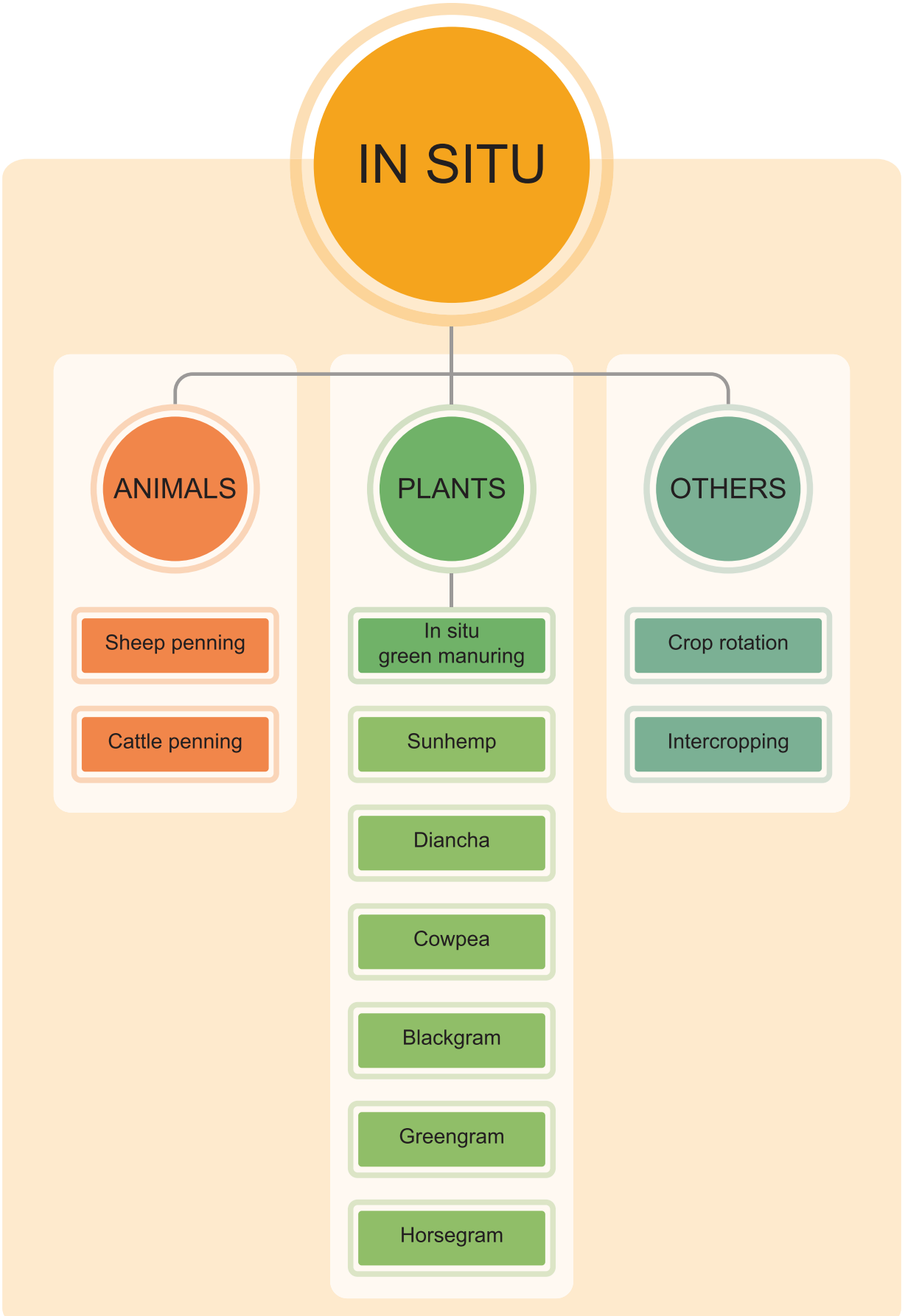
Major source of organic manures

- Cattle shed wastes-dung, urine
- Biogas slurry
- Human habitation wastes-night soil, human urine, town refuse, sewage, sludge and sullage
- Droppings of sheep , goat and Poultry litter
- Bone meal, meat meal, blood meal, horn and hoof meal, fish wastes in slaughter houses
- Oil cakes, bagasse and press mud, fruit and vegetable processing wastes etc
- Crop residues: sugarcane trash, stubbles and other related material
- Weed and tank silt- green manure crops and green leaf manuring material

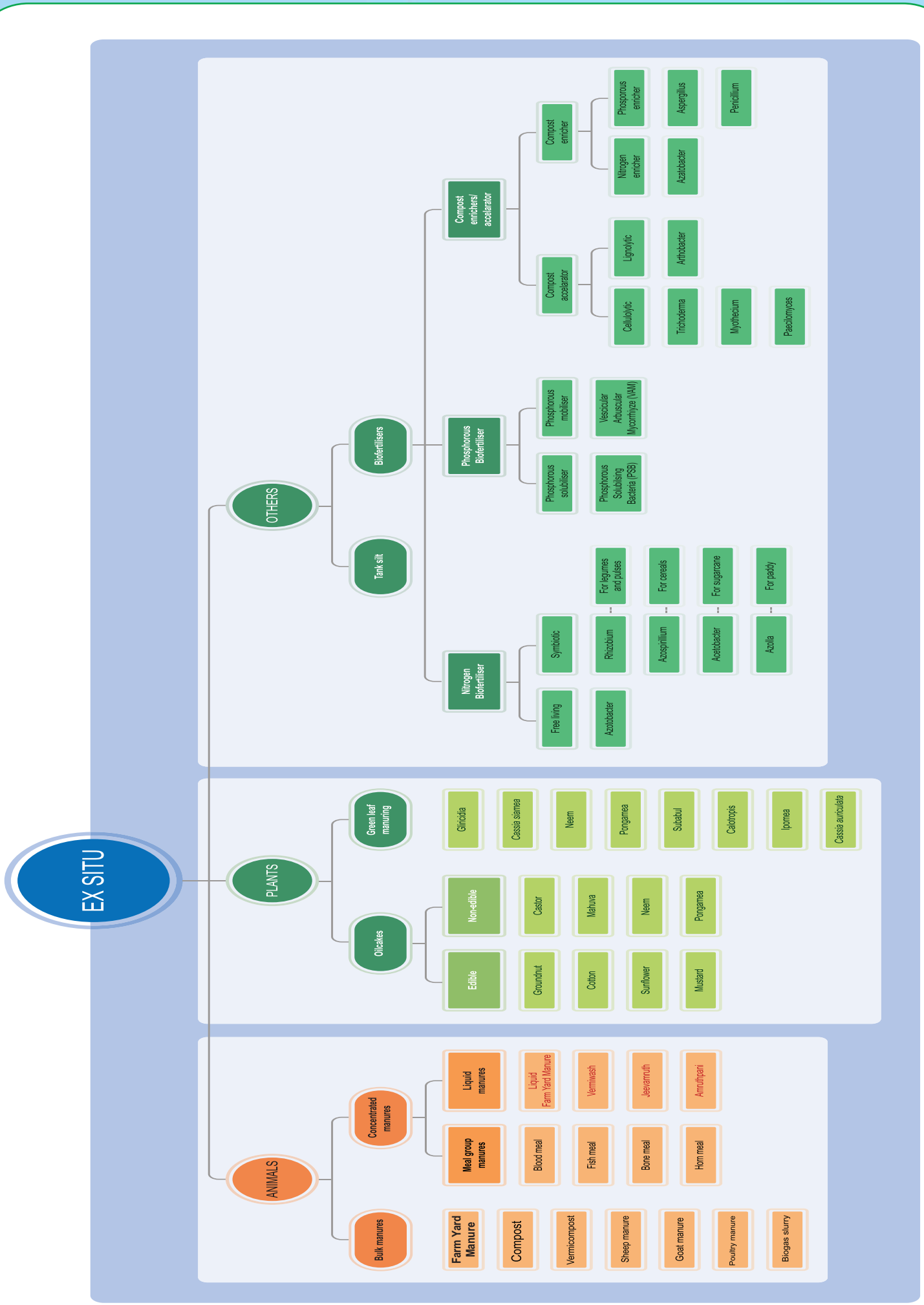
The chapter outlines

- Major sources of organic manures
- Generation and use of organic manures like compost vermicompost, green manures and bio-fertilisers to improve soil health status.

1. Source of Organic Manure



Sources of Organic Manure



COMPOST FOR SOIL HEALTH IMPROVEMENT

What

Compost is a odorless, granular, humus rich and stabilized material obtained after thorough decomposition of organic matter.

Why

* Improves soil microbial activity.
* Improves soil aeration and water holding capacity of soil.
* Improves availability of micro and macronutrients.
* It supplies growth promoting substances such as hormones.
* It helps in better penetration of roots as the soil gets loosened

How

Site selection

* Better if , closer to cattle shed
* It should be easy to either carry raw materials for composting or shift the compost to the site of application
* The site should be located at elevated point to avoid water stagnation during rainy seasons.

Ingradients

* Agro-wastes,
* Animal dung and
* Soil

Pit method

Preparation of the pit :

The pit should be about 1 m deep * 1.5-2.0 m wide and of any suitable length.

Different methods of compost preparation

Pit method
NADEP method
Improved method

COMPOST FOR SOIL HEALTH IMPROVEMENT

Filling the pit :

* Spread organic materials followed by a layer of cow dung slurry and repeat until the pit is filled.
* Maintain moisture (90%)by sprinkling water regularly
* Avoid compacting composting material.

Turning:

* The material is turned upside down at 15, 30 and 45 days after filling the pit
* At each turning the material is mixed thoroughly, moistened with water and replaced with the pit.

BIO-FERTILISERS FOR SOIL HEALTH IMPROVEMENT AND NUTRIENT MANAGEMENT

Bio-fertilizers:

Bio-fertilizers are ready to use live formulates of beneficial micro organisms, which on application to seed, root or soil mobilize the availability of nutrients to plants. Different types of micro organisms have an ability to mobilize nutritionally important elements from non-usable to usable form through biological processes.

Advantages of using Bio-fertilisers:

- Sustain soil health
- Increase crop yields by 20-30%
- Activate soils biologically
- Replace synthetic N and P by 25%
- Stimulate plant growth
- Restore natural fertility
- Protect crop from drought and soil borne diseases.

Sl.no	For Nitrogen	For Phosphorous	For enriched compost
1	Rhizobium for legumes	PSB (Phosphorus solubilizing bacteria) for all crops to be applied with Rhizobium, Azotobacter, Azospirillium and Acetobacter	Cellulolytic fungal culture
2	Azotobacter and Azospirillium for non-legumes		PSB and Azotobacter
3	Acetobacter for sugarcane only		
4	Blue green algae(BGA) and Azolla for lowland paddy only		

Rhizobium:

- A soil habitat bacterium that fixes atmospheric nitrogen symbiotically by forming root nodules in legumin ous plants
- Quantity of biological N fixed by Liqiud Rhizobium in different crops.

	Host Group	*Rhizobium* Species	Crops	N fix kg/ha
1	Pea group	*Rhizobium leguminosarum*	Green pea, Lentil	62- 132
2	Soybean group	*R.iaponicum*	Soybean	57- 105
3	Beans group	*R. phaseoli*	Phaseoli	80- 110
4	Cowpea group	*R. species*	Moong, Redgram, Cowpea, Groundnut	57- 105
5	Cicer group	*R. species*	Bengal gram	75- 117

Azospirllium:

- Azospirillium can fix consider able quantity of nitrogen in the range of 20-40 kg/ha
- Present in the Rhizosphere of non-leguminous plants such as cereals, millets, Oilseeds, cottonetc.
- It can induce abundant roots in several plants like rice, millet sand oil seeds even in up land conditions.
- The genus Azospirillium has three species viz., Alipoferum, A. brasilense and A. amazonense

Amount of N2 fixed by Azospirillium

	Plant	Mg N2 fixed/g of substrate
1	Oryza sativa (Paddy)	28
2	Sorghum bicolour (Sorghum)	20
3	Zea mavs (Maize)	20
4	Panicum sp.	24

Azotobacter:

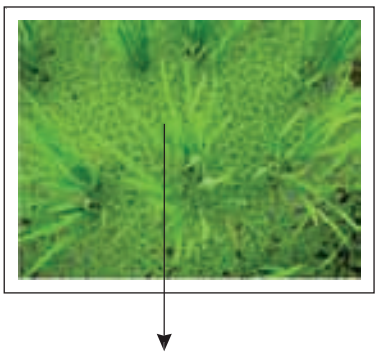
Azotobacter is a free living nitrogen fixing aerobic bacterium is used as a Bio-Fertilizer for all non leguminous plants especially rice, cotton, vegetables etc. It is also known to fix 20-40 Kgs N/ha/year.

Acetobacter :

Acetobacter is a sacharophillic bacteria which associates with sugarcane, sweet potato and sweet sorghum plants and fixes 30 kg N/ ha/ year. Mainly this bacterium is commercialized for sugarcane crop.

Azolla

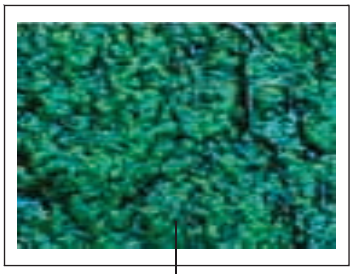
Used as a green manure before transplanting in water in undated areas Azolla green manuring can produce 10-20 tonnes per ha of green matter containing 20-40 kg N. (15 years study by CRRI , Cuttack)



Azolla in paddy field

Blue Green Algae

- Blue-Green Algae (BGA) is a free living N fixer
- It can increase rice yield by 6-35 per cent
- It can contribute 20-30 kg N per hectare



Blue green algae scum in paddy field

Phosphate Solubilizing Microorganisms:

- PSM makes available Phosphorous from unavailable to consumable form
- Bacteria can be used in neutral too
- Soils and fungi can function better in acid soils

USE OF BIO-FERTILIZERS

1. Seedling root dip treatment
2. Main field application
3. Seed treatment or seed inoculation

1. Seedling root dip treatment:

- Make a slurry by mixing 1 kg of Azospirillium culture, 1 kg phosphorous solubilising bacteria culture, 500 grams of Pseudomonas flourescens and 500 grams. Trichoderma viride in 30-45 litres of water. (Generally, the ratio of inoculant and water is 1:10 {Approx} i.e.1 Kg of inoculant in 10 litres of water.)
- Make small bundles of seedlings.
- Dip the root portion of these seedlings in this solution for 15-30 minutes and transplant immediately

2. Main field application of bio-fertilisers

Four packets of the inoculant (200 grams each) and 20kgs of dried and powdered farm yard manure broadcasted in one acre of main field just before transplanting.

3. Seed treatment

a. Non-legumes:

- Add 100-150 grams of jaggery in 0.5 liter of water and heat until it forms a sticky solution
- Cool the solution and add 20 grams of Azospirillium/Azotobacter, 20 grams of P.S.B and 4 grams of Trichoderma viride to treat 1 kgs of seeds
- Mix it thoroughly form a thin film over the seeds and shade dry before sowing

b. Legumes:

- Add 100-150 grams of jaggery in 0.5 liter of water and heat until it forms a sticky solution
- Cool the solution and add 20 grams each of Rhizobium, P.S.B and 4 grams of Trichoderma viride to treat 1 Kg of seeds.
- Mix it thoroughly form a with thin film over the seeds.
- Shade dry before sowing

GREEN MANURES

FOR SOIL HEALTH IMPROVEMENT

Gliricidia (Gliricidia maculata)

- Keep plants short by pruning or lopping at a height of 2-3m to avoid shading effect.
- Pruned two times under rain fed and three times under irrigated conditions

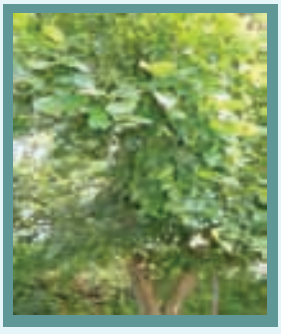
starting 2nd year onwards.

- Yield : 6 to12 kg of green leaf.

Subabul (Leucaenaleucocephala)

- Contain about 3-4% of N.
-
- Leucaena fixes about 500-600 kg N/haperyear.

Pongamea (pongamia pinnata)



- Planted at 4to5m spacing between plants
- Lopping once or
- twice ayear
- 100to150kgof green biomass per lopping.

Neem (Azadirachta indica)

- Thetrees are grown along field borders, rivers banks, roads, waste lands.
- One or two loppings yielding 150 to 200 kg of green matter.

An ideal green manure crop should possess the following traits:

- Early establishment and high seedling vigor.
- Should be fast growing in short period
- Tolerant to drought, shade, flood and adverse temperature.
- Have an ability to accumulate large bio mass and nitrogen in 4-6 weeks.
- Leguminous plants are largely used as green manure due to their symbiotic N fixing capacity, some non-leguminous plants are also used if they are locally available.
- Easy to incorporate in the soil.
- Quickly decomposable.

Green manures for soil health improvement

Green manuring is a practice of turning green plants tissues grown in to the soil for improving the soil health.

Advantages of green manuring

- Adds nutrients and increases the humus content
- Improves the soil structure and aeration
- Increases the water and nutrient holding capacity of the soil
- Helps control the soil borne insects
- Binds soil in the slopes
- Protects soil from the erosion
- Promotes habitat for natural enemies and soil microbial population

Two types of green manuring.

a. Insitu-Green manuring

b. Exsitu-Green manuring

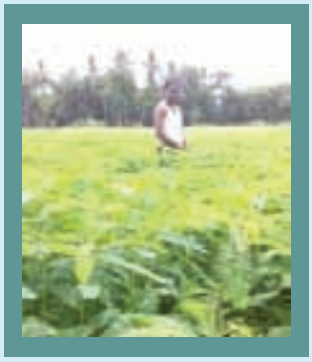
Insitu-Green Manuring:

Incorporating green manuring crops back in the same field Commonly grown crops for green manuring are as follows...

Sun hemp (Crotalaria juncea)

- Turned in to soil in10 weeks after sowing, before flowering.
- It does not with stand water logging.
- Increases the water and nutrient holding capacity of the soil,
- Seed rate is 25-35kg/ha.
- Green matter yield is 15-20 t/ha.
- Protects soil from the erosion
- Quantity of nitrogen fixed by the crop is 75-80 kg/ha.

Daiancha (Sesbania aculeata)



- Turned into soil at 8 to10 weeks after sowing
- Grown in adverse conditions (drought, water logging, salinity etc.)
- Seed rate is 20 to 25 kg/ha
- Green matter yield is 10-20 tonnes per ha
- Quantity of nitrogen fixed is 75 to 80 kg/ha

Cowpea / Greengram / Blackgram / Cluster beans

- The plants are easily decomposable
- June-July months are suited for sowing
- Use of effective Rhizobium bacteria increase the fixation of nitrogen up to 40 kg/ha.

CHAPTER 4
QUALITY SEEDS

Introduction

Seed is the basic and most critical input for sustainable agriculture. It is any propagative part of the plant that has the capacity to germinate, grow and develop into a new individual plant. Seed could be tuber, bulb, stem cutting, roots, leaves etc. The response of all other inputs depends on quality of seeds to a large extent. It is estimated that the direct contribution of quality seed alone to the total production is about 15 – 20% depending upon the crop and it can be further raised up to 45% with efficient management of other inputs. Every farmer should be able to access seeds that are healthy, genetically pure, good in germination and vigour for better crop production and productivity Ensuring timely availability of quality seeds in required quantities of preferred choice of farmers at affordable cost plays a major role in achieving food security and enhancing income of farmers .

What are good quality seeds?

- Seed that are pure (seeds of same variety)
- Able to germinate rapidly and have high yielding potential.
- Free from seed borne diseases and pests
- Clean, free from weed seeds or any inert materials.
- Whole and not broken or damaged.
- Optimum moisture (8-12 %).
- High germination percentage

Why quality Seeds?

- Ensures genetic and physical purity of the crops
- For desired plant population
- To withstand the adverse conditions
- Good vigour, fast growing and can resist pest and disease incidence to certain extent
- For uniform growth and maturity
- Better root system for efficient absorption of nutrients
- It will respond well to added fertilizer and other inputs.

Good quality seeds of improved varieties ensures higher yield atleast 10-12 %

Differences between seeds and grains

Sr.No	Seeds	Grains
1	Any plant part used for propagation is seed.	It is final produce of grain crops used for consumption.
2	Can be treated with fungicide, pesticide.	Not treated with fungicide and Pesticide.
3	Embryo is important.	Endosperm is important.
4	Viability is important.	Viability not considered
5	Genetic purity must.	Genetic purity not necessary
6	Comes under preview of seed acts.	Comes under preview of food acts

SEED GERMINATION TEST

seed germination test is done to find out how many seeds of a particular plant species, variety or seed lot are likely to produce normal plants. It is usually expressed in percentage.

Advantage: Only required amount of seeds will need to be sown.

1

Take cleaned and graded seeds

2

Count 400 seeds

3

Fill sand in 4 bowls

4

Mark lines

5

100 seeds in each bowl

6

Label and keep the bowls under shade

7

Count number of seeds germinated starting from 4th - 14th day as per recommendation

8

Record the germination progress in a table

Check if the seed lot achieves the minimum germination percentage as per the prescribed table.

If the germination percentage is greater than than the specified standard, then crop production will be economically viable.

SEEDLING ROOT DIP TREATMENT
- FOR BETTER GROWTH AND DEVELOPMENT

Why Root Dip Treatment required:

- **For protection against soil borne diseases like Sheath Blight (paddy) and Wilt, Root Rot, Collar Rot and Damping-off (vegetables)**
- **Increased availability of Nitrogen and Phosphorous to crops**

Which Crops:

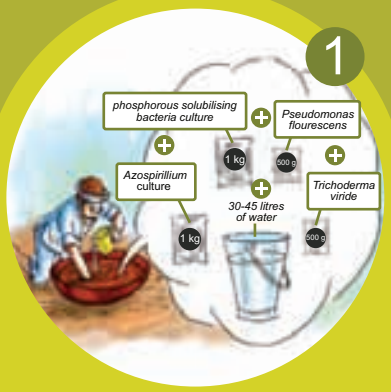
All transplanted cops like Paddy; Vegetables like Brinjal, Tomato, Chili,

Cauliflower, Cabbage, Onion and medicinal plants

Problems when root dip treatment is not done

Paddy sheath blight Tomato wilt Chilli wilt

Seedling Treatment



Prepare a solution

Instruction: Ratio of inoculant to water: 1:10 i.e.,1 kg of inoculant in 10 litres of water for 1 acre.

Bundle seedlings

Make small bundles of seedlings required for transplanting in 1 acre.

Dip root in solution

Dip root of seedlings in solution for 15-30 minutes.

Transplant immediately

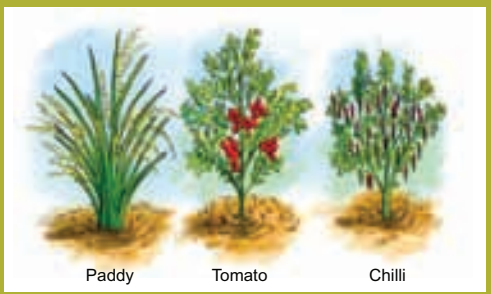
Transplant immediately after removal from solution.

Transplant seedlings

Transplant treated seedlings in the main field

Impact

Healthy and disease-free crops!



Paddy Tomato Chilli

Seed Treatment of legumes with biofertilisers

What are bio-fertilisers?

Bio-fertilisers are live microbial formulations that upon seed treatment or soil application would colonise in the roots or rhizosphere and augment the supply of nutrients like nitrogen, phosphorous and potassium to crop plants. Rhizobium are root nodule bacteria present in the roots of leguminous crops that can fix atmospheric nitrogen and make it available to crops.

Phospho-bacteria is a free living soil bacterium that can solubilise the fixed P in soil and make it available to plants. Phospho-bacteria is popularly known in the market as Phosphorus Solubilizing Bacteria (P.S.B.).

	Crops	Rhizobium species	Nitrogen fixed(kg/ha)
1	Greenpea, Lentil	*R.leguminosarum*	62-132
2	Soybean	*R.japonicum*	57-105
3	Beans	*R.phaseoli*	80-110
4	Green, black and redgram, Cowpea, groundnut	*R.species*	57-105
5	Bengalgram(Chickpea)	*R.species*	75-117

Materials required

- Jaggery : 100-150 grams
- Water: 0.5 litre
- Stirrer
- Legume seeds (Redgram/ Greengram/Blackgram/Chickpea, etc.)
- Rhizobium@ 20 grams for every Kg of seeds
- PSB culture @ 20 grams for every Kg of seeds
- Basin/Bowl
- Polythene sheet/ clean gunny bag

Step 1: Add 100-150grams of jaggery in 0.5 litre of water and heat it so that a sticky solution is obtained and cool it.

