Farmer Field School

Training Manual






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CONTENT

Integrated Pest management

IPM is a sustainable approach of managing insect/pests by combination of biological, cultural, mechanical and chemical methods, to minimize economic, health and environmental risks.

Excessive and continual use of chemical insecticides/pesticides as part of farming practices can harm farmers and farm workers. Hazards may arise as they contaminate air, water and can remain active in soil for many years, causing harmful effects to humans, plants, animals and beneficial flora and fauna. IPM technology manages the insect/pest population in such a manner that economic loss is avoided and adverse side effects of chemical pesticides are minimized.

Methods-

(i) Cultural control: It includes

- Removal and destruction of stubbles after harvest.
- Trimming and plastering of field bunds and keep field free from weeds
- Synchronized sowing
- Leaving rogue space
- Avoiding closer spacing
- Judicious water management
- Avoiding excess fertilization especially nitrogenous fertilizers which induces BPH and leaf folder.
- Remove stem borer egg masses by dipping off tip of rice seedling during transplanting
- Using resistant varieties.
- Behavioural: Using traps (light/sticky) for monitoring and trapping of insects in rice field.

(ii) Mechanical control: These are done through hand picking, installation of bird perches, mulching and installation of traps.

(iii) *Biological control*: These include increasing the use of natural enemies of pests such as insect predators, parasites, pathogens and weed feeders. It includes –

- Conserving spiders, mirids and other natural enemies by reduced rounds of insecticidal sprays and spraying safer insecticides.
- Release T. Japonicum @ 1 lakh per ha twice on 30 and 37 DAP against stem borer and T. chilonis @ 1 lakh per ha thrice on 37,44 and 51 DAP against leaf folder.
- Release Platygaster oryzae parasitized galls @ 1 /102 10 days after planting against gall midge.
- Use of Bio-agents like Trichogramma three times, at one week interval after one month of transplanting for one hectare for the control of rice stem borer.

(iv) *Chemical control :* Synthetic pesticides are used to keep the pest population below economically damaging levels, only if the pest's damaging capacity is nears the threshold. It includes –

- Need based application of insecticides at recommended doses. Plant products like neem seed kernel extract (NSKE) 5% or Neem oil 3% can be sprayed against BPH, leaf folder and GLH.
- Ipomea leaf powder and Prosopis leaf powder are effective against earhead bug.
- Use NSKE 5% or Neem oil 2% against Earhead bug.

1. Major insects-pests and diseases of rice -

Gundhi bug (Leptocorisa varicornis)
Gall midge: Orseolia oryzae
Rice hispa (Dicladispa armigera)
Green leafhopper (Nephotettix sp.)
Climbing cutworm/Rice Ear Cutting Caterpillar/Armyworm (Mythimna separata)
Thrips (Baliothrips biformis)
Termite (Odontotermes spp.)

2. *Diseases* -

Rice blast (Pyricularia oryzae)
Sheath blight (Rhizoctonoa solani)
Bacterial leaf blight (Xanthomonas campestris pv oryzae)

3. *Rodents* -

- Soft furred field rat (Millardia meltada)
- Field mice (Musa spp).

4. Birds

<u>Farmer activity 1 –</u> General discussion amongst the groups on

- what is IPM,
- its importance,
- major insect /pests of rice and losses incurred due to them.
- methods used for control

Questions:

- What are the characteristics of healthy & unhealthy rice plants? What are the causes?
- Which varieties are resistant to different insect/pest? How resistant are healthy plants to pests and disease?
- Best way to destroy disease-infected plant materials?
- Do you know what are the Pheromone traps and light traps and how to use them?
- What do you understand by biological control of insects?

<u>Farmer activity 2</u> – Field walk to collect and identify insects/pests present during the crop season and observe damage levels.

Materials needed:

- Papers, marker pens.
- One notebook and a pen for each participant.
- 3 sets of color pencils.
- Traps (yellow sticky or pheromone) for monitoring specific insect populations.
- Plastic jars or bags to collect insects and/or to set up insect zoos.

- Different cages to study life cycles, emergence of larvae, etc.
- Polystyrene (or other soft material) and needles to set up an insect collection.
- Colored rope to mark plants or traps in the field.

Method :

- Collect different species of insects observed in the crop using traps, bags and jars.
- Identify and discuss on different species collected- farmers can draw major harmful insects and document losses caused by each
- Discuss best method to control major insects/pests.

Farmer activity 3 – Preparing Neem Seed Kernel Extract (NSKE) (5 % solution)

Material :

For preparation 100 liters of 5% NSKE solution -

- Neem seed kernels (well dried) – 5 kg
- Water (reasonably good quality) – 100 litres
- Detergent (200 g)
- Muslin cloth for filtering

Method:

- Take required quantity of neem seed kernel (5 kg)
- Grind the kernels gently to powder it
- Soak it overnight in 10 litres of water.
- Stir with wooden plank in the morning till solution becomes milky white
- Filter through double layer of muslin cloth and make the volume to 100 liters
- Add 1% detergent (Make a paste of the detergent and then mix it in the spray solution)
- Mix the spray solution well and use

Note:

- Collect the neem fruits during bearing season and air-dry them under shade.
- Do not use the seeds over eight months of age. The seeds stored over this age lose their activity and hence not fit for NSKE preparation.
- Always use freshly prepared neem seed kernel extract (NSKE).
- Spray the extract after 3.30 P.M. to get effective results.
- Observe the effects after 2-3 days.

Farmer activity 4 – Discussion on safe use of insecticides/pesticides and first – aid precautions

Questions :

- Initiate by asking any pesticide poisoning incidents they have experienced
- Which chemicals being used for what purpose? Its effectiveness and costing?
- How they handle/store them?

Discussion on precautions -

Purchase:

1. Do not purchase without proper/approved labels
2. Read labels carefully and follow manufacturer's instructions
3. Purchase only required quantity of insecticides/pesticides for each application.
4. Do not purchase leaking containers, loose, unsealed or torn bags.

