System of Rice Intensification (SRI)

Growing More Rice while Saving on Water

An information brochure used for Training on SRI in Mwea, Kenya

Prepared by:

Prof. Bancy M. Mati and Matolo Nyamai

IMAWESA

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KENYANS WANT MORE RICE

The demand for rice in Kenya continues soar as more Kenyans show progressive changes in their eating habits, coupled with urbanization. Rice is currently the third most important cereal crop after maize and wheat. The national rice consumption is estimated at 300,000 metric tons compared to an annual production range of 45,000 to 80,000 metric tons. The deficit is met through imports, valued at Ksh.7 billion in 2008. Moreover, rice is currently the most expensive cereal (or any grain) in the country, retailing at about Ksh.150-200/kg. Most of the rice in Kenya is grown in irrigation schemes established by Government, which include Mwea, Bura, Hola, Perkera, West Kano, Bunyala and Ahero. Smaller quantities are produced along river valleys. About 80% of rice in Kenya is grown under continuous flooding as is typified in the Mwea Irrigation Scheme. The paddy system of rice production depends on a continuous supply of water for irrigation and soils with high water holding capacities. Even in Mwea, water scarcity in times of drought means the scheme has ration water, like what has happened this year (2009).

Throughout the country, the shortage of water and land suited for rice production means that extensive expansion of rice growing farmlands is not a likely option. There is therefore need to consider water saving alternatives and any intervention that can increase the productivity of rice and also save on water is a most welcome initiative. The System of Rice Intensification (SRI) therefore offers this opportunity to improve food security through increased rice productivity, increase smallholder farmers' income, water savings and reduce the national rice import bill. Moreover SRI makes use of assets already available to rice farmers. In Kenya, very few people know about SRI and this training session is organized to raise awareness, for learning and implementation support.

What is SRI?

SRI stands for System of Rice Intensification. It is a set of practices that change the way we manage the environment where rice is grown. This environment comprises of soil, water, and nutrients, and how they interact with the rice plant in order to improve its yield. Put more simply; ***SRI is a package of practices especially developed to improve the productivity of rice grown in paddies***. Unlike the conventional method of continuous flooding of paddy fields, ***SRI involves intermittent wetting and drying of paddies*** as well as specific soil and agronomic management practices. The practices under SRI are said to be innovative in nature because they differ from the conventional way of growing rice. By practicing SRI, rice farmers in countries where the system began noticed that their rice yields increased - some by 50%, some doubled, and even others tripled, while their water use for paddy rice reduced by half.

What SRI is not

- SRI is NOT a new type of rice, nor does it modify the genetic make-up of rice. It is simply a combination of agricultural practices especially developed to improve the productivity of rice grown in paddies.

What are the practices under SRI?

SRI works best when the following rice agronomic practices are combined:

1. Use **young seedlings,** i.e. 8-12 days old, maximum 15 days - to preserve mature plants' growth potential
2. **Avoid trauma (or shock) to the roots** - transplant quickly, shallow (1-2 cm), with no inversion of seedlings' root tips that will delay the plants' resumption of growth after transplanting.
3. Transplant **one plant per hill** instead of the usual 3-5 seedlings (*"ngundi"*) and plant in a square pattern
4. Give plants optimally **wider spacing** – 25cm X 25cm.
   NB: With wider spacing and a single plant per hill, plants get increased exposure to sunlight, air and nutrients, allowing profuse growth of roots and canopies. These in turn produce stronger stalks and more tillers.
5. **Do not continuously flood the soil.** You can keep the soils just sufficiently moist or practice alternate wetting and drying (AWD) especially where the soils are of the type that swells when wet and cracks when dry, such as most soils in the rice growing areas of Mwea. The idea is to ensure the soil is mostly aerobic and not saturated. This concept has been scientifically proven to allow plant roots to grow more profusely due to presence of

more oxygen in the soil, leading to effective nutrient uptake, which in turn results to **healthier plants.**

6. **Weed control** is preferably done using a simple mechanical (rotary) weeder. This kind of weeding actively **aerates the soil as much as possible,** while mixing weeds with the soil to form green manure.
7. **Enhance soil organic matter as much as possible** applying compost, mulch, manure, etc. Chemical fertilizers can be used with SRI, but the best results have come with organic soil amendments.