Step 2: Take 20 grams of Rhizobium and 20 grams of P.S.B for every kg of paddy seeds. A medium size matchbox measures about 10 gm of culture.

Step 3: Mix uniformly with above prepared binder solution

Step 4: Pour the binder solution on seeds and mix with seeds properly so that each and every seed gets coated with culture

Step 5: Spread the seeds on clean gunny bag & dry the seeds under shade for at least 30 minutes before sowing

Step 6: Such treated seeds are used for sowing within 24 hrs of incoculation

Note: Only crop specific species of Rhizobium should be used for seed treatment.

Seed treatment of paddy with bio-fertilizers: A low cost method of nutrient management

What are bio-fertilisers ?

Bio-fertilisers are live microbial formulations that upon seed treatment or soil application would colonise in the roots or rhizosphere and augment the supply of nutrients like nitrogen, phosphorous and potassium to crop plants.

- Rhizobium are root nodule bacteria present in the roots of leguminous crops that can fix atmospheric nitrogen and make it available to crops.
- Phosphobacterium is a free living soil bacterium that can solubilise the fixed P in soil and make it available to plants.
- Azospirillium is associative nitrogen fixing bacteria present in the rhizospere of the cereals.
- Azatobacter is free living nitrogen fixing bacteria present in the soil and used for seed treatment of cereals generally.

Advantages of seed treatment with biofertilizers:

- Crop yields could be increased by 20-30%
- Soils will be activated biologically and
- Plant growth will be stimulated and natural fertility will be restoredchemical N and P will be replaced by 25%

Preparation of binder from jaggery

Materials required:

- Jaggery : 100-150 grams
- Water: 0.5 litre
- Stirrer
- Paddy seeds
- Azospirillium OR Azatobacter @ 20 grams for every Kg of seeds
- PSB culture @ 20 grams for every Kg of seeds
- Basin/Bowl
- Polythene sheet/ clean gunny bag

Step 1: For preparation of Binder Solution, add 100-150 grams of jaggery in 0.5 liter of water and heat it so that a sticky solution is obtained and cool it.

Seed treatment of Paddy with Azospirillium & PSB

Generally, 20 gm of Azospirilluim/Azatobacter and 20 gm of P.S.B are needed to treat 1kgs of seeds. A medium sizematchbox contains about 10 gm of culture.

Step 2: Take 20 gm of Azospirilluim/Azatobacter and 20 gm of P.S.B for every kg of paddy seeds. A medium size matchbox measures about 10 gm of culture.

Step 3: Mix uniformly with binder solution

Step 4: Pour the binder solution on seeds and mix well. Every seed must get coated with culture.

Step 5: Spread the seeds on clean gunny bag & dry the seeds under shade for at least 30 min before sowing

Seed treatment with *Trichoderma viride*

Have you noticed plants dying in the field? Do they appear like this?

These are soil borne diseases caused by pathogens present in the soil or seed. They spread from one place to another through seeds, water, air, soil, humans, insects, animals, etc.

How to manage these soil borne diseases?

Through seed treatment with antagonistic fungi, i.e., Trichoderma viride.

Trichoderma viride is a fungus and a bio-fungicide. It is used for seed and soil treatment for suppression of various diseases caused by fungal pathogens.

It is found naturally in soil and is effective as a seed dressing in the management of seed and soil-borne diseases.

How it works?

When applied at the same time as the seed, it colonizes the seed surface and kills the pathogens present on the cuticle and provides protection against soil-borne pathogens.

Bengalgram wilt

Collar rot in Tomato

Wilt in groundnut

Seed treatment using *Trichoderma spp*

Materials required: Jaggery: 100-150 grams, Water: 0.5 litre, Stirrer, Trichoderma viride: 4 grams for every kg of seeds, Basin/Bowl, Polythene sheet/clean gunny bag

Materials required: Trichoderma culture, binder, seeds, bowl

Step 1: For preparation of Binder Solution, add 100-150 grams of jaggery in 0.5 litre of water and heat it so that a sticky solution is obtained and cool it.

Step 2: Take Trichoderma @ 4gm for every kg of seed

Step 3: Mix uniformly with above prepared binder solution

Step 4: Pour the binder solution on seeds and mix with seeds properly so that each and every seed gets coated with Trichoderma culture

Step 5: Spread the seeds on clean gunny bag & dry the seeds under shade for at least 30 minutes before sowing. Treated seeds should be used for sowing within one week of treatment.

CHAPTER 5
SEED PRODUCTION AND STORAGE

What:

Seed production is aimed to produce the crop under standardized conditions to ensure adequate quality of the seeds to be used for sowing purpose.

Seed production requires availability of proper location and season, maintenance of proper isolation distance, roughing, proper harvesting, threshing and processing

Why

- Create timely access to quality seeds in required rates as affordable price to farmers as per the seed standards
- Better income to farmers as seeds fetch better price than normal grains
- To achieve seed self –sufficiency

How

A. Technical control during seed production

Seeds should be produced as per the standardised conditions. Followings stages of seed production are universally accepted to ensure quality of seeds produced

➢ **Nucleus seeds** - Pure lines (100% pure)

It is handful of seed maintained by concerned breeder for further multiplication.

➢ **Breeder seeds**

- It is produced by the concerned breeder or sponsoring institute or and which is used for producing foundation seed. It is of 99.9% genetic purity.
- The label/tag issued for B/s is **golden yellow** in color.
- The quality of breeder seed is assured by the monitoring team constituted by the govt.

➢ **Foundation seeds**

- It is produced by govt. farms or by private seed producers from breeder seed and maintained with specific genetic identity and purity. The quality of foundation seed is certified by certification agency.
- It has genetic purity of above 99.5%.The certification tag or label issued for F/s is white in colour

➢ **Certified seeds**

- Progeny of foundation seed produced by registered seed growers under the supervision of Seed Certification Agency by maintaining the seed quality as per minimum seed certification standards.
- Seed Certification Agency issues a blue colour (Shade ISI No. 104, azure blue) certificate.(99%)

➢ **Truthfully labelled seeds**

- It is the category of seed produced by cultivators, private seed companies while required seed standards are followed as per seed act and certified seed stage.
- Under the seed act, the seed producer and seed seller are responsible for the seed quality.
- Colour of the tag is green.

B. ABSTAINING FROM VOLUNTEER PLANTS

➢ The selected fields must be free from volunteer plants that belong to other varieties of the same crop or the other species to avoid contamination

Show pictorially

Precautions to be taken:

- The selected field, should have not been sown with the same crop in last one or two seasons. E.g. If we are planning for paddy seed production then paddy should not be grown in the same field in the previous season
- In case, the seed variety of same crop was sown in the selected field, irrigation should be done that initiates the germination of fallen seeds in soil that could be ploughed back into soil.

C. AVOIDING NATURAL CROSSING AND DISEASE INFECTION BY MAINTAINING ISOLATION DISTANCE

The pollen grains get transferred from one plant to another by wind or insects. This would deteriorate the genetic purity of seeds.

To overcome this issue, maintaining proper isolation distance is very much essential. Minimum isolation requirement of crops is given in

TABLE 1: MINIMUM ISOLATION REQUIREMENTS OF CROPS

Sr.no	Crop	Isolation distance required (in metre)	
		Foundation seed	Certified seed
1	Paddy, wheat, barley, oats	3 *(150)	3 *(150)
2	Hybrid sorghum	300 *(400)	200 *(400)
3	Pearl millet	1000	200
4	Maize		
	a. Inbred line	400	Crop is not grown
	b. Single cross	600	-do-
	c. Hybrid maize	-	200 *(300)
	d. Maize-composite	400	200
5	Soyabean	3	3
6	Rape & mustard	400	200
7	Groundnut	3	3
8	Cotton	50	30
9	Berseem	400	100
10	Peas	20	10
11	Cabbage & Cauliflower	1600	1000
12	Carrot, Onion	1000	800
13	Brinjal	200	100
14	Chillies, Okra	400	200
15	Tomato	50	25
16	Cucurbits	800	400

D. Rouging off-type plants

- Offtype plants are those that differ in their characters from those of the seed variety are found in the field.
- Their removal before maturity is called rouging-off-types plants

E. Inspection by seed certification agency

- To ensure that crop seed-lot meets the requirement of good quality pedigree seeds.
- Feld inspections are carried out at various stages of crop-growth, processing, storing and marketing etc.
- On meeting prerequisite conditions conforming the genetic purity of seed, a certificate to this effect is issued for commercial distribution of the seed.
- During growing season, the standards of inspection include, land requirements, its previous crop, isolation requirements, maximum permissible off-types, shedding pollens etc.

.

Illustrations, for some crops are listed in table- 3.

Table 3: Minimum number of field inspections and stages of inspections

Sl. No	Crop	No. of inspections	Stages of inspections
1	Paddy, wheat, barley, oats etc	2	Flowering, harvesting
2	Sorghum	4	Pre-flowering, flowering and maturity
3	Maize	4	Pre-flowering (1) Flowering (3)
4	Rapeseed, mustard, sesamun	3	Pre-flowering, flowering and maturity
5	Jute	3	Pre-flowering, bud-stage, maturity
6	Cauliflower	4	Pre-marketable stage, initiation of curd formation, when curd have formed and flowering stage
7	Cucurbits	3	Pre-flowering flowering to maturity and mature fruit stage
8	Tomato, brinjal, okra, chillies	3	Pre-flowering flowering to maturity and mature fruit stage

F. Testing genetic purity by grow-out test

The seed production organization must draw a sample of seed

Grow it in the field to check, the genetic purity of the variety by comparing the standard/norms/characters related to that crop variety.

This actual field grown crop observation is called as grow-out test.

Adoption of recommended agronomic practices

Agronomic practices like preparation of land, hoeing, weeding, irrigation, application of manure, harvesting, threshing, etc. must be carried out as per requirements of the seed crop.

2. OBJECTIONABLE WEEDS

Seed size, of some weeds is such, that if they once get mixed with the crop seed, it is very difficult to separate them. Such weeds are called objectionable weeds. They are given below.

- Seeds of wild rice with seed of cultivated rice.
- Seeds of hirankhuri or seeds of wheat.
- Seed of satyanashi or seed of mustard.
- Seed of Khesari or seed of berseem.
- Inseparable other crops seed

There are number of crop seeds, which if allowed to mix, are difficult to be separated because of their uniformity of size. Example are slated below.

- Wheat seed mixed with barley seed.
- Gram seed mixed with wheat seed.
- Barley seed mixed with oat seed.

For better management of seed plots it is essential to maintain line sowing and inspection spaces. This would make the rouging and inspection easier.

TABLE 2: STANDARD FOR CERTIFICATION FOR OFF-TYPE OR DISEASED PLANTS

-

Sl. No	Crop	Off-type %	Inseparable other crop plants %	Objectionable	
				Weeds %	Plants %
1	Barley, oats paddy, wheat	0.3	0.05	0.02	0.5
2	Sorghum	0.05	-	-	0.1
3	Maize	-	-	-	-
4	Rapeseed & mustard	0.5	-	0.1	0.2
5	Cotton	0.2	-	-	-
6	Cabbage, cauliflower	0.5	-	-	0.5
7	Onion, garlic	0.2	-	0.1	-
8	Potato	0.5	-	-	2.0
9	Brinjal, chillies	0.2	-	-	0.5
10	Tomato	0.5	-	-	0.5
11	Cucurbits	0.5	-	-	0.2

D. INSPECTION

Inspection by the seed certification agency is a very essential step for commercial seed production, especially for registered and certified seeds. This is to ensure that crop seed-lot meets the requirement of good quality pedigree seeds. A team of qualified, well-experienced and administrative personnel carry out field inspections at various stages of crop-growth, processing, storing and marketing etc. They check the quality of each stage as per standards laid down for it. On confirmation of prerequisite conditions conforming the genetic purity of seed, a certificate to this effect is issued for commercial distribution of the seed. During growing season, the standards of inspection include, land requirements, its previous crop, isolation requirements, maximum permissible off-types, shedding pollens etc. Illustrations, for some crops are listed in table- 3.

TABLE 3: MINIMUM NUMBER OF FIELD INSPECTIONS AND STAGES OF INSPECTIONS

Sr.No	Crop	No. of inspections	Stages of inspections
1	Paddy, wheat, barley, oats etc.	2	Flowering, harvesting
2	Sorghum	4	Pre-flowering, flowering and maturity
3	Maize	4	Pre-flowering Flowering (3)
4	Rapeseed, mustard, sesamun	3	Pre-flowering, flowering and maturity
5	Jute	3	Pre-flowering, bud-stage, maturity
6	Cauliflower	4	Pre-marketable stage, initiation of curd formation, when curd have formed and flowering stage
7	Cucurbits	3	Pre-flowering, flowering to maturity and mature fruit stage
8	Tomato, brinjal, okra, chillies	3	Pre-flowering, flowering to maturity and mature fruit stage

E. TESTING GENETIC PURITY BY GROW-OUT TEST

The seed production organization must draw a sample of seed and grows it in the field to check, the genetic purity of the variety by comparing the standard/norms/characters related to that crop variety. This actual field grown crop observation is called as grow-out test. This is very important test for those crops for which no-seed treatment for disease is available. It is also important for crops, for which multiplication has been repeated over many generations, and periodically has not been tested for genetic purity.

F. ADOPTION OF RECOMMENDED AGRONOMIC PRACTICES

Agronomic practices like preparation of land, hoeing, weeding, irrigation, application of manure, harvesting, threshing, etc. must be carried out as per requirements of the seed crop.

SELECTION OF SEED PLOT FOR SEED PRODUCTION

The criteria to select farmer

Farmer selected for the seed production should be sincere and hard working.

- Must have previous experience of growing that crop.
- Have good will in the village.

The criteria for selection of seed production plots

- The plot should be free from volunteer plants.
- Ensure recommended isolation distance from the same crop (see Table-1)
- No serious outbreak of disease and pest in the plot
- Good soil depth
- No much of undulation
- Good drainage facility.
- Avoid plots where too many stones are there.
- Have provision for critical irrigation facility.

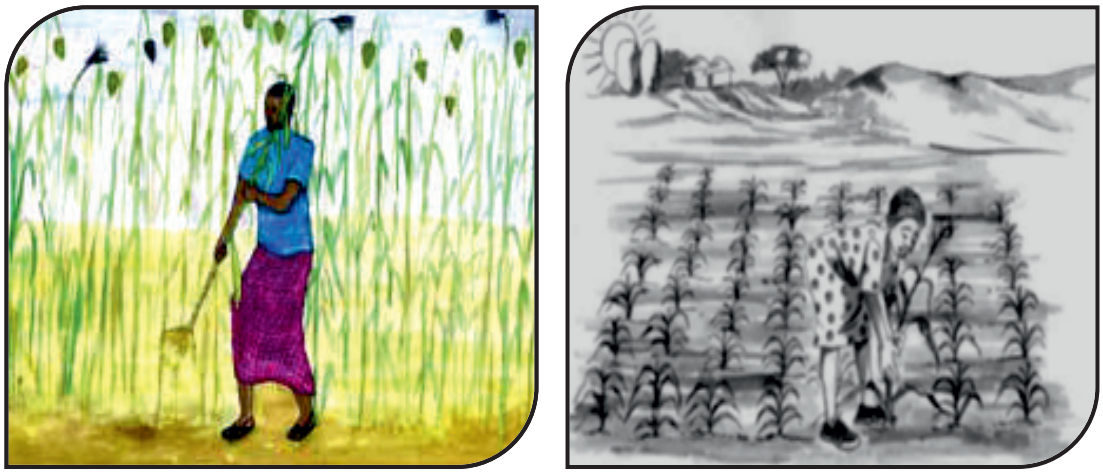
Table 1: Minimum Isolation Requirement for Seed Production of Field Crops

S.No.	Crop	Isolation distance required (in metre)	
		Foundation seed	Certified seed
1	Paddy, wheat, barley, oats	3 *(150)	3 *(150)
2	Hybrid sorghum	300 *(400)	200 *(400)
3	Pearl millet	1000	200
4	Maize		
	a. Inbred line	400	Crop is not grown
	b. Single cross	600	-do-
	c. Hybrid maize	-	200 *(300)
	d. Maize-composite	400	200
5	Soyabean	3	3
6	Rape & mustard	400	200
7	Groundnut	3	3
8	Cotton	50	30
9	Berseem	400	100
10	Peas		2010
11	Cabbage & Cauliflower	1600	1000
12	Carrot, Onion	1000	800
13	Brinjal		200100
14	Chillies, Okra	400	200
15	Tomato	50	25
16	Cucurbits	800	400

ROGUING TO IMPROVE SEED QUALITY & VARIETAL PURITY

Objective of this note is to provide a common understanding about the following

- What is roguing and how it is done
- Objectives of roguing
- Stages at which it is done



Roguing showing symbolic roguing activity i.e. removal of off type plants from field

OBJECTIVES OF ROGUING:

- Enhance seed quality
- Improve varietal purity
- Improve productivity
- Improve market value of produce

WHAT IS ROGUING?

It is defined as the operation of removing rogues/undesirable plants/off-type plants from the field. It is done by visual inspection of crop in the plot and identification of problematic plants that needs to be removed from the field. Roguing also referred as negative selection as it involves selection of undesirable plants from a uniform plant population and subsequent removed from the field.

Roguing off type red flower in yellow flower tuar crop

- A rogue/off-type plants are not true to type. Means, the plants which show characters other than the variety planted in the field or shows heterogeneous characters are called rogue.
- Weeds, diseased plants and inferior plants are also categorized as rogue and needs to be removed from seed plot.

HOW ROUGING IS DONE?

It involves 4 key steps as follows

- Thorough inspection of the entire plot
- Select the plants to be rouged/if necessary mark those plants for identification
- Uproot the plants
- Remove those plants from the plot.

ROGUE PLANT SELECTION/WHAT TYPES OF PLANTS TO BE REMOVED ?

4 categories of plants are to be removed. They are as follows

- Plants other than the variety or not confirming the variety
- Weed plants
- Other undesirable/inferior plants
- Disease plants to check further spread

PLANT SELECTION TOOLS:

Plants needs to be removed from the field can be identified by observation of the following characters in the plants;

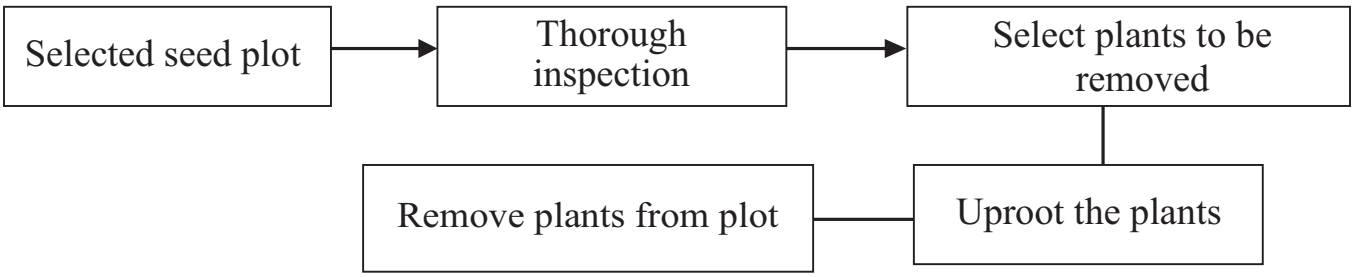
- Plant height: Plants abnormally taller and shorter than most of the population in the field; Provided the sowing dates are similar
- Plant shape/appearance that differ from the uniform population
- Leaf morphology: Plants with different size/color/shape of leaves
- Inflorescence color/flower color i.e. red flower in a yellow flower population i.e Fig 1
- Ear head type/Pod color etc

WHEN TO ROGUE:

Important roguing stages of the crop are as follows and it is applicable for all most all crops

- Vegetative stage
- Flowering
- Pre-harvest times

FLOW CHART FOR ROGUING:



POINTS TO REMEMBER:

- Roguing is mandatory in all plots that are short listed for seed production
- Roguing is possible for all crops
- It is desirable to rogue out at vegetative and before/during flowering stage
- Seed fields should be rogued before undesirable plants cause genetic or physical contamination
- It is advisable to rogue out early in the morning
- During roguing, the whole plant should be removed and taken out of the field

ANTICIPATED OUTCOME/BENEFITS OF ROGUING:

- Improves seed quality
- Maintain varietal purity
- Reduce admixtures
- Increase market value of the produce

NOTE: ROGUING IS NOT APPLICABLE;

- When the plot is not selected/short listed for seed selection/production purpose
- The plots from where we are not suppose to collect/procure seeds for seed bank
- When the seed plot is severely affected with diseases or heavily infested by the off type plants or both

SEED STORAGE

INTRODUCTION

To meet current and future demand of food grains, it is very essential to reduce the seeds loss during both before and after harvest. Post harvest losses in India are estimated to be around 10 per cent, of which the losses during storage alone are estimated to be 6.58 per cent..In the past insect pest infestation was not a major issues as traditional crop varieties were resistant to storage pests. However due to use of high yielding and hybrid seed varieties , seed storage loss has also increased as these seeds are highly susceptible to infestation by insect pests. Hence safe storage of seeds is very essential for better production and income of farmers.

WHY SEED STORAGE?

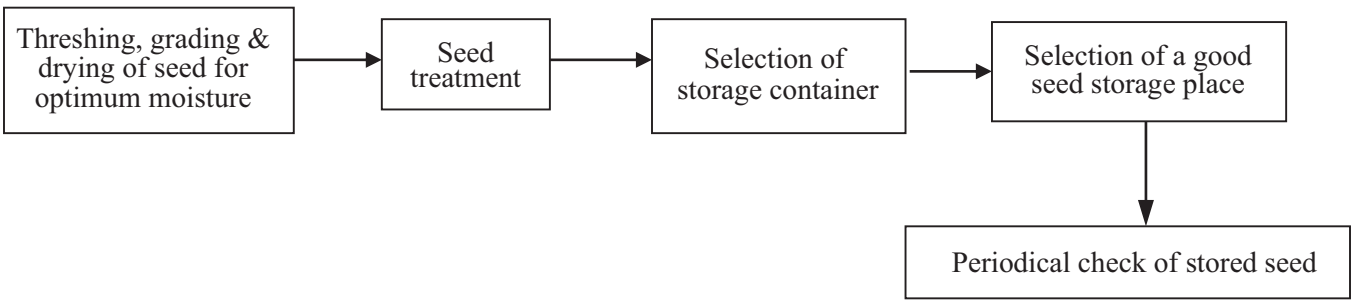
To maintain germination percentage and vigour of seeds from harvest till sowing.

STORAGE PRINCIPLES

Every storage container, no matter what it looks like or what it is made of, should;

- Contain only dried seeds i.e. seeds dried to safe moisture limits i.e. 10%
- Store only good quality seed i.e. disease free, cleaned, graded as well as of high germination seeds i.e. > 75%
- Provide cool and dry environment to seeds
- Protect from insects, pests, redonts and other harmful creatures

DIFFERENT STEPS OF SEED STORAGE:



I. SEED DRYING FOR OPTIMUM MOISTURE:

A. WHY PROPER DRYING OF SEEDS:

- Seeds with high moisture content (>10%) are more susceptible to diseases , pests, reduces seed viability and germination capacity

Crop	Moisture content (%)
Cereals and millets	10-12
Pulses	7-8
Oilseeds	7-9

B. SEED DRYING: PRECAUTIONS

Seed drying	
Do's	**Don'ts**
Seeds are dried on either on a clean cement floor, plastic sheet or tarpaulins spread on the ground.	Direct contact of seed with the soil or ground. Dried on metal sheet as this may become too hot.
While drying spread seeds in thin layer i.e. thickness of seed layer must not exceed 5 cm	Seeds are spread in thick layer or heap
First dry the seeds at a shady place for 1-2 days and then sun dried for 5-7 days till moisture reduced to 8-10% i.e. confirm by moisture meter test.	Rapid drying of seeds by direct exposure of fresh threshed seeds to hot sun. No confirmation test for seed moisture.
Seeds are stirred and turned at least 4 to 5 times a day to make drying fast and even. Avoid drying between 11 am to 2 am when the sun is hot.	Seeds are left as such without turning them
Choose a dry, clean and elevated area for drying	Swampy, water logged area for drying
Before it rains or gets dark, cover the seeds and take them indoors	Left outside at night as they may become damp or be eaten by rodents.