Storage:

1. Avoid storage inside house premises.
2. Keep them in labeled, original containers with intact seal.
3. Store in a safe and locked place, out of reach of children and pets.
4. Never store them near food/feed/fodder or medicines.

Handling:

1. Never carry/transport them along with food material.
2. Avoid carrying them in bulk head, shoulder or back.
3. Do not tear open bags, cut them with knife.
4. In their handling wear necessary protective clothing and devices.

Farmer activity 5 – Understanding how pesticide use can be directly hazardous to humans.

Time : 2 hours

Materials :

- Large sheets of paper, markers, adhesive tape
- Sprayer (17 liter)
- 1 roll of toilet paper
- Red dye
- Water
- Field

Method :

1. Prepare a mixture of water and red dye. Fill the sprayer with the colored water.
2. One volunteer to wrap toilet paper around his or her legs, arms, head and face leaving eyes free.
3. Ask the volunteer to put on the sprayer and spray the field as he/she would normally do with pesticide. Allow this to go on for about 10 minutes.

4. Take off the sprayer and observe which parts of the body of the volunteer have changed colour, the head, chest, back, forearms, elbows, legs and other parts.

Discussion :

- What parts of the body did the red water hit?
- How can these chemicals enter the body?
- Can using protective clothing such as masks, gloves, or boots reduce poisoning?
- How does wind affect which parts of the body become exposed to pesticide while spraying?
- Are pesticides safe? What are their effects on humans?

Seedbed Preparation and Sowing

Seedbed preparation and management is the most important factor in the success of any planting. The seedbed must be smooth and weed free. Weeds will compete with seedlings for nutrients, water and sunlight. If not controlled they can considerably delay the growth and maturation of the seeds. A smooth, clump-free seedbed will guarantee firm contact between the soil and seed, thus enhancing seed germination and growth.

1. *Steps to prepare seedbeds -*

- Chose the right time to plow, right time to disc, right time to harrow.
- Preparation seed beds :

- Clear off all heavy trash and crop residue - dried stocks, rocks, branches, etc.
- Use plows in light soils such as sandy loams and silts. Plow in heavy soils containing large amounts of clay.
- Disc plow the ground immediately so as not to give it the chance to get hard and dry after plowing.
- Use disc harrow/plank or pata to level the field.

2. *Sowing -*

It is placing of specified quantity of seeds in soil in the optimum position for its germination. Too shallow sowing results in thin germination due to inadequate soil moisture at top soil layer and if sown very deep, the young seedlings may not be able to push their shoots above, through thick soil layer. They should be properly covered with soil so that they get adequate moisture for germination. Seeds are sown either directly in the field or in nurseries where they are raised and then transplanted later. The seeds selected for sowing should have following characteristics –

- They should be healthy, pure and free from all inert materials and weed seeds.
- Should be viable for germination and if the seeds are from older lot, it is important to break their dormancy either by :
  a) Physical treatments like heat treatment at 40 to 45oC for different durations, or low temperature treatments at 2 to 8oC for 12-24 hours; alternate wetting or drying 4 to 5 times
  b) Using dilute acid solutions of HCl or H_2SO_4 (0.1-0.5%) for different durations.
  c) Using organic chemicals like Ascorbic acid, thiourea (10-100 ppm) or Gibberellic Acid (1-100ppm).
- They must be uniform in texture, structure abd look.
- Must be well labeled and produced ubder due care to prevent mixing of varities.
- Must free from any diseases or insects at the time of sowing.

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Sowing Methods:

Rice is mainly grown as, (i) uplands and (ii) low lands. The method of cultivation depends largely on factors like situation of land, type of soils, irrigation facilities, availability of labour, intensity and distribution of rainfalls. The following methods are adopted for sowing:-

Dry or Semi-dry upland cultivation -

(a) Broadcasting the seed - Seeds are scattered uniformly by hand all over well-prepared field and then covered with soil through the help of light implement or plank.

Advantages

i. It is a quicker and cheaper method in terms of labour cost.
ii. Implements are not required for sowing.
iii. Skilled labour is not required for sowing.

iv. It can be done in moist condition.

Disadvantages

i. It requires more seed per unit area.
ii. The seeds fall at different depth resulting in uneven and gapy plant stand as shallow-sown seed may not germinate due to adverse moisture condition and germination of deep sown seed may have adverse effects due to depth.
iii. Inter culture operation is difficult as spacing is not maintained

(b) Sowing the seed behind the plough or drilling - Sowing of seeds in lines is done with sowing implements like seed drill. These rows may be straight or parallel. Drilling may be adopted for pure cropping and intercropping.

Advantages:

i. Seed placement is done at proper and uniform depth resulting into uniform germination.
ii. Seed rate required is less as compared to broadcasting method.
iii. This method avoids crowding of seedling and maintains uniform spacing between two rows.
iv. Inter culture can be carried out easily.
v. Plant population can be adjusted.
vi. Sowing depth can be adjusted in order to place the seed at moist zone.

Disadvantages:

i. It is not possible to maintain plant to plant distance using ordinary seed drill.
ii. Requires seed drill for sowing hence it is costly than broadcasting method.
iii. Skilled person is required for carrying out sowing operation, if seeds are not sown properly it may lead to uneven germination and ultimately poor crop stand.

Wet or lowland cultivation - Transplanting in puddled fields.

Nursery Raising :

There are three major methods of raising nursery -

1. The dry nursery where the dry seed is sown in dry soil. This method is practiced in areas where water is not sufficient to grow seedlings in wet nursery
2. Wet nursery where sprouted seed is sown on the moist puddled soil. Wet nurseries are preferred under irrigated condition
3. "Dapog" method - Dapog method of raising nursery consists of growing seedlings on a concrete floor or a raised soil bed covered with polyethelene sheets. The method is used especially in places where supply of water is assured.