What are the benefits of SRI?

- SRI gives higher yields - more tons of rice per hectare.
- SRI Saves on inputs – over 75% less seed; about 25-50% less water; about 40-50% less fertilizer depending on the fertility status of the soil.
- SRI makes use of what the farmer has. It may not be necessary to purchase any extra external inputs.
- SRI ensures more water is available to more farmers and other beneficial uses

Why SRI is a better practice scientifically

Basically, SRI promotes:

- The growth and health of rice plant roots -- so that they grow larger and deeper, not degenerating for lack of oxygen in the soil, and
- The abundance, diversity and activity of soil organisms -- bacteria, fungi, earthworms and other soil biota -- that improve soil fertility and contribute to plant growth and health.

Can poor farmers adopt SRI?

Yes. SRI methods are particularly accessible to and beneficial for the poor, who need to get the maximum benefit from their limited land, labor, water and capital. Although there is an added demand on labour, especially for weeding, family labour can be made effectively more productive through SRI.

What about size of farm?

SRI concepts and practices can be adapted and used with ***any scale of production***, from small-scale to large-scale. In an unprecedented way, *SRI methods raise the productivity of land, of labor, of water and of capital* all at the same time. SRI's higher productivity is making more rice available, with prospectively lower prices and with widely distributed benefits.

Farmers' guide on How to implement SRI on the farm

SRI Key element	Description of specifics
1. Land preparation	• Soak field for 5 days, then plough • Harrow 2-3 times, with a 2-3 day pause – this ensures proper soil-water mixture. • Spread appropriate amount of Organic fertilizer (or manure) or chemical equivalent for the size of your land before the last harrowing. • It is important to level the field so that water can reach all areas. • For easier management of water, create ditches in your field to help in draining the field for intermittent irrigation and drying of the soil.

SRI Key element	Description of specifics
	• Divide the field using grids. This is achieved by raking the field using a specially constructed rake to mark grids on the muddy surface. Rakes can be made from wood, bamboo or tools that can be found in local markets • Start with 25cm x 25cm spacing. If the soil is fertile, wider spacing of 30 x 40cm can give even higher yield • During grid making, the field should not have much standing water. If the field does not hold the marking, it is a clear sign it is not ready to transplanting.
2. Seedling preparation	• Should be started while land is being prepared • Select good seed because in SRI every seed matters. Use available methods for good seed selection eg., soaking in salty water of specific density of about 1.6 (enough to float an egg) • On top of a plastic sheet, make a 2-3cm thick seedbed of a mixture of soil and organic fertilizer or well dried fine manure, at a ratio of 1:1. The sheet prevents seedling roots from running too deep into the soil at the time of transplanting. • Sow 5-7kg/ha of treated and pre-germinated seed not too densely on the seed bed • Spread organic fertilizer on the seed bed 2 days after sowing • Spray organic pesticides if needed • Water the nursery daily. Do not flood, but just keep the soil moisture saturated. • Seedlings can be grown on plates, or banana leaves
3. Innovative transplanting	• Transplant before the third leaf appears, at 8-10 days old • Before transplanting, disassemble the seedbed and remove the seedlings. Be careful not to damage the young roots. Put the seedlings on a plate or tray to make it easier to transport them to the field. • Plant one seedling per hill on the grid intersections marked on the field. This reduces the seedlings required by 80-90% from that required in common practice. • Plant seedlings at shallow depth, just 1-2cm deep • Slip the seedlings into the soil sideways so that the roots stay horizontal into the soil. Do not push the seedlings in from above as this may cause the root tips to point upwards from the soil, slowing down their growth • Allow no more than 30 minutes between the uprooting of seedlings and their transplanting. It reduces mortality and stress on the young seedlings, and they will grow faster. • With wider spacing and a single plant per hill, plants get increased exposure to sunlight, air and nutrients, allowing profuse growth of roots and canopies. These in turn produce stronger stalks and more tillers.
4. Intermittent irrigation	• As a start try a 3 to 7 day cycle. i.e., irrigate field for three days and let it dry out for 7 days. This cycle can be modified based on soil and plant conditions. The idea is to keep the soil ***moist and not***