II. SEED TREATMENT:

These are add on substances either into the storage container or treatment of storage container or kept along with the seeds to keep them free from insects/pests. They are as follows;

a. SOME COMMON ADD ON SUBSTANCES FOR SAFE SEED STORAGE:

Materials	Methods	Remarks
Ash from cattle dung or wood 	Ash obtained from casuarinas, mango and tamarind is very suitable otherwise use the ash available at households in village. You can use ash @ 500 g/kg of seed.	Controls many insects and pests & absorbs excess moisture if any. This can be mixed with all sorts of seed.
Neem leaves 	Add neem leaves (dried/fresh) @ 50 g/kg of seed. Also spread on the top layer of the seed in the seed container	Controls many insects and pests. This can be mixed with all sorts of seed.
Lime 	Dusting of lime @ 10-50 g/ kg of seed and mixed thoroughly	Control weevils. This can be mixed with all sorts of seed.
Ground castor seed or Castor oils 	Add and mix @ 20 ml/ kg seed	pulse seeds are best stored
Fine sand 	Mix the sand with the seeds (2:1 ratio); alternatively layered and make the storage container full. Put Sand layers of 2 and 3 cm thickness on the top of the stored seeds	Control weevils. Best applicable for green and black gram

III. SELECTION OF SEED STORAGE CONTAINER:

A. Seeds can be stored in various types of containers:

Sl.No.	Type of container	Crop seeds stored
1	 Bamboo baskets smeared with cow dung and dried	All seeds
2	 Mutka/Mud bin/Earthen structures tightly sealed on the top	All seeds
3	 Gunny bag/gunny bag with polythene layer fully packed and tightly tied	All seeds
4	 Biscuit tins/metal drums	**Pulses**
5	 Polythene bags i.e 0.2-0.25 mm thick (500-700 gauge)	All seeds
6	 Kuthirs/Kothars	All seeds
7	 Metal bin	All seeds
8	 Glass jar	Vegetable seeds
9	 Plastic bottle	Vegetable seeds

NOTE *: If the seed moisture content is more than 10% then it should not be stored in air tight containers. Seeds having moisture content around 8-10% is best stored in air tight containers.Except pea and bean all other seeds can be stored air tight.*

SOME COMMON SEED STORAGE PRACTICES AT VILLAGE LEVEL:

In the basket, layer after layer ash, seeds, neem leaves are placed.
Then plaster it air tight with a mix of clay, dung and ash. **Applicable for all most all seeds.**

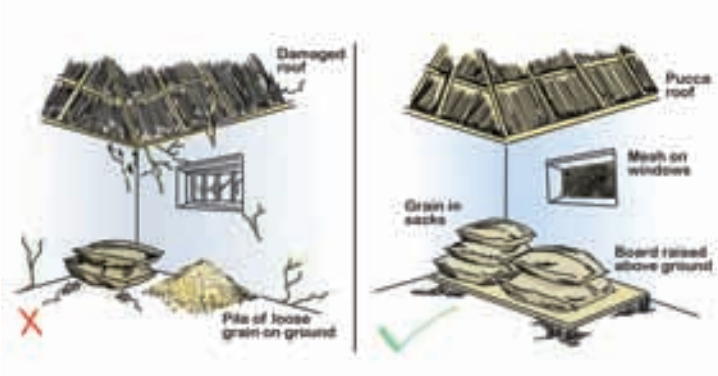
A basket with cow dung is dried and kept ready.
In the basket first place a layer of foxtail millet than a layer of pulses and then foxtail millet.
Fill the basket alternatively. Before sealing the basket with clay, dung and ash plaster, layer the top with green gram /black gram dried husk. **Pulses are best stored.**

A basket with cow dung is dried and kept ready.
In the basket, mix the Sesame seeds with paddy husk.
Then layer it with just the husk and plaster it with clay, dung and ash.
Best for sesame seeds. Mixture of dry-cool-fresh ash for seed storing

IV. SELECTION OF A GOOD STORAGE PLACE:

Characteristic of a good storage place are as follows;

- The place should be airy, shady, cool and dry having no leaks at roof.
- Protection against insect pests, diseases and rodents
- Have space for for inspection, loading, unloading, cleaning etc.
- The site should be in an elevated area, no dampness rising from the ground.
- Doors have controlled ventillation and have sealing nets



V. PERIODICAL CHECK/PRECAUTIONS AT STORAGE PLACE:

Some precautions are essential while store seeds in gunny bag. They are as follows;


1. Proper tagging
2. Seeds shall be packed tightly in gunny bags /other air tight containers
3. Gunney bags shall be
4. Stacking up to 6 bags on wooden rafts
5. Rotate the bags periodically by shiting the layers to the top and vice versa
6. Check for rodent attacck and use bait
7. Leave space between the sacks for aeration between the sacks.

- If insects or mold noticed then take out the grains, dry under sun, sieve, clean and store grains in sacks
- Chemicals such as insecticides, fertilizers should not be stored along with seeds.
- If you are storing the seeds in glass bottle or bamboo baskets then they are properly tagged and can be placed on the iron or bamboo racks as shown below.


Fig: Seeds in glass jar & bamboo baskets kept on iron and wooden racks

Conclusion:

- Before storage check the seeds are properly dried i.e 8-10% moisture
- For air tight containers moisture percentage should be around 8%
- Only properly dried, mechanical damage free,cleaned, disease free and graded seeds are allowed for storage
- Seeds should not have met adverse conditions during maturation in the field.
- Seed stoarge area should be free from insects and rodents
- Seeds should be treated before storage
- Storage area anvironment or godown should be dry and cool
- Restacking should be done once in 3 months for prolonging seed viaibility
- Use wooden pallets for arranging the bags in cris-cross manner for effective ventilation on all sides of the bags.
- Never keep/store the seeds directly on floor.

Depict above with pictures

CHAPTER 6
NUTRIENT MANAGEMENT

Nutrient management involves using crop nutrients as efficiently as possible to improve productivity while protecting the environment. The key principle behind nutrient management is balancing soil nutrient inputs with crop requirements. When applied in proper quantities and at the right times, added nutrients help achieve optimum crop yields; applying too little will limit yield and applying too much does not make economic sense and can harm the environment. Nutrients that are not effectively utilized by crops can potentially leach into groundwater or enter nearby surface waters. Too much nitrogen or phosphorus for example can impair water quality.

What Is Nutrient Management Planning?

- A major focus of nutrient management planning is to prevent the over-application of nutrients to protect water quality and minimize impact on the environment while still providing optimum yield for economic benefit.
- It involves accounting for and recording all the nutrients you have, determining what nutrients you will need, and planning how, how much, when and where to apply them to your crop land. This involves first determining what nutrients are in the soil (soil-testing) and what's available in a growing or harvested crop, and then determining what has to be added to meet the needs of crops.
- This plan will lay out how nutrients are managed according to land base characteristics, crops being grown, type of nutrient, proximity to water and application methods.
- Records of nutrient application rates, methods and timing help with future planning

Why Is Nutrient Management Necessary?

Nutrient management planning helps to reduce contamination to waterways by plant nutrients. Without proper management, nutrients can dissolve in soil water and go into surface or ground water through leaching or runoff. This could contaminate surface and groundwater, and on-farm drinking water, community wells and other drinking water sources can be affected. Valuable nutrients could be lost, resulting in reduced crop yields or additional costs for commercial fertilizers.

Steps In Nutrient Management Planning?

- Soil sampling
- Soil testing
- Interpretation of soil test results
- Calibration of soil test results
- Designing Nutrient management strategies

SOIL TESTING

Introduction:

The basic objective of the soil-testing programme is to give farmers a service leading to better and more economic use of fertilizers and better soil management practices for increasing agricultural production. One of the basic issues faced is improper soil sampling leading to inaccurate soil test results. Thus nutrient management would definitely would be inaccurate leading to suboptimal crop yields. In this context, proper soil test based nutrient management is critical for better nutrient management for optimum yields.

What:

Rapid chemical analysis of a soil to estimate the available nutrient status, reaction and salinity of the soil

Why:

- To estimate the available nutrient status, reaction (acidic/alkaline) of a soil.
- To evaluate the fertility status of soils of a country or a state or a district.

Steps:

- Soil sample collection
- Chemical analysis
- Calibration and interpretation of results
- Recommnendation

What does soil test report contain?

Status of Ph, electrical conductivity, organic carbon content, macro (n, p, k, ca, mg, s) and micro nutrients (B, Cu, Cl, Mn, Fe, Zn, Mo)

SOIL SAMPLING

What:

Systematic collection of soil samples in a representative geographic area

Why:

- Soil samples collected are sent to soil testing lab for assessing chemical, physical and biological characters of soil

Where:

- In fields where crops are planned to be grown

When:

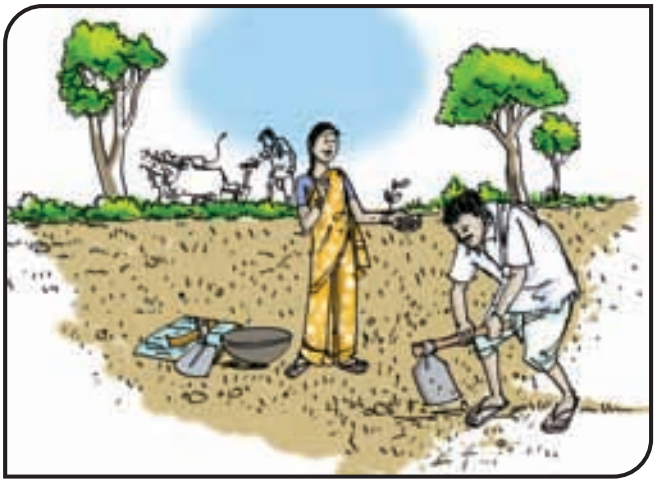
Fallow period (especially during april- may)

Nature of Samples:

Atleast one sample for every two hectares

SOIL SAMPLING – HOW?

Sampling spot selection



Remove litter in the selected spot

Make a "V' shaped cut in the sampling spot

"V" shaped cut

Take out the soil-slice (like bread-slice) of ½ inch thick from both the exposed surface of the pit from top to bottom using spade

Soil collected is spread on a polythene paper or gunny bag and mix soil samples properly

Remove foreign materials like stones, pebbles , trash etc

Divide soil into four equal parts

Two opposite parts are discarded

Mix remaining parts

Repeat the process to get 0.5 to 1 Kg of soil sample

Label the soil sample with basic information

Soil samples sent for soil testing

Basic information (as it is- no change)

Precautions

Please label in the picture itself
Avoid sampling near bunds
Marshy spots(wet spots)
Under trees
Recently manured areas
Near compost /manure pits

Avoid contact
with

Soil sample storage - How

PLEASE LABLE THE PICTURE AS CLEAN CLOTH BAG OR POLYTHENE BAGS

How:

Label the soil sample with basic information

Soil sample sent for testing

Basic information:

- Name and address of the farmer (or farm owner)
- Name of the block
- Plot number or any other number that identifies the plot (or Soil unit)
- Soil texture (sandy/clay/loam)
- Availability of irrigation facilities
- Availability of drainage system
- Upland/ Medium land/Lowland
- Depth of soil sample
- Information of the previous crop
  - Name and variety of the crop
  - Dose of organic manure, if applied
  - Yield
- Informations of the crop that will be grown
  - Name and variety of the crop
  - Season (pre Kharif/Kharif/rabi)
- Problem, if any
- Date of sample collection
- Signature of the farmer (or farm owner)

Precautions:

During soil sample collection	During soil samples storage
Avoid sampling near, • Bunds • Channels • Marshy spots • Trees • Recently manured areas • Compost pits • Any other abnormal spots and • Other non-representative locations	Avoid contact with chemicals, fertilisers or other manures Cotton, jute or plastic bags, which had previously been containing fertilisers, salt or lime should not be used at any stage. Soil samples should preferably be stored in clean cloth or polythene bags.

Soil Sampling Depth:

S.No.	Crop	Soil sampling depth	
		Inches	cm
1	Grasses and grasslands	2	5
2	Rice, finger millet, groundnut, pearl mille small millets etc.(shallow rooted crops)	6	15
3	Cotton, sugarcane, banana, tapioca, vegetables etc . (deep rooted crops)	9	22
4	Perennial crops, plantations and orchard crops	Three soil samples at 12, 24 and 36 inches	Three soil samples at 30, 60 and 90 cm

CALIBRATION AND INTERPRETATION OF RESULTS

Why:

- Soil tests interpretation is very much essential to make farmers aware of nutrient management practices based on the soil test result
- It helps in balanced used of manures rather than over or under application of organic manures
- It helps farmers to undertake required soil health management practices

Why:

- Once soils are tested and soil test reports are generated

Steps in interpretation of soil test results:

- Rating of nutrients based on soil test results
- Refer soil test report

1. For each of the parametres, based on the soil test rating chart, rate the nutrients as low medium or high for macro nutrients or asses reactions(acidic or alkaline or neutral etc) or critical limits for micro nutrients

pH	
pH value	**Rating**
<6	Acidic
7.0 - 8.5	Normal
8.6 - 9.0	Tending to be alkaline
Above 9	Alkali

Organic Carbon %	
Category	**Org.C (%)**
Very Low	< 0.20
Low	0.21 - 0.40
Moderate	0.41 0.60
Moderately High	0-6-0-80
High	0.81-1.00
Very High	Above 1.00

Electrical Conductivity	
EC	**Rating**
<1 dS/m	Normal
1-2 dS/m	Critical for germination
2-3 dS/m	Critical for salt sensitive crops.
>3	Injurious to most of the crops

- It indicates the level of total soluble salts in the soil. It indicates if the soils are saline/alkaline/normal
- If the salts are more, then more will be the electrical conductivity and vice-versa

Steps in interpretation of soil test results:

Macronutrients

Primary nutrients

Category	Av.N (kg/ha)	Av.P (kg/ha)	Av.K (kg/ha)
Very Low	<140	<7	<100
Low	141-280	8.0-14	101-150
Moderate	281-420	15-21	151-200
Moderately High	421-560	22-28	201-250
High	561-700	29-35	250-300
Very High	>700	>35	>300

Secondary nutrients

Nutrient	Critical level in soil
Calcium	<25% of CEC or < 1.5 me Ca/100 g
Magnesium	<4% of CEC or <1 me Mg/100g
Sulphur	Usual 10 ppm (range 8-30ppm)

A. Micro nutrients

Nutrient	Critical level in soil (ppm)
Boron	0.5
Copper	0.2
Iron	2.5 - 4.5
Manganese	2
Molybdenum	0.2
Zinc	0.4 - 1.2

Examples:

- Organic carbon: <0.2 : Very low
- pH: <6 : Acidic
- EC: <1: Normal
- N: Low, P: Medium, K: High etc

To recommend nutrient management for crops

- Identify the crop to being planned by farmer to grow in that particular field
- Look for recommended dose of nutrients for crops selected (as recommended by Agriculture University in Jurisdiction)
- Based on the soil test results, some corrections to be made in recommended doses of nutrients using the chart below
- Increase or decrease the recommended dose of nutrients according to the category as mentioned below

Sr. No.	Rating	Correction
1	Very high	50% less
2	High	25% less
3	Moderate	Recommended
4	Moderately high	Recommended
5	Low	25% more
6	Very low	50% more

Crop	Soil test values			Soil test rating			Recommended dose of nutrients			Corrected recommended dose of nutrients		
	OC %	P	K	N	P	K	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Wheat	0.24	27.42	200	Low	Moderately high	Moderate	120	60	40	150.00	60	40.00

How to work out nutrient management practices based on corrections made in recommended dose

- One should be aware of nutrients required by crop during different stages (we can get this in package of practices)
- Based on that explore the most easily available and cost effective source of nutrients like FYM, compost, vermicompost, tank silt, oil cakes etc
- One should also be aware of nutrient contents of above nutrient sources as mentioned below in the chart

Bulk manures (display with nutrient content)

Organic manures	Nutrient content (%)		
	N	P_2O_5	K_2O
FYM	0.4-1.5	0.3-0.9	0.3-1.9
Compost	0.5-1.0	0.4-0.8	0.8-1.2
Vermicompost	0.5-1.5	0.1-0.3	0.15-0.56
Poultry manure	3.03	2.63	1.4
Goat manure	3	1	2
Sheep manure	3	1	2
Biogas manure	1.43	1.21	1.2

Meal group manures

Organic manures	Nutrient content (%)		
	N	P_2O_5	K_2O
Blood meal	10 - 12	1 - 2	1.0
Meat meal	10.5	2.5	0.5
Fish meal	4 - 10	3 - 9	0.3 - 1.5
Horn and Hoof meal	13	-	-
Raw bone meal	3 - 4	20 - 25	-
Steamed bone meal	1 - 2	25 - 30	-

Oil Cakes

Oil-cakes	Nutrient content (%)		
	N	P_2O_5	K_2O
Non edible oil-cakes			
Castor cake	4.3	1.8	1.3
Cotton seed cake (undecorticated)	3.9	1.8	1.6
Karanj cake	3.9	0.9	1.2
Mahua cake	2.5	0.8	1.2
Safflower cake (undecorticated)	4.9	1.4	1.2

Edible Oil-Cakes

Coconut cake	3	1.9	1.8
Cotton seed cake (decorticated)	6.4	2.9	2.2
Groundnut cake	7.3	1.5	1.3
Linseed cake	4.9	1.4	1.3
Niger cake	4.7	1.8	1.3
Rape seed cake	5.2	1.8	1.2
Safflower cake (decorticated)	7.9	2.2	1.9
Sesamum cake	6.2	2	1.2

Based on the availability, work out the nutrient management measures

	Soil test values			Soil test rating			Recommended dose of nutrients			Corrected recommended dose of nutrients			Compost (10 tonnes /ha)			Gap			
Crop	OC%	P	K	N	P	K	N	P2O5	K2O	N	P2O5	K2O	N	P2O5	K2O	N	P2O5	K2O	Remarks
Wheat	0.24	27.42	200	Low	Moderately high	Moderate	120	60	40	150.00	60	40.00	75.00	60.00	100.00	75.00	0.00	-60.00	Seeds should be treated with Azosoirillium and PSB @ 20 grams per Kg of seeds.Balance N should be suplied through Urea.Spray liquid manures like Liquid farm yard manure and vermiwash also.
													Nutrient management			Compost (tonnes /ha)+ Fertilisers	Remarks		
													N	P2O5	K2O				
													75.00	60.00	100.00	10 tonnes of compost	50% N as basal dose		
													75.00	0	0.00	163 Kgs of urea	50 % N at crown root initiation stage		

Notes:

- Consider soil test rating charts developed by Agriculture Universities in the jurisdiction of your respective clusters
- Consider nutrients recommended for different crops by Agriculture Universities in the jurisdiction of your respective clusters
- If it is very difficult to compensate the required nutrients through organic manures, gaps must be fulfilled through chemical fertilisers under proper guidance to protect the interests of the farmers

PLANT NUTRIENTS

Plants require seventeen elements required for growth and development. The seventeen chemical elements are divided into two main groups: Non-Mineral and Mineral.

1. Non-mineral nutrients

The Non-Mineral Nutrients are hydrogen (H), oxygen (O), & carbon (C).
These nutrients are found in the air and water. In a process called photosynthesis, plants use energy from the sun to change carbon dioxide (CO2 - carbon and oxygen) and water (H2O- hydrogen and oxygen) into starches and sugars. These starches and sugars are the plant's food. Photosynthesis means "making things with light".

2. Mineral nutrients

The 14 mineral nutrients, which come from the soil, are dissolved in water and absorbed through a plant's roots. There are not always enough of these nutrients in the soil for a plant to grow healthy. Thus farmers use fertilizers to add the nutrients to the soil.

The mineral nutrients are divided into two groups:
Macronutrients and Micronutrients

3. Macronutrients

Macronutrients can be divided into two more groups:
Primary and Secondary Nutrients.

The Primary Nutrients are Nitrogen (N), Phosphorus (P), and Potassium (K). These major nutrients usually are lacking in the soil as plants use these nutrients in larger quantities.

The Secondary Nutrients are Calcium (Ca), Magnesium (Mg), and Sulfur (S). There are usually enough of these nutrients in the soil so fertilization is not always needed.

4. Micronutrients

Micronutrients are those elements essential for plant growth which are needed in only very small (micro) quantities. These elements are sometimes called minor elements or trace elements. The micronutrients are Boron (B), Copper (Cu), Iron (Fe), Chloride (Cl), Manganese (Mn), Molybdenum (Mo) and Zinc (Zn).

NITROGEN: IT IS A MACRO PRIMARY NUTRIENT

Why:

- Formation of amino acids, the building blocks of protein
- Plant vegetative growth
- Photosynthesis
- Necessary component of vitamins
- Aids in production and use of carbohydrates

Deficiency Symptoms:

- General yellowing of older leaves (V shaped)
- Rest of the plant will be green

Management:

- **Common organic sources:** compost, vermicompost, green manures, cow dung, sheep, goat, poultry, pig, manures, oil cakes like neem, pongamea, castor, mahua etc
- **Common in-organic sources:** urea, dap, ammounium, sodium and calcium nitrates

NOTE: Nutrient dose and management depends on soil test results

PHOSPHOROUS: IT IS A MACRO PRIMARY NUTRIENT

Why:

- Photosynthesis, respiration, energy storage and transfer, cell division, and enlargement
- Early root formation and growth
- Improves quality of fruits, vegetables, and grains
- Seed formation
- Helps plants survive harsh winter conditions
- Increases water-use efficiency

Deficiency Symptoms:

- Older leaves turn into reddish purple colour
- Leaf tips look burnt

Management:

- **Common organic sources:** Compost, vermicompost, green manures, cow dung, sheep, goat, poultry, pig, manures, oil cakes like neem, pongamea, castor, mahua etc
- **Common in-organic sources:** Rock phosphate, single super phosphate, dap etc

NOTE: Nutrient dose and management depends on soil test results

CALCIUM: IT IS A MACRO SECONDARY NUTRIENT

Why:

- Cell elongation and division
- Photosynethsis
- Leaf and root development
- Important in cell wall structure
- Acts as a enzyme activator

Deficiency Symptoms:

Calcium deficiency in corn
Youngest leaves remain rolled and joined together at their tips

- New leaves hooked and cupped
- Terminal bud dies

Management:

- **Common organic sources:** egg shells, wood ash, bone meal
- **Common in-organic sources:** gypsum, limestone, calcium nitrate, burnt lime , hydrated lime etc

NOTE: Nutrient dose and management depends on soil test results

POTASSIUM: IT IS A MACRO PRIMARY NUTRIENT

Why:

- Promotes vigour in plants
- Disease resistance
- Development of root system
- Seeds and fruits formation
- Formation and transfer of starch, sugar and oils in plants
- Photosynthesis

Deficiency Symptoms:

- Drying of leaf margins
- Yellowing at the tips and edges in young leaves
- Yellow patches (dead patches) in leaves

Management:

- **Common organic sources:** Wood ash, compost, vermicompost, green manures, cow dung, sheep, goat, poultry, pig, manures, oil cakes like neem, pongamea, castor, mahua etc
- **Common in-organic sources:** Murate of potash, suplhate of potash

NOTE: Nutrient dose and management depends on soil test results

MAGENSIUM: IT IS A MACRO SECONDARY NUTRIENT

Why:

- Magnesium is necessary for formation of sugars, proteins, oils, and fats
- Regulates the uptake of other nutrients (especially p)
- Component of chlorophyll, and is a phosphorus carrier

Deficiency Symptoms:

- Mottled yellowing between veins of older leaves while veins remain green
- Yellow areas may turn brown and die
- Leaves may turn reddish purple due to low p metabolism
- Decreased seed production

Management:

- **Common organic sources:** organic manures
- **Common in-organic sources:** magnesium sulphate

NOTE: Nutrient dose and management depends on soil test results

BORON: IT IS A MICRO NUTRIENT

Why:

- Germination of pollen grains and growth of pollen tubes
- Seed and cell wall formation
- Promotes maturity
- Necessary for sugar translocation

Deficiency symptoms:

Boron deficiency

- Youngest leaves become light green and get distorted
- Reduced flowering
- No proper seed set
- Terminal bud may die
- Poor stem & root growth

Management:

- **Common organic sources:** Organic manures
- **Common in-organic sources:** Borax or Borate

NOTE: Nutrient dose and management depends on soil test results

IRON: IT IS A MICRO NUTRIENT

Why:

