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RICOWAS

"Scaling up Climate-Resilient Rice Production in West Africa"

(Benin, Burkina Faso, Cote d'Ivoire, Gambia, Ghana, Guinea Conakry, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo).

TRAINING MANUAL

TRAINING OF FARMERS ON SUSTAINABLE LAND AND WATER MANAGEMENT (SLWM)

.....Building climate resilient rice production system

NOVEMBER 2024

INTRODUCTION

Concept of sustainability

- **Sustainability** is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs.
- Sustainability seeks to prevent the depletion of Natural Resources, so that they will remain available for long time.
- **Natural resources**: These are resources that exist on the planet that are independent of human action. These include but not limited to soil, water, air and light.
- In agriculture, sustainability is the ability to maintain productivity of farmlands over time through the adoption of practices that improve plant environment.

Sustainable Land and Water Management (SLWM):

- This are practices and technologies that aim to integrate the management of land, water, and other environmental resources to meet human needs while ensuring long-term sustainability, ecosystem services, biodiversity, and livelihoods.
- The importance of application of SLWM practices in agriculture are to: -
  - protect vulnerable lands;
  - prevent and mitigate land degradation;
  - restore degraded soils;
  - control soil erosion;
  - improve soil-water storage;
  - manage soil organic matter;
  - manage and enhance soil fertility;
  - promote integrated soil–crop–water management
  - rehabilitate and sustainably manage dryland environments (e.g. managing rainwater harvesting; sand-dune reclamation and drought land management;
  - manage soil salinity in irrigated land agriculture.
- Implementing SLM, practices are essential in ensuring the sustainable use of land resources and maximizing resilience food production system.

Rice Production Systems

- There are three common rice production systems.
  i. Rainfed lowland system: a system of growing rain in bunded field in lowland or valley that relies on rainfall as primary source of water.
  ii. Rainfed upland system: a method of growing rice in areas with normal soil moisture conditions from valley bottoms to sloping land normally unbunded.
  iii. Irrigated rice system: is a production system in areas that have partial or full irrigation infrastructure and can range from small system to large system that uses pump or gravity.
- Challenges of rice production systems
  i. The amount and timing of water supply.
  ii. Soil erosion.
  iii. Soil fertility often low.
  iv. Drought and seasonal flood.
  v. High cost of input.
  vi. Weed and weed control.
  vii. High post-harvest losses.
  viii. Multiple stresses such as floods, pests and diseases or drought, pest and diseases.
  ix. Soil salinity.
  x. Iron toxicity.

Fig. 1. Lowland rice production system.

Fig. 2. Upland rice production system.

Fig. 3. Irrigation rice production system

APPLICATION OF SUSTAINABLE LAND AND WATER MANAGEMENT PRACTICES

Module 1: Control of Soil Erosion – Tillage System

- In agriculture, soil erosion is the wearing a way of a top soil by the natural physical forces of water or through forces associated with farming activities such as tillage.
- Tillage during land preparation activities such as ploughing and harrowing as well as weed control by mechanical means often contribute to soil erosion.
- The negative impact of soil erosion includes lost of soil nutrients, reduced water holding ability of the soil and organic matter loss from the soil.
- Soil erosion can be controlled using following sustainable soil management practices
  - crop rotation.
  - cover crop,
  - intercropping,
  - establishing water retention basin,
  - building terraces,
  - contour ploughing and
  - conservation tillage minimizes such as no-till, ridge till, zone till and minimum till.
- In SRI practices soil erosion can be controlled through: -
  - Proper land preparation which ploughing, puddling and leveling of fields.
  - Construction of bonds.
  - Use of organic manure.
  - Mechanical weed control at early stage.

Fig. 4. Soil erosion in upland rice ecology

Fig 5. Soil erosion in lowland rice ecology

Fig. 6. Manual tilling of land by hoe.

Fig, 7. Ploughing of field using draught animals

Fig. 8. Puddling of field using draught animal.

Fig. 9. Puddling of field using power tiller

Fig. 10. Leveling of field before transplanting.

