African Organic Agriculture Training Manual

A Resource Manual for Trainers

9-1 RICE

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Ready for field testing

FiBL

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FACTSHEET 1: RICE

Learning targets for farmers:

- Understand how to properly select rice varieties and seeds
- Recognize diversification strategies in rice production
- Learn good husbandry practises in rice production
- Develop awareness on how to improve incomes and organic certification of rice production

1 Introduction

Rice *(Oryza sativa)* is a very important staple food in the world and feeds more than half of the entire population. Africa has become a big player in international rice markets importing a record 9 million tonnes in 2006 – accounting for more than 30 % of global imports. Approximately 40 % of the rice consumed in Africa is imported. Africa's emergence as a big rice importer is explained by the fact that during the last decade rice has become the most rapidly growing food source in sub-Saharan Africa. Indeed, due to population growth, rising incomes and a shift in consumer preferences in favour of rice, especially in urban areas, the relative growth in demand for rice is faster in this region than anywhere in the world.

Rice is also becoming increasingly important for food security in some low income, food deficit countries in sub-Saharan Africa (SSA). About 100 million people depend on rice for their livelihoods. The demand in SSA far outstrips production, which in the last 30 years has increased by 70 %, mainly because of the expanded area planted with rice. Only 30 % of the increase can be attributed to improved productivity.

Rice is cultivated in tropical and subtropical environments across a wide range of production systems. This includes production under different soil conditions, water management systems, levels of mechanization and levels of input applications. Rice production systems in Africa can be classified into rainfed upland, rainfed lowland (swamp), irrigated lowland and flood-prone (deep water) systems, based on the water availability for growth and the topography where rice is grown.

- **Irrigated rice system -** In this system, rice is grown in bounded fields in lowlands where supplemental irrigation is necessary in addition to rainfall. Due to the possibility to irrigate, the rice crop can be grown during both the dry and wet seasons.
- **Rainfed lowland rice system -** In this system, rice is grown in bounded fields in lowlands where the main source of water is rainfall. Due to heavy reliance on rain, too much water (floods) or too little water (drought) are potential limitations in this system. Nonetheless, this is the most dominant rice production system in Africa. Rice yields in rainfed lowlands depend on the degree of water control and vary from 1 to 3 tonnes per hectare. With improved water control and soil fertility management, rice yields may increase rapidly in these systems that are inherently much more stable than the upland areas.
- **Flood-prone rice system -** In this system, deepwater and floating rice is grown in unbounded fields on the floodplains and deltas of rivers. Rice is sown or transplanted before the floodwaters rise and it flowers at about the time of maximum water depth.
- **Rainfed upland rice system -** This is where rice is grown under normal soil moisture conditions, from low-lying valley bottoms to gentle and steep sloping lands. This is the dominant rice culture in West Africa, but also becoming popular in East and Central Africa. In this system, slash and burn is a common way of clearing land for upland rice production. Rice yields in upland systems average about 1 ton per hectare. Weed competition is the most important yield reducing factor followed by drought, blast, soil acidity and general soil infertility. Farmers traditionally manage these stresses through long periods of bush fallow. More recently, population growth has led to a dramatic reduction in fallow periods and to extended periods of cropping in many areas, with resulting increases in weed pressure.

1.1 Common challenges of rice production in Africa

Due to prevailing challenges such as low soil fertility and low soil moisture, it has been difficult to achieve the full potential of the existing rice production systems in Africa. Some of these challenges include:

- **Limited access to good quality seeds -** Most rice farmers typically grow traditional varieties. In most cases, these varieties are well-adapted to local conditions and have low nutrient requirements, but produce low yields. In addition, farmers do not carefully select and handle the seeds to ensure purity and seed viability for the next season's planting. They instead pick rice seeds from any remaining stock after harvest and preserve them for the next growing season. The seed problem has increased further in that there is no suitable national rice seed development programmes for the screening, testing and release of varieties to satisfy the demands of the specific ecologies, farmers, brokers and consumers.

- **Decreasing soil fertility -** Most farmers grow rice as a monocrop, season after season, without any added inputs for soil improvement. Due to the continuous loss of nutrients with every harvest and leaching, soil fertility continues to decline. In the long run, nutrients become deficient thus affecting rice yields. Generally, nitrogen (N) and phosphorus (P) are the most limiting nutrients for rice production in SSA. For example, the humid forest agroecosystem of West Africa is characterized by highly weathered and strongly acid, low activity clay soils, Ultisols and Oxisols (with low P supply potential). About 70 % of the upland rice produced in the subregion is in this agroecosystem where N and P deficiencies are common.
- **Land shortage -** Normally, land is left fallow to regenerate and restore the soil fertility through the decomposition of biomass. This fallow period has decreased considerably due to increasing population; the soil is not allowed to regain adequate fertility before it is used again for cropping. The continuous need for new virgin land has forced farmers to utilise marginal lands, for example wetlands, forest lands, and tidal lands for rice production. This has led to increased deforestation for upland rice and draining of wetlands for lowland rice production.
- **Soil erosion -** Farmers grow rice along steep slopes of hills and mountains under upland rice cultivation. The removal of vegetation exposes the soil to the force of raindrops and destroys soil particles. The combined effects of raindrops and steep slopes promote the erosion of topsoil, leading to soil degradation.
- **Water problems -** Water is the primary factor determining the success of rice crops. Most farmers rely on rainfall for rice cultivation. Cultivating land near rivers for rice often pollutes the rivers, especially in cases where pesticides and fertilizers are used in cultivation. Under rainfed lowland systems, the erratic nature of rain sometimes leads to either too much rainfall causing floods,

POOR MANAGEMENT PRACTICES

or very little rain causing droughts; both of these conditions affect yields.