Transplanting :

Before transplanting, field are puddled with bullocks or tractor drawn puddlers. Seedlings about 15 to 20 days old from the nursery are uprooted and planted in this puddle fields.

Transplanting should be done with proper age of seedlings. In case of short duration varieties, the seedlings are transplanted, when they are three to four weeks old. In case of medium and long duration varieties, four to five weeks

old seedlings are transplanted. Always healthy seedlings are be used for transplanting at the four to five leaf stage or when they are about 15-20 cm high.

Advantages :

i. It helps to kill the weeds and buries them in puddled soils.
ii. It suppresses germination of weeds in subsequent growing period of crop.
iii. Keeps soil surface in a more even condition, b
iv. Creates beneficial physical, biological and chemical conditions for rice plant growth

Disadvantages :

i. Destroys soil aggregates
ii. Releases methane a green house gas
iii. Breaks capillary pores
iv. Disperses fine clay particles
v. Compacted layer resists root penetration of following crop
vi. Can cause water logging.

Farmer activity 1 : Identification and discussions on –

(a) Best method of seed bed preparation according to farmers using local resources.
(b) Discussion based on -

Questions :

1. When do you start preparing land for planting rice?
2. What do you do to prepare the land?
3. What happens if you do not till the land?
4. Under what circumstances do you not till the land?
5. What are the advantages and disadvantages of the tilling methods you normally use?
6. What is the best way to till the land?

Farmer activity 2 : Observing and discussions on growth stages of rice

Growth stages are broadly characterized into three -

- *Vegetative* (germination to panicle initiation); It includes germination, early seed growth and tillering. It is characterized by active tillering, a gradual increase in plant height and leaf emergence at regular intervals. The period is of ten days after seedling establishment to maximum tillering stage which comes between 35 to 42 days after transplanting.
- *Reproductive* (panicle initiation to flowering) - This is characterized by culm elongation, decline in tiller number, booting, emergence of the flag leaf, heading and flowering. The reproductive stage usually lasts approximately 30 days in most varieties. This stage is referred to as the internode elongation or jointing stage and varies slightly by variety and weather conditions.
- *Ripening* (flowering to mature grain) - It consists of following stages :
    a) Milk stage – At this stage, the developing starch grains in the kernel are soft and the interior of the kernel is filled with a white liquid resembling milk. It appears between 7 to 12 days after anthesis.
    b) Soft dough stage – The starch in the grain begins to become firm but is still soft.

c) Hard dough stage – The whole grain is firm during this stage and almost ready for harvest. The moisture content is still above 22 percent. The period required from milky to dough stage is about 2 to 3 weeks.
d) Maturity – The whole grain is hard and ready for harvest. This stage is reached at approximately 20 to 22 percent moisture.

Discussions on -

1. How is rice nursery raised–flat land or raised seedbed?
2. Quantity of organic manure or chemical fertilizer being used for raising nursery?
3. Method and time of application of manure or chemical fertilizer?
4. Management of water and weeds in the nursery?
5. Which varieties sown early/medium or late? Why?
6. Is seed treatment been practiced? If yes, how do you use this technique? If no, why?
7. Do you use pre-germinated seeds or soaked seeds for raising nursery?
8. Outcome to be noted and knowledge of best practices used by the farmers to be disseminated to members not using the techniques for better yields.

Soil Management

Soil is the topmost layer of earth's surface which serves as a natural medium for the plants to grow. Soils are formed due to weathering of rocks and minerals over a period of time. Soil suitable for rice cultivation is heavy to sandy loam, it needs to hold water well, hence soil with 50% clay content is ideal.

Importance- Plants rely on soil for water and nutrients, good understanding of these can help determine what crops to grow and how best to cultivate and manage the land. Imbalanced fertilized soils would result in increased cost of production or will lead to loss in yields.

Composition – Soils mainly consists of sand, silt and clay. They vary in structure, texture, colour, drainage, slope, depth and erosion.

Farmer activity 1: Involve in describing and naming the main soil types of their area.

The main soils descriptors can be -

(a) ***Soil colour :*** This is used by famers as an indicator of soil fertility

Observations -

1. Dark coloured soil indicates it is high in organic matter, which leads to better drainage, good soil structure and better nutrient content
2. Red or brown colour indicates well drained, well aerated soils, which allow free movement of air and water leading to better fertility.
3. Dull yellow soils pose seasonal drainage problems (waterlogging) during the season
4. Grey coloured soils are poorly drained, water-logging is a big issue.

(b) ***Soil texture*** **:** It is the relative amount of sand, silt and clay particles present in the soil.

Observations -

1. Fine textured soils (more clay content) are more difficult to till, its water holding capacity is good, due to slow water movement through its profile. There nutrient content is high, however, root penetration is difficult and the surface crusts easily.
2. Sandy soils comprise of bigger sized particles and have large pore spaces – called which leads to poor water holding capacity and are low in nutrient content. They are easy to till.
3. Loamy soils which have more of silt and clay content are best for cultivation of crops as its ability to hold water and nutrient retention capacity is optimum hence are best suited for plant growth.

Farmer activity 2 - Soil texture-feel test activity for determining texurure

Time required: 1-2 hours

Material :

• water bottle
• soil from different soil types and soil layers
• smooth hard surface such as plywood or metal, or a piece of cardboard

Method :

For carrying out this test, the soil sample should be added with small amount of water till a 'putty' like consistency is obtained.

1. If the soil feels gritty and lacks cohesion (i.e. does not hold together) the soil texture is - very light or sandy

2. Form the moist soil into a round ball, roll the ball of soil between your palms and then on a hard smooth surface to form a ribbon as thick as a pencil, up to about 20-25 cm long. If no ribbon or only a very small ribbon can be formed the soil texture is - light or sandy loam

3. Form the ribbon into a circle. If a circle is formed with cracks the soil texture is - medium or loamy

4. If a circle is formed with no cracks, and the soil is very sticky the soil texture is - heavy or clayey

(c) ***Soil structure*** : This refers to the arrangement of soil particles, which can be prism- like, block like, or spheroidal. This arrangement can be easily changed or disturbed by farming practices such as tillage and water management. Well aerated, friable structure is best suited for crop growth.