- Promotes vigour in plants
- Acts as an oxygen carrier
- Reactions involving cell division and growth

Deficiency symptoms:

- Yellow or white areas on youngest leaves
- Older leaves remain green
- Veins typically green

Management:

- **Common organic sources:** Iron chelates and sequestrates
- **Common in-organic sources:** Ferrous suplhate, ferric sulphate

NOTE: Nutrient dose and management depends on soil test results

ZINC: IT IS A MICRO NUTRIENT

Why:

- Needed for auxin synthesis
- Chlorophyll production
- Carbohydrate formation
- Starch formation
- Seed formation

Deficiency symptoms:

- White to pale yellow bands in lowerhalf of leaf
- Yellow to white colour between veins (interveinal chlorosis)
- Distorted or puckered leaf margins
- Reduction in size of leaves ("little leaf") and in internodes

Management:

- **Common organic sources:** organic manures
- **Common in-organic sources:** zinc sulphate

NOTE: Nutrient dose and management depends on soil test results

MANGANESE: IT IS A MICRO NUTRIENT

Why:

- Chlorophyll synthesis and photosynthesis
- Component of enzyme systems
- Increases availability of calcium, magnesium and phosphorous

Deficiency symptoms:

- Yellow to white colored leaves, but with green veins
- First noted on new growth
- May have a typical "gray speck" symptom

Management:

- **Common organic sources:** Organic manures, manganese chelate
- **Common in-organic sources:** Manganese sulphate

NOTE: Nutrient dose and management depends on soil test results

MOLYBDENUM: IT IS NOT A MICRO NUTRIENT

Why:

- Chlorophyll synthesis
- Nitrogen metabolism

Deficiency symptoms:

Management:

- **Common organic sources:** Organic manures
- **Common in-organic sources:** Sodium molybdate and ammonium molybdate

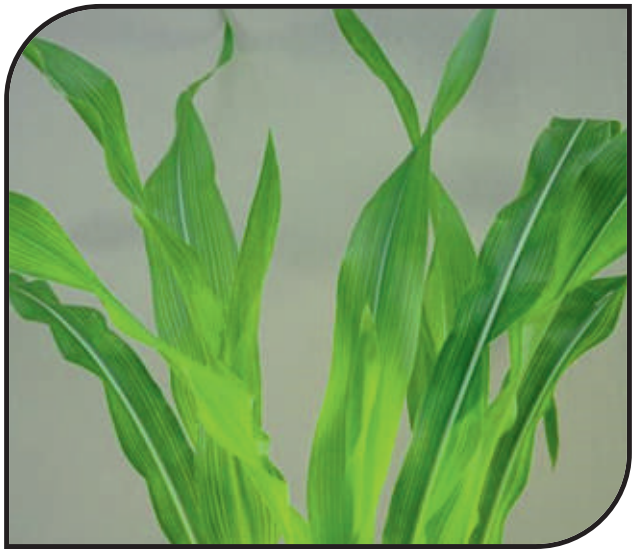
NOTE: Nutrient dose and management depends on soil test results

COPPER: IT IS A MICRO NUTRIENT

Why:

- Copper is a constituent of enzyme systems
- It is involved in photosynthesis and respiration
- Formation of lignin

Deficiency symptoms:



- The youngest leaves show yellow inter-veinal discolouration as they come out of the whorl
- Mainly the basal part of the leaf is uniformly yellowgreen

Management:

- **Common organic sources:** Organic manures, manganese chelate
- **Common in-organic sources:** Manganese sulphate

NOTE: Nutrient dose and management depends on soil test results

LIQUID MANURES

Liquid manures are the fermented preparations obtained by active fermentation of plant or animal residues. It is prepared using cow dung and cow urine as base material and addition of green plants, leaves and tender stems of plants that are available locally like

- Green manuring plants: Sunhemp, dhaincha, sesbania, erythrina etc. and other leguminous plants can be used
- Tree leaves: Leaves of other local medicinal trees
- Tender stems: Eupatorium sp. and local plants
- Weeds: Parthenium and other weeds before flowering
- A mixture of different plants results in good quality liquid manure

Different types of liquid manures:

- Liquid farm yard manure
- Dung brew
- Compost tea
- Amrit jal
- Panchagavya
- Vermiwash etc

Method of using liquid manures:

- The liquid manure has to be diluted with water prior to application
- The standard dilution is one part liquid manure in ten parts water and sprayed on the foliage

Advantage:

- Act as tonic or stimulant to plants
- Is used as insecticide and fungicide when artemisia, stinging nettle and other aromatic plants are used as raw materials for liquid manures
- Improves the nutrient assimilation

Precautions:

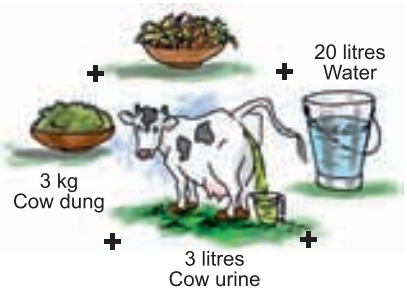
- Stirring the liquid manure is very important
- The concentrated liquid manure should not be sprayed on the plant as it scorches the plants
- The liquid manure should be sieved before spraying otherwise the sprayer nozzle gets clogged
- Spraying should be done in the evening or cool sunshine hours

LIQUID FARM YARD MANURE

Acts as a growth promoter or stimulant to plants and improves nutrient assimilation.

Materials required

1



Method of preparation

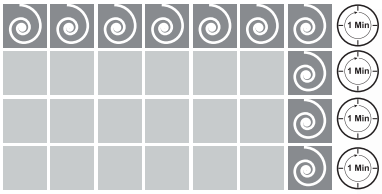
2A

Put plant material, cattle dung and cattle urine in the bucket and fill with water

2B

Cover bucket with a gunnysack

2C



Stir for a miniute everyday for 7 days
Stir only once a week for the next 3 weeks
The biomass will get fully fermented in a month

2D

Dilute one part liquid manure in ten parts water

2E

Sieve the liquid manure

Caution!

- Stirring the liquid manure is very important
- Do not spray concentrated liquid manure as it will scorch the plants
- Sieve the liquid manure before spraying to prevent the nozzle from clogging
- Spray in the evening or cool sunshine hours

Method of application

3

Spray on the foliage of crops

COMPOST TEA

**Rich in micro organisms beneficial for crop growth and health,
Compost Tea offers resistance against many pests and diseases.**

Materials required

1

1 part of compost in 10 parts of water

Method of preparation

2A

Tie compost in gunny bag or cotton/rag cloth

2B

5-7 days

Immerse compost in water for 5 to 7 days.

2C

Stir the water for 5 minutes every day,

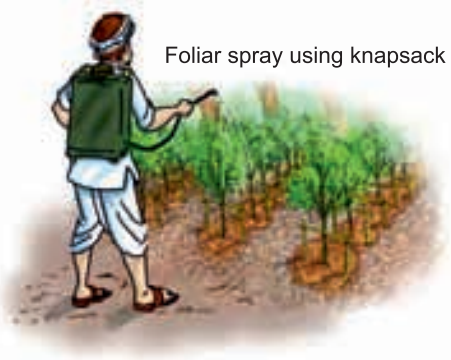
2D

Filter the solution

Method of application

3

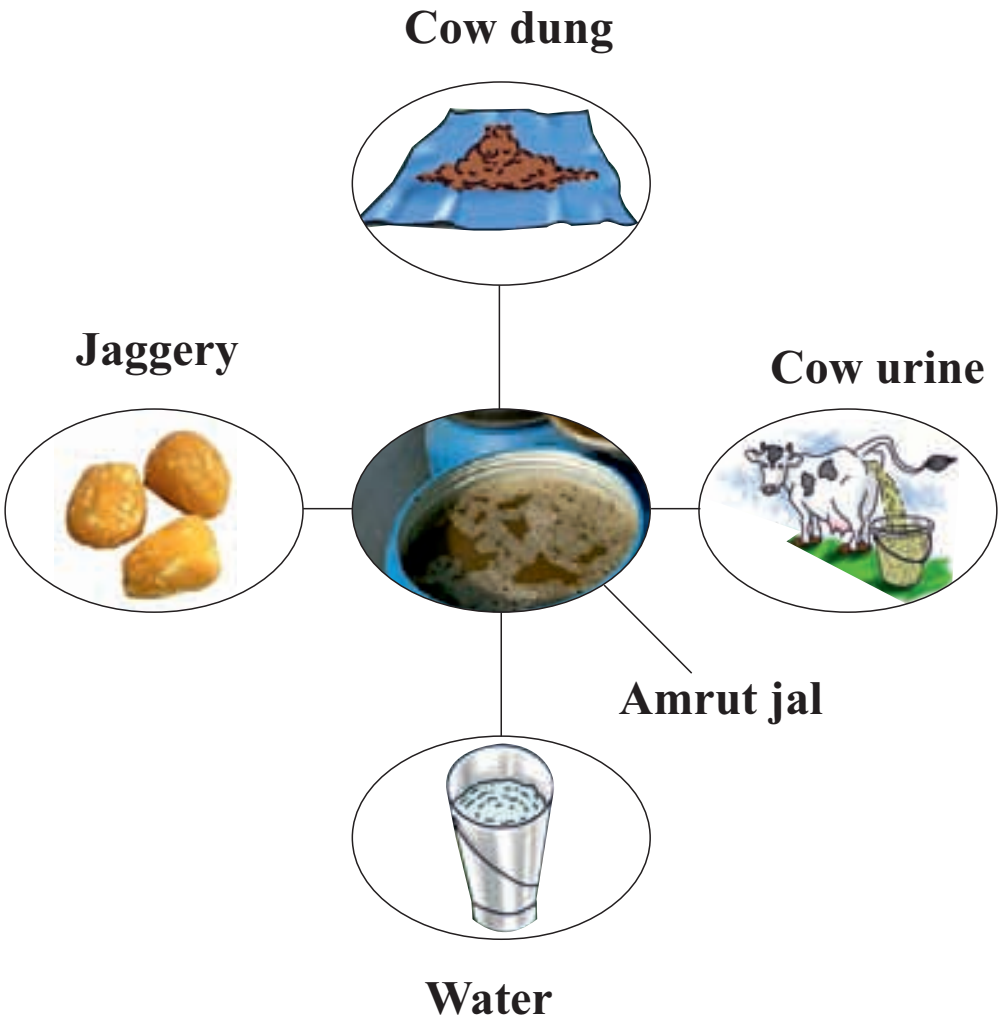
Foliar spray using knapsack sprayer



AMRUT JAL

Amrut jal is a liquid manure prepared by using fresh cow urine, fresh cow dung and jaggery. This preparation contains large number of plant beneficial microbes.

- Mix a kilogram of cow dung with water
- Dilute this mixture with 10 litres of water
- Add a litre of cow urine and 50 grams of jaggery to this mixture
- Stir with a wooden stick 12 times clock wise and 12 times anticlockwise to enhance aeration for multiplication of microbes
- Repeat this process thrice a day for 3 days
- Cover and store the solution away from sun light
- Dilute the solution in 100 litres of water on the 4th day
- Solution is ready for soil application



VERMIWASH – as liquid manure

Vermiwash is the solution collected from washing of body fluids of earthworms and burrows in the soil that is generally rich in nutrients. Vermiwash is found to contain various growth promoting substances apart from being anti-fungal and anti-bacterial in nature.

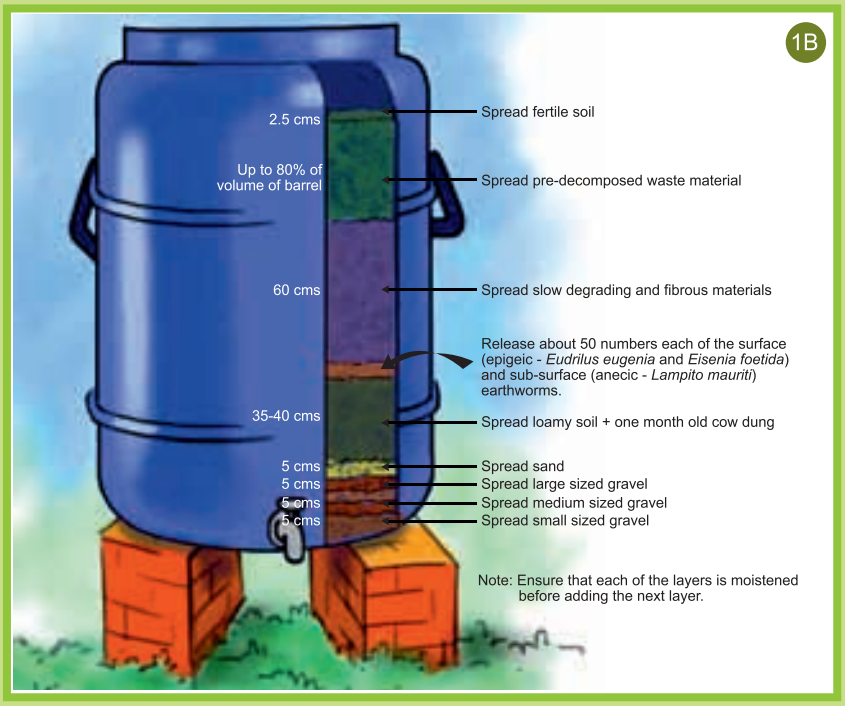
Uses of Vermiwash

- Vermiwash acts as a plant growth promoter
- Acts as a liquid manure
- Increases the rate of photosynthesis in crop / plant
- Increases the microbial population in the soil
- Increases the resistance to pest and diseases
- Increases the rate of decomposition of compost
- Increases the crop yield

Method of preparation

1A

Take a plastic barrel of 200 litres capacity with a tap attached at the bottom.



The tap is kept open for the next 15 days

Water is added every day to keep the unit moist.

On the 16th day, close the tap and suspend a perforated metal container or mud pot on top of the barrel.

Add 5 litres of water and allow to gradually drip into the barrel overnight.

This water percolates through the compost, the burrows of the earthworms and gets collected at the base.

The tap of the unit is opened the next day morning and the vermiwash is collected.

The tap is then closed and the suspended pot is refilled with 5 litres of water that evening to be collected again the following morning.

The entire set up may be emptied and reset between 10 and 12 months of use.

Method of application

Add 1 litre of Vermiwash in 10 litres of water. Vermiwash acts as a liquid manure.

Spray on crop.

Precautions

- Water should be poured slowly.
- Do not mix un-decomposed material.
- Do not add any green material.
- Do not allow to compact the contents.

DUNG BREW

Materials required

1

Method of preparation

2A

Pour the materials in the bucket and mix it well.

2B

Cover the bucket with a gunny sack or any material that provides sufficient aeration.

2C

Alternate days

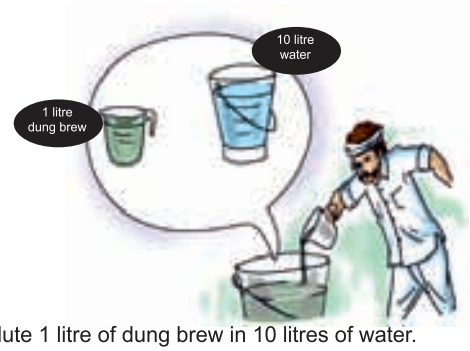
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15						

Stir every alternate day for 15 days.

2D

The dung brew is ready for spray after 15 days and can be stored for 2 months.

2E



Dilute 1 litre of dung brew in 10 litres of water. Mix thoroughly.

2F

Filter solution through cloth and then put into the knapsack sprayer.

Method of application

3

Spray on the foliage of crops.

CHAPTER 7
INSECT & PEST MANAGEMENT

INTRODUCTION

Insects being found in all types of environments, are known to occupy two thirds of the known species of animals in the world. They infest all types of crops including field, forest, and horticulture, medicinal and aromatic crops that not only reduces the quantity but also the quality of produce. Insect pests are also know to infest stored produce that severely affects the quality of produce. If the loss caused by an insect is less than 5 percent, then it is not at all called as a pest. However, if the loss caused is in-between 5-10 percent, it is called minor pest and if the loss exceeds 10 percent, then it is called major pest. Insects that cause injury to plants are grouped as chewing insects that chew and swallow the plant parts and other ones are sucking pests that suck the sap and inject salivary toxins that causes injury to crops.

Insect pests management is important because the new technologies introduced after green revolution like use of improved varieties, indiscriminate use of chemical pesticides and fertilisers, expansion in irrigation facilities have no-doubt contributed for the success of green revolution, but equally and majorly resulted in creation of imbalance in pest and predators, natural enemies, resurgence of pests, resistance development to insecticides etc. In this context, sustainable pests' management strategies play a very significant role.

PEST: SEMI LOOPERS

WHAT IT DOES: Feed on inter-veinal region of leaves (shot holes) followed by skeletonising the leaves ex. cotton, soybean, castor, greengram, blackgram, etc



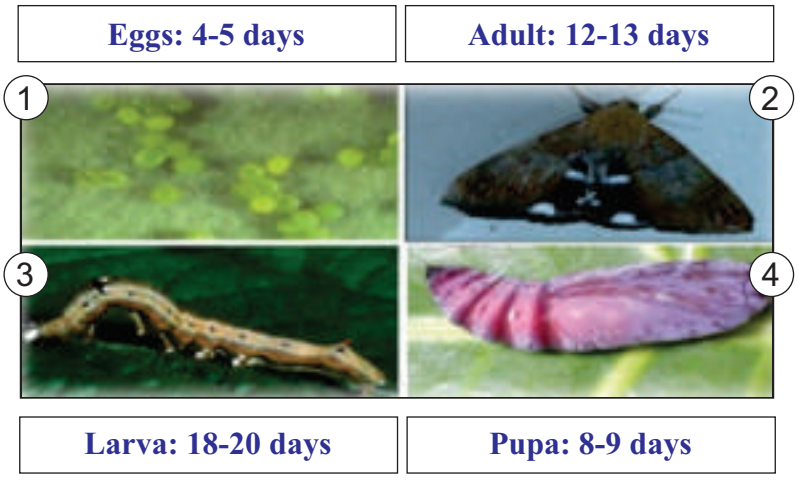
DAMAGE SYMPTOMS:

Shot holes on the leaves

Larvae feeding on leaves

Leaves skeletonised

LIFE CYCLE:



MANAGEMENT MEASURES:

- Delay planting up to mid-august in endemic areas
- Installation of pheromone traps @ 5-8 per acre
- Installation of bird perches @ 10/acre
- Release of egg parasitoid Trichogramma evanescens @ 50000/acre
- Spray NSKE 5 % synchronizing with egg and early larval stage

PEST: RED HAIRY CATERPILLAR

WHAT IT DOES: Caterpillars feed on the leaves leaving main stem alone

CROPS: Ground nut, greengram, soybean, black gram etc

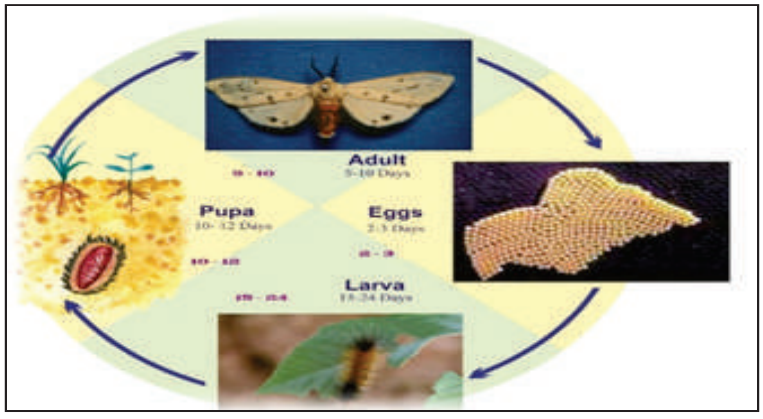


DAMAGE SYMPTOMS:



Defoliation **Skeletonisation of leaves**

LIFE CYCLE:



MANAGEMENT MEASURES:

- Set up 3 to 4 light traps and bonfires after first rains to trap adults
- Collect and destroy gregarious, early instar larvae on lace-like leaves of intercrops such as red gram and cowpea
- Collect and destroy egg masses in the cropped area
- Dig a trench of 30 cm deep and 25 cm wide around the infested fields to prevent migration of larvae
- Spray quinalphos 1.5% DP 375 gm a.i /ha

PEST: LEAF FOLDERS

WHAT IT DOES: Larvae scrapes the green tissues of the leaves due to which leave become white and dry. Leaves are folded longitudinally and larvae will be inside the fold



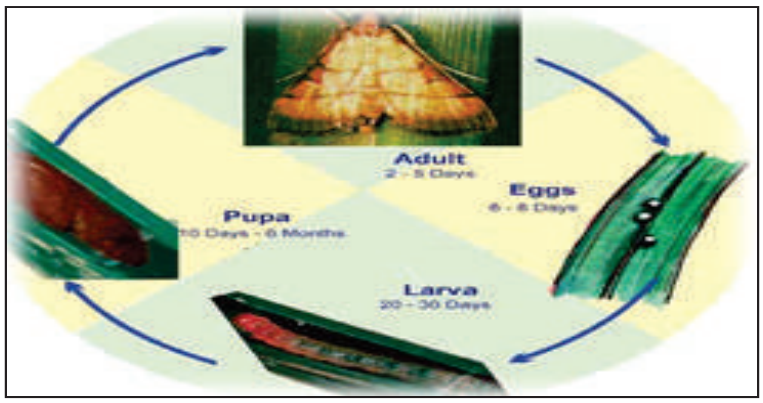
DAMAGE SYMPTOMS:

Larvae feeding internally

Leaves turn white and dry

Leaf folder longitudinally

LIFE CYCLE:



MANAGEMENT MEASURES:

- Balanced application of nitrogenous fertilizers in splits (3-4 times)
- Sufficient quantities of Potassic fertilizers are to be applied to reduce infestation
- Remove grass weeds on bunds
- Tricho egg cards containing 1000 parasitized eggs are stapled to the underside of leaves at 100 points uniformly distributed across one ha area
- Acillus thuringiensis var. galleriae;Spray Indoxacarb 15.8% EC 30 gm a.i /ha

PEST: TOBACCO CATERPILLAR (SPODOPTERA LITURA)

WHAT IT DOES: Larva feeds on the foliage, tender buds and fruits/pods/heads. infests crops like groundnut, castor, brinjal, chilli, tomato, potato, soybean, sunflower, cotton, greengram, blackgram, beetroot etc.