› **Weed problems -** A major constraint to the production of rice under rainfed upland and lowland conditions are weeds, because of the favourable growing conditions. Weeds normally grow very fast and can outgrow the rice plants if the farmer does not intervene in time. They compete for space, nutrients and water, and also harbour diseases and pests. Furthermore, weeds also hamper harvesting activities and can ultimately reduce rice yields.

› **Pest and disease problems -** Rice is generally not as vulnerable to insect pests during its growth compared to other crops. However, in areas where stem-borers are present, this can pose some problems. Rodents and birds are the major problems for rainfed rice cultivation. Grass cutters/rodents can cause tremendous damage to the crop during its cultivation, especially after booting, while birds will destroy the grains especially during the grain-filling period. Quelea birds in great numbers can consume a substantial amount of rice grains on the field. But in situations where rice is grown continuously on the same fields without rotation, the risk of pests and diseases increases. Especially diseases like rice blast, rice yellow mottle virus and the bacterial blight are common in such areas.

› **High postharvest losses -** Poor harvesting techniques, and untimely harvests cause the rice grains to shatter on the field before and during harvesting. Mixing seeds of different varieties also promotes high yield loss, as the varieties have different maturity periods and time for harvesting. Losses of up to 50 % have been reported in many rice growing areas, especially during drying and storage of harvested grains. Lack of simple and appropriate automation through farm machinery and equipment like harvesters and threshers also slows down the postharvest process and thus losses increase.
Some of the problems can also be attributed to the weak rice extension system to help farmers learn about appropriate water harvesting and management technologies, improved production and postharvest management practises.

› **Low returns from rice production -** Most rice farmers rely on rice production alone as the only source of income. This is risky, especially if the rice crop fails due to unpredictable weather conditions, disease outbreak or a drop in rice prices. Furthermore, due to the lack of labour-saving implements and machines for timely harvesting, the farmers cannot compete effectively with those using mechanization, who cultivate large tracts of land.

Discussion: Evaluation of the local situation

Inquire about the participants' knowledge of rice production. Have they experienced any of the above or any other challenges and how have they tried to address them?

BETTER MANAGEMENT PRACTICES

The objective of this chapter is to introduce organic approaches to rice production which can be adapted to the prevailing local conditions to help enhance sustainable rice production and positive impacts on the environment. In the following sections, specific organic approaches necessary to address some of the above mentioned production challenges will be discussed.

2. Improving access to good quality seeds

In order to increase access to good quality seeds, it is important to first ensure that farmers select varieties suitable and adapted to local conditions. Secondly, farmers should be able to select the seeds from these varieties for the next crop. Lastly the seeds should be properly stored and carefully handled during the seedling production process.

2.1 Selection of good rice varieties and seeds

Selection of appropriate rice varieties for a given location is very critical, because it will affect eventual yields. Although varieties can be selected based on many parameters (e.g. yield potential, weed competitiveness, disease resistance, height and lodging resistance), farmers should look out for some key parameters.

Recommendations to farmers for selecting good varieties:

› The first consideration is to decide whether to grow upland or lowland rice, and this will be determined by the type of land available (upland or lowland with available water).
› Then consider either locally adapted traditional or improved varieties which have been tested under local conditions by other farmers or research stations. It will then be clear if the variety's growing period, weed tolerance, moisture and nutrient requirements are adaptable to local climatic stresses. It is also important to consider varieties that are in high demand on the market and varieties that are preferred by locals because they are easy to cook and because of other local cuisine preferences.
› It is also important to select varieties whose seeds can be selected, multiplied and re-used for the next crop. If completely new seeds are brought from

Discussion: Variety and seed selection

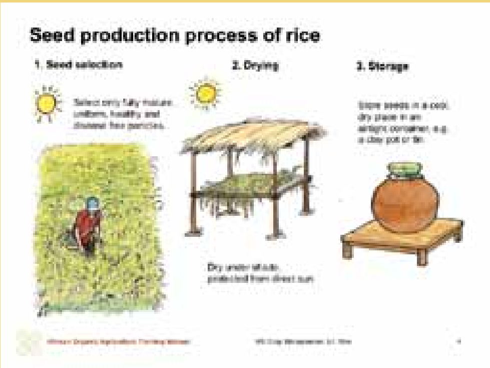
Evaluate the current situation by asking the participants the following questions:

› Which upland and lowland rice varieties are locally available?
› What factors do you consider in selecting rice varieties in order of importance?
› How do you select seeds and produce seedlings for the next season's crop?

Discuss the approaches noting any shortcomings and then introduce the guidelines below.

CRITERIA FOR SELECTING VARIETIES FOR RICE PRODUCTION

THE SEED PRODUCTION PROCESS OF RICE



another area, they should be tried and tested under local conditions before scaling up. When possible, select at least four varieties to create the genetic diversity necessary to satisfy different needs.

A good example of new upland and lowland rice varieties is the New Rice for Africa (NERICA) varieties. They combine the high yields from the Asian rice, Oryza sativa, with the ability of the African rice, Oryza glaberrima, to thrive in harsh environments and have a shorter growing period compared to the traditional varieties. Hybrid and genetically modified seeds are not recommended for organic production, especially among small-holder farmers in Africa.

Since rice is self-pollinating, farmers can select their own seeds directly from the field. However, it is advisable to carefully select seeds to ensure healthy plants and to avoid mixing of varieties. Planting seeds of poor quality will lead to poor germination and transmission of diseases.

Recommendations to farmers for good seed selection:
Select healthy and superior plants (true-to-type) of that variety for seed to make sure that only the best seeds which are well adapted under local conditions are used.