Farmer activity 3 - Study on root development and soil compaction

They observe and discuss the properties like size and shape of open spaces, through which roots, air and water can move easily. Good soil structure will lead to good root development.

- In the fields farmers observe rooting pattern , depth of roots and observe moistness of soil at different depths
- Observe and discuss importance of soil compactness/hardness for proper root development and growth of plants. Methods and techniques to improve aeration and pore spaces for movement of water, like – addition of organic manure, compost, addition of worms, insects, roots and fungi improve soil porosity and prevent re-compaction. Gypsum also helps in preventing re-compaction of soils when used with organic manures.

(d) ***Soil organic matter****:* Soil organic matter constitutes that part of soil which is produced by decomposition of plant and animal residues by the microbes and other living organisms present in soil like bacteria, fungi, earthworms, beetles, etc. Organic matter is a vital constituent of soil and provides following benefits –

(i) It is a great source of plant nutrients like N, P, K, Ca etc.
(ii) It helps in improving water holding capacity and increases infiltration of air
(iii) It helps in reduction of soil and water erosion due to its good binding capacity of soil particles.
(iv) It helps in maintaining soil health including texture, structure, compaction and helps in maintaining soil flora and fauna useful for plants.

Farmer activity 4 - Discussions on management practices, importance and methods of adding organic matter in the soil.

- Group identifies various types of manures and their methods of preparation and application in the plots
- Discussion on types and methods of manuring and composting, use of easily available inputs for preparing compost.
- Group discusses and compares importance and benefits of organic manuring over chemical fertilizers.
- Practical demonstration on preparing organic manures like FYM and Vermicomposting.

A. Preparing FYM – methods :

Content (%)	Nutrient
Nitrogen	0.5
Phosphorus	0.25
Potassium	0.4

i) *Pit Method* **:**

Pits of 8m x 2m x 1m dimensions are prepared, which are filled in layers by the mixture of dung, urine and litter up to about 50 cm above ground level. The top is covered by dry soil and then plastered by mud paste. The manure is ready after about 150 to 180 days of plastering. Usually 10-12 tones of FYM obtained/pit or every animal gives out about 5 to 6 tones of FYM /year.

ii) *Heap Method :*

Every day sweepings, cow dung and litter are collected and heaped at any fixed place. After about 6 to 9 months, the rotten manure is used. In this method, about 30 to 35% N, 20 to 25% P_2O_5 & 4-6% K are lost during preparation of manure due to leaching, washing and volatilization

iii) *Trench Method :*

Trenches of 6 to 8 m length, 1.5 to 2 m width, and 1 to 1.25 m depth are prepared. Mixture of dung and urine soaked litter is deposited in layers until it becomes 50 cm above the ground layer. It is covered with 50 cm deep soil or wood ash- soil layer and then plastered by mud paste. Manure becomes ready for use after about 150 – 160 days of plastering.

Methods of FYM Application **:**

- FYM is uniformly spread over soil surface and mixed thoroughly.
- It is applied 15-20 days before sowing or transplanting so that manure goes under ammonification and nitrification process.
- Application of undecomposed manure should not be applied.
- Soil should have sufficient moisture at the time of application for proper microbial activity to take place. Rate of application ranges between 2-5 tones/ha for most crops. It can be 50 to 100 tones/ha for vegetables, sugarcane etc. For best response it must be well powdered and sieved, especially for use in nurseries.

Beneficial Effects of FYM :

- FYM is rich in nutrients
- A small amount of N is directly available to the plants while a larger portion is made available as and when the FYM decomposes.
- Application of FYM improves soil fertility.
- It improves physical, chemical & biological properties of soil.

Disadvantages:

- Its decomposition releases harmful gases which pollutes atmosphere.
- Needs inputs like cowdung etc., which may not be readily available in large quantities with the farmer.
- Requires time to prepare.

B. Preparing Vermicompost – methods :

It is defined as a process of converting organic waste into vermicompost through the activities of earthworm.

Content (%)	Nutrient
Available N	0.50
Available P	0.30
Available K	0.24

(i) Bed method : Composting is done on the pucca / kachcha floor by making bed (6x2x2 feet size) of organic mixture. This method is easy to maintain and to practice.

(ii) Pit method: Composting is done in the cemented pits of size 5x5x3 feet. The unit is covered with thatch grass or any other locally available materials. This method is not preferred due to poor aeration, water logging at bottom, and more cost of production.

(iii) Following steps are followed for preparation -

- Beds/units should be located in a cool, moist and shady place
- Cow dung, food waste, chopped dried leaves, twigs etc. are mixed in the proportion of 3: 1 and are kept for partial decomposition for 15 – 20 days.
- A layer of 15-20 cm of chopped dried leaves/grasses is kept as bedding material at the bottom.
- Red earthworm (1500-2000) are released on the upper layer of bed.
- Water is sprinkled with can, immediately after the release of worms.
- Beds are kept moist by sprinkling of water and covering with gunny bags/polythene
- Beds are turned at 30 days intervals, for maintaining aeration and proper decomposition.
- Compost gets ready in 45-50 days.
- The finished product is 3/4th of the raw materials used.
- For field crops and vegetables, vermi-compost is applied at the time of final land preparation using broadcasting method.

Advantages of Vermicomposting -

- Improves soil physical structure
- Helps multiplication of microbes and maintains normal soil pH
- As particle size is very small, plants can absorb very easily
- Contains almost all essential nutrients and hormones for plants growth
- Improves water holding capacity of soil
- Due to healthy plant growth, plant can resist insect attack.
- Products have good taste, odour and nutritive value

(e) *Soil Conservation -* It refers to the management practices to safeguard soil from erosion and depletion by water and wind.

Importance : If soil fertility and good soil health is degraded due to erosion, the crop yields would be adversely affected due to non-availability of right amount of nutrients, water and im .

