

Guide to rice culture in lowland

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World Journal of Advanced Research and Reviews, 2022, 13(03), 496–506

Publication history: Received on 18 February 2022; revised on 27 March 2022; accepted on 29 March 2022

Article DOI: <https://doi.org/10.30574/wjarr.2022.13.3.0254>

Abstract

Rice is one of Liberia's most significant grain crops, mostly for human use. Rice comprises around 25% of the cultivated land in Liberia during the agricultural season, which has a significant economic impact. Our recommendations include increasing productivity per unit area by optimizing yield potential per unit area, generating new varieties with high yielding ability and resilience to biotic and abiotic stressors, enhancing cultural techniques, and updating the package of recommendations. Furthermore, by implementing different systems, such as ICM and IPM, and transferring new rice cultivation technology to farmer's fields. The main objectives of our guide are to increase national rice production by transferring research recommendations and new technology to rice farmers, to identify problems and suggest appropriate solutions in rice fields, to evaluate and disseminate research information, and to update the package of recommendations to rice farmers. To summarize, teach the new rice production technology to extension personnel and farmers.

Keywords: Liberia; Guide; Rice Culture; Lowland

1. Introduction

The Central Agricultural Research Institute has produced a series of field guides, including this one. This handbook was prepared in collaboration with Mr. David P. Tokpah, Dr. Quaqua S. Mulbah, and Dr. Victor H. Sumo to increase extension agents' technical knowledge of lowland rice production and practices in farmers' efforts to raise a healthy rice harvest.

2. Getting the land ready [1]

The following are some of the benefits of a well-prepared field:

- Follow these steps for proper land preparation: Clean irrigation and drainage canals prior to land preparation.
- First, repair the bund to keep water in the fields.
- Irrigate the fields 3 to 5 days before tilling after repairing the bund. Irrigate to increase the planting area, cut the bund and open up the field to avoid creating a rat nest, the bund should be narrow and small.
- After tilling, re-irrigate the field. This accelerates the organic matter or materials that were mixed in with the soil.
- To minimize the loss of nitrogen, keep the field flooded.

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- Puddle the fields one week after the first tilling. Pudding reduces water loss, conserves energy, and increases the retention and availability of nutrients.
- Before final tilling, drain standing water in the field and apply a basal fertilizer. It should be mixed in with the soil. This reduces nitrogen loss into the atmosphere. DAP 25 kg / acre + Urea 25 kg / acre as a base fertilizer.
- Make the field level.

Table 1 Rice varieties native to the lowlands and input

Rice varieties	Input
Suakoko-8	50 kg seed per acre (Conduct germination test)
Nerica-L 19	DAP (18-46-0) 25 kg/acre fertilizer
WITA-9	50 kg urea per acre

2.1. The method of transplantation has the following advantages

2.1.1. Reduce the number of weeds

- The time weed seeds germinate; seedlings planted are about three weeks.
- When transplanting in straight rows, a rotary weeder can be used.
- Reduce lodging problem

2.2. The method of transplanting has the following disadvantages

- Costs/labor for seedbed preparation and transplanting are required.

2.3. Test for germination

- A germination test should be performed prior to sowing to ensure 80% germination.
- If the germination rate is less than 80%, increase the seed rate.

2.4. Preparation of seeds

- Floating grains means empty.
- With the current technology, determining seed viability is difficult with the naked eye. It is recommended that you carry out seeding with the floatation method to make a selection.
- Separate sunken seeds (filled grain) with a high-powered separator or those that float have the potential to germinate (dead grain) that will not germinate.
- Soak seeds in clean water for 1 day.
- Place the seeds in an incubator for 30-36 hours in a sack that has been half-filled.



Figure 1 Seeds management and seedbed preparation (wet seedbed)

To raise the temperature, you will need a warm environment inside the seed's activities. Incubation keeps the seeds warm, helps the embryo's development, and results in a uniform germination. When the temperature is too high, however, germination is inhibited. The rate of reproduction decreases, and it is possible that it will die.