› Before the final harvest, select that part of the farm where the plants are uniform, healthy, and disease-free with productive panicles.
› At full maturity, harvest the panicles and allow them to dry under cool environment until the moisture content of the grain reaches about 14 to 15 %. Do not thresh with a machine, as the seeds could be contaminated with other varieties.
› From the harvested seeds, set aside between 30 to 40 kilos to plant one hectare. The dry season harvest is usually a better source of good seed because it has reached full maturity and, therefore, viability of seeds is longer than seeds harvested during the wet season.
› Store the seeds in a cool, dry place in an airtight container like a pot or hang in the house to deter rodents and other pests. Sometimes pest repelling materials may be added to keep away storage pests. For example, by mixing dried and crushed neem, castor leaves or any locally available herbal repellants.

2.2 Determining the seed viability

Seeds for planting should be properly, prepared, particularly for transplanted rice. A higher germination percentage is required in order to achieve the proper number of plants in the field. The ability of the selected seeds to germinate will depend on their viability. Seeds of high viability avoid wastage of time and the farmer is able to plan properly for the quantity required.

Recommendations to farmers for testing seed viability:
To test for viability, count 100 seeds of the rice variety, put the seeds in water, ensuring that all the seeds are covered with water. Allow the seeds to be in the water for 24 hours, thereafter removing the seeds and wrapping then in a moist paper or cloth, then incubate for 2 days. Count the number of seeds that have germinated after the incubation, and express it as a percentage. For example, if out of the 100 seeds selected, 70 out of the 100 seeds germinated, then the germination percentage is 70.

Seeds coming from 3 months or more of storage time need to be prepared by warming in the sun for about 3 hours. Allow them to cool off before soaking; seeds warmed in the morning may be soaked late in the afternoon or seeds warmed in the afternoon may be soaked in the evening or early the next day. Soak for 1 to 1.5 days and remove the seeds that float and use only seeds that sink. Then incubate the seeds to quicken germination. Start incubation in the morning, to take advantage of the sunlight that hastens rapid germination. Fill sacks just about half full, tie or close them tightly during the first day and place them under the sun and cover with sacks, plastics or rice straw. Check in the afternoon, loosen the sacks and mix the seeds if the heat is too much. Pile the sacks on top of each other, but reduce the cover. Repeat checking and mixing on the next day (second day of incubation).

The farmer can sow pre-germinated seeds to avoid the uncertainty of the seeds not germinating. Pre-germinated seeds can be prepared as described for the germination test, but should be incubated for 36 hours instead of the 24 hours. However, sowing pre-germinated seeds is recommended when rainfall is imminent within the next day, to avoid damage by birds and rodents.

Finally, prepare a seedbed 60 to 80 cm wide, with a height of 3 cm from the ground. This will be easier to prepare and easy to manage during sowing and taking care of the seedlings. Level the beds in order to produce a uniform growth of seedlings. Make a bed for each variety separately and label the beds with the variety name. Water regularly and protect from direct sunshine.

NOTE: The method of raising rice seedlings, described above, is widely used in irrigated lowland systems. In rainfed upland or lowland systems, planting is done directly in the prepared fields' drilled rows, hills or by broadcasting. Dibbling, planting in drills and hills is preferable to broadcasting, in order to ensure optimum plant population and to aid subsequent field activities. Straight row planting can be achieved by using a planting rope or rake, at a spacing of about 30 cm between rows.

Discussion: Improving soil fertility in rice fields
Ask the participants whether they grow rice with any other crops together or in rotation in both upland and lowland systems. Do they apply any organic manure to rice fields?

3. Improving soil fertility

There are three organic approaches to increasing soil fertility in rice production. First is to prevent soil and organic matter loss. Second is to grow crops that can improve the soil fertility either in rotation or intercropped with rice. The third approach is to plant leguminous cover crops, add organic manures, compost and other organic amendments directly to the soil to improve the fertility before planting.

3.1 Soil conservation

The organic approach to solving the land shortage problem in rice production is to improve the productivity of the soil. With productive soil, farmers can stay on the same land and cultivate rice for a long time, and reduce the frequency or rate of developing new fields when the fertility of the soil goes down. Some traditional methods of rice production like slash and burn in preparation of the land for planting, the clearing of trees/forests and reclaiming of swamps in search of fertile land for rice production are unsustainable in terms of soil fertility management and environmental conservation. Farmers, therefore, need to conserve the soil organic matter and prevent erosion of the topsoil.

The effectiveness of the agronomic practises applied to prevent loss of soil and conserve soil organic matter will depend on the production system. In up-

SOIL CONSERVATION STRATEGIES IN ORGANIC RICE PRODUCTION

land rice systems in hilly areas, loss of soil on sloping land can be prevented by constructing terraces in the form of hedgerows or boundary strips of grass or stones across the slope. Because of the fragile nature of most tropical soils, minimal disturbance of soil is important to conserve soil organic matter. Ploughing or digging should only be done when necessary, like to break the hard topsoil, while incorporating organic materials like green manures, rice straw or compost into the soil to improve its structure. In addition, cover crops can be used to avoid bare soil and smother weeds in between rice growing seasons.

In lowland systems, a levelled field ensures minimal erosion of the soil and minimises water requirements. Ahead of the planting time, rice straw from the previous harvest and other green material should be ploughed or dug under the soil.

Discussion: Soil conservation in rice fields

Ask the participants to describe how they manage land. Do they practise slash and burn, cutting down of trees and using swamps for rice production? What do the participants feel about these practises?