Fig. 11. Construction of bunds to conserve water

Module 2. Building Soils with Organic Fertilizers

- ❖ Compost, and Manures:
  - Compost and manures are decomposed organic form of plant and animals which are added to the soil to improve its fertility and the crop yield of crops.
  - It is a mixture of decayed and decaying organic matter use as fertilizers for crops and for soil amendment.
  - Sources of organic fertilizers can be from cattle dung, sheep dungs, poultry manure, green manuring and compost.
  - Benefits of compost and manures in crop production include.
    - Supply nutrient for plant growth
    - Increase organic content of soil
    - Improve soil texture and structure
    - Improve soil permeability
    - Improve water holding capacity of soil
    - Encourage activities of soil microflora and fauna.
- ❖ Green manuring and cover crop
  - Fresh plant material incorporated as green manure into the soil to build its fertility
    - Green manuring are key strategies for soil building, which is the foundation of sustainable farming.
- ❖ Use of Compost, manures and organic fertilizers is key practices in SRI and CRRP
  - Apply 5 – 20 tons of organic manure per hectare improve soils and increase productivity of rice crops.
  - Apply Organic Matter before ploughing to allow it to be buried in the soil.
  - Organic fertilizer had limited N nutrient, thus mineral fertilizers to overcome N deficiencies.
  - UREA super granules are recommended to be applied at 3-4 weeks after transplanting to address N deficiency.

Fig 12. Nitrogen Content of Organic Fertilizers and Compost

Fertilizer	Urea	Poultry Manure	Cattle Manure	Compost
% N	46%	2%	1%	0.50%
100 kg N	217 kg	5000 kg or 5 ton	10,000 kg or 10 ton	20,000 kg or 20 ton

Fig. 13. Recommended application of organic fertilizer and urea during rice growing period

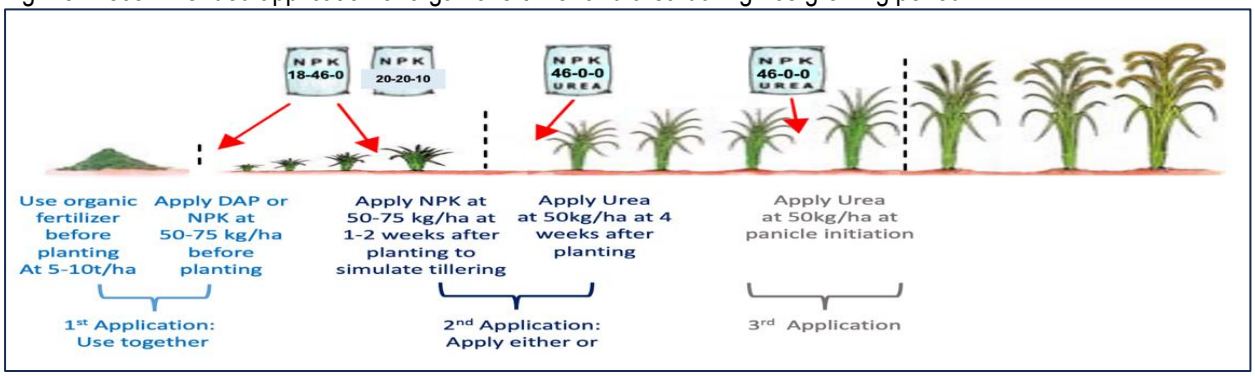


Fig. 14. Compost produced through decomposition of organic materials.

Fig 15. Organic manure drive from cattle dung

Module 3. Practice of Crop Rotation, Intercropping and Diversification

- Crop rotation is growing one crop after another on the same piece of land on different timing to avoid exhausting the soil.
- Diversification is a shift from less profitable and sustainable crop or cropping system to more profitable and sustainable crop or cropping system.
- Practice of rotation of crops can be any of following: -
    - Deep rooted crops succeeded with shallow rooted crops.
    - Cereals crops succeeded with legumes crops
    - Exhaustive crop succeeded by restorative crops.
    - Long duration crop succeeded by short duration crops.
    - Crops susceptible to soil borne diseases succeeded by tolerant crops.
    - Crops with problematic weeds succeeded with dissimilar crops.
    - Heavy irrigation and labour intensive crop succeeded with less water and labour requiring crop.
- Practice of diversification of crops can be any of following: -
    - Shift from low value crop to high value crop.
    - Shift from water loving crop to water saving crop.
    - Shift from single crop to multiple crop.
    - Shift from crop alone to crop with livestock.
    - Shift from crop production to production with processing and value addition
- Rotation and diversification of crops has the following advantages.
    - Reduces soil erosion,
    - increases fertility and yield of crops
    - controls weeds, pests and diseases.
    - Saving farm input such as fertilizer.
    - Avoid accumulation of toxic substances.
    - Better utilization of soil nutrient and moisture.