- A day before planting, prepare seedbed plots of 1 m width and any convenient length sowing.
- Sow 15 kg of seeds for one acre, a plot area of about 150 m² is required.
- Collect mud around the seedbed area and raise it 5 cm above the original level.
- Level of the field allows for a 40 ~ 50 cm space between beds.
- The seedbed surface should be leveled and smoothed.
- Sow evenly about 100 g of seeds / m² on the seedbed.
- Irrigate once the seeds have sprouted to a height of 3-4 cm and maintain a shallow water level.
- As the seedlings grow taller, gradually increase the water depth (Do not allow the seedbed surface to dry).



Figure 2 Seedbed preparation (wet seedbed) and Seedlings germination

- 12-16 days after sowing, seedlings should be transplanted.
- Before 25 days after sowing, seedlings should be transplanted.
- When uprooting seedlings, keep deep water in the seedbed to make washing the seedlings' roots easier.

3. Seedling of the DAPOG [2]

Farmers in the Philippines practice this type of nursery.

- On a concrete floor, pre-germinated seeds are sown at a rate of 2 kg/m². A tarpaulin is a piece of fabric that is used to cover an area. For one-acre seedlings, the nursery area is only 12 m².
- Seeds should be watered frequently after sowing, and the surface should be pressed by a palm for 2-3 days to prevent the seeds from rising up.
- Watering is required three to four times per day.
- Seedling should be transplanting 12-16 DAS.
- Nutrients from seeds can be used to grow seedlings after 15 days; the nutrients in the seeds have been consumed.
- Due to the small size of the seedlings, proper field preparation and leveling are required.
- For one acre, approximately 25 kg of seeds are required.

3.1. How to transplant a rice plant

If the seedlings are tall, the tip of the seedlings can be cut off. You are capable of handling and it is less difficult to transplant.

3.2. Planting technique

- Transplanting can be done in the field with standing water.

- To transplant effectively, a large number of people are required. In general, it takes longer time.
- Planting in straight rows results in a higher plant population and makes application easier.
- Agricultural chemicals, fertilizer Weeding can also be done with a rotary weeder.

3.3. Making use of a line marker

- The field should be drained the day before making use of a line marker.
- If the soil is too soft, the line will not work.
- It takes less time in general when compared to the use of a guide rope.
- Plant spacing of 25 cm x 25 cm (16 hills per m²), 25 cm x 20 cm (20 hills per m²), and 30 cm x 15 cm (22.2 hills per m²) is suggested.
- No. of seedlings per hill
- Plant three to four seedlings per hill.
- 10 days after transplanting, replant any missing hills.
- Place extra seedlings in the field's corner after transplanting to be used for replanting.

3.4. Fertilizer

Fertilizers (both inorganic and organic) provide nutrients to the rice plant. The soil does not always provide the rice plant with the nutrients it requires as a result, fertilizer is required.

- The rice plant requires a variety of nutrients, but nitrogen (N), phosphorus (P) and potassium (K) are most important required in large amounts.
- To keep rice growing, these nutrients must be replenished on a regular basis.

Table 2 The type of fertilizer

Nitrogen (N)	Urea 46-0-0, Ammonium sulphate 21-0-0
Phosphorus (P)	Super phosphate 0-18-0, Triple super phosphate 0-46-0
Potassium (K)	Potassium chloride (muriate of potash) 0-0-60 Potassium sulphate 0-0-53
N,P fertilizer	16-20-0(AP) , 18-46-0(DAP)
N,K fertilizer	13-0-46 (Potassium nitrate)
N,P,K fertilizer	17-17-17

3.5. Fertilizer application amount and timing

- **Basal:** Before final harrowing, apply 25 kg of DAP (18-46-0) and 25 kg of urea.
- **Top dressing:** At panicle initiation, apply 25 kg of urea as a top dressing (65-70 days after planting).

Irrigate the field after applying top dressing and maintain a standing water level of 2 to 3 cm

- Fertilizer applications become useless if there is no water in the field.
- If fertilizer is not applied at the correct rates and at the right time, rice will lodge.

3.6. Controlling weeds

- Weeds reduce rice yields by competing for sunlight, moisture and soil nutrients with rice plants.
- Fertilizer application in weedy fields may not result in increased output because weeds absorb fertilizer at a higher rate than rice plants.
- Weeds can also act as alternate hosts for insects and rice diseases, as well as offering a safe habitat for rats.