3.2 Introduction of leguminous crops into rice production

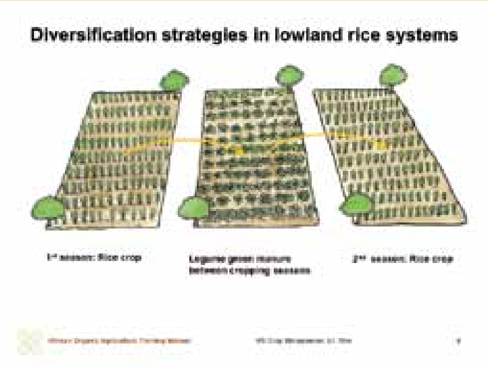
Planned rotation or intercropping of rice with leguminous crops or green manures improves soil fertility and prevents the buildup of pest populations, diseases and weeds. Leguminous crops (e.g. cowpea, pigeon pea, green gram and soybean) or green manure crops (jack beans, perennial peanut or Mucuna) fix nitrogen and produce large quantities of biomass that can be used to increase nitrogen availability and soil organic matter.

a. Lowland rice systems

There are limited options for intercropping in flooded lowland rice systems due to the semi-aquatic growing conditions. However, in rainfed areas and in places where water can be drained at the end of the season, other crops can be intercropped or in rotation with rice. For example, rice farmers can plant a legume between the cropping seasons or intercrop with legumes or vegetables. This could be done after harvest of the first rice crop at the time when there is still sufficient soil moisture to allow germination of the legume seeds. Other legumes like mungbean are usually broadcast a couple of weeks before harvest of rice or immediately after harvest. However, integration of legumes can be done in either of the following ways:

› In a one season rice crop, the legume can be planted after harvesting the main crop to take advantage of the remaining soil moisture. The legume (e.g.

INTEGRATING LEGUMES IN LOWLAND RICE SYSTEMS



INTEGRATION OF LEGUMES INTO UPLAND RICE SYSTEMS

mungbean or mucuna) is left to grow to full maturity. Then at the start of the rainy season, it is ploughed under the soil.

› In two season rice crops, the legume is planted after harvesting the second crop of rice. It is then planted to serve both as cover crop and green manure. After it attains full biomass, it can be ploughed under to serve as green manure for the next crop.
› The legume may also be grown to control weeds, where it is cut at full vegetative growth, shredded and scattered on the field to serve as green manure.

b. Upland rice systems

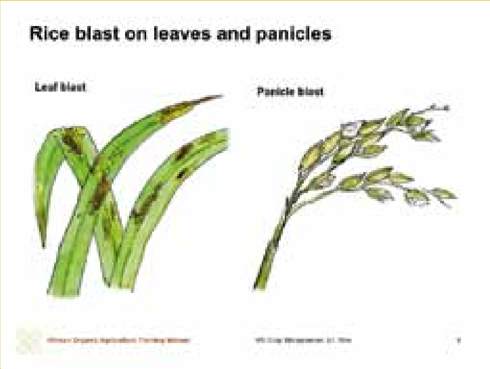
Unlike upland rice systems, there are many opportunities for integrating leguminous crops and vegetables in upland systems:

› Upland rice can be intercropped with several annual leguminous crops, such as beans, peas, mungbean, soybeans and vegetables like okra and eggplants. These crops can simultaneously increase farmers' incomes and contribute to sustainability of the farming system.
› Green leaf manuring is done by using the fresh biomass of shrubs and trees, which are planted along the rice field boundaries as hedgerows. Tree/shrub species like Tithonia, Crotalaria, Leucaena, Sesbania, Gliricidia or Acacia, grow very fast and have deep root systems whereby they will not compete with the rice, but instead recycle nutrients from deeper layers into their biomass. They also further stabilise terraces in hilly areas.
› Crop rotation is done with leguminous crops or green manures. Green manure legumes serve as cover crops to protect soil surface, increase soil fertility through nitrogen fixation and produce organic matter to improve the soil.

3.3 Addition of organic materials

As mentioned earlier, growing rice continuously season after season depletes soil organic matter and nutrients. In many rice growing areas, nitrogen and phosphorus availability are the main limiting nutrients in rice production. Typical symptoms of phosphorus deficiency are stunted plants, reduced tillering and leaf discolouration, while yellowing of leaves indicates nitrogen deficiency. The planting of leguminous cover crops and the use of rock phosphate (RP) can address these issues. The use of indigenous rock phosphate (RP) as fertilizer is be-

COMMON SIGNS OF N AND P DEFICIENCIES



coming increasingly important as a water-soluble phosphorus fertilizer under suitable environments. The application of RP with organic manure enhances the solubility of RP in the soil and thus increases availability of P to plants. In association with phosphate-solubilising microorganisms and organic manure, RP can be used as a P source in many crops.

The soil organic matter acts as a 'nutrients bank'. It needs to be refilled regularly in order to achieve good yields. This can be achieved through application of organic plant materials, compost or animal manures.

Organic plant materials, animal manures or compost should be applied by spreading in the field before land preparation so that it can be incorporated into the soil.

Compost is a highly concentrated material which supplies soil nutrients for a longer period of time. It also improves the soil structure and increases the water holding capacity of the soil. Therefore, it serves as a good soil amendment, rather than a quick source of nutrient availability to rice. The composting process helps to quickly recycle tough materials like rice straw and rice husks. This is done in combination with animal manure (from pigs, cows, goats or poultry), together with fresh succulent plant material.

At critical growth stages of rice, i.e. during early tillering and panicle initiation, a quick source of nutrients is needed. Therefore, another application of N rich animal manures such as decomposed poultry manure is recommended in order to achieve better yields.

4. Proper weed management

Weeds can reduce rice yields by competing for moisture, nutrients and light. Delays in weeding can cost a great deal to the farmer in terms of reduced yields. This is normally the case where farmers establish large fields of rice at the same time and lack enough labour to weed them. Weed control is necessary to prevent yield loss, maintain purity of harvested grain and prevent clogging of irrigation channels. Use of synthetic herbicides to control weeds is not allowed in organic farming because of their negative residual effect in the ecosystem.