Techniques / Methods of Soil Conservation -

(i) Cover crops such as grasses, legumes are planted on uncultivated lands or exposed soil surfaces.

(ii) Using modified farming techniques such as strip cropping a practice of planting alternate rows of crops like beans and peas (closely planted species), with wide spaced crops like corn, or contour cropping in hills which involves sowing crops in lines against the slope to reduce run-off and soil erosion, are effective measures in soil conservation.

(iii) Terracing, the practice of growing crops on flat steps in hills or regions with uneven topography, prevents soil from getting washed away by run-off.

(iv) Construction of check dams on steep slopes and hills prevents gully erosion.

(v) Planting of trees, hedges or fences as wind breaks which act as barriers against winds, reducing soil erosion.

(vi) Controlled grazing of pastures will lead to retention of grass cover which will prevent exposure of barren surface for wind and water to erode.

(vii) Using proper tillage operations – Zero till or minimum till operations should be adopted to conserve soil moisture and degrading soil structure in unirrigated areas.

(viii) Mulches – Prevents soil erosion both from wind and water acting as barriers against them in the exposed soil surfaces.

(ix) Crop rotations – Following proper crop rotations including cereals, oilseeds, pulses, conserves soil nutrients and reduces soil erosion, due to planting of differentially rooted crops.

Farmer activity 5 - Soil conservation and local methods adopted to conserve soil and water.

- Discussions on importance and methods of soil conservation
- Best method to conserve soil, using readily available local resources, with practical demonstration using crop mulches (straw, leaves etc.).[As in Farmer activity – 9]

Farmer activity 6 - Soil sample collection and testing for essential plant nutrients -

This activity is essential to know the nutrient status of the soils of farmers plots. The major nutrients essential for rice growth and yields are – nitrogen, phosphorus, potassium, sulphur, calcium, magnesium and zinc.

Nitrogen (N) increases plant height, panicle number, leaf size, spikelet number, and number of filled spikelets, which largely determine the yield capacity of a rice plant. Panicle number is largely influenced by the number of tillers that develop during the vegetative stage.

Phosphorus (P) nutrition is critical for producing maximum rice grain yields. It is very important in the early vegetative growth stages, as it promotes tillering, root development, early flowering, and ripening in rice plants.

Potassium (K) nutrition promotes tillering, panicle development, spikelet fertility, nutrient uptake of nitrogen and phosphorus, leaf area and leaf longevity and disease resistance.

Method -

Tools like shovel or spade, knife, pail and plastic bags will be used to collect the soil samples using following soil sampling technique –

i) A map of the farm will be prepared, showing sampling areas as rounded circles. selected in such a manner that it is more or less uniform in cropping history, fertilizer application, slope, soil texture, etc.
ii) For shallow rooted crops, samples are collected taken from surface layer (20-30 cm), while soil samples are collected from the subsoil (approximately 20-26 cm), for deep-rooted crops.

iii) 5-10 pits are dug upto a depth of 20-30 cm, depending on the rooting pattern of the crop.

iv) From one vertical side of the pit, a slice of soil 2-3 cm thick is taken with a single downward thrust of the spade. Using a knife, trim the slice of soil on both sides to a bar 3-4 cm width.

v) Place this bar of soil (representing one spot soil sample) in a pail or any suitable clean container.

vi) Cover the pit and move to another spot.

vii) After collecting all the spot soil samples of a particular sampling area, pulverize, mix thoroughly and remove stones and fresh leaves from the soil in the container.

viii) Place the composite soil sample (about ½ kg) in a clean plastic bag. After that, the composite soil sample, which represents the soil of the sampling area, is now ready for chemical analysis using a soil testing kit or samples may be sent to a soil testing laboratory with pertinent label and information for for N,P,K, Ca, Mg and other trace elements.

ix) Soil testing kits are useful in determining in situ nutrient status and can mainly be used for determining major soils nutrients like N, P, K, Ca and Mg. it is also useful if soil test has been recently conducted at soil testing laboratory of the area. If the soil tests have not been carried out for 2-3 years it is important to get them tested at local test laboratories for other micro-nutrients like Zn, Fe, Mn, etc and for other characteristics like soil pH and texture.

Water Management

Water consists of over 90% of plant body when it is green. It helps in absorption of nutrients provides turgidity to them and is an important constituent during photosynthesis, process of preparing food in plants. It becomes necessary that an ideal soil moisture level is maintained for better growth, yield and quality or rice. Rice being a Kharif season crop is highly dependent on rainfall to meet its water requirement. Timing of the rains is everything for farmers and knowing ahead of planting schedule when the monsoon will come helps them to know -

• When to sow rice successfully under rainfed or un-irrigated conditions.
• Predicting risks of crop failure if water stress or drought occurs.
• In case of crop failures, alternate crops to be taken
• Identify critical stages for applying water to different crops to get better yields.

Main sources of water are -

- Above the surface : Rain
- Surface water : Reservoirs, rivers, streams, ponds, tanks and lakes.
- Ground Water : Shallow wells, deep wells and springs.

Soil Water balance -

Gains of water in soil	*Loss of water from soil*
- Rain	- Evaporation
- Irrigation	- Transpiration
- Flood	- Soil infiltration/seepage
- Snowfall	- Drainage & surface run-off
- Dew	

Human activities are continuously increasing pressures on water resources. Urbanisation, population growth, growing competition for water, and pollution along with improper management and unequal access is leading to global water crisis. The impacts of climate change will negatively affect livelihood security, induce risks and vulnerabilities in sectors such as health, agriculture and food security, energy, transport, water supply and sanitation, industry,

Water Management & Conservation of Water Resources :

Supply of freshwater is quickly being depleted through rapidly warming temperatures and variations in the hydrological cycle among other changes. Global warming is taking place at an alarming rate. It is leading to greater intensity of monsoon episodes but for shorter duration causing flash flooding. Another worry is a lack of adequate water supplies to irrigate fields creating drought scenarios.