3.7. You can use the following weed control methods

Methods include (cultural, chemical, mechanical and preventive) measures.

- One technique of prevention is to utilize good seeds, control weeds beforehand (without weed seeds), and keep the bund and canals weed-free.
- Hand weeding and the use of a rotary weeder are part of the mechanical method.
- The cultural method entails proper land preparation, crop spacing, and crop rotation. Furthermore, most weed seeds or rhizomes will not sprout or grow beneath the puddled soil's surface in a flooded area without air.
- Chemical control entails the application of the proper herbicides.
- Herbicides are chemicals that are used to kill or prevent weeds from growing.



Figure 3 A. A rotary weeder



Figure 3 B. Hand weeding

3.8. Herbicide's type

- Contact herbicides: are those that harm only the parts of the plant that are sprayed. Usually applied on leaves and stems.
- Systemic herbicides: migrate within the plant to destroy parts that were not sprayed. Applied to the soil or to the leaves and stems.

3.9. Improper herbicide application

- Using much herbicide or high rate.
- Using herbicide at the wrong time.
- To avoid damage to rice, follow the herbicide label instructions at all times.

3.10. Lowland rice insect pests [3]

3.10.1. *Hispa rice*

The larva, which is a leaf miner, begins to eat internal tissue from the tip to the base of the leaf a section of a leaf and turns it into a white galler.



Figure 4 Damage of leaf miner at nursery (APPLY FURADAN 5G: 2 G / m²)



Figure 5 Flies with stalked eyes (*Diopsis thoracica*) The larvae bore into the rice stem and feed the plant tissue, leaving a dead heart behind

3.10.2. African midge gall (*Oreolia oryzivora*)

- The larvae attack the developing point of the apical bud, causing the leaf sheath tissues to create a tube-like structure known as a tube at a node, also known as a 'Silver shot gall' or 'onion shoot.'
- Rice fields planted early are less damaged than rice fields planted later.



Figure 6 Attack of African midge gall (*Oreolia oryzivora*)

3.10.3. Caseworm (*Paraponynx stagnalis*)



Figure 7 Folder for rice leaves (*Lepidoptera, Pyralidae*)



Figure 8 The larvae scrape the leaves, fold them in half, and scrape the insides

- The larva may eat the leaf tissue. Insects attacked from the seedling to the stage of tillering. Larvae make their cases use leaf.
- Because the damage is not uniform, the larvae carried in their cases as they float by wind or water to one side of the field.
- Draining the field 4-6 days will kill the weeds and larvae.

3.11. BORERS OF THE STEM (*Pyralidae*)

- The larvae eat their way through the stem because of the plant tissue; a condition developed Known as "dead heart" and/or "white head."



Figure 9 Attack Stem borers (*Pyralidae*)

3.12. Rice bug and stink bug

- The bugs stick to the panicle and suck the milky juice from the young panicles, causing them to rot.
- Staining of the grains, resulting in a reduction in grain quality.



Figure 10 Attack of Stink bug and Rice bug

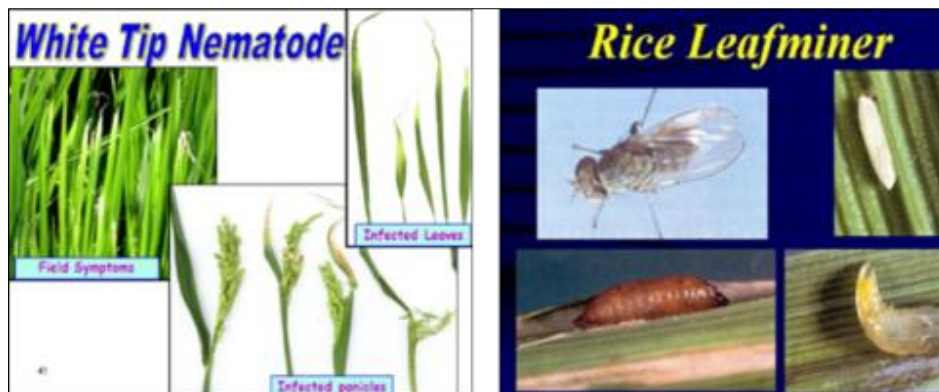


Figure 11 Symptoms of White tip nematode and Rice leaf miner

3.13. Lowland rice diseases [4]

3.13.1. Rice yellow mottle virus (RYMV)

- RYMV is a virus that causes yellow spots on rice grains.
- RYMV is a virus that only known in Africa and is one of the Rice diseases most dangerous in Africa.