Generally weed management in both upland and lowland systems is targeted on the proper control of weed multiplication. This means any intervention to control weeds should be carried out before the weeds produce seeds.

Discussion: Weed management in rice fields

Ask the participants whether they experience any major weed problems. List the local names of major weed species and identify the local weed control strategies that are being used.

Keeping the fields covered with green manure cover crops, whenever there is no rice crop, helps to reduce weeds. Well-managed green manure legumes planted during the season of no rice crop also provides good opportunities for controlling weeds. Legumes like Stylosanthes guianensis, Canavalia ensiformis, or Mucuna spp grow aggressively and establish a thick biomass which kills most weeds. This biomass, combined with rice straws left in the field after harvesting, will provide good mulching material to protect the soil and later increase soil organic matter when ploughed or dug into the soil during land preparation.

There are other agronomic methods mentioned below that can be used in controlling weeds in rainfed and irrigated lowland systems.

4.1 Weed management in rainfed systems

- **Timely land preparation -** A reduction in weeks is achieved by waiting for moist conditions so that any weed remnants from last season germinate. They should then be dug or ploughed under before planting begins.
- **Establishment of adequate plant population -** Sowing/planting rice seeds/seedlings close enough so that adequate plant population is maintained with little or no space left for weeds to grow.
- **Selection of suitable rice varieties -** Rice varieties such as NERICA can compete effectively with weeds compared to others. NERICA varieties possess early vigour during the vegetative growth phase and this is a potentially useful trait for weed competitiveness.
- **Timing of weeding -** Manual weeding, hand pulling or using a hand hoe is a common, efficient method of weed control, especially if timed when weed pressure is still minimal in the field. For example, one weeding within 15 to 21 days after sowing, followed by a second weeding at panicle initiation stage (about 42 to 50 days after sowing) is sufficient for upland rice to grow well. To manage this weeding routine, farmers should scatter the planting of rice fields in a mosaic pattern to avoid being overwhelmed by the weeding requirements.

4.2 Weed management in irrigated lowland systems

- **Water management -** With good water management, especially in flooded systems, many weed species can be well-managed since they will not germinate or survive under flooded conditions. But flooding will be more effective if fields are levelled well. Levelling can be done by removal and deposition of surface soil from high- to low-lying areas mechanically or manually with rakes. It makes the water depth uniform and facilitates rapid flow into and from the field. A continuous water level of 2-5 cm can be maintained for some time to kill weeds under the flooded conditions.
- **Timing of weeding -** Although manual weeding can be very labour intensive in flooded rice systems, it is also effective, especially when it is done at the right time. For example, farmers may start weeding either with a hoe or a mechanical rotary weeder (if available) about 10 to 12 days after transplanting, followed with hand weeding immediately or within one week, and complete the weeding sessions within 20 to 30 days after transplanting. The weeds should then be buried in between the plants to rot and provide additional nutrients. In case of very hardy grasses such as Cyperus spp, which cannot be suppressed this way, they should be left to dry in the sun, and when dead, buried or composted.

5. Proper water management

Enough supply of water is needed for optimum rice production in both upland and lowland systems. Proper management of water depends on the rice variety, rainfall patterns, soil properties, management practises and availability of other sources of water.

The water requirement in rainfed upland systems is met by making the most use of the available water from the rains. Therefore, planting of rice should be based on the cropping calendar, so that the stages of growth that need water most (i.e. from panicle initiation to heading) receive maximum rainfall. This will be complemented with reduced tillage practises, mulching and proper water harvesting channels on sloping lands. It is important to establish the time to sow in each season based on the long-term (15 years) daily rainfall pattern or actual trials on optimum sowing date.

Discussion: Water management in rice fields

Assess the situation by asking the participants the following questions;

- How do you ensure enough water availability for both upland and lowland rice production?
- Are there any farmers who irrigate their rice farms? If yes, where do they get the irrigation water from?

Ideally, the water level in irrigated flooded rice needs to be maintained at about 2 cm during most of the growing season, except during the ripening stage. This is, however, possible only if the producer is assured of access to water whenever it is needed. In many situations this is not the case as the availability depends on rainfall patterns and irrigation is not accessible to many farmers. Where resources permit, farmers should tap and conserve the available water more appropriately, for example, by creating bunds and channels to trap moving water from uphill into man-made ponds or dams. Such collected water can later be redistributed into the fields in seasons of low water availability.

The System of Rice Intensification (SRI)

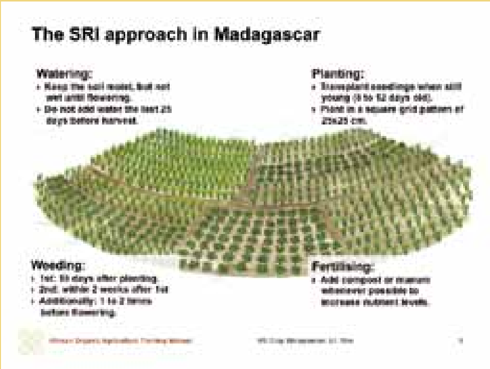
SRI is a methodology for increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients. SRI, which originated in Madagascar, leads to healthier soil and plants supported by greater root growth and the nurturing of soil microbial abundance and diversity. In its simplest form, SRI involves:

› Soil only needs to be kept moist during the period of growth when the plant is putting out tillers and leaves, before it begins to flower and to produce grains. During this reproductive stage, the rice plants should be given a thin layer of water (1-2 cm) on the surface of the soil. The field should not be supplied with extra water during the 25 days before harvest.

› Transplanting seedlings when still very young, usually just 8-12 days old, with just two small leaves, done carefully and quickly to have minimum trauma to the roots, putting only one seedling per hole instead of 3 to avoid root competition, and using wide spacing to encourage greater root and canopy growth in a square grid pattern, 25 x 25 cm or wider in good quality soil.