Fig. 16 Example of crop rotation in upland ecology

Fig. 17. Crop Diversification over a period of time.

Module 4. Sustainable Weed Management

- Weed management poses one of the greatest challenges to the sustainable rice production systems.
- Weed compete with crops for nutrients, water, light and space which reduces yield of crop plants.
- A basic understanding of weed ecology will help farmers refine their use of control measures against weeds.
- There are several control measures of weed management
    - Preventive: This include prevention existing weeds from set seed and minimize the arrival of new weed seeds from outside the field.
    - Cultural: developing sound rotation and diversification of crops.
    - Manual and Mechanical: Early removal of weed manually or using mechanical weeders e.g. rotary hoe.
- Weed control programs include a range of carefully timed interventions designed to kill as many young seedlings as possible.
- While a good weed-prevention program will decrease weed pressure substantially, successful crop production still requires a well-conceived program for controlling weeds to the point where they have no negative impact on net income.
- Weed control for SRI/CRRP
    - SRI encourages use of manual and mechanical weeding and discourage use of herbicides.
    - When and how to use the Mechanical Weeder?
        - Use mechanical weeder to control weed from 10 days after transplanting
        - Repeat every 7-10 days up to 4 times until the plant rows are closing
        - Use weeder immediately after irrigation in both directions.
        - Never drain water after weeding to keep solubilized nutrients in the field.
    - Advantages of using mechanical weeders
        - Incorporation of weeds.
        - Aerates soils.
        - Stimulates root growth.
        - Re-distributes water across plot.
        - Contributes to field leveling.
        - Nutrients from soil and manure become better available to roots.

Fig. 18. Manual weed control by hand.

Fig. 19. Weed control in rice crop using mechanical weeders

Module 5. Sustainable Water Management

- **Irrigated Rice System: 4 Phase**
    - First 2 weeks after transplanting, keep the soil humid.
    - Vegetative phase: **Alternate Wetting and Drying (AWD)**
        - ✓ Introduce a shallow layer of water of 1-2 cm
        - ✓ Leave to dry, until cracks in the soil become visible
        - ✓ Another shallow layer of water is added
        - ✓ Repeat

- Reproductive phase: irrigate abundantly and regularly during flowering and grain filling
  - ✓ 2 weeks before harvest: Drain the plot and keep it dry during the maturation phase

❖ **Lowland Rice Systems**

- Flood seasonally (often 2nd half of season)
  - ✓ Vegetative phase still in non-flooded phase, which is ideal for tillering
  - ✓ Bunding and leveling can help get good crop started
  - ✓ If vegetative phase is prone to flooding, try to start the growing season earlier.

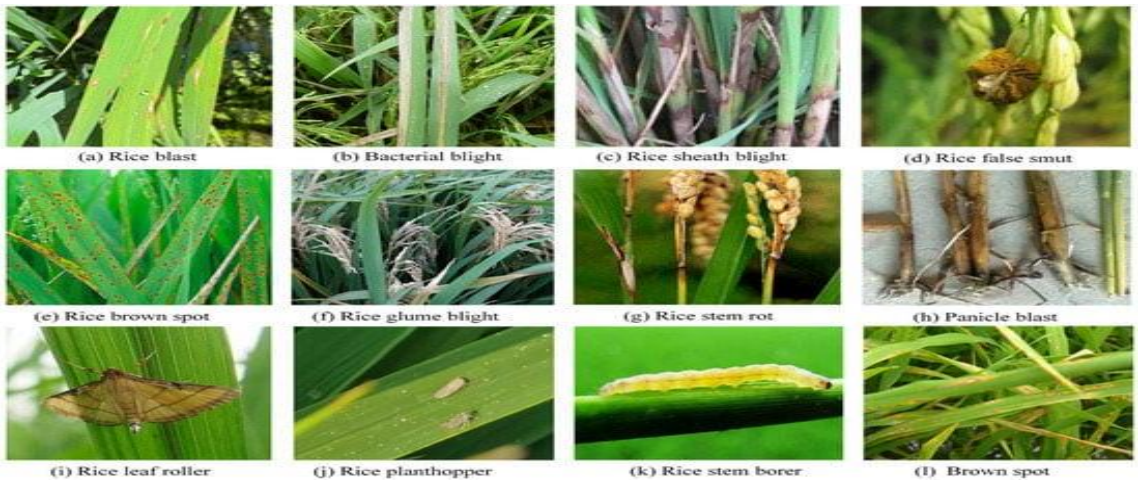
❖ **Upland Rice Systems**

- Drought prone areas
- Leveling and bunding prevents erosion and keeps water in the plot.
- Organic matter helps retain soil moisture and nutrients.
- Water infiltration is improved.
- Small dams or ponds next to fields can store irrigation water