Water Conservation

Improvements in the efficiency of irrigation can have dramatic effects on the availability of water for other sectors like domestic. Sustainable agriculture management practices can help conserve water and at the same time reduce demand for agriculture use.

1. ***Check dams***

   Check dams are constructed over gullies that help to sustain water table levels. They conserve water following storms and recharge groundwater which can be drawn up through wells. There are many advantages to check dams, among them being they are inexpensive to build and do not require a great deal of upkeep. It slows down water speed during flood events and captures extra monsoon rains and run-off for future irrigation or drinking uses. It also controls erosion and prevents soil being carried away by the rain.

2. ***Contoured bunding***

   Contour bunding is built on flat land for growing crops between parallel ridge lines. It is used to slow down the speed of and reduce water run-off. The bunds act as barriers against soil erosion, maintaining moisture in the field for crops.

3. ***Mulching***

   Mulching is a technique used cover the surface of the soil to prevent heat loss in the ground and evapotranspiration of water. It conserves water by absorbing rainfall and shields soil erosion from wind and rain. Also called residue cover, material from past harvests, leaves, branches and other plant materials can also be used. Crop residues and mulch are vulnerable to decomposing in hot climates and to termites in semi-arid regions. Plastic mulching is an alternative that solves some of these problems but they increase run-off and can be polluting

4. **Terracing**

   They are built along slopes, forming risers or steps from each layer of flat land helping to control soil erosion and run-off from monsoon rains. Vegetation on slopes further helps in preventing hazards such as landslides, although extremely saturated land after torrential rains may slip. Terraces are often built with cover. Trees and crops can be grown on the even spaces in between risers. Terracing not only provides irrigation, it also serves to drain away excess water in a safe manner. However the disadvantage of terracing is that it is time-consuming and expensive to build.

5. **Rainwater harvesting**

   It is the process of collecting excess rain water trough pipes and drain channels into a storage tank for future use. These practices are particularly useful in regions that are drier and do not receive as much rainfall nor irrigation. RWH provides a decentralized means of catching surplus rainwater that would otherwise flow to the sea or cause floods. This method enhances water supplies, is low-cost, effective, and creates equal opportunities for access since every household can build one outside.

   In roof-top harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to artificial recharge system.

Farmer Activity 1 - Introduction to concept of SRI (system of rice intensification) –

It is an agro-ecological methodology for increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients. It has resulted in 50%-100% or more increased yields, up to a 90% reduction in required seed, and up to 50% water savings.

Method:

- Rice plants: Transplant very young seedlings carefully and singly, and space them widely in a square grid pattern (30 x 30 cm)
- Soil: Keep moist but well drained with good structure and organic matter.
- Water: Apply a minimum of water to keep soil moist but well drained.
- Nutrients: Augment soil nutrients preferably with compost.
- Weeds: Early and regular weeding, using hand or mechanical weed control and incorporating weeds into the soil.

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Farmer activity 2 - **Observe effect of soil cover in reducing evaporation**

Time required: Beginning 45 minutes and after 4 hours another 20 minutes. The activity is undertaken on a hot sunny day.

Materials :

- mulch (dry grass or any crop residue) cut into small pieces, or a plastic sheet
- 2 big transparent plastic bags
- watering can, water
- nails
- sticks

Method :

1. Barren piece of land is selected.
2. Two squares 50 cm x 50 cm are marked. Cover one of the squares with a 1 cm layer of mulch.
3. These two plots are watered using 10 litres of water in each.
4. Plastic bags are placed over the soil surface in a way that the open end of the bags covers the plot and are filled with air. Wooden sticks are placed inside the bags to keep them upright.
5. Bags are nailed to the ground near the openings.
6. This set-up is left for exposure to sunshine for 4 hours. After 4 hours observe amount of water that has evaporated, making a layer inside the plastic bags, from both the plots.
7. Discuss the outcome of experiment and share the benefits of soil cover.

Farmer activity 3 – To observe loss of water through transpiration in crops

Time required: 1 hour each during different times of the day (morning, afternoon, evening)

Materials:

- clean, dry transparent plastic bags (approx. 30 cm x 40 cm)
- string

Method :

1. Select (2-3) healthy crop plants for the activity from sunny area and 2-3 from shady portion in the field.

2. Tie plastic bag over the uppermost stem enclosing maximum leaves at both the locations.

3. Wait for 10-15 minutes, remove the plastic bags. Observe and measure the quantity of water droplets ***formed*** inside the plastic bags.

4. Observe the differences and discuss conclusions

Questions –

- What are the different sources of water in the area and their contribution to drinking, irrigation and consumption by farm animals?
- Sources of availability of Agro-met data and its interpretation for scheduling crops
- What evidences are used by farmers to identify crop water stress.
- What are the methods adopted to conserve water in fields, at home?

Weed Management

Weeds are wild plants growing where they are not wanted and they compete with cultivated plants for space, light, nutrients and water.

Effect of weeds on rice -

1. They reduce the yield and quality of rice by competing for nutrients, water and sunlight

Upland direct seeded rice	: 35-45% reduction in yield
Direct seeded on puddle land	: 20-25% reduction in yield
Transplanted rice	: 10-15% reduction in yield

2. Weeds intensify the pest and disease problem by serving as alternate host
3. Reduce the efficiency of harvesting
4. Reduce the land value

Major weeds of rice -

- *Panicum spp. (Bansi)*
- *Echinochloa spp. (Sawan)*
- *Cyperus spp (Motha)*
- *Eclipta* alba (*Jal bhangra)*
- *Commelina benghalensis*

Methods of weed control –

A. *Mechanical methods :* these include removal by – hand-pulling, hoeing, tillage, flooding, burning and mulching. these methods are useful for destroying weeds in smaller areas or plots. These practices are more labour intensive and are time consuming.