› The first weeding should be within about 10 days after transplanting, and at least one more weeding should follow within two weeks. This will dig up weeds at the same time that it allows more air into the soil for the roots to utilize. Doing one or two additional weedings (3 or 4 weedings in all), before the plants have completed their growth or begin flowering, will provide still more oxygen to the soil. A very simple mechanical weeder, called a rotating hoe, pushed by hand has been developed to enable farmers to eliminate weeds easily, quickly and early. It reduces the hard labour

THE SRI APPROACH IN MADAGASCAR



of pulling up individual weeds by hand once they emerge.
- Adding compost or manure whenever possible to add nutrients to the field.

The benefits of SRI, which have been demonstrated in over 40 countries include: increased yield (50 to 100 % or more), a reduction in required seed (up to 90 %) and water savings (50 % or more). Many SRI users also report a reduction in pests, diseases, grain shattering, unfilled grains and lodging. Additional environmental benefits stem from the reduction of agricultural chemicals, water use and methane emissions that contribute to global warming. See SRI website: http://ciifad.cornell.edu/sri/ for more information on country experiences with SRI.

Recommendations for farmers for better water management in irrigated systems:
For efficient water saving in irrigated rice systems, allow water into the field 3 to 4 days after transplanting, then irrigate and drain the field alternately from the seedling stage up to flowering time. Plan to irrigate, especially during the flowering or heading period, which requires adequate water for good yields. Allow the soil surface to dry before irrigating but keep the soil in a saturated state. But avoid leaving standing water of more than 2 cm except in rice-fish systems and construct borders on the rice plots to facilitate proper collection and drainage of excess water. Make sure the water is free of contaminants from conventional fields and is of good quality to avoid soil related problems, like salinity.

Ensure that no inflow of water from any conventional fields exists. But if the field is already contaminated, construct drainage canals to divert the water away, thus minimizing contaminants from entering the plots. Meanwhile encourage all immediate neighbouring farmers to adopt organic farming practises and reduce use of pesticides or fertilizers.

6. Effective pest management in organic rice production

Rice is not very susceptible to many pests, except stem borers whose effect differs depending on the region. Even when rice is attacked by pests, they cannot cause significant yield loss despite damage to the plant. Rice can recover very

Brainstorming session: The SRI approach
Explain the SRI approach to the participants and afterwards, ask the participants whether the approach is applicable under their local conditions and what could be some of its challenges.

well and still deliver more or less the same yield as the non-damaged crop. Research and observations have shown that there is no direct relation between moderate damage and yield loss as trials with farmers in many integrated pest management training programs have demonstrated. These trials show that up to 30 to 40 % of damage to leaves and 10 to 20 % of damage to tillers will not result in any yield loss because the rice plant is able to compensate for lost leaves and tillers.

However, stem borers can be devastating in rice if not properly managed and can delay flowering and time of harvest and reduce yields e.g. such cases have been reported especially in West Africa. The stem borers attack the panicles and result in dead shoots.

Generally, rice pests can be categorised into three main groups depending on the stage of the rice growing cycle when they are most likely to attack:

a. **Seedling pests** which attack seedlings during the younger stages of the rice crop include rice gall midge, snails, crabs and thrips.
b. **Leaf and tiller feeding pests, sucking leafhoppers and stem borers** which bore in the tillers include Chilo zacconius (striped borer), Marliarpha spp. (white borer), Scirpophgaga spp. (yellow borer), Sesamia calamistis (pink borer) common in uplands, Diopsis thoracica (stalk-eyed fly) and Orselia oryzivora (African rice gall midge) common in lowland rice.
c. **Pests in ripening rice** include birds, rats and bugs (stink bug, rice bug, mealy bug and rice weevil). While bugs stay on the young panicles and suck the milky juice causing staining of the grains (lowering grain quality), rodents (e.g. rats) cut down the rice plant and feed on the soft parts and on the mature grains. Birds feed on the filling grain as well as mature grains.

Generally, there are many preventive methods of managing rice pests which have proved very effective, and thus direct pest control is rarely needed. Some of the popular and widely used methods in organic cropping systems are:

› **Good land preparation** whereby all material remaining after harvest is ploughed/dug into the soil during land preparation will minimize the incidence of most pests, especially stem borers as they are covered and killed under the soil. Proper plant spacing also allows sunshine to penetrate into the basal portion of the rice plants and thus conditions like coolness and humid environment which favour the growth of pests are reduced.

Working group/ field visit – Pest and disease identification

Visit different rice fields and, together with the participants, identify any observable signs of pest or disease problems. Ask the participants whether they are familiar with those signs of pests and diseases and whether they have monitored to see when the pests and diseases attack.

MOSAIC PATTERN ON RICE FIELDS

- **Mosaic planting** can be achieved by growing different rice varieties of varying growth patterns and resistance to pests and diseases on the same land at the same time or through varietal diversification. Varietal diversification can be achieved by planting at least three rice varieties on the same fields to create a mosaic pattern of varieties. Due to the differential resistance of varieties to pests and diseases, any devastative effects from any pest or disease outbreaks can be avoided. Likewise, varieties with varying plant maturity duration in terms of planting and harvesting dates can be considered to distribute labour requirements on the farm.
- **Intercropping** has a high potential as a cultural method of controlling the major stem borers on rice. Maize is a suitable trap crop for stem borers. Strip cropping of four rows of maize alternating with an equal number of rice plants (NERICA) rows has been found effective in controlling stem borers.
- **Proper water management** in irrigated lowland systems: especially if the water level can be raised up to 10-15 cm so that it can drown and wash out any worms, bugs or leaf hoppers during drainage.
- **Birds** are a problem in most rice growing areas, however, they can be effectively controlled. They do most harm in the early morning and late evening, and with routine monitoring and scaring, the damage caused will be reduced significantly. Scaring them away by hanging old tins in the field to make noise, use of scarecrows, catapults or shielding the field with nets have proved effective to some extent. Shooting to kill and trapping the birds are not friendly practises to the ecosystem. They are, therefore, not recommended in organic farming.