Fig.20. Sustainable water management using Alternate wetting and drying in SRI rice production system

Module 6. Insect Pest and Disease Management

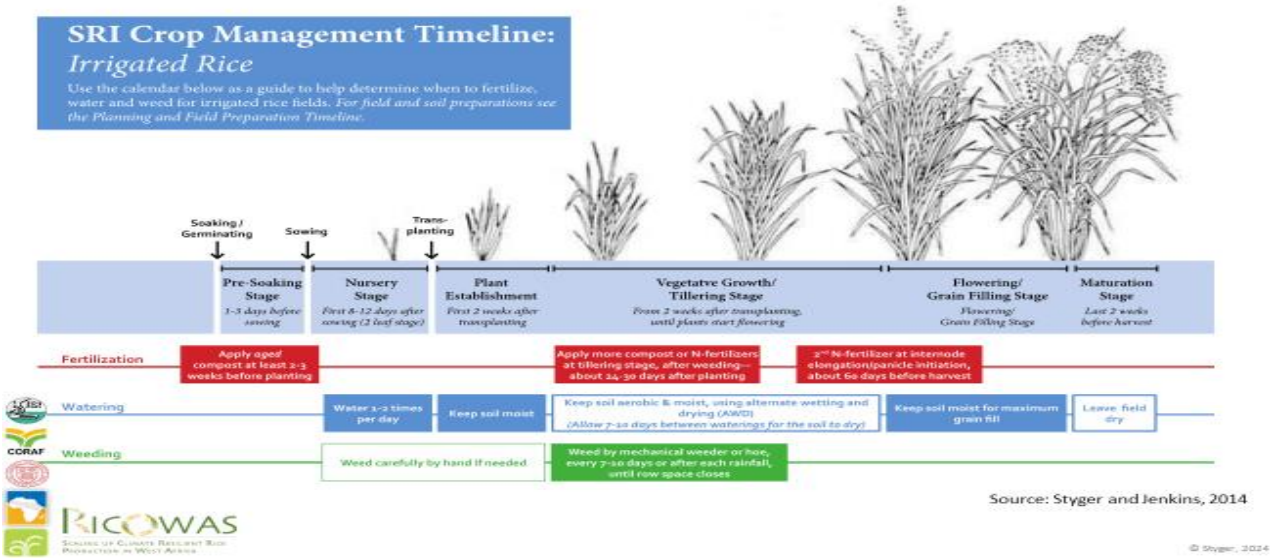
- ❖ SRI fields have improved resilience towards pest and diseases
- ❖ SRI plants have larger roots, thicker tillers and leaves, they are stronger, therefore resist Pest and Disease better.
- ❖ Basically, pest and diseases thrive in humid conditions
- ❖ SRI fields have a lower humidity level due to wide spacing and single seedling transplanting.
- ❖ Wider spacing of plants permits higher air circulation around the plants
- ❖ Supplemental strategies include crop rotation, resistant cultivars, good soil drainage, adequate air movement, and planting clean seed reduce incidences of pest and diseases.
- ❖ Organic pesticides are recommended for use to control pest and diseases in SRI system.