B. *Biological Methods :* This is a permanent, safe and cheap method of controlling weeds. In this natural enemies are employed to kill the weeds. Following *c*rop rotation is an important aspect as growing crops of same family should not be practiced in succession as they act as alternate hosts to weeds eg. Johnson grass grows with Graminae crops throughout the year. Rice may be successfully intercropped with legumes, such as Crotalaria juncea, Vigna sinensis, Glycine max and Sesbania rostrata. which mothers weed stand composed of Echinochloa colona, Panicum spp., Ischaemum rugosum, Cyanotis spp. and Eclipta prostrata.

C. *Chemical method :* use of chemicals kills weeds in two ways either through contact or by translocation into the system of weeds i.e. systemic action. These can be used before sowing of the crop, pre-emergence of weeds as a precautionary measure and post –emergence of weeds. Eg. Basalin (3 lit/ha) can be applied as pre-planting and pre-emergence to control both dicot & monocot weeds. Basagran (3 lit/ha) is applied in rice as post emergence to kill Echinochloa sp. This method is very effective, convenient and less labour intensive, but it leaves harmful residues in soil and plant parts, which can lead to soil degradation and can lead to diseases like cancer in humans and animals on its consumption.

<u>Farmer activity 11 -</u> Field study - Recognizing weeds and discussing weed control methods

Materials needed :

• pen, paper
• hoe

Time required: 2 hours (preferably during crop season).

Method : Farmers take a walk in the field in different directions, collecting weed samples

• Identify the weed status in the plot. Enlist the dominant weeds. (Record local names)
• Compare and identify the samples
• Note any weeds discovered for the first time
• Discuss methods for their control.

Questions :

• what are the common weeds of rice in the area?
• what factors lead to heavy weed infestation?
• what practices and innovations farmer use for weed control?
• which weeds are difficult to control and why?
• is it worthwhile to weed? what are the costs and benefits?
• what is the best time to weed? During what stage of crop growth should you weed?

On-Farm Seed Storage and Seed Conservation

GENERAL OBJECTIVE OF SEED STORAGE

Seed storage is the maintenance of high seed germination and vigour form harvest until next planting. It is important to get adequate plant stands in addition to healthy and vigourous plants. The purpose of seed storage is to maintain the seed in good physical and physiological condition from the time they are harvested until the time they are planted. Seeds have to be stored, of course, because there is usually a period of time between harvest and planting. During this period, the seed have to be kept somewhere. While the time interval between harvest and planting is the basic reason for storing seed, there are other considerations, especially in the case of extended storage of seed.

Seed producers are not always able to market all the seed they produce during the following planting season. In many cases, the unsold seed are "carried over" in storage for marketing during the second planting season after harvest. Problems arise in connection with carryover storage of seed because some kinds, varieties, and lots of seed do not carryover very well.

In the broadest sense the storage period for seed begins with attainment of physiological maturity and ends with resumption of active growth of the embryonic axis, i.e., germination. Seeds are considered to be physiologically and morphologically mature when they reach maximum dry weight. At this stage dry-down or dehydration of the seed is well underway. Dry-down continues after physiological maturity until moisture content of the seed and fruit decreases to a level which permits effective and efficient harvest and threshing. This stage can be termed as harvest maturity. There usually is an interval of time between physiological maturity and harvestable maturity, and this interval represents the first segment of the storage period. Any delays in harvesting the seed after they reach harvest maturity prolongs the first segment of the storage period – often to the detriment of seed quality.

WHY ON-FARM STORAGE?

The small and marginal farmers of India and the Indian subcontinent suffer from one very important problem. The agriculture carried on is on a very low input form. Seeds, fertilizers, plant protectants are purchased and utilized very carefully. There is quite a good awareness on the use of quality seeds but when the need arises to produce their own seeds, the major bottleneck that comes is the storage of the seeds produced. Scientific and technical seed storage requires some good amount of investments towards infrastructure, namely concrete premises. To invest in these kinds of infrastructure, the farmers has to form co-operatives and enter into some Government schemes already in place.

There are certain other, low cost intensive methodologies, that we will be discussing in this manual so that farmers get an access to good quality storage facility within their farming or residential premises.

FACTORS AFFECTING SEED STORAGE / LONGEVITY

We are concerned about the seed longevity for short and medium term storage (below 5 years). For higher storage periods we need to invest on refrigerated storage facilities. There are basically two factors that determine the seed longevity. Seed factors/internal factors and external factors.

SEED FACTORS

Genetic make-up of seed: the storage is influenced by the genetic makeup of the seed. Some kinds are naturally short lived (e.g) onion, soybeans, ground nut etc., Based on the genetic makeup seeds are classified into
Micro biotic – short lived
Meso biotic- medium lived
Macro biotic – long lived

Initial seed quality: Seeds of high initial viability are much more resistant to unfavourable storage environmental conditions than low viable seed. Once seed start to deteriorate it proceeds rapidly. The seed which injured mechanically suffered a lot and loses its viability and vigour very quickly. Generally small seeds escape injury whereas large seeds are more likely to be extensively damaged (e.g) bean, lima-bean and soybean. Spherical seeds usually give more protection than flat or irregularly shaped seeds

Seed moisture content : Most important factor influence the storability. The amount of moisture in the seeds is the most important factor influencing seed viability during storage. Generally if the seed moisture content increases storage life decreases. If seeds are kept at high moisture content the losses could be very rapid due to mould growth very low moisture content below 4% may also damage seeds due to extreme desiccation or cause hard seededness in some crops.

Since the life of a seed largely revolves around its moisture content it is necessary to dry seeds to safe moisture contents. The sage moisture content however depends upon storage length, type of storage structure, kind / variety of seed type of packing material used. For cereals in ordinary storage conditions for 12-18 months, seed drying up to 10% moisture content appears quite satisfactory. However, for storage in sealed containers, drying upto 5-8 % moisture content depending upon particular kind may be necessary.