DAMAGE SYMPTOMS:



Leaves eaten up **Flower damaged** **Fruit bored**

LIFE CYCLE:

MANAGEMENT MEASURES:

- Destruction of egg masses and big sized larvae
- Deep summer ploughing of fields to expose pupa and larva
- Digging trenches around the fields
- Install 'T' shaped bird perches in field and Pheromone traps @ 15/ha
- Grow trap crops like castor and sunflower
- Spray bio-pesticides like Nomura ea rileyi, Beauveria bassiana, Metarrhizium anisopliae etc.
- Spray SLNPV @ 500 lt/ha; Set up light trap @ 1/ha
- Spray- methomyl 40% SP 300-350 gm a.i /ha;

PEST: AMERCIAN BOLL WORM

WHAT IT DOES: Feeds on foliage and flowers, bores into stem, fruits, seeds



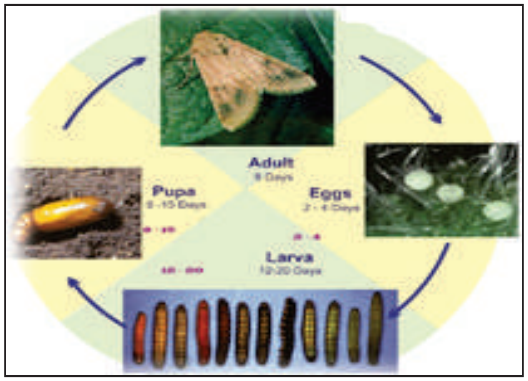
DAMAGE SYMPTOMS:



Larva bores into fruit head inside, body outside

Larva feeds on flowers

LIFE CYCLE :



MANAGEMENT MEASURES:

- Deep summer ploughing and crop rotation with non-hosts
- Erect pheromone traps @ 12/ha; Light traps during @ 1 light trap/5 acre
- Clipping of terminal leaves /twigs
- Planting of trap crops like marigold, bhendi
- At very early instars/stages, spray NPV 250 LE /ha with teepol 0.1% and Jaggery 0.5% thrice at 10 – 15 days interval commencing from flowering stage
- Followed by which chilli-garlic extract alternated with neem leaf or neem seed kernel extract
- Installation of bird perches @ 50 per hectare
- Bengal gram - azadirachtin 0.03% (300 ppm) neem oil based WSP containing chlorpyrifos 1.5% DP 375 gm a.i /ha;

PEST: SPOTTED AND SPINY BOLL WORM

WHAT IT DOES: Larvae bore into terminal shoot, squares, flowers and young bolls leading to rotting of bolls /fruits



DAMAGE SYMPTOMS:



Larva bore into shoot

Larva inside fruit

Larva damaging lint

LIFE CYCLE:

MANAGEMENT MEASURES:

- Timely sowing preferably by first quarter of July
- Avoid excess application of nitrogen at reproductive stage
- Water logging should be prevented
- Use neem based insecticides like 5% neem seed kernel extract (NSKE) and commercial neem based formulations @ 500-600 ml/ha, starting from 45 days age of the crop
- Spray indoxacarb 14.5 SC @ 0.5 ml/l

PEST: COTTON PINK BOLL WORM

WHAT IT DOES: Larvae feed on flowers, squares, seeds and damage the quality of lint

larvae

DAMAGE SYMPTOMS:

larva feeding on seeds

larva boring into lint

larva inside the boll

LIFE CYCLE:

MANAGEMENT MEASURES:

- Three weekly releases of egg parasitoid Trichogrammatoidea bactrae @1,00,000/ha per release; Install pheromone trap @ 20 per hectare 45 days after planting
- Removal of the cotton stalks/stubbles soon after harvest
- Avoid ratooning or summer crop, Use acid-delinted seed only, grow trap crops like bhendi
- Collection and destruction of infested flowers, buds etc along with infested shoot
- Allow cattle or goats / sheep to graze upon green bolls, and attacked bolls after final picking; Spray W.P 1200 gm a.i /ha

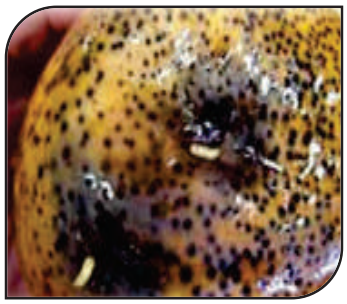
PEST: FRUIT FLIES

WHAT IT DOES: Adult flies puncture fruits to lay eggs - maggots tunnel the pulp leading to rotting of fruits



DAMAGE SYMPTOMS:

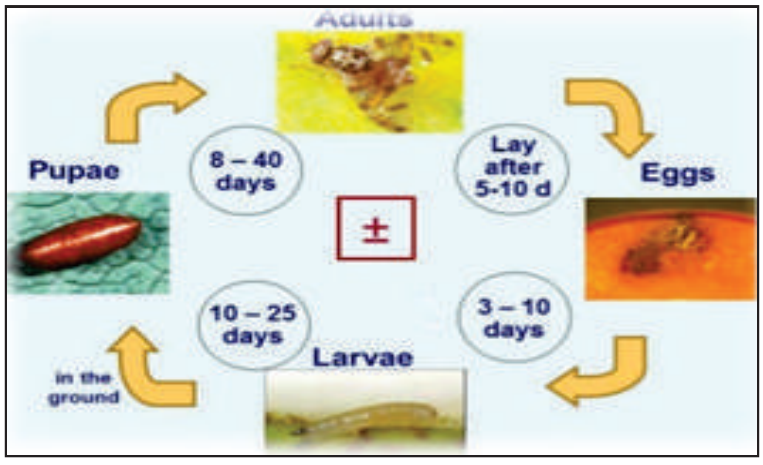
Maggots feed on pulp



Fruits rot

Tunnels inside the fruit

LIFE CYCLE:



MANAGEMENT MEASURES:

- Destroy all fallen fruits at weekly intervals
- Under-sized fruits left on the tree should be picked and destroyed
- Ploughing the orchards and exposing the diapausing pupae to sun's heat
- Plough the soil at the tree basin at frequent intervals
- Hang traps containing methyl eugenol lures during April to June @10 traps per hectare of orchard
- Early harvesting of mature fruits

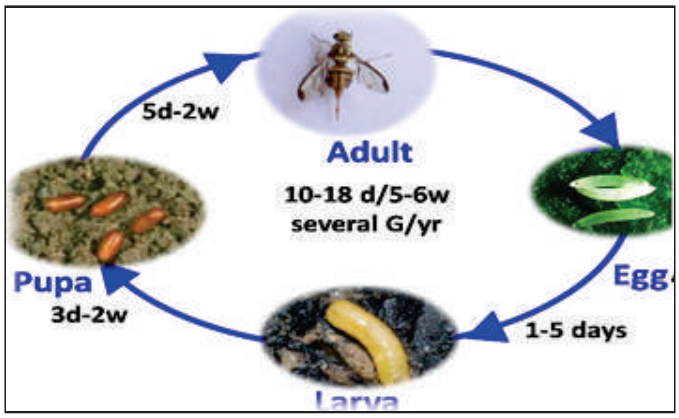
PEST: MELON FRUIT FLY

WHAT IT DOES: Adult flies puncture fruits to lay eggs -. maggots tunnel the pulp leading to rotting of fruits. maggots some times feed on flowers and fruits



Maggots tunnel inside the fruit and damage the fruit

LIFE CYCLE:



MANAGEMENT MEASURES:

- Bagging of fruits with 2 layers of paper bags at 2 to 3 day intervals
- Remove all un-harvested fruits or vegetables from a field
- Burying damaged fruits in the soil prevents population increase
- Slight ploughing and raking of soil after the harvest
- Install cue-lure traps to attract males from mid-July to mid-November
- Poison baiting with fermented palm juice (one part) + saturated sugar solution (5 ml) + Malathion 50 EC (5 ml) in earthen lids so as to attract adult flies
- A leaf extract of Ocimum sanctum, which contain eugenol (53.4%) when placed on cotton pads attract flies from a distance.

PEST: SERPENTINE LEAF MINERS

WHAT IT DOES: Maggots after hatching from eggs feed on the mesophyll leaf tissues and damage the leaves



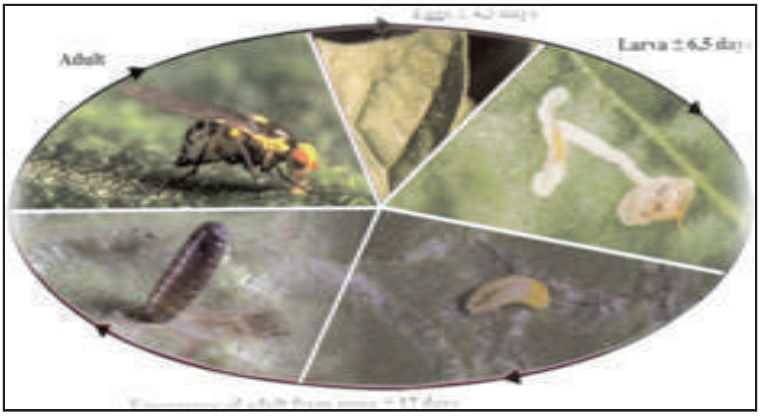
DAMAGE SYMPTOMS:

Leaf missing damage

Tunnels

Dried leaves

LIFE CYCLE:



MANAGEMENT MEASURES:

- Collection and destruction of infested plants
- Removal of alternative hosts, mainly the plants belonging to Family Asteraceae
- Setting up of yellow sticky traps
- Application of neem based insecticides
- Spray carbofuran 3% CG, 1500 gm a.i /ha, imidacloprid 17.8% SL 10 gm a.i /ha,

PEST: CITRUS FRUIT SUCKING MOTH

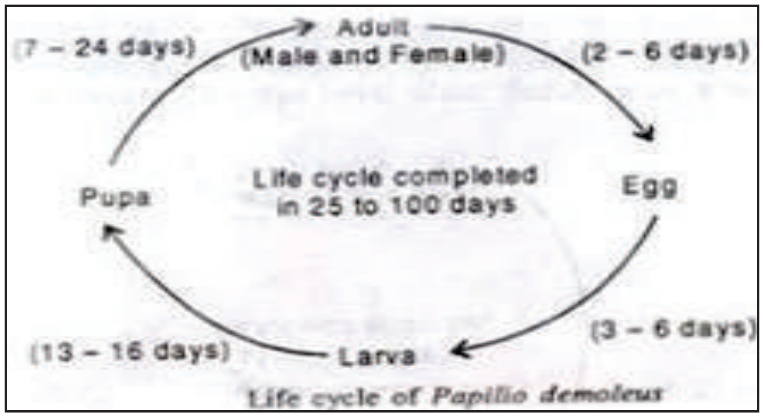
WHAT IT DOES: Larva feeds on the tender leaves

DAMAGE SYMPTOMS:

Leaves left with only mid ribs

Defoliation

LIFE CYCLE:



Life cycle of *Papilio demoleus*

MANAGEMENT MEASURES:

- The weeds found around orchards should be destroyed
- Grow tomato crop as a trap crop to attract moths
- Creating smokes in the orchards after sunset may keep the pest away
- Poison baiting with 100 grams of gur/molasses + Malathion 50EC 0.05% (1ml/L) + 1L water). Keep the bait suspension in small bowls, to attract moths
- Use figlet trap or food lure to attract moth

PEST: FRUIT SUCKING MOTH

WHAT IT DOES: Adult pierce the fruit and suck the juice



DAMAGE SYMPTOMS:

Holes on fruits

Rotting, fruit drop

MANAGEMENT MEASURES:

- Collect and destroy damaged fruits
- Clean cultivation as weed plants serve as alternate hosts
- Cover the fruit with polythene bags when the fruits are up to 5 cm
- Use light trap @ 1/ ha to monitor the activity of adult
- Release Trichogramma chilonis at one lakh/acre
- Spray dimethoate 30 EC 0.06%, two rounds, one at flower formation and next at fruit set
- At flowering stage - spray NSKE 5% or neem formulations 2 ml/

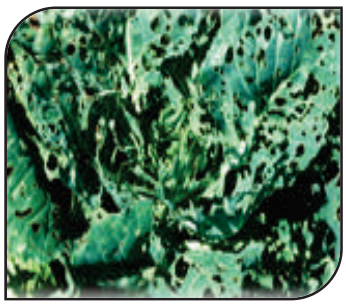
PEST: DIAMOND BACK MOTH

WHAT IT DOES: Larvae Feed On Leaves, Bore Into Heads Of Cabbage, Cauliflower Etc



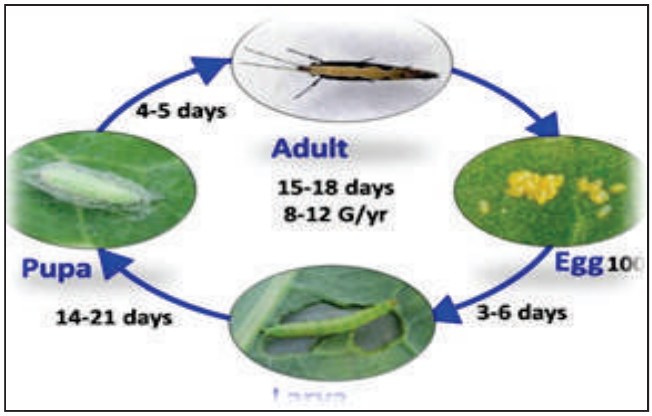
DAMAGE SYMPTOMS:





Larvae scrape epidermis | **Skeletonise leaves** | **Holes on leaves**

LIFE CYCLE:



MANAGEMENT MEASURES:

- Start with clean-healthy transplants
- Installing pheromone trap to trap adults
- Collection and destruction of the larvae at gregarious stage at least twice a week
- Mustard intercropping
- Chlorfenapyr 10% SC 75-100 gm a.i /ha
- Understand the life cycle of moth and recognise the caterpillar stage

PEST: ROOT GRUBS

WHAT IT DOES: Grubs feed on the roots that later on get infected by soil born pathogens. The affected plants wither and die ex ground nut, jowar, maize etc.



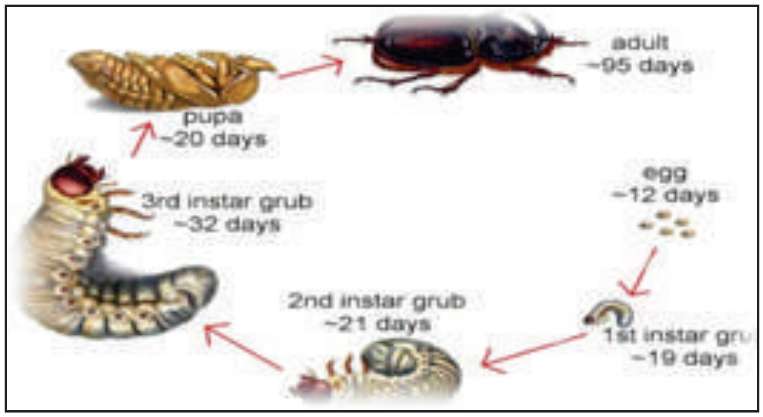
DAMAGE SYMPTOMS:



Roots cut and damaged by root grub

Crop damaged by root grubs

LIFE CYCLE:



MANAGEMENT MEASURES:

- Ploughing the field deep after the crop
- After the emergence of adult beetles in June (after the break of monsoon), they fly to neem or other tress, hence beetles can be killed by spraying
- The beetles are active at night and are phototropic in the night times; hence, light traps can be setup during June in the endemic areas. Then beetles can be collected and killed to check from further generation
- Bajra : Ist Jan 2019 manufacture Fipronil 40% + Imidacloprid 40% WG 175+175-200+200 gm a.i /ha; Groundnut : Phorate 10% CG 2500 gm a.i /ha

PEST: YELLOW STEM BORER IN PADDY

WHAT IT DOES: Larvae bores into stem causing dead heart

Larva

Adult

DAMAGE SYMPTOMS:

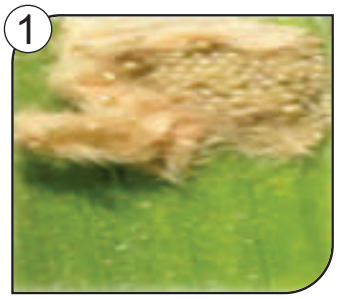
White ear head

Frass at entry

Larva inside

Dead heart

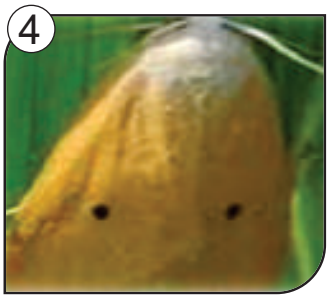
LIFE CYCLE:



Eggs (8 days)-100–200 eggs by each female, 50- 80 eggs in a batch)

Larva 30 days

Pupa 8 days



Adult

MANAGEMENT MEASURES:

- Harvest at ground level; Plough and flood the field Planting at right time;
- Setting up of pheromone traps for YSB @ 20-25/ha; Avoid heavy dose of chemical fertilizers
- Trap cropping with basmati rice in the ratio of 9:1 or for every 2.5-3 metres of main crop, a row of basmati rice should be planted
- Ensure that the trap crop reaches the booting stage 6-7 days earlier to main crop
- Spraying of Beauveria bassiana @ 1kg/ha. Erect bird perches @ 20-25 /ha
- Clipping the seedlings before transplanting reduces the carry-over of eggs from seed bed to the transplanted field
- Trichogramma japonicum may be released @ 1 lakh/ha on appearance of egg masses / moth. Spray

PEST: BRINJAL FRUIT AND SHOOT BORER

WHAT IT DOES: Larva bores into tender shoot or flower or fruit and feeds internally affected branches, leaves, flowers and fruits get dried and falls off

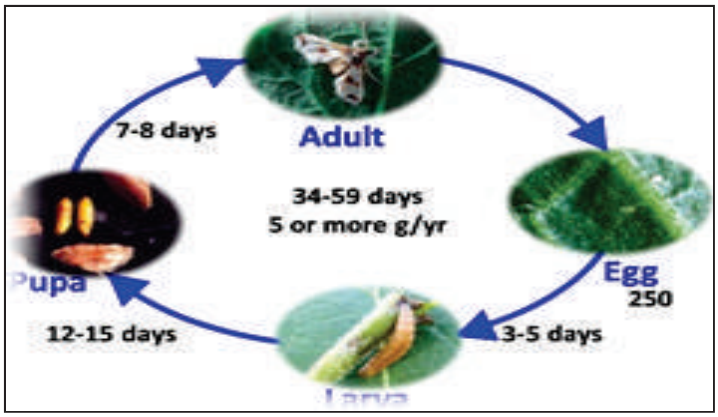
DAMAGE SYMPTOMS:

Wilted shoot

Larva feeding internally

Enrty holes

LIFE CYCLE:



MANAGEMENT MEASURES:

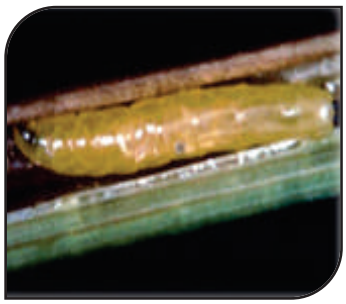
- Avoid continuous cropping of Brinjal in same field
- Collect and destroy damaged tender shoots, fallen fruits and fruits with bore holes
- Use light traps @ 1/ha to attract and kill the moths & pharomone trap@10/ha
- Uproot and burn old plants before planting new plants since they harbour pest and carry over infestation; Spray Fenpropathrin 30% EC 75-100 gm a.i /ha;

PEST: SHOOT FLY

WHAT IT DOES: Larve bore into the central shoot causing dead heart

CROPS: Maize, Sorghum, Bajra

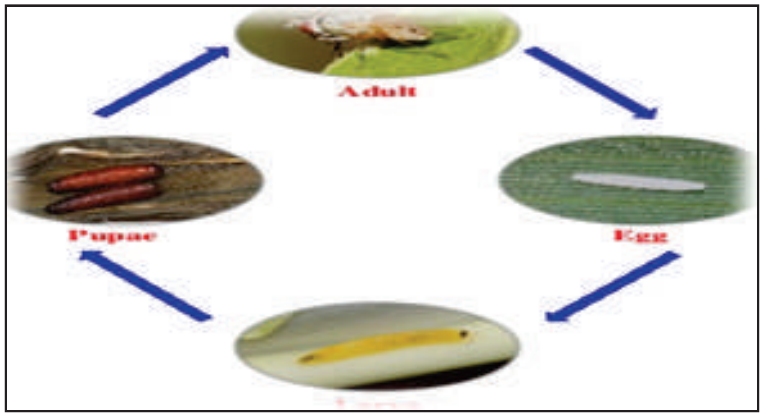




DAMAGE SYMPTOMS:


Dead heart

LIFE CYCLE:



MANAGEMENT MEASURES:

- Ploughing and removal of stubbles from the field
- Use of a higher seed rate of about 12 kg/ha
- Removal of infested and extra plants 3 or 4 weeks after germination
- Early sowing in kharif, with the onset of monsoon
- Setting up of fish meal trap @12 /ha till the crop is 30 days old
- Application of NSKE 5%; Carbofuran 3% CG 1000 gm a.i /ha

PEST: STEM BORERS

WHAT IT DOES: Young larvae feed on leaves, make shot holes, bore downwards through central whorl as it opens

CROPS: Jowar, Maize, Bajra etc.



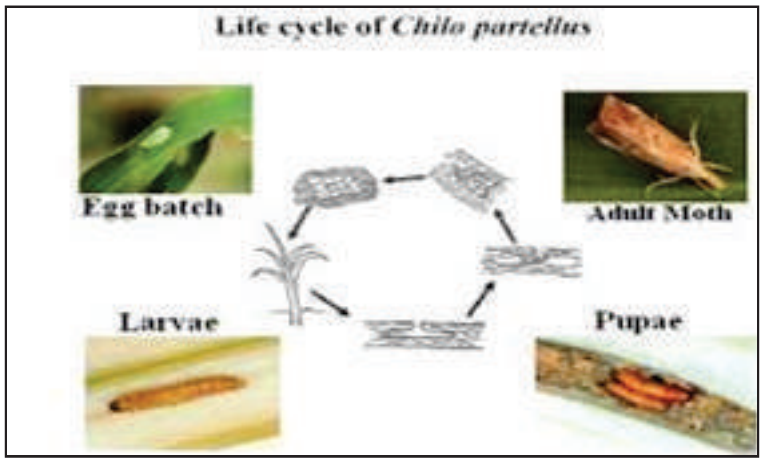
DAMAGE SYMPTOMS:

Pinholes on leaves

Larva feeding on central whorl

Bore holes on stem

LIFE CYCLE:



MANAGEMENT MEASURES:

- Collection and burying stubble and stalks or ploughing
- Removal of infested plant parts or infested plants through hoeing are recommended
- Release egg parasitoid Trichogramma chilonis @ 2,50,000 /ha coinciding egg laying period for three weeks.. Third release is to be accompanied with larval parasitoid Cotesia flavipes @ 5000/ha; Spray carbaryl 4% GR. 250 gm a.i /ha

PEST: MANGO STEM BORER

WHAT IT DOES: Grubs make irregular tunnels in the sapwood on the trunk; grubs feed on vascular tissues

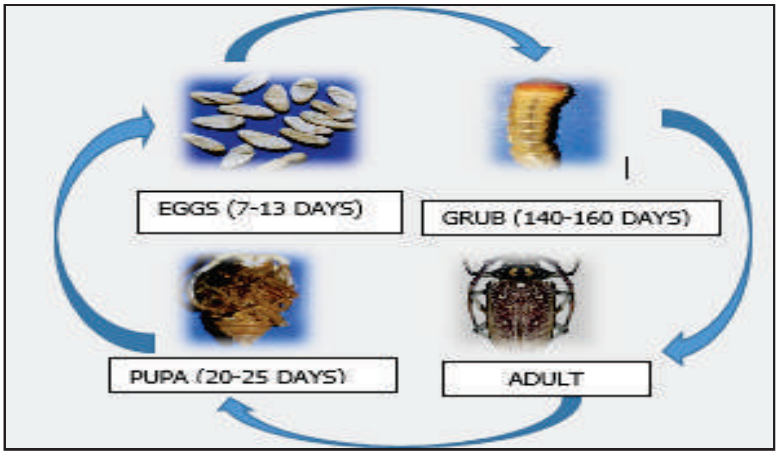


DAMAGE SYMPTOMS:



Holes on the trunk, frass at entry hole of borer, drying of terminal shoot

LIFE CYCLE:



MANAGEMENT MEASURES:

- Destroy dead affected branches ; Remove alternate host, silk cotton etc
- Grow tolerant mango varieties viz., Neelam
- Swab Coal tar + Kerosene @ 1:2 or Carbaryl 50 WP 20 g / l (basal portion of the trunk - 3 feet height) after scraping the loose bark to prevent oviposition by adult beetles
- Under severe conditions, apply the copper oxychloride paste on the trunk of the tree
- Apply One celphos tablet (3 g aluminum phosphide) per hole
- Apply carbofuran 3G 5 g per hole and plug with mud

PEST: RHINOCEROS BEETLES

WHAT IT DOES: Adults bore into the centre of the crown, injuring the young grow in tissues and feed on the exuded sap. Major pest of coconut crop

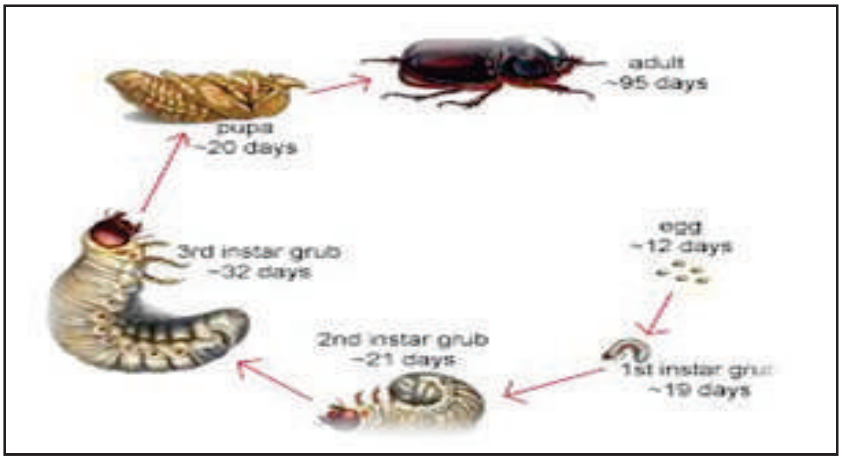


DAMAGE SYMPTOMS:



Fronds with hole **Chewed fibre** **Diamond shaped cuttings**

LIFE CYCLE:



MANAGEMENT MEASURES:

- Remove and burn all dead coconut trees in the garden
- 1 Kg castor cake soaked in 5 litres of water in small mud pots to trap adults
- Set up light traps after first rains in summer to trap adults
- Apply mixture of either neem seed powder + sand (1:2) @150 g per palm or neem seed kernel powder + sand (1:2) @150 g per palm in the base of the 3 inner most leaves in the crown
- Set up Rhino lure pheromone trap @ 1 for every 2 ha to trap and kill the beetles.
- Place Phorate 10G 5g in perforated sachets in two inner most leaf axils for 2 times at 6 months intervals.