7. Effective disease management in organic rice production

Effective disease management also starts with prevention of attack by ensuring clean planting materials or resistant varieties which should be planted in a clean environment followed by proper field sanitary procedures and good husbandry practises. Normally all cultural practises that enhance plant vigour will enhance its ability to reduce the impact of disease attacks.

Rice can be attacked by different diseases, for example blast, rice yellow mottle virus (RYMV), leaf scald, brown spot, glume discolouration and bacterial leaf blight. Poor variety and seed selection, lack of proper rotation and poor soil fer-

BLAST AND RYMV DAMAGE

tility management increase the risk of attack to the plant by these diseases. The rice blast and the rice yellow mottle virus are the most important diseases of rice in sub-Saharan Africa, especially under upland conditions. They can affect rice yields and quality, in extreme cases, leading to heavy losses.

a. **Rice Blast** *(Magnaporthe grisea)* is the most damaging fungal disease of rice in Africa, and is transmitted by spores carried by wind or field implements. The fungus attacks all parts of the rice plant above the ground causing elongated spots/lesions, pointed at each end, on leaves, nodes, panicles and grains, characterized by 'burning' of leaves, stunted growth, empty heads, and sometimes neck rot.
   In the upland systems, any traditional upland cultivars and improved varieties like NERICA show stable resistance to this disease. So the risk from blast is only common with other improved varieties of low resistance and some lowland varieties.
   Prevention can be achieved by avoiding excessive application of nitrogenous fertilisers (manures) and by keeping the field weed free as some weeds are alternate hosts to the fungus. Also, remove and burn all straw infected fields and restrict movement of tools from infested to healthy fields.
b. **Rice Yellow Mottles Virus (RYMV)** is transmitted from an infested plant to a healthy plant by insect vectors, mainly beetles, and causes the selective yellowing and mottling of leaves, stunted growth and reduced tillering. Control can be achieved by using resistant varieties and by removing and burning infected rice plants from the field.

8. Minimising postharvest losses

Proper postharvest handling of organic rice aims at maximizing grain quality, minimizing losses and any contamination risks from extraneous materials and agents. In case of certified organic rice production, maximum separation of organic, in-conversion and conventional rice throughout the handling process is also important.

The postharvest handling process starts with proper and timely harvesting, threshing, drying, milling, storage up to safe and secure packaging:

Discussion – Disease management in rice

Ask the participants whether they have experienced any serious disease problems in the area. Let them describe the signs associated with the diseases and when they are most likely to attack the crop.

- **Harvesting -** Rice is ready for harvest when the grains are full-sized, hard and the panicles have bent down. The number of days from flowering to harvest is fixed for the varieties. This should be used to ensure timely harvest and reduce grain shattering. At this stage, most of the panicles have turned golden brown in colour. In order to prolong the shelf life, rice should be harvested only when it reaches full maturity. The date is chosen taking into consideration the stage of maturity, the shattering characteristics of the variety and the weather conditions (preferably during dry weather). Take care to avoid mixing weed seeds with the harvested rice grains, so any weeds with fully matured seeds can be removed prior to harvesting. Harvesting by cutting the stem of the rice close to the ground with serrated sickles is much faster than harvesting using knives. The harvested paddy should be put on tarpaulins or similar materials to reduce contamination with foreign materials such as stones.
- **Drying -** Rice is usually harvested when it has high moisture content and, therefore, needs immediate drying. Delays in drying or uneven drying will result in qualitative and quantitative losses by discolouration of grains, moulding, and will increase the risk of insect damage. The paddy should be spread evenly on the tarpaulin, and this should not be too thick as this will develop heat and cause discolouration. Drying under a cool, dry environment is preferred to fast drying of the grains under a hot sunny environment, which may affect the quality of the grain and break during milling.
- **Threshing and Milling -** Threshing methods range from simply beating the rice sheaves on a stone or piece of wood to the fully mechanized combine harvesting. The rice husk and the bran are separated by milling to obtain the edible seed. If the rice was not dried well before threshing then it should be dried again to about 14 % before milling. In the simple method, mostly used at the household or village level, rice is milled in a one-step milling process. However, proper milling facilities are required in order to achieve a higher percentage of whole grains for better quality and higher price. To fetch good prices, the milled rice must be whole grains and free of husks, weed seeds, stones and other foreign materials.
  Under certified organic production, the rice mill should be cleaned properly prior to milling organic rice. For example, five sacks of organic rice can be milled first to clean the mill and classified as conventional. Only the succeeding milled rice will be recognised as organic.

Discussion: Post-harvest handling of rice

Ask the participants to describe how they handle the rice crop from harvesting to final storage of the milled grain. Identify any shortcomings with their methods and recommend appropriate modifications.

POSTHARVEST HANDLING

› **Storage -** Rice quality can be affected by temperature and air moisture. Different processed rice (wholegrain or white) require different storage conditions. For example, wholegrain rice can be stored for two years under airtight storage and moderate temperatures (10-35 degree Celsius) while white rice can be stored up to three years under the same conditions.

9. Increasing income from the rice production system

High dependence on rice alone is not only risky for the farmer, but often unsustainable. Common to the organic approach of achieving a sustainable rice production system is to diversify the sources of income from the system. This is done by adopting other enterprises which are closely linked and complementary with the rice enterprise. This will eventually ensure that any risks that may affect the rice enterprise are well-buffered by the other enterprises. Then the total income received by the farmer will not be heavily affected.