Microflora, Insects and Mites : The activity of all these organisms can lead to damage resulting in loss of viability. The microflora activity is controlled by Relative Humidity temperature and Moisture Content of seed. Treated seeds with fungicides can be stored for longer periods. Fumigation to control insects will also help in longer period of storage.

Effect of provenance: The place where the seed crop was produced greatly influences the storability. For example, rice harvested in humid climates (Gangetic plains) normally has bad storability than when harvesting done in drier climate (Deccan region). This is due to different climatic conditions and soil types prevailing in different places.

Effect of weather: Fluctuating temperature during seed formation and maturity will affect seed storage. Pre-harvest rain may also affect the viability.

Pre harvest sanitation spray: In pulses, insect infestation comes from field (e.g.) bruchids.

EXTERNAL FACTORS :

Relative humidity: Relative humidity is the amount of water vapour present in the air at a given temperature in proportion to its maximum water holding capacity. Relative Humidity and temperature are the most important factors determining the storage life of seeds. Seeds attain a specific and characteristic moisture content when subjected to given levels of atmospheric humidities. This characteristic moisture content called equilibrium moisture content. Equilibrium moisture content for a particular kind of seed at a given Relative Humidity tends to increase as temperature decreases. Thus the maintenance of seed moisture content during storage is a function of relative humidity and to a lesser extent of temperature. At equilibrium moisture content there is no net gain or loss in seed moisture content.

Temperature: Temperature also plays an important role in life of seed. Insects and moulds increase as temperature increases. The higher the moisture content of the seeds the more they are adversely affected by temperature. Decreasing temperature and seed moisture is an effective means of maintaining seed quality in storage.

Storage Atmosphere: Increase in O_2 pressure decrease the period of viability N_2 and CO_2 atmosphere will increase the storage life of seeds. Oxygen increases the rate of respiration and many times causes the generation of reactive Oxygen species (ROS) that hastens the degradation of mitochondrial membranes and thus reduced viability. So making the seed storage containers fully air tight enhances storage life (of course if the seeds are dried well below 7-8% moisture content).

ON-FARM METHODS OF STORING SEEDS

Primary concerns

a. Keep away moisture: So dry the seeds and store in airtight containers
b. Keep rodents away: Use a higher ground where rodents cannot access or use rodent control poison, glue pads or traps
c. Avoid direct sunlight: Direct sunlight causes "hot-spots" and hastens the process of deteriorations.

Modern methods of seed drying

Its always easy to do sun drying for seeds. If the seeds are dry enough, there will be no fungi/insect problem or deterioration problem. Sundrying of seeds is economical and easy but uncontrolled. If atmospheric humidity is high, sun drying is not effective.

There are many drying agents that are commonly used for seed drying like Silica gel or Lithium Chloride but they are either needed in large quantities or unsafe. Some ceramic types are currently available that are safe, easy to regenerate and are very efficient. This technology uses Drying Beads ® which are small spherical "seed-like" materials that has the capacity to absorb 20% of its weight of water. It absorbs moisture in vapour form from the surrounding air and in turn dries the air. Seeds in turn lose their moisture to come to the Equilibrium moisture content and this process continues till the beads no longer absorb more moisture. This is when the beads are regenerated for further use.

Regeneration happens in an oven with temperatures of 200-250^{0}C for 2-3 hours. The beads are cooled in a metallic airtight container for use again.

Storage of dry seeds

Once the seeds are dry, care is to be taken that they do not acquire moisture again from the atmosphere. So we need to do storage in certain airtight containers. Metal containers are regularly used for foodgrain storage in North and Central India

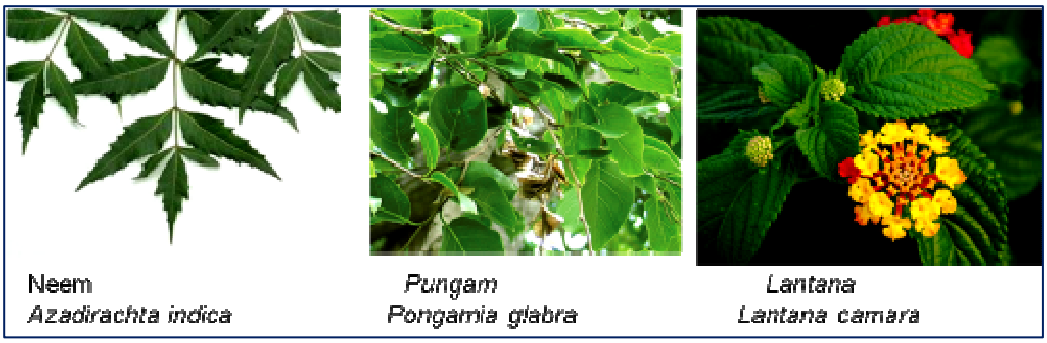
Metal bins /Silos for storage of different seeds

Moreover, PVC drums of 50 or 200 litres capacity (which are used for industrial purpose) can be used for storage of dry seeds. Care to be taken so that the containers are closed in an airtight way. If necessary wax, Teflon tape sealants can be used.

IRRI grain bags are also a new concept where an inner lining by a very specialized, layered plastic bag is used alongwith the normal gunny bags which are 100% impervious to moisture. The only care that needs to be taken while using these bags is that to **AVOID USING HOOKS** for handling as they will puncture the lining of the grain bag.


Fig: The IRRI grain bag

Insect/pest control: the premises of storage is to be kept clean and monitored for any signs of storage insects visible. Prophylactic treatments with Endosulphan can be used. Inside the drums, dried leaves of *Neem, Pungam* or *Lantana (see images below)* can be used in layers as they have the potency to inhibit the growth of any insects or fungi. When the seeds are very dry, however, the chances of insect or fungi developments are quite slim



Steps towards effective seed storage (Field crops, cereals and pulses)

1. Ensure that the seeds are harvested at the right stage and initial sun drying completed to the desired level.
2. Seeds ideally should be cleaned and graded with inert matter taken out as much as possible from the seed lots.