3.13.2. Symptoms

- If infected at an early stage, rice plants will be stunted.
- Reduce the number of tillers.
- Leaves are yellowing and mottling.
- Other diseases (such as brown spot) easily attack plants that are infected.

3.13.3. Controlling the RYMV

- There are not any practical options (no chemicals) after a plant become infected.
- The most cost-effective method is to plant resistant varieties and the most efficient method of control. RYMV. NERICAs are resistant varieties.
- Other diseases (such as brown spot) easily attack plants that are infected.

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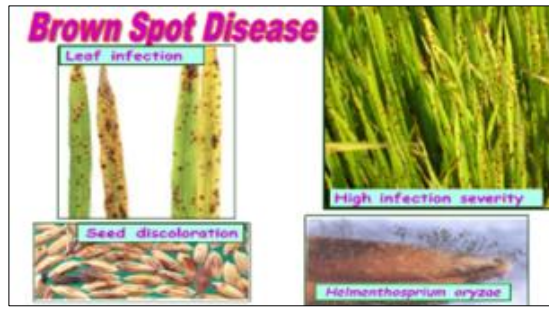


Figure 12 Symptoms Rice yellow mottle virus (RYMV)

3.13.5. Rice blast (*Magnaporthe grisea*)(*Pyricularia oryzae*)



Figure 13 Symptoms of Rice blast (*Pyricularia oryzae*)



BROWN SPOT (*Cochliobolus miyabeanus*)



SHEATH BLIGHT (*Thanatephorus cucumeris*)



SHEATH ROT (*Acrocyndrium Oryzae*)



Leaf scald (*Metasphaeria albescens*)

Figure 14 Symptoms of Sheath rot (*Acrocyndrium Oryzae*) and Leaf scald (*Metasphaeria albescens*)

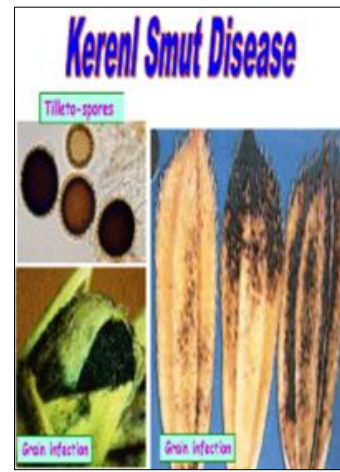
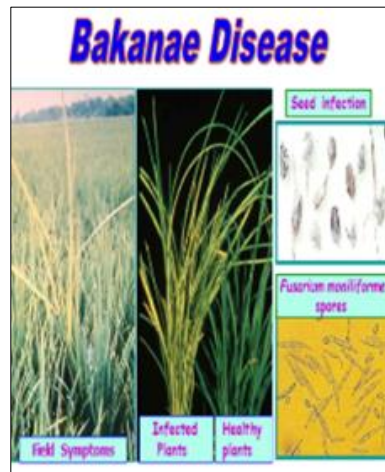
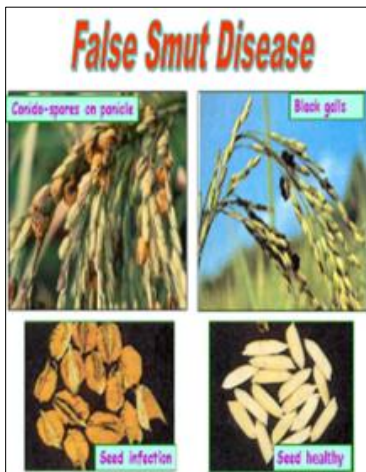


Figure 15 Symptoms of False smut, Bakanae and Kernel smut diseases



Salinity



Symptoms of iron toxicity



Iron toxicity

Figure 16 Symptoms of Salinity and Iron toxicity [5]

- On leaves, nodes, panicles, and grains, the fungus causes spots or lesions. The spots are typically elongated with pointed ends. The term "damage" is frequently used to describe damage that is 50% of the original value or a decrease in yield.