PEST: SOYBEAN GIRDLE BEETLE

WHAT IT DOES: Grubs bore into stem to form tunnels



DAMAGE SYMPTOMS:

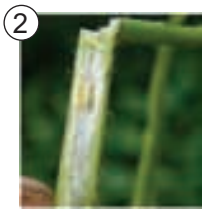
Girdling of stem

Tunnels inside the stem by grubs

Breaking of stem at girdling points

LIFE CYCLE:

Adult



Eggs(8-72 eggs)

Larva/grub (30-35 days)

Pupa(10-13 days)

MANAGEMENT MEASURES:

- Deep summer ploughing
- Planting time on the onset of monsoon
- Optimum seed rate (70-100 kg/ha) should be used
- Crop rotation should be followed
- Avoid excess nitrogenous fertilizers
- Remove the infested plant parts at least once in 10 days and bury them in compost pit
- Apply 10 G @ 10 kg/ha or 3 G @ 30 kg/ha at the time of sowing

PEST: BLISTER BEETLES

WHAT IT DOES: Adults feed on buds and flowers of greengram, blackgram, redfram, beans, mustard etc



DAMAGE SYMPTOMS:

Reduced number of pods leading to reduced yields

MANAGEMENT MEASURES:

- Brush the beetles off plants into a small container with some soapy water
- Erect bird pirches so that they feed on the blister beetles
- Better not use nitrogen in excess
- Use light traps at night to control to trap adults

PEST: PUMPKIN BEETLES

WHAT IT DOES: Grubs feed on roots, stem and fruits in contact with soil. Adults feed on leaves and flowers



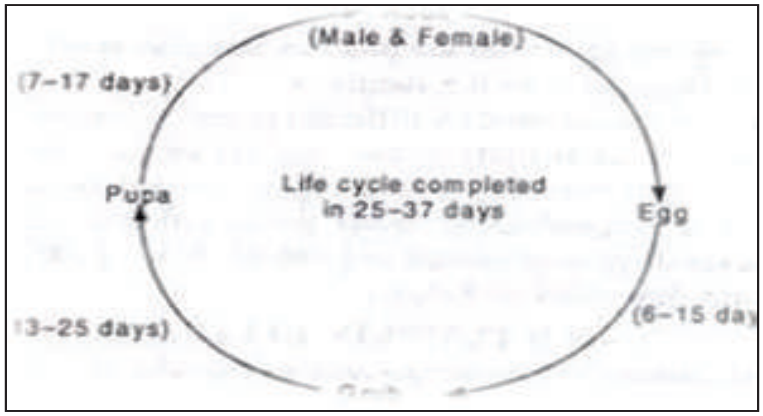
DAMAGE SYMPTOMS:



Disc holes or cuts on leaves

Skeletonisation of leaves followed by wilting and drying

LIFE CYCLE:



MANAGEMENT MEASURES:

- Plough the field after harvest to destroy the pupae and larvae of the pest
- Early sowing of cucurbit plants (November)
- Dusting the crop with kerosinized ash will repel the beetles
- The vines may be dusted with Malathion 5% dust @ 15 -20 kg/ha or 4% dust @ 15 -20 kg/ha

PEST: FLEA BEETLES

WHAT IT DOES: Adult beetles feed externally on plants, surface of leaves, stems and petals

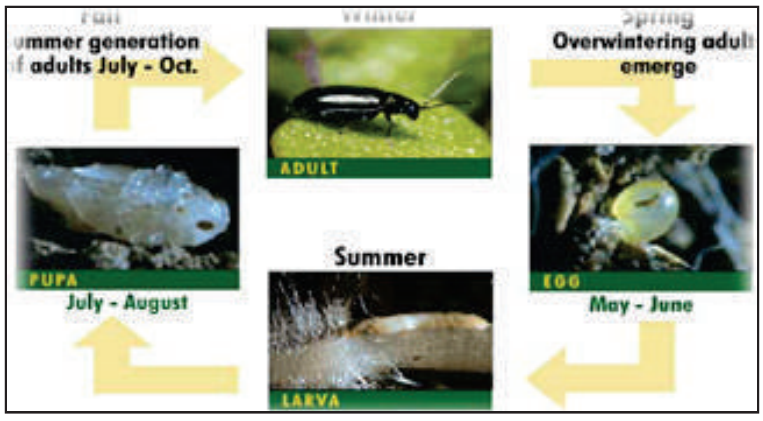


DAMAGE SYMPTOMS:



Shallow pits **Small and rounded circular**

LIFE CYCLE:



MANAGEMENT MEASURES:

- Shake plants to dislodge adult beetles
- Erect yellow or white sticky traps
- Collect into trays containing kerosenated water and destroy them
- Grow mustard or radish as trap crops Insecticide: phosalone 35 EC 0.07% after pruning

SUCKING PESTS

PEST: APHIDS

WHAT IT DOES: Sucks sap from tender leaves, twigs and buds

CROPS: Cotton, Tomato, Bhendi, Ginger, Chilly, Cowpea, Beans, etc.

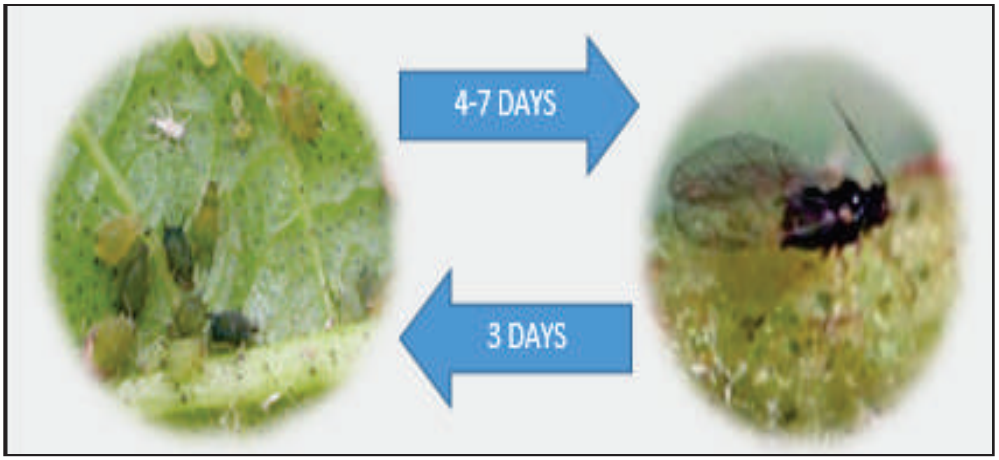


DAMAGE SYMPTOMS:



Downward curling | **Honey dew secreted** | **Black sooty mould, yellowing**

LIFE CYCLE:



MANAGEMENT MEASURES:

- Grow different crops or grow crops in rotation every cropping season
- Avoid using heavy doses of highly soluble nitrogen fertilizers
- Spray a steady stream of water on the host plant to knock-off aphids
- Use yellow sticky traps. Aphids are attracted to yellow colour
- Parasites and predators especially Coccinellids reduce the population of aphids considerably. Spray neem leaf extract or neem seed kernel extract
- Under severe conditions Spray acetamiprid 20% SP 10 gm a.i /ha; azadirachtin 0.03% min.

PEST: JASSIDS

WHAT IT DOES: Sucks sap from undersurface of leaves

MAJOR CROPS: Cotton, Bhendi, Tobacco, Several weeds

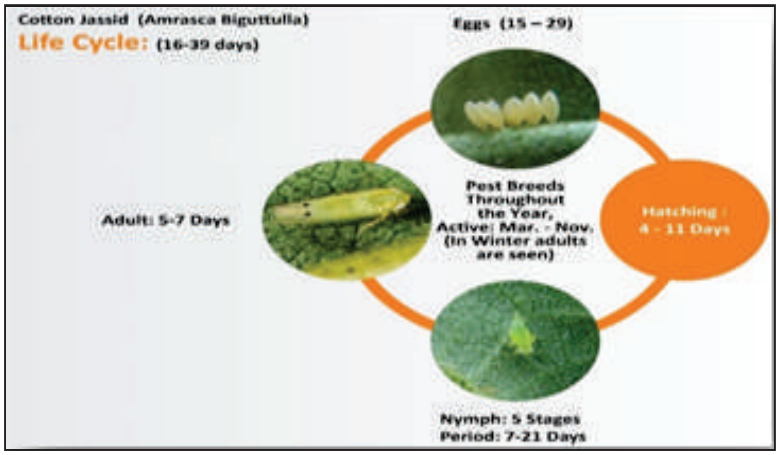
DAMAGE SYMPTOMS:

Downward curling

Burnt leaf edges

Reddish yellowing

LIFE CYCLE:



MANAGEMENT MEASURES:

- Crop rotation
- Do not use high doses of nitrogenous fertilizers;
- Grow cowpea/ soya bean/onion as intercrop
- Use yellow sticky traps @ 20/acre
- Conserve and release predators like Chrysoperla sps and lady bird beetles
- Release first instar larvae of green lacewing Chrysoperla carnea @ 10,000/ha
- Spray NSKE 5% @ 2500 ml/ha
- Under severe conditions spray cotton -acetamiprid 20% SP, 10 gm a.i /ha;

PEST: THRIPS

WHAT IT DOES: Suck sap from lower and upper surface of leaves

MAJOR CROPS: Onion, Garlic, Tobacco, Several weeds etc



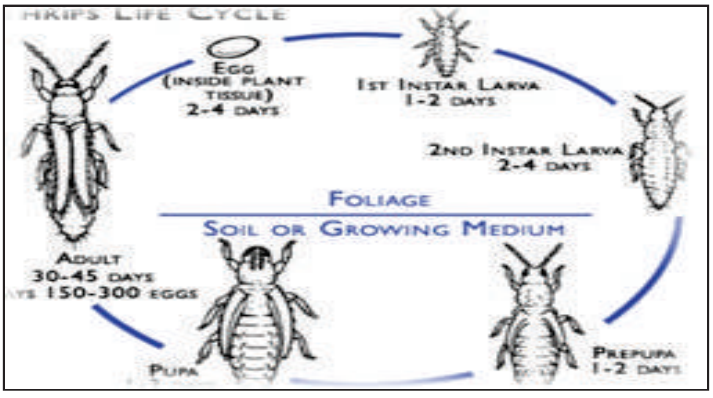
DAMAGE SYMPTOMS:



Wrinkled, distorted

Rusty and shiny appearnce on lowerside of leaves

LIFE CYCLE:



MANAGEMENT MEASURES:

- Prune and destroy injured and infested terminals
- Use blue and yellow sticky traps @ 20 per acre
- Spray azadirachtin 1%
- Spray Dimethoate 30% EC 200 gm a.i /ha

PEST: MEALY BUGS

WHAT IT DOES: Adults and nymphs suck the sap from the leaves, branches, stem, fruiting bodies and roots

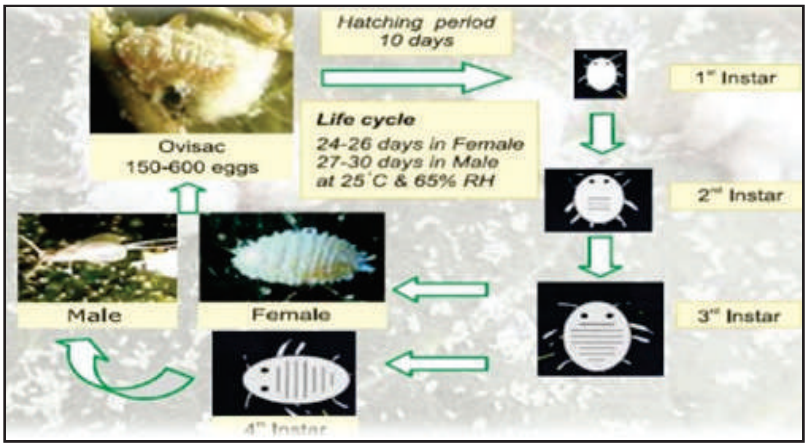


DAMAGE SYMPTOMS:

- Plants get weakened due to sap sucked by mealy bugs
- Honey dew secretion on leaves
- Black sooty mould develops
- Severe infestation leads to death of plant



LIFE CYCLE:



MANAGEMENT MEASURES:

- Pruning of infested branches and burning them
- Removal and burning of crop residues
- Removal of weeds/alternate host plants
- Destruction of already existing ant colonies
- Sanitization of farm equipment before moving it to the un-infested crop
- Use of botanical insecticides such as neem oil (1 to 2%) or NSKE (5%)
- Spray – dimethoate 30% EC @ 0.03%

PEST: WHITEFLIES

WHAT IT DOES: Suck sap from leaves, stem, flowers, pods/fruits

MAJOR CROPS: Cotton, Brinjal, Tobacco, Tomato, Potato, Bhendi, Cucumber, Sunflower, Cassava, Sweet potato and pulses



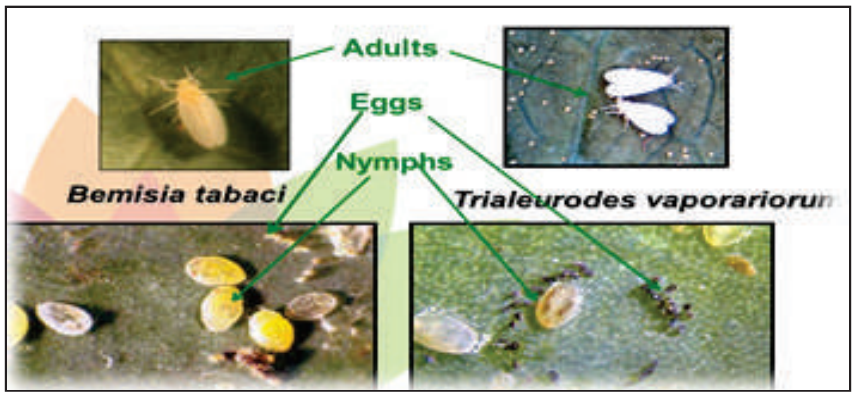
DAMAGE SYMPTOMS:

Honey dew secretion

Sooty mould

Chlorotic spots

LIFE CYCLE:



MANAGEMENT MEASURES:

- Field sanitation, roguing
- Plant tall border crops like maize, sorghum or pearl millet to reduce whitefly infestations (4 rows).Peppermint plants act as repellent for whitefly
- Release Chrysoperla carnea @ 8,000 larvae/acre
- Spray NSKE 5% or azadirachtin 0.03% (300 ppm)
- Under severe conditions spray phosphamidon 40% SL 250-300 gm a.i /ha;

PEST: SPIDER MITES

WHAT IT DOES: Puncture the leaves from under surface, feed on the sap

MAJOR CROPS: Cotton, Brinjal, Tomato, Bhendi, Paddy, Potato, Onion, Papaya etc.



DAMAGE SYMPTOMS:

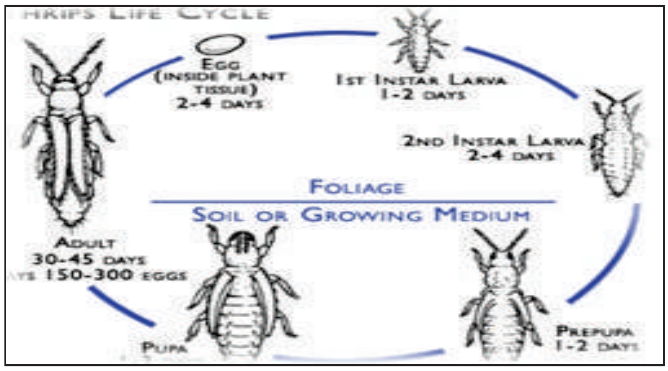

Reddened upper surface


Punctured lower surface


White speckles on upper surface

- Punctured undersurface of leaves due to sucking of sap
- White or yellow speckles or turn red on corresponding upper surface of leaves; webbing on leaves; leaves wither and fall off

LIFE CYCLE:



MANAGEMENT MEASURES:

- Infested plants must be rogued out from the fields, to prevent further spread
- Use yellow sticky traps @ 20/acre
- Spray dicofol 18.5% EC 230 gm a.i /ha

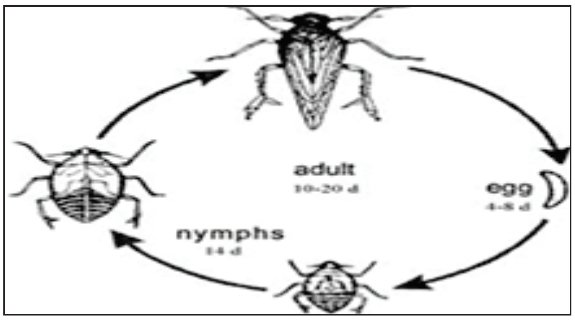
PEST: BROWN PLANT HOPPER IN PADDY

WHAT IT DOES: Adults and nymphs suck sap from leaves and stem

DAMAGE SYMPTOMS:

Premature drying, Yellowing in circular fashion, Hopper burn

LIFE CYCLE:

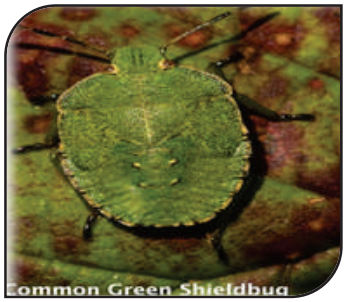


MANAGEMENT MEASURES:

- Avoid excessive use of nitrogen; control irrigation by intermittent draining
- Flood the seedbed, for a day, so that only the tips of seedlings are exposed
- Set up light traps during night or yellow pan traps during day time
- Drain the water before use of insecticides and direct the spray towards the base of the plants. Apply Neem oil 3% 15 lit/ha ;
- Spray Methyl demeton 25 EC 1000 ml/ha

PEST: SHIELD BUGS

WHAT IT DOES: Suck sap from leaves. stem, flowers and fruits deforming fruits. Severe infestation leads to drying and death of the plants



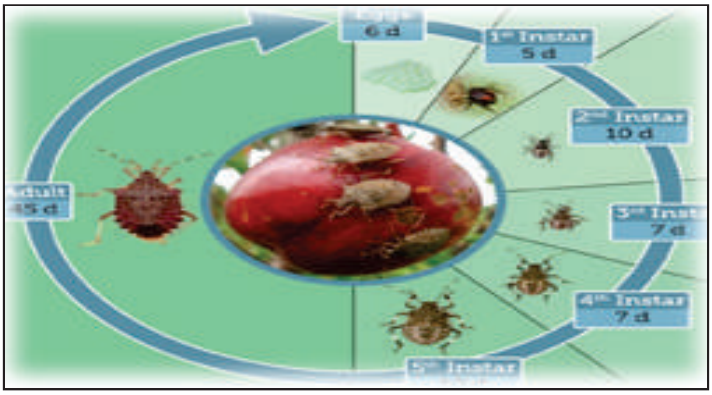
DAMAGE SYMPTOMS:

Sap sucked from leaf petiole

Sap sucked from flowers

Sap sucked from fruits

LIFE CYCLE:



MANAGEMENT MEASURES:

- Destroy weeds (legumes, mustards) that are good overwintering hosts around fields
- Use yellow sticky traps @ 20/acre
- Spray NSKE 5%; Under severe conditions Spray

PEST: RED COTTON BUGS

WHAT IT DOES: Red stained lint, bolls rot

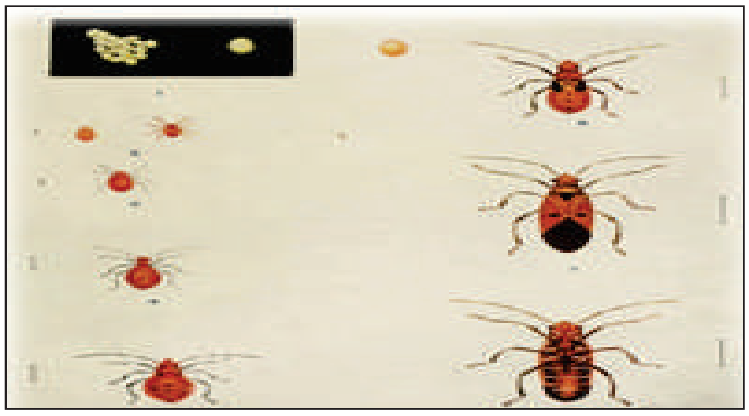


DAMAGE SYMPTOMS:



Red Stained Lint **Rotten Boll**

LIFE CYCLE:



MANAGEMENT MEASURES:

- Dis-lodging the gregarious population of the stainers on the bolls in to a vessel containing water with a thin film of kerosene is recommended as the late season insecticidal applications leave residues in the harvested produce besides being uneconomical
- Spray NSKE 5% or neem leaf extract

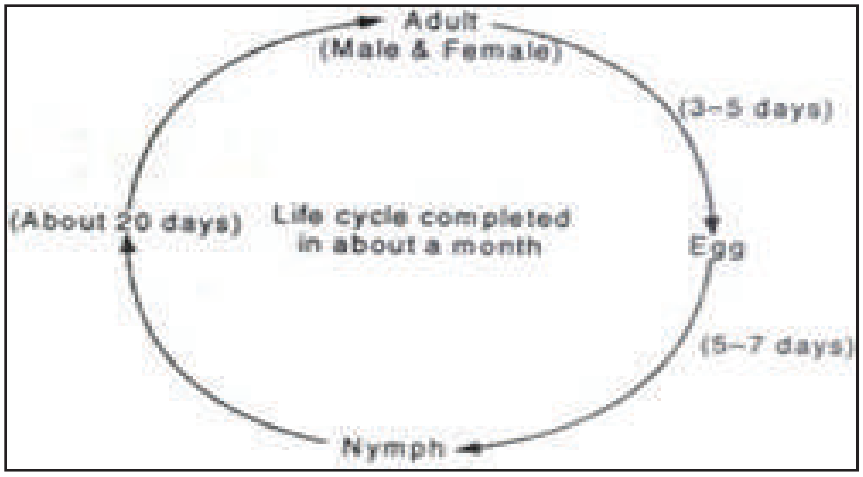
PEST: PADDY GUNDHI BUG

WHAT IT DOES: Both adults and nymphs suck sap from grains at milky stage because of which grains get shrivelled

DAMAGE SYMPTOMS:

Shrivilled grains

LIFE CYCLE:



MANAGEMENT MEASURES:

- Remove weeds from fields and surrounding areas
- Capturing rice bugs, in the early morning or late afternoon by net
- Spray Neem seed kernel extract 5% 25 kg/ha or Notchi or Ipomoea or Prosopis leaf extract 10%; Dust Quinalphos 1.5 D at 25 kg/ha twice, the first during flowering and second a week later:

PEST: MANGO STONE WEEVIL

WHAT IT DOES: Bores into pulp, tunnels cotyledons in matured fruits leading to rotting of fruits

DAMAGE SYMPTOMS:

Ovisposition injuries

Tunneled mango stone by grub

LIFE CYCLE:

Adult

Grub

Pupa

MANAGEMENT MEASURES:

- Destruction of infested and fallen fruits at weekly interval till fruit harvest
- Ploughing of orchard after harvest to expose hibernating adults, reduce, infestation levels
- Destroy all left over seeds in the orchard and also in the processing industries. Spray application of Fenthion 100EC 1ml/l; (first at marble stage of the fruit second at 15 days interval)
- During non-flowering season direct spray towards the base of the trunk

PEST: BANANA RHIZOME WEEVIL

WHAT IT DOES: Grubs bore into corm and root stock resulting in decay and rotting of corm



DAMAGE SYMPTOMS:

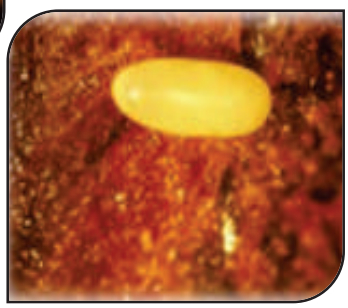


Yellowing of leaves **Tunnels inside the corm rotting of tissues**

LIFE CYCLE:

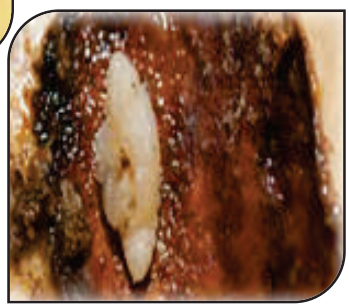
Adult

Egg



Grub

Pupa



MANAGEMENT MEASURES:

- Planting of healthy suckers
- The planting field should be free from weeds and previous plant debris
- Do not take regular crop in the same field to avoid initial infestation
- Ensure clean cultivation
- Removal of pseudo stems below ground level
- Trimming the rhizome
- Prune the side suckers every months
- Use cosmolure trap at 5/ha
- Carbofuran 3% CG 1 g/ suckers

STORAGE PESTS

PEST: RICE WEEVIL

WHAT IT DOES: Both adult and nymphs feed on the grains and make them unfit for consumption



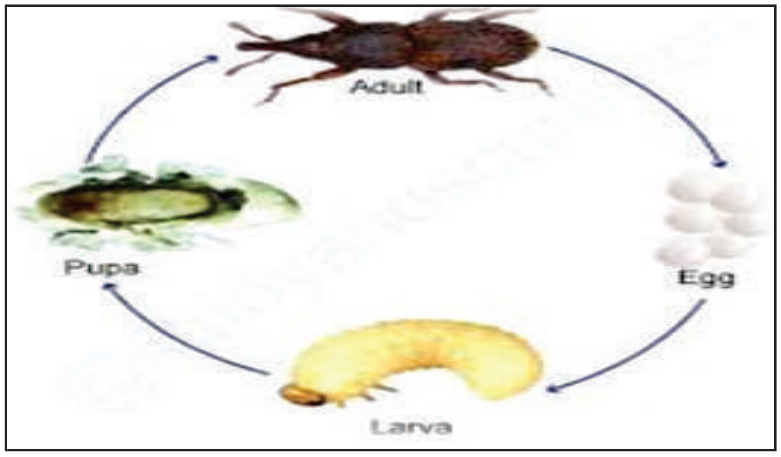
DAMAGE SYMPTOMS:

Adult and larave feed on the grains and make them hollow



Adults pierce grains, feed on the endosperm and damage grains completely

LIFE CYCLE:



PEST: KHAPRA BEETLE

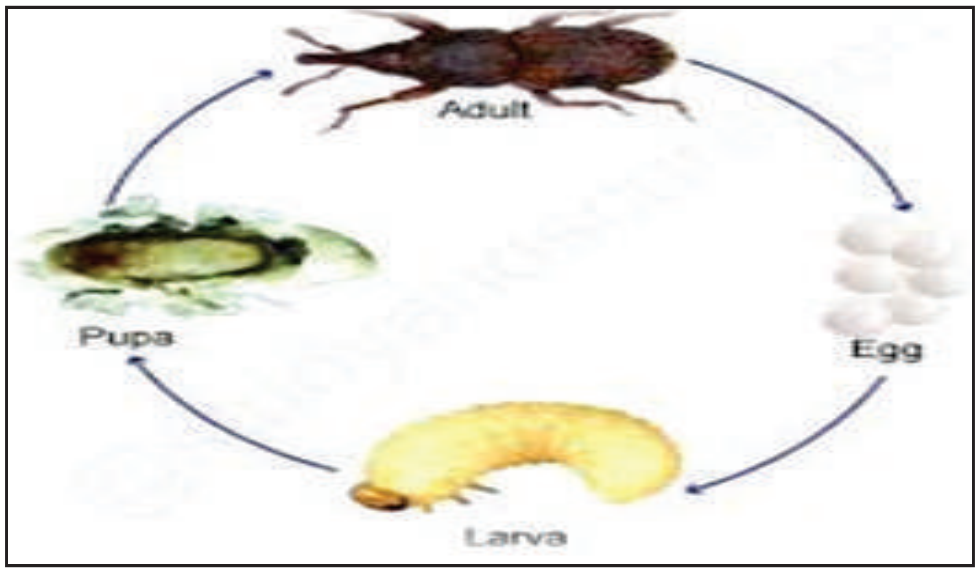
WHAT IT DOES: Young larvae feeds on damaged grains. old larvae feed on whole grains and damage the grains



DAMAGE SYMPTOMS:

Beetles feed on the grains making unfit for consumption or use

LIFE CYCLE:



PEST: RED FLOUR BEETLE

WHAT IT DOES: Adult and larva feed on broken grains and turn grains into dust

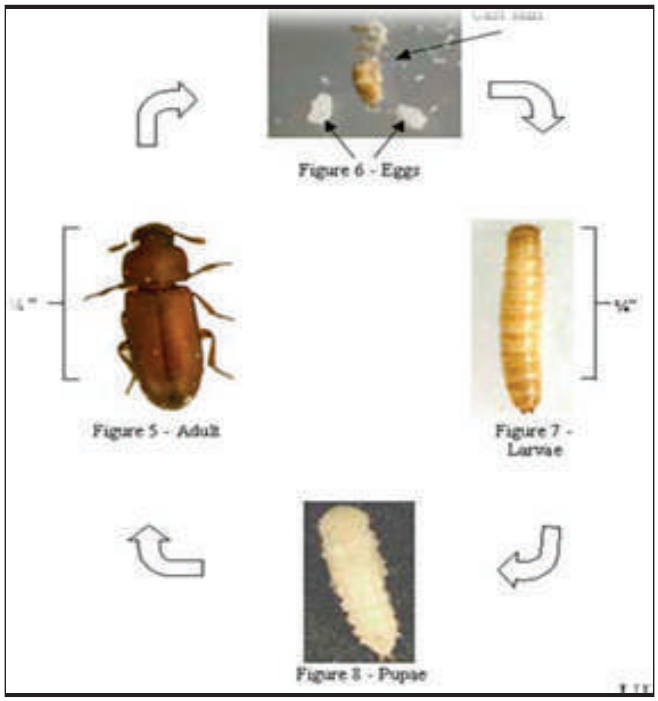


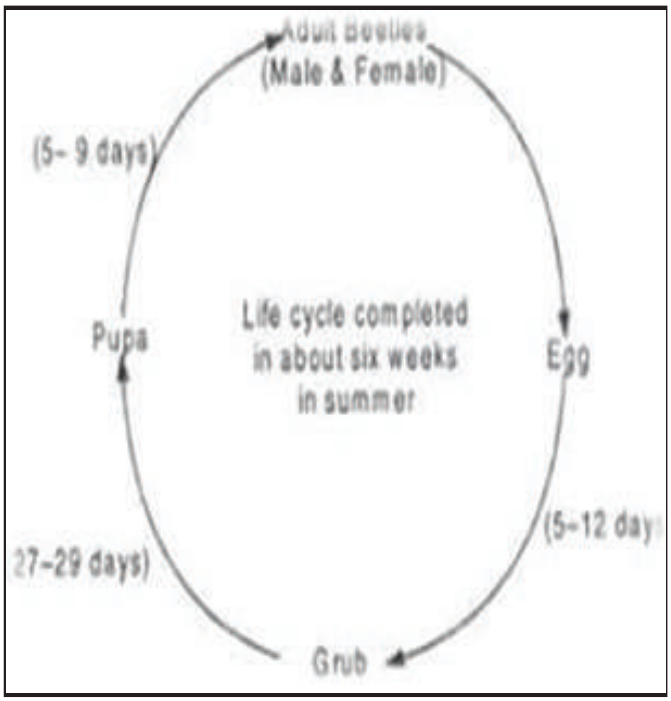
DAMAGE SYMPTOMS:



Grains will be turned into dust, flour emits sour and pungent smell

LIFE CYCLE:





PEST: PULSE BEETLES

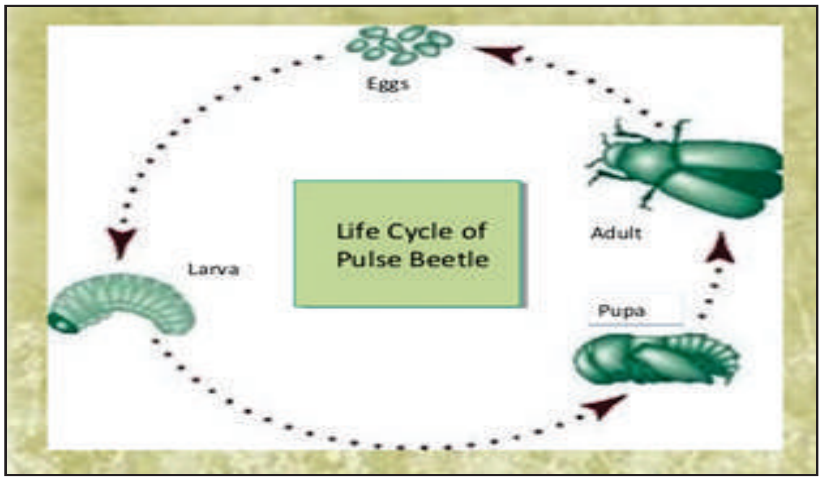
WHAT IT DOES: Larvae Feed On Grains Of Green Peas, Chickpeas, Pigeonpeas, Redgram, Blackgram, Greengram Etc. Grubs Bore Inside

The grains and feeds on the endosperm

DAMAGE SYMPTOMS:

Exit holes seen on the grains. Adults emerge out of these holes

LIFE CYCLE:



PEST: RICE MOTH

WHAT IT DOES: Larvae feed on the grains making unfit for consumption



DAMAGE SYMPTOMS:


Food grains with frass, moults and dense webbing. Whole grains are bound into lumps

INTEGRATED MANAGEMENT OF STORED PRODUCE PESTS

- Brush the cracks, crevices and corners to remove all debris in the godown
- Clean and maintain the threshing floor/yard free from insect infection and away from the vicinity of villages
- Clean the machines like harvester and thresher before their use
- Clean the godowns / storage structures before storing the newly harvested crop
- Provide a metal sheet upto a height of 25 cm at the bottom of the wood in doors to arrest the entry of rats
- Fix up wire meshes to windows, ventilators, gutters, drains etc., to prevent entry of rats, birds and squirrels
- Remove and destroy dirt, rubbish, sweepings and webbings etc. from the stores
- Close all the rat burrows found in godown with a mixture of broken glass pieces and mud plastered with mud/ cement
- Plaster the cracks, crevices, holes found on walls, and floors with mud or cement and white wash the stores before storing of grains
- Disinfest the storage structures receptacles by spraying malathion 50 EC @ 3 lit 100 m before their use. Store the grains at around 10 % moisture content
- Dry the produce to have moisture content below 10% to prevent the buildup of pests. Dry storage bags and bins in the sun light
- Seed purpose: Mix 1 kg of activated kaolin (or) malathion 5 D for every 100 kg of seed and store/pack in gunny or polythene lined bags
- Grain purpose: Mix 1 kg activated kaolin for every 100 kg of grain and store. To protect the pulse grains, mix activated kaolin at the above dosage or any one of the edible oils at 1 kg for every 100 kg of grain or mix 1 kg of neem seed kernel for every 100 kg of cereal / pulse and store
- Do not mix synthetic insecticides with grains meant for consumption. Store the food grains in air tight sealed structures to prevent the infestation by insects
- Sieve and remove all broken grains to eliminate the condition which favour storage pests. Stitch all torn out bags before filling the grains
- Treat the walls, dunnage materials and ceilings of empty godown with malathion 50 EC 10 ml/L. Spray malathion 50 EC 10 ml/ L with @ 3 L of spray fluid / 100 m2 over the bags. Do not spray the insecticides directly on food grains
- Use knock down chemicals like lindane smoke generator or fumigant strips pyrethrum spray to kill the flying insects and insects on surfaces, cracks and crevices
- Decide the need for shed fumigation based on the intensity of infestation

NEEM SEED KERNEL EXTRACT 5%

Prevents moulting in insects, avoids feeding by insects, prevents females from laying eggs and is effective against leaf-eating caterpillars, borers, sucking pests etc.

Acts as an insect pest repellant

Method of preparation

1A

Important!

If seed coat is not removed, then take more quantity of seeds

The seeds should be of 3-8 months old

Care should be taken during grinding of seeds, to ensure that oil is not released

Grind 5 kgs of well-dried neem seed to powder form

1B

Check the colour of kernel extract

1C

Gather powder in a muslin pouch and soak in 10 litres water overnight

1D

Squeeze the pouch and filter the extract

1E

Add the extract to 90 litres water

1F

Add 500 gm of Khadi or neutral soap and stir well

Method of application

2A

Foliar spray

Note:

Increase or decrease quantity of materials based on volume of spray required

20-30 kg of neem seed kernel (average yield from 2 trees) is required for an hectare of crop

CHILLI GARLIC EXTRACT

Broad spectrum botanical insect-pest repellent effective against various leaf eating caterpillars and sucking pests.

Acts as an insect pest repellant

Method of preparation

1A

Grind 3 kg of chilli and 0.5 kg garlic separately

1B

Take grounded chilli in cloth and soak in 10 litres of water overnight. Take grounded garlic and soak it directly in 250 ml of kerosene.

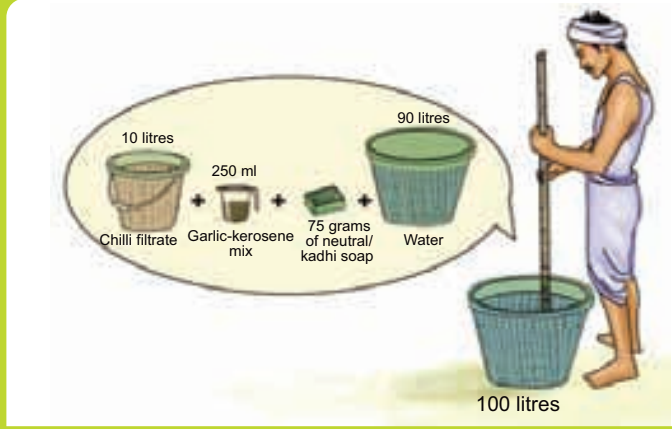
1C

Squeeze to get the chilli filtrate

1D

Soaked garlic kerosene mix

1E



Add chilli filtrate, garlic-kerosene mix and the soap to 90 litres of water

Method of application

2

Spray

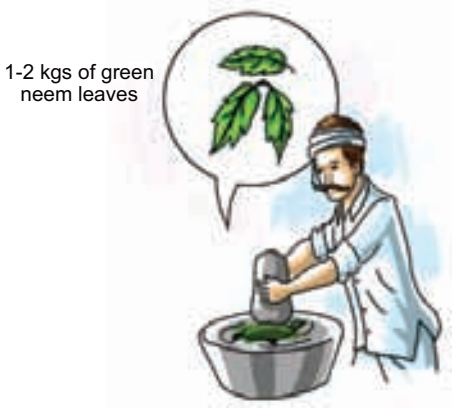
NEEM LEAF EXTRACT

Prevents moulting in insects, avoids feeding by insects, prevents females from laying eggs and is effective against leaf-eating caterpillars, borers, sucking pests etc.

Acts as an insect pest repellant

Method of preparation

1A



Gently pound 1-2 kg of neem leaves in mortar

1B

Place in a pot and add 2-4 litres of water.
Cover the mouth of the pot securely with a cloth and leave it aside for 3 days.

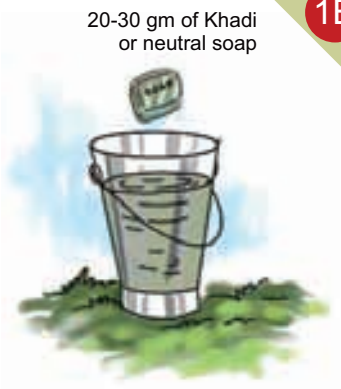
1C

Strain to get clear extract

1D

Dilute 1 litre of neem leaf extract with 9 litres of water

1E



Add 20-30 gm of Khadi or neutral soap and stir well

Method of application

2A

Foliar spray

Note:
Increase or decrease quantity of materials based on volume of spray required

CHAPTER 8
DISEASES MANAGEMENT

INTRODUCTION

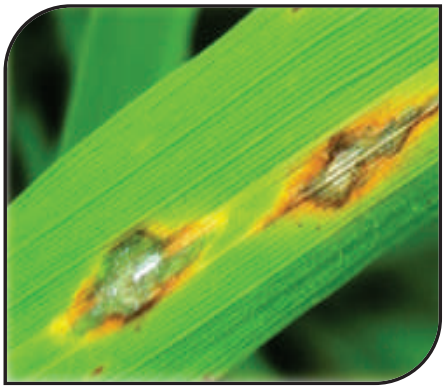
It is estimated that around 15-25 % of crops are lost every due to insect pests, diseases and weeds posing a threat to nation's food security. These economic losses can occur at various stages of crop production starting from seed sowing till crop harvesting and storage. Some will cause damage by interfering with water and mineral absorption from the soil (diseases of the roots and stem base), some will affect photosynthesis by killing the leaves of the plant (diseases of the foliage), some will impair translocation of sugars produced in the photosynthesis to the grain (systemic virus diseases) and yet others will completely destroy developing grains (disease of the head and kernel).

These crop losses can be reduced substantially by adopting appropriate crop protection measures. Holistic, integrated and multi-disciplinary approach is needed for effective management of crop diseases as diseases are caused by fungi, Bacteria, virus and nematode. Major integrated disease MANAGEMENT MEASURES include use of resistant varieties, application of enough organic manures, crop rotation, use of botanicals, bio-control agents and using chemical insecticides as last resort.

This chapter would outline major diseases of major crops, causal agents, symptoms and integrated disease MANAGEMENT MEASURES that serves as a ready reckoner for village level youth to train farmers

DISEASE: Blast

CROP: Paddy



Blast

Blast

Nodal Blast

Paddy Blast Affected Field

Spindle /diamond shaped spots on leaves, neck and nodes on stem. these spots coalesele to give burnt or blast appearence

MANAGEMENT MEASURES

- Remove collateral weed hosts from bunds and channels
- use only disease free seedlings
- Avoid excess nitrogen fertilizer application
- Apply n in three split doses (50% basal, 25% in tillering stage and 25% in panicle initiation stage)
- Seed treatment with pseudomonas fluorescence liquid formulation @ 10 ml/kg of seed
- Seedling root dipping with pseudomonas fluorescence liquid formulation (500 ml for one hectare Seedlings)
- Soil application with pseudomonas fluorescense liquid formulation (500ml/ha)
- Foliar spray with pseudomonas fluorescence liquid formulation @ 5ml/lit.
- Spray tricyclazole 75% wp @0.3g/l of water

CROP: Paddy

DIAGNOSTIC SYMPTOMS



Large Lesions On Leaf Sheath That Join Later Resulting In Blight Appearance
Blight And Death Of Plant

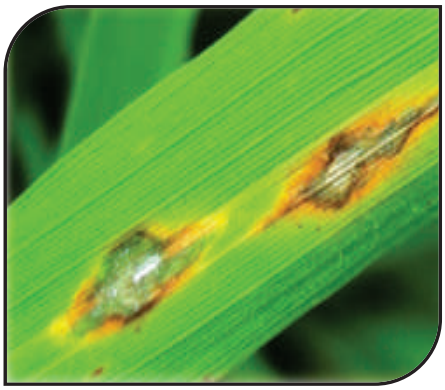
MANAGEMENT MEASURES

- Avoid excess dose of fertilizers
- Adopt optimum spacing
- Eliminate weed hosts
- Avoid flow of irrigation water from infected fields to healthy fields
- Spray hexaconazole WG 50 a.i. (g) or Propiconazole 13.9% + Difenoconazole 13.9% EC 0.02% - 0.03%

DISEASE: Bacterial Leaf Blight

CROP: Paddy

DIAGNOSTIC SYMPTOMS



Yellow Stripes Leading To Blight

Bacterial Ooze On Lesions

Yellow Stripes Turn Brown, Join Together To Result In Blight

MANAGEMENT MEASURES

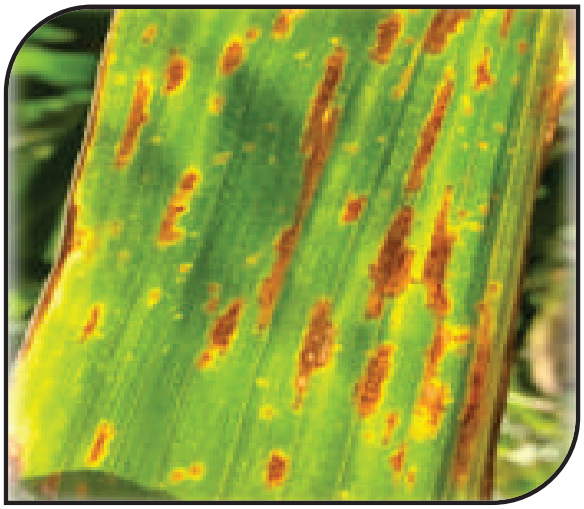
- Affected stubbles are to be destroyed by burning
- Judicious use of nitrogenous fertilizers
- Avoid flooded conditions or drying of the field (not at the time of flowering)
- Avoid flow of irrigation water from infected to healthy field
- Copper hydroxide 53.8% DF 525 a.i. (g); (Streptomycin Sulphate 90% + Tetracycline Hydrochloride 10%) SP Seed treatment

DISEASE: Leaf Blight

CROP: Maize, Bajra, Sorghum

DIAGNOSTIC SYMPTOMS

Small spindle shaped spots initially



Spots enlarge leading to blight

Premature drying of leaves

MANAGEMENT MEASURES

- Rogue out affected plants
- Grow recommended resistant varieties for the region
- Soil application of P. fluorescence (or) T. viride @ 2.5 kg / ha + 50 kg of well decomposed FYM (mix 10 days before application) or sand at 30 days after sowing
- Spray Matalaxyl 1000 g / Mancozeb 2.5 g/liter at 10 days interval after first appearance of the disease

DISEASE: Leaf Blight

CROP: Chickpea, Beans, Sunflower

DIAGNOSTIC SYMPTOMS

Small brown spots initially

Enlarge gradually leading to leaf blight

Chickpea blight affected field

MANAGEMENT MEASURES

- Sow disease-free seed
- Follow crop rotation
- Intercrop with wheat, barley, mustard
- Seed treatment with Carbendazim @ 1g/kg of seed
- Spray the crop with Mancozeb @ 2.5g/lit if noticed during the growth period or Spray wettable sulphur at the rate of 2 -3g/lit of water

DISEASE: Common Light (Caused By Bacteria)

CROP : Beans, Greengram

DIAGNOSTIC SYMPTOMS

Light greenish yellow circles initially

Yellow circles enlarged resulting in leaf blight

MANAGEMENT MEASURES

- Start with certified, disease free seed
- Rain and damp weather favour disease development
- Rotate with non-host crops for 2-4 years
- Eliminate weeds and volunteer beans that might be potential reservoirs for the bacteria
- Furrow or drip irrigation is preferred to prevent secondary spread of the bacteria
- Spray Copper oxy chloride 50% WP 1.25 a.i. @3g/L of water

DISEASE: Late Blight

CROP: Tomato, Potato

DIAGNOSTIC SYMPTOMS

Water soaked patches initially

Later patches join resulting in blight

Blight on stem

Blight on fruits

Infected field

Rusty brown tubers

MANAGEMENT MEASURES

- Injuries during harvest to be avoided and store disease free tubers
- Destruction of the foliage few days before harvest is beneficial
- Spray Carbendazim 25%+ Mancozeb 50% WS @ 1.5 + 3.0 To 1.75 + 3.5 grams for 10 kg seed for seed treatment,

DISEASE: Early Blight

CROP: Tomato, Potato

DIAGNOSTIC SYMPTOMS

Black spots with concentric rings in centre of spot, join gradually leading to blight

Eventually disease spreads and covers the entire field reducing yields drastically

MANAGEMENT MEASURES

- Disease free seed tubers should be used for planting
- Infected plant debris should be destroyed
- Very early spraying with Zineb or captan 0.2% and repeating it for every 15 – 20 days gives effective control