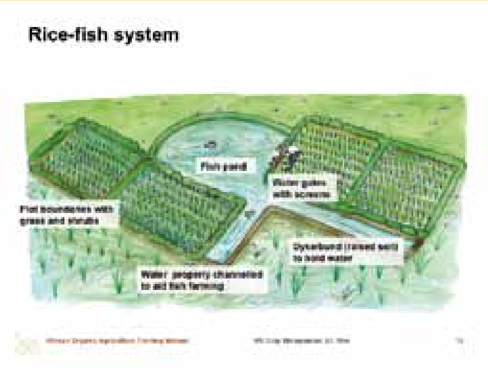
a. Crop diversification especially in upland systems. By introducing leguminous crops as intercrops or rotation crops, or high value vegetable crops, such as garden eggs, okra, pepper, the farmer has extra crop to sell. The farmer should, therefore, carefully select the crops to introduce in the system. As a guide, the farmer should select crops that can be used as food for the household and any excess is able to be sold for income.
b. Introducing fish into the rice production system especially in the lowland systems, which are prone to flooding. A rice-fish system is an integrated rice field where fish is grown concurrently or alternately with rice. This system allows for the simultaneous production of fish and rice, without the reduction of the rice yield, while providing an additional source of income to the farmer. The field may be deliberately stocked with fish or the fish may enter the field with the irrigation water, depending on the locally available species. This system is especially suited for rice production systems where farmers are not using chemicals.

Where water control is good, fish should be deliberately left to grow and is harvested just before the fields dry up. Research has also shown that performance of rice is significantly improved by the rice-fish polyculture compared to the

Discussion – Improving incomes from rice production

Let the participants identify which other enterprises they are managing in addition to rice production. Guide the selection of appropriate enterprises based on complementarity and affordability.

ILLUSTRATION OF THE RICE-FISH SYSTEM



rice monoculture. In principle, as long as there is enough water in a rice field, it can serve as a fish culturing system.

However, a rice field is by design intended for rice and conditions may not always be optimum for fish, for example whereas rice may survive long periods of standing water, fish may not. Thus, there is a need to make some modifications to rice fields in order to accommodate fish culture. This can be done in many ways, for example:

i. **Increasing dike (bund) height -** Rice field embankments are typically low and narrow since most rice varieties do not require deep water. To make the rice field more suitable for fish, the height of the embankment needs, in most cases, to be increased to a height of about 40-50 cm. This is sufficient to prevent most fish from jumping over.
ii. **Provision of weirs or screens -** To prevent loss of the fish stock with flowing water, farmers install screens or weirs across the path of the water flow, depending on the local materials available e.g. bamboo slats, a basket, a piece of fish net material or any well perforated piece of sheet metal.
iii. **Provision of drains -** The common practise for managing water levels is to temporarily break a portion of the embankment to let the water in or out at a convenient point. It is advisable to provide a more permanent way of conveying water in or out. Types of water outlets that can be installed include bamboo tubes, hollowed out logs or metal pipes.
iv. **Fish refuges -** A fish refuge is a deeper area provided for the fish within a rice field. This can be in the form of channels or several channels or ponds. The refuge will provide a place for the fish in case water in the field dries up or is not deep enough. It also serves to facilitate the fish harvest at the end of the rice season or to contain fish for further culture while the rice is harvested.

10. Marketing and organic certification of rice production

Organic certification of rice production is only reasonable if done as a market requirement, i.e. there should be a market that demands it. As the organic markets continue to grow in Africa both domestic and export markets, more rice producers will need to verify and approve their systems as organic. Thus certification is expected to increasingly become important.

Discussion – organic certification of rice production

Ask the participants if there are any farmers who are certified organic for rice production. Are there markets that require certified organic rice?

SUMMARY GUIDE ON CERTIFICATION REQUIREMENTS OF ORGANIC RICE PRODUCTION

In such a case, interested farmers should be willing to adopt the general organic production requirements, like no use of synthetic pesticides and fertilisers, treated and genetically modified seeds, as well as other sustainable production methods as discussed in the previous sections of this chapter. Farmers should be willing to learn and apply new knowledge to find organic solutions to any existing challenges to rice production.

Other considerations include:

› Farmers should have a sizeable amount of land to produce rice beyond the household requirement (commercial volumes) in order to be able to cover the extra costs of certification. The land should also be owned by the producers or they should have assured a long-term lease on the land.
› The producers should have access to at least one processing facility (especially for milling and packing), where they can negotiate for preferential treatment of their harvests to minimise contamination. Eventually as volumes increase, they can acquire their own processing facilities.
› A group of farmers of the same village, with adjacent fields can form a producer organisation of organic producers to minimise the risks of contamination from neighbouring fields. For organic rice, it is also important to avoid any contamination with conventionally grown rice and other substances during processing. All postharvest equipment used for handling conventional rice should be adequately cleaned before being used for organic rice. It is also very important to use clean sacks that have not been used for synthetic fertilizers or any chemicals, or sufficiently wash them before using them for harvested produce.

Further reading

› IRRI fact sheets. http://www.irri.org/
› System of Rice Intensification (SRI) - http://sri.ciifad.cornell.edu/index.html
› Organic Farming in the Tropics and Subtropics, Rice, Naturland 1st edition 2002
› www.naturland.de/fileadmin/MDB/documents/Publication/.../rice.pdf
› Growing NERICA in Zambia – Upland Rice. Food Crop Diversification Support Project, (FoDiS) Information Series, June 2010. www.zari.gov.zm/media/growing_nerica_in_zambia_08.06.2010.pdf