Planting resistant varieties and avoiding excessive nitrogen application are two methods of control.

3.14. Harvest

- 10 days before harvest, drain the field.
- When 80-85 percent of the grains are straw-colored and the grains in the lowest half of the panicle have reached the stage of hard dough, it is time to harvest.

3.15. Threshing

- Threshing can be done with a thresher or by beating with sticks against a log.
- Threshing by beating, on the other hand, increases the likelihood of broken grains during milling.

3.16. Drying and winnowing

- Empty grains should be winnowed before drying and throw away the straw.
- Under the hot sun, open air-drying heat in the tropics, is widely practiced.
- Drying should preferably be done on a clean drying floor or a tarpaulin void of stones.



Figure 17 Drying and winnowing



Keep 4-5 cm thickness for sun dry

Rapid drying cause broken rice

Figure 18 Sun drying and Broken rice

The rice should be 4 to 5 cm thick and turned over every 30 to 60 minutes to allow an equal amount of time to be exposed to the sun's heat. It is critical to keep an eye on moisture levels less than 3% reductions per day are recommended. When rice is milled quickly, it becomes broken. DRY CAREFULLY!

Table 3 Average per acre cost and revenue for all varieties

Particulars	Unit	Quantity	Rates (Rs.)	Amount/ acre(Rs.)
Land preparation				
i) Ploughing with tractor	Hr	3	200	600
ii) Puddling with bullocks	Day	1	500	500
Raising nursery				
i) Seed	Kg	30	15	450
ii) Nursery bed preparation	Day	2	120	240
iii) Nursery maintenance	Day	1	120	120
iv) Nursery pulling, transport	Day	4	120	480
Fertilizers				
i) DAP	Kg	25	9	225
ii) Urea	Kg	50	8.6	430
Transplanting	Day	10	120	1200
Irrigation	Day	4	120	480
Insecticides	--	--	--	600
Harvesting	Day	10	120	1200
Threshing (with tractor)	Hr	1	300	300
Cleaning/handling	Day	7	120	840
Land rent	--	--	--	5300
Total Cost				13565

Source: Field survey

4. Conclusion

Many West African nations have high irrigated rice production costs, owing to high initial irrigation infrastructure costs and inadequate operation of many irrigated rice projects [5]. Furthermore, due to less-than-optimal input utilization and crop management, irrigated rice farmers have not fully realized the potential of enhanced irrigated rice varieties. Rainfed wetland rice production by smallholders, on the other hand, is frequently hampered by a variety of biotic and abiotic challenges, as well as poor crop management. All of these lead to poor yields of less than 1.5 Mg ha⁻¹. Furthermore, postharvest losses are significant, and milled rice quality is generally low in many nations.

Compliance with ethical standards

Acknowledgments

The writers of this guide thank all of the mentioned works and their authors for the significant insights obtained, particularly those whose texts and conclusions were explicitly cited, as well as everyone who helped with the completion of this work.

Disclosure of conflict of interest

The participants in the research all gave their informed permission.

References

- [1] Miézan KM, Wopereis M, Dingkuhn M, Deckers J, Randolph TF. Irrigated rice in the Sahel: prospects for sustainable development.
- [2] Bell M, Shires D. The Rice Knowledge Bank. Copyright International Rice Research Institute 2005. 2005:576.
- [3] Tokpah DP, Li H, Wang L, Liu X, Mulbah QS, Liu H. An assessment system for screening effective bacteria as biological control agents against *Magnaporthe grisea* on rice. *Biological Control*. 2016 Dec 1;103:21-9.
- [4] Tokpah DP, Li H, Newmah JT, Page Z, Luther Z, King CF, Smith MS, Voor VM. Biological control of potential antagonistic bacteria isolates to restrict *Magnaporthe grisea* infection on rice. *African Journal of Microbiology Research*. 2017 Jul 21;11(27):1108-19.
- [5] Page Z, Tokpah DP, Drame KN, Luther Z, Voor VM, King CF. Morphological variation of iron toxicity tolerance in lowland rice (*Oryza sativa* L.) varieties. *World Journal of Advanced Research and Reviews*. 2022;13(1):038-46.