DISEASE: Bacterial Blight

CROP: Cotton

DIAGNOSTIC SYMPTOMS

Water soaked lesions

Angular leaf spot

Veinal blight

Boll rot and blight

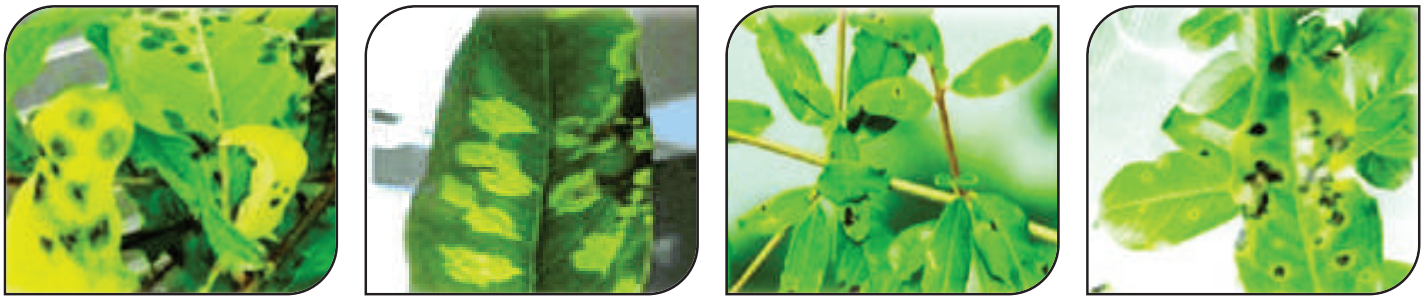
MANAGEMENT MEASURES

- Remove and destroy the infected plant debris
- Rogue out the volunteer cotton plants and weed hosts
- Follow crop rotation with non-host crops
- Early thinning, good tillage, early irrigation, early earthing up and addition of potash to the soil reduces disease incidence

DISEASE: Bacterial Blight

CROP: Pomegranate

DIAGNOSTIC SYMPTOMS



Initially black water soaked lesions on leaves ,eventually enlarge, finally leaves drop

Initially black water soaked lesions on leaves ,eventually enlarge, finally leaves drop

MANAGEMENT MEASURES

- Use disease free planting materials
- Affected leaves, stem, fruits should be removed and burnt
- Provide proper spacing 4.5 X 3.0m
- Enrich soil with organics and bioagents
- First year bearing flower should be removed
- Application of micronutrients (Zn, B, Ca, Mg) immediately after antibiotic spray

DISEASE: Blister Blight

CROP: Tea

DIAGNOSTIC SYMPTOMS

Blisters on underside of leaves

blisters burst open, turn brown, leaves drop off, spreads to stem and stem breaks off

MANAGEMENT MEASURES

- Removal of affected leaves and shoots by pruning and destruction of the same have been recommended
- Spray Hexaconazole 5% EC @ 10 g ai/ha

DISEASE: Bud Rot

CROP: Coconut

DIAGNOSTIC SYMPTOMS

Yellowing of crown leaves

Basal tissues of leaves rot

Crown falls and palm dies

MANAGEMENT MEASURES

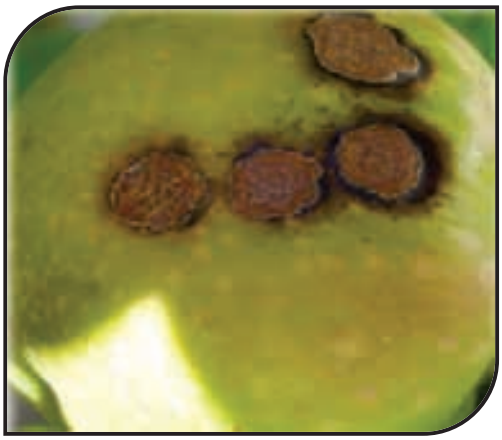
- Provide adequate drainage in gardens
- Adopt proper spacing
- Avoid overcrowding in bud rot prone gardens
- Removal and burning of infected trees
- In the early stage of infection, cutting and application of Bordeaux paste to the infected spindle

DISEASE: Scab

CROPS: Citrus, Apple

DIAGNOSTIC SYMPTOMS

Lesions on leaves that develop into sharp elevations, corresponding sites on leaves are sunken



Corky projections on fruits that crack eventually there by deteriorating market value

MANAGEMENT MEASURES

- The diseased leaves, twigs and fruits should be collected and destroyed. Spray Bordeaux mixture or Blitox (0.3%) OR CARBENDIZIM 0.1%

DISEASE: Canker

CROP: Citrus, Apple

DIAGNOSTIC SYMPTOMS

Water soaked round, yellow spots which enlarge slightly and turn brown, eruptive and corky.

Several lesions on fruit may coalesce to form larger canker.

MANAGEMENT MEASURES

- Control leaf miner when young flush is produced
- Before monsoon, prune infected twigs
- Spray Streptocycline 50 to 100 ppm solution repeatedly at an interval of 15 to 20 days after the appearance of new growth

DISEASE: Stem Bleeding

CROP: Coconut

DIAGNOSTIC SYMPTOMS

Stem bleeding

Fungal growth on infected parts

Wilting of coconut palms

MANAGEMENT MEASURES

- Avoid any mechanical injury to trunk
- Apply 50kg FYM and 5kg neem cake mixed with Trichoderma @ 200g/palm/year to the basin during September
- Irrigate during summer and
- Provide drainage during rainy season along with recommended fertilizer
- Chisel affected tissues and paint with tridemorph 5% or Bordeaux paste. Apply coal tar after 1-2 days on the treated portion
- Root feed with Tridemorph 5ml in 100 ml water, thrice a year during April-May, September-October and January-February

DISEASE: Fruit Rots

CROP: Chilli, Tomato, Mango etc.

DIAGNOSTIC SYMPTOMS

Necrosis of tender twigs from the tip backwards called die back, leaves drop, twigs dry up and get shrivelled

Grey spots on fruits, rots, fruits drop off eventually

MANAGEMENT MEASURES

- Use of disease-free seeds is important in preventing the disease
- Seed treatment with Trichoderma viride @10g/kg
- Copper oxy chloride 50% WP @ 1.25 g ai/ha,

DISEASE: Leaf Curl

CROP: Chilli, Tomato

TRANSMITTED BY: White Flies

DIAGNOSTIC SYMPTOMS

Leaves turn towards mid rib, gets deformed, size gets reduced

Plants become stunted, flowers drop, poor fruit set, reduced size of fruits, less or no yield

MANAGEMENT MEASURES

- Setupyellow sticky traps @ 12/ha to monitor the white fly
- Raise barrier crops-cereals around the field
- Removal of weed host. Protected nursery in net house or green house
- Spray Imidachloprid 0.05 % at 15, 25, 45 days after SOWING

DISEASE: Leaf Spots

CROP: All Crops

DIAGNOSTIC SYMPTOMS

Cercospora leaf spot

Septoria leaf spot

Alternaria leaf spot

Small circular lesions initially, later join to form larger spots, leaves dry up and fall

MANAGEMENT MEASURES

- Use disease free seeds or planting material
- Spray Mancozeb 1000g /ha at initiation of the disease and 10 days later

DISEASE: Tikka Leaf Spot

CROP: Ground Nut

DIAGNOSTIC SYMPTOMS

- **Early leaf spot (prominent yellow hallow and brown spots)**
- **Lesions are small initially**

- **Late leaf spot (less prominent yellow hallow and dark spots)**
- **These spots enlarge, leaves dry and fall off**

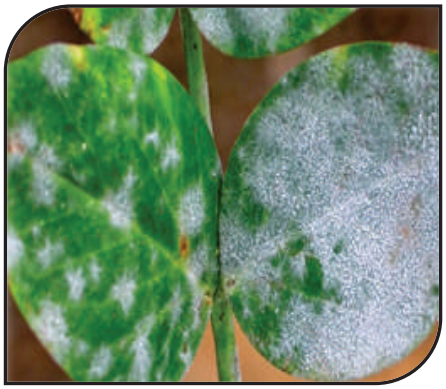
MANAGEMENT MEASURES

- Intercropping WITH pearl millet or sorghum with groundnut (1:3)
- Crop rotation with cereals
- Deep burying of crop residues in the soil, removal of volunteer groundnuplants
- Spray Carbendazim 0.1% or Mancozeb 0.2%

DISEASE: Powdery Mildew

CROP: Greengram,blackgram, Beans, Peas, Redgram, Cucurbits, Rose, Grapes, Mango Etc

DIAGNOSTIC SYMPTOMS



White powdery growth on upper surface of leaves

Affected leaves turn yellow, brown , dry and fall off

MANAGEMENT MEASURES

- Overhead sprinkling may help reduce powdery mildew because spores are washed off the plant
- Spray Difenoconazole 25% EC @ 0.0125% or 12.5 g/100 lit. water

DISEASE: Downy Mildews

CROP: Cucumber, pumpkin, watermelons, muskmelon, grapes

DIAGNOSTIC SYMPTOMS

Irregular yellow spots on upper surface of leaves

White fungal growth on corresponding lower surface

Chlorotic streaks on leaves shredding of leaves, plants are stunted

Leaf like structures develop in tassesls

MANAGEMENT MEASURES

- Use disease-free seed seeds
- Removal and destruction of infected plants reduces the spread of disease
- Seed treatment with Metalaxyl 35% @ 6 g. kg seed
- Foliar application of the Ridouril HZ 72 at 3g per litre of water

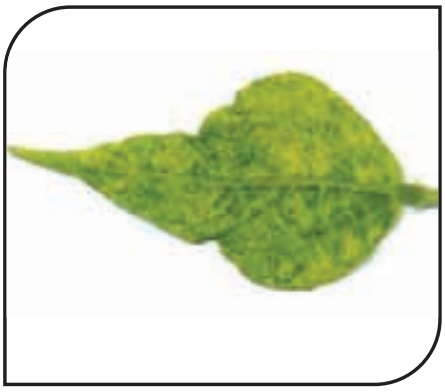
DISEASE: Yellow Mosaic

CROP: Greengram, Blackgram, Beans, Cowpea, Soybean

TRANSMITTED BY: Sucking Pests Like Whiteflies, Jassids, Thrips Etc

DIAGNOSTIC SYMPTOMS

Yellow patches alternated with green patches



New leaves turn totally yellow, plants remain stunted, yield less or no yield at all

MANAGEMENT MEASURES

- Rogue out the diseased plants upto 40 days after sowing
- Increase the seed rate (25 kg/ha)
- Grow two rows of maize (60 x 30 cm) or sorghum (45 x15 cm) for every 15 rows of black gram or green gram
- Under severe conditions spray phosphamidon 40% SL 250-300 gm a.i /ha;

DISEASE: Yellow Vein Mosaic

CROP: Bhendi, Potato

DIAGNOSTIC SYMPTOMS

Yellowing of veins, yellowing of inter-veinal areas, stunted plants, yield loss

MANAGEMENT MEASURES

- Grow resistant varieties like Arka Abhay, Arka Anamika etc
- Set up yellow sticky traps to trap whiteflies
- As the disease is spread by whitefly, spraying chlorpyriphos 2.5 ml + neem oil 2 ml lit of water can minimise the disease infestation

DISEASE: Rusts

CROP : Wheat, Sorghum, Bajra, Millets, Groundnut, Sunflower, Rose, Bengalgram Etc

DIAGNOSTIC SYMPTOMS

Rust pustules on undersurface of leaves

Chlorotic patches on corresponding upper surface

chlorotic patches on corresponding upper surface

orange/red/brown rust pustules on undersurface of leaf

MANAGEMENT MEASURES

- Eradication of self-sown wheat plants and weed hosts
- Adjust time of sowing
- Avoid late sowing
- Balanced application of nitrogenous fertilizers
- Mixed cropping and crop rotation
- Avoid excess “N” Fertilizers
- Propiconazole 25% EC 125 a.i. gm or Sulphur dusting @ 35-40 kg/ha

DISEASE: White Rust

CROP: Mustard

DIAGNOSTIC SYMPTOMS

Creamy yellow pustules develop on the lower leaf surface which later join to form patches on the lower leaf surface pustules formed on pods, infected flowers turn sterile

MANAGEMENT MEASURES

- Destroy infected plants
- Planting crops in dry seasons can reduce infection
- Intercrop crucifers with non-susceptible hosts
- Use recommended resistant variety
- Use at least a three years crop rotation
- Spray propiconazole 25 EL (0.05%)

DISEASE: Damping Off

CROP: Nursery of Vegetables, Flowers, Cereals, Fruit And Forest Trees

DIAGNOSTIC SYMPTOMS

Seed rot due to infection

Seedlings die in patches

Water soaked lesions on stem of young seedlings, fall and die

MANAGEMENT MEASURES

- Avoid shade places for nursery establishment
- Use recommended seed rate
- Avoid flooding type of irrigation and maintain optimum moisture level in nursery
- Drench soil with captan 75% WP @ 0.25%

DISEASE: Root Rot

CROP: Bengalgram, Greengram, Blackgram, Redgram, Cotton, Cabbage, Chilli, Tomato Etc

DIAGNOSTIC SYMPTOMS

Sunken reddish brown lesions on hypocotyl

Yellowing

Wilting of infected plants

MANAGEMENT MEASURES

- Treat the seeds with Trichoderma viride @ 10 g/kg or Pseudomonas fluorescens @ 10g/kg of seed
- Apply farmyard manure @10 t/ha.
- Sowing early (First week of April) or late sowing (Last week of June)
- Intercropping with sorghum or moth bean
- Drench soil with 1% Bordeaux mixture

WILTS: Caused by Fungi (fusarium And Verticillium)

CROP: Redgram, Bengalgram, Greengram, Blackgram, Tomato, Brinjal, Chilli, Banana, Beans, Green Peas, Bhendi, Cabbage, Cauliflower etc.

DIAGNOSTIC SYMPTOMS



Yellowing, drying of leaves, wilting of plants



Brown discoluration of vascular bundles

NOTE:

Symptoms of both verticillium and fusarium are similar but in verticillium wilt discolouration in vascular bundles is not so prominent

MANAGEMENT MEASURES

BANANA WILT

- Selecting healthy suckers from disease fields
- Remove and destroy infested plant material after harvest
- Provide good drainage especially during rainy season
- Apply well decomposed compost around the plants mixed with Pseudomonas fluorescens @ 2.5kg/ha
- Provide mechanical barriers in and around the infected plants
- Apply 60 mg of Pseudomonas fluorescens capsule in a 10 cm deep hole made in corm
- Apply Trichoderma viride @ 25 g per pit at the time of planting followed by application during third, fifth and seventh month after planting
- Soil drenching of Carbendazim 0.2 per cent solution alternated with Propiconozole 0.1% around the pseudostem at bimonthly intervals starting from five months after planting
- Application of urea + sugarcane trash (250g/pit) followed by lime (1Kg/pit) and neem cake (1-2Kg/pit)

WILTS OF OTHER CROPS

- Use of disease free seeds or planting material
- Removal and destruction of infected plants
- Crop rotation with Cereal crops
- Seed treatment with carbendazim @2g/kg
- Deep Summer ploughing
- Destruction of left over plants, crop rotation
- Mix 2kg T.viride formulation mixed with 50kg FYM, sprinkle water and cover with a thin polythene sheet. When mycelia growth is visible on the heap after 15 days, apply the mixture in rows of chilli in an area of one acre

DISEASE: Bacterial Wilt

CROP: Tomato, Brinjal, Chilli, Cucumber, Muskmelon Pumpkin, Squash etc.

DIAGNOSTIC SYMPTOMS



Sudden wilting, leaves remain green and then brown, sudden death of plants

MANAGEMENT MEASURES

- Crop rotation with cruciferous vegetables such as cauliflower
- Fields should be kept clean and effected parts are to be collected and burnt
- Spray 2% Bordeaux mixture

DISEASE: Quick Wilt

CROP : Pepper

DIAGNOSTIC SYMPTOMS

Die back

Leaf spot

Stem rot

Collar and root rot

MANAGEMENT MEASURES

- Destruction of dead vines along with root system
- Select Disease free Planting material
- Avoid Injury to the root system during cultural practices
- Avoid fresh runner shoots from trailing on the ground
- Spray Metalaxyl M 4% + Mancozeb 64% WP @ 1700 g ai/ha,

DISEASE: Loose Smut

CROP : Sorghum, Bajra

DIAGNOSTIC SYMPTOMS

Long smut

Grain smut

Head smut

Seeds replaced by smut sori leading to severe yield loss

MANAGEMENT MEASURES

- Treat the seed with Vitavax @ 2g/kg seed before sowing
- Burry the infected ear heads in the soil, so that secondary spread is avoided

DISEASE: False Smut

CROP : Paddy

DIAGNOSTIC SYMPTOMS



Grains get transformed into yellow spore mass which after bursting turn black

MANAGEMENT MEASURES

- Use of disease-free seeds that are selected from healthy crop
- Avoid field activities when the plants are wet
- Early planted crop has less smut balls than the late planted crop
- At the time of harvesting, diseased plants should be removed and destroyed
- Field bunds and irrigation channels should be kept clean to eliminate alternate hosts
- Excess application of nitrogenous fertilizer should be avoided
- Spray Copper hydroxide 53.8% DF 525 a.i. (g)

DISEASE: Ergot

CROP: Sorghum, Bajra

DIAGNOSTIC SYMPTOMS



Honey dew secretion from infected florets, sooty mould infection observed

MANAGEMENT MEASURES

- Sowing of ergot free seed
- Soaking seeds with 5% salt solution will aid to remove ergot infested seeds, as ergot infested seeds will float in the salt solution
- Spray either Carbendazim 500g or Mancozeb 1000g /ha at 10% and 50% flowering stage respectively

DISEASE: Spotted Wilt Virus

CROP: Tomato

TRANSMITTED BY: Thrips

DIAGNOSTIC SYMPTOMS

Chlorotic rings on leaves

Necrotic rings on leaves

Thickening of veins, wilting, dieback

Concentric rings on fruits

MANAGEMENT MEASURES

- Destruction of infected plants and weedhosts
- Growing Crotolaria juncea as a barrier crop reduces vector migration
- Raise barrier crops – Sorghum, Maize, Bajra 5-6 rows around the field before planting tomato
- Spray dimethoate 30% EC 200 gm a.i /ha,

PREPARATION OF BORDEAUX MIXTURE (1%)

FOR MANAGEMENT OF FUNGAL DISEASES LIKE LEAF SPOTS, BLIGHTS, POWDERY MILDEW, RUSTS, ROTS, WILTS, DAMPING OFF, ETC.

Method of preparation

Quicklime solution

1 Kg of quicklime or burnt lime

1A

Copper sulphate solution

1 Kg of powdered copper sulphate

1B

Caution

Use earthern or plastic containers. AVOID metallic containers.

Caution

Do not pour the copper sulpate solution first.

Pour the quicklime solution first.

1C

Then pour the copper sulphate solution.

1D

or

Mix both solutions together, stirring.

1E

1F

Check for acidity/alkalinity

Test the mixture before use by dipping a polished knife or sickle in the mixture.

1G

If the tip shows a reddish colour stain then add lime to the mixture and check again.

If you see a white deposit/stain, then add a bit of copper sulphate.

No stain - neutral pH

1H

Storage

To store solution for 3-5 days, add 1 Kg sugar or jaggery to the mixture.

1I

Method of application

Bordeaux spray is effective against almost all fungal diseases.

PREPARATION OF BORDEAUX PASTE

FOR MANAGEMENT OF FUNGAL DISEASES LIKE CITRUS GUMMOSIS, STEM BLEEDING AND SECONDARY INFECTIONS AFTER PRUNING.

Method of preparation

Caution

Use earthern or plastic containers. AVOID metallic containers.

Caution

Do not pour the copper sulpate solution first.

Pour the quicklime solution first. 1C

Then pour the copper sulphate solution. 1D

or

Mix together to make a paste.

Caution

Don't store the paste. Use immediately. 1E

Method of application

Smear on trunk 1 meter from soil. 2A

Diseased twigs and branches should be pruned few centimeters above ground and burnt.

Dress pruned ends with paste. 2B

CHAPTER 9
POST-HARVEST MANAGEMENT

Context

Reducing crop losses at every stage of crop production is very important for realising food security and price realisation for small and marginal farmer households. According to the Associated Chambers of Commerce of India, India loses approximately INR 926 bn (US$ 14.33 bn) on account of Post-Harvest Loss and crop worth approximately US$ 19.4 mn is wasted daily due to rejection at the farm gate and delays in the distribution process.

Post- harvest handling

The harvested crop needs to be cleaned, sorted, cooled, packed and appropriately stored to preserve/ retain the quality and worth human consumption.

Harvested crops need to be kept in proper storage conditions to

- avoid loss of moisture
- slow down undesirable chemical changes and
- reduce any physical damages during the process of handling the produce
- keeping produce free from pathogens.

Best practices for timing harvest include

1. **Timing**:

   Crop should be harvested at a specified time based on colour, size, shape, and firmness of the grain/ fruit/ root. If the crop is harvested too early – it will not be ripe enough and if it is harvested too late, it may rapidly spoil/ rot.

Harvesting indicators of some of the major crops:

Crop	Harvest indicators
Rice	**Time** : Harvesting after 32 days of flowering **Colour** : Milky grains - less than one percent Green grains - not more than four to nine percent Atleast 80% of the panicles turn straw coloured **Moisture** : content - less than 20% **Firmness** : Grains in lower part of the panicle in hard dough stage *Atleast 5 hills have to assessed for harvest criterias*
Sorghum	**Time** : 40 days after flowering **Firmness** : Ear heads will be yellow with hard grains **Moisture** : Grains with less than 28% moisture content
Bajra	**Firmness** : Ears will be very compact On pressing ears grains will come out **Time** : 28-35 days after flowering
Ragi	**Colour/ Firmness :** Ear heads will be brown with hard grains
Maize	**Time** : 25- 30 days after tasseling **Moisure** : Less than 22-25% moisture in the grains **Colour** : Pale brown husk
Wheat	**Colour** : Spikelets will turn yellow **Moisure** : Less than 15% moisture in the grains **Firmness** : Grains in hard dough stage
Redgram	**Colour** : 80% of the pods turn brown **Time** : 35-40 days after flowering
Greengram, Blackgram Cowpea	**Colour/ Firmness :** Pods turn brown or black with hard seeds inside
Groundnut	**Firmness/Texture :** Oil on fingers if kernels are crushed **Colour** : Dark coloured patches inside the shell Kernels will be red or pink Pods will turn dark from light colour.
Soybean	**Time** : 30 days from 50% flowering **Colour** : 70% of pods turn yellow and few at the base turn brown Most of the basal leaves have dropped and rests are yellow coloured
Cotton	**Appearance :** Bolls - fully opened.

2. Handling

- Store horticultural crops under shade while being harvesting
- Use tools and techniques that cause minimum damage while harvesting
- Use cartons, wooden crates, and plastic containers to store produce

3. Threshing/ Shelling

- process of separation of grains
- usually done after the grain moisture content is reduced to 15 to 17%
- Three basic operations rubbing, impact and stripping

4. Drying

- to lower the moisture content of the grain for safe storage and further processing
- Exposing the produce to the sun in an open, well-ventilated space
- Ensuring that drying produce does not mix with dirt and pests by keeping it off the ground, for instance on a raised drying platform
- Using more advanced solar-drying / mechanical hot air technologies.

5. Cleaning and Sorting

Harvested crops need to be cleaned and sorted to remove damaged, diseased, mouldy, un-ripe and over-ripe produce and pests

6. Transporting

- Avoiding stacking produce too high
- Use reusable boxes or crates
- Layer straw or soft material between produces to reduce rubbing
- Measures to reduce overheating of produce

7. Storing

Produce from smallholder farming systems is commonly stored:

- For domestic consumption
- For later sal

Note: Storage covered in previous chapter

8. Marketing

Marketing is the final, decisive element in the post-harvest system. Any losses and damage before, during, and after harvest determine the price paid for the product in the market**.** The price paid in the market affects all the other financial interactions, right down to the producer level.

Most of the losses associated with marketing result from the product moving from production to processing and to market, in addition to spoilage in the market itself.

Types of market:

wholesale, assembly (where farmers sell to small traders), farmers' markets, organised/ unorganised retail outlets, direct consumer sale, online etc.

Produce marketing best practices:

Identifying the points/ cause of damage : people, methods before/during/ post-harvest and addressing them to improve the market price

- Holding/ storing fruits and vegetables in shade to avoid drying out in open-air
- Avoid stacking high
- Keeping them moist

Reliance Foundation
Reliance Corporation Park-Thane, Navi Mumbai, Maharashtra
www.reliancefoundation.org

National Institute of Agricultural Extension Management (MANAGE)
(An Autonomous Organization under the Ministry of Agriculture and Farmers Welfare, Govt. of India)
Rajendranagar, Hyderabad 500 030, Telangana, India
www.manage.gov.in