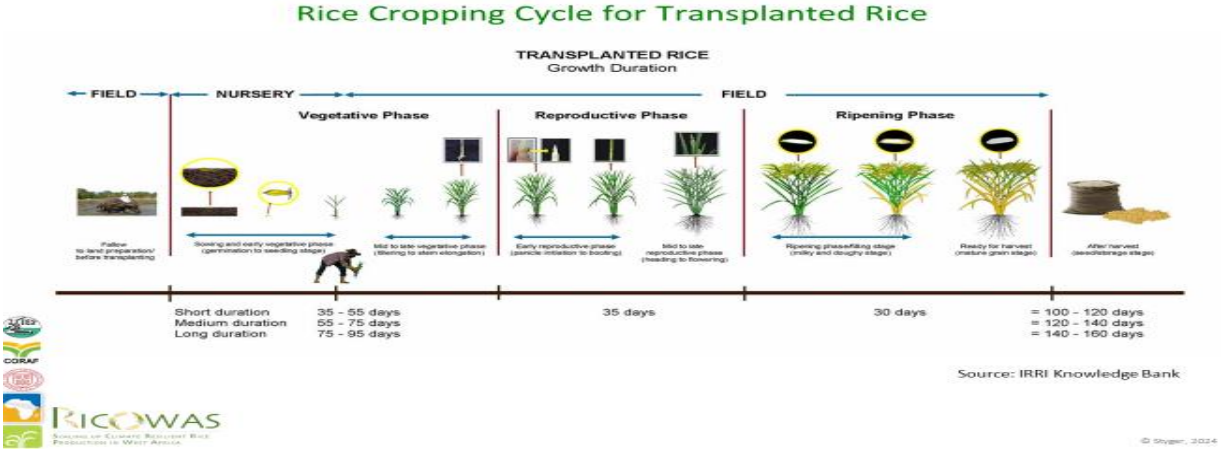
Module 7. Integrated Pest Management (IPM)

- IPM integrates habitat modification and cultural, physical, biological, and chemical practices to minimize crop losses.
- There are four steps of Integrated Pest Management
  - Set action threshold
  - Monitor and identify pests
  - Prevention
  - Control
- Look out for signs/symptoms of diseases or insects attack every time in rice field until harvest time.
- If a farmer observes signs/symptoms of diseases, insect attack that are above the economic threshold, deploy a combination of control measures including spray of the field with fungicides or insecticides.
- Organic sprays are now available and are preferably recommended.
- Use net or other bird scaring technique to protect your field 12 to 16 weeks after transplanting

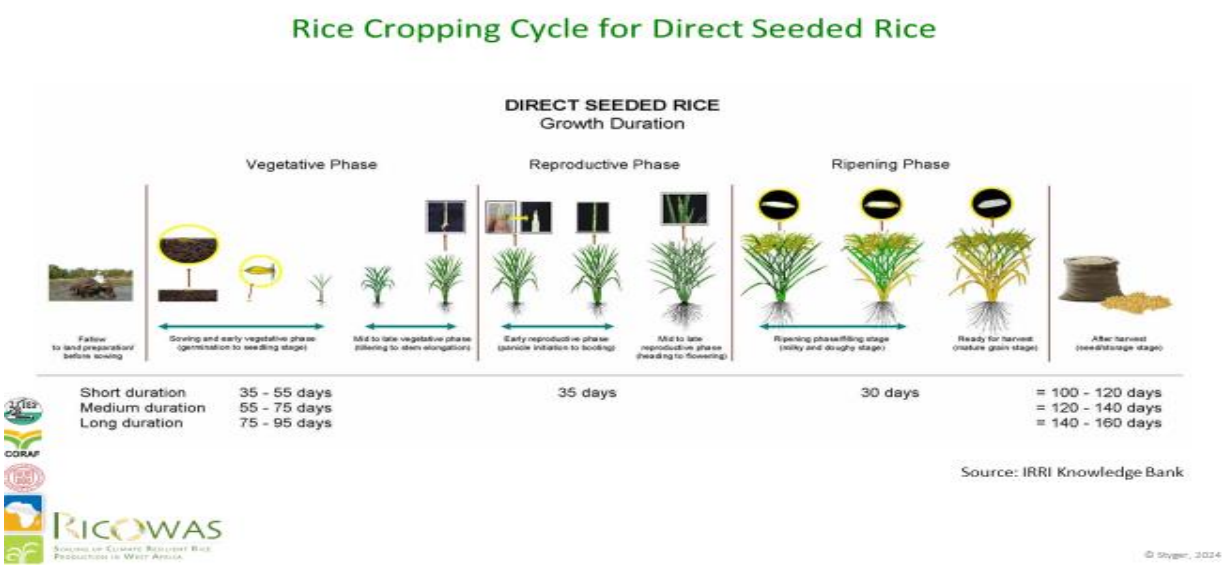
SRI Crop Management Timeline for Irrigated Rice



Rice Cropping Cycle For Transplanted Rice



Rice Cropping Cycle For Direct Seeded Rice



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