SRI Key element	Description of specifics
	saturated to allow air to get into the soil for the benefit of the roots and soil organisms • Begin the cycle 10 days after transplanting • Shift to continuous irrigation when the panicles start to appear, in which a thin layer of water, 1-2cm, can be kept on the field. • You can determine visually when to irrigate depending on the size of the cracks that appear on the soil surface. • Irrigation should be stopped 1-2 weeks before harvest for the field to dry and the plant to transfer maximum nutrients into the grains • Intermittent irrigation promotes root elongation and aerates the soil. • Adjust the time and the amount of intermittent irrigation according to the availability of water especially in the dry season
5. Rotary weeding	• Start weeding 10-12 days after transplanting • Repeat 2-3 times every 10-12 days • Spike-teethed rotary tools are recommended to manual weeding or chemical spraying because this way, weeds are mixed into the soil as green manure. It also enhances the tilth. • Intermittent irrigation requires more weeding than the common practice, as weeds tend to grow more rapidly under un-inundated conditions. However, farmers will note that this extra effort has a payoff because the method of weeding aerates the soil more, leading to even increased yield by 1-2 tonnes per hectare.
6. Organic fertilization	• Farmers can use locally made decompositions of rice straw, banana pulp, animal dung, or indigenous microorganisms • Farmers can also use organic fertilizers together with the chemical fertilizers used, as availability of the OF depends on materials available for their making and finances as well. • The idea in organic fertilization is to not to feed the plant, but to feed the soil and let the soil feed the plant.

Why SRI practices work better

SRI is most easily visualized in terms of ***certain practices*** that are recommended to farmers for trying out on their own rice fields to improve the productivity of their rice crop. These practices are based upon important insights and principles that constitute SRI. The practices discussed below which are recommended for SRI are in effect the 'signature' of SRI.

SRI recommendations change what are often ***age-old methods*** for growing irrigated rice. This means that even though the practices are simple, they may not be readily adopted. It is important always to emphasize ***the reasons for making changes in practice***: to promote bigger, healthier root systems that support larger, more productive plants that grow in more fertile soil systems.

1. When establishing a rice crop by ***transplanting***, use ***very young seedlings*** -- less than 15 days old, and preferably 8-12 days old in tropical climates. The usual age of seedlings used now is 3-4 weeks, and up to 6-7 weeks in some places. Seedlings older than about 15 days lose much of their potential for profuse growth of roots and tillers (stalks).
    - Note that in colder climates, somewhat older seedlings, even up to 20 days, can be the physiological equivalent of 'young seedlings' because their grown will be slower.

- Note further that farmers in several countries are experimenting successfully with **direct seeding**. This saves them labor. SRI will probably evolve in this direction; but for now, SRI focuses on reduction in seedlings' age when transplanting, a familiar practice.

2. Seedlings for transplanting should be grown in ***an unflooded, garden-like nursery***, watered by watering can, with a fairly low seeding rate, so that seedling roots have plenty of room to grow. Soil used should be very loose and rich in organic matter, for easy removal.
3. When taking seedlings out of the nursery, they should be removed ***very carefully***, lifted with a trowel (unless being grown on trays for easy transport to the field). This will keep the seed sac attached to the root. *Dirt should not be knocked off from the roots.* Seedlings should be transplanted ***quickly*** after being removed from the nursery so that their roots do not dry out, and they should be transplanted in the soil ***very shallow***, just 1-2 cm deep.
4. Seedlings **should not be pushed down vertically into the soil**. This inverts their root tips upward. This will delay resumption of growth after transplanting. Root tips that are inverted take a week or more to reorient themselves downward and start growing again.
5. Seedlings should be transplanted into the field with ***wider spacing than usual***: (a) putting ***single seedlings*** in each hill, instead of 3-6 plants together in a clump as is usually done, and (b) in a ***square pattern***, 25x25 cm or even wider if or when soil fertility is very good due to biological activity. Square-pattern/grid planting permits weeding in perpendicular directions.
6. ***Paddy fields should not be kept continuously flooded*** as this creates oxygen-less (hypoxic) soil conditions that inhibit root growth and prevent the flourishing of aerobic soil organisms, ones that require oxygen. ***Small amounts of water*** should be applied daily to keep the soil moist but not saturated; or ***fields can be alternatively flooded and dried***, which requires less work. Both serve the same purpose: ***keeping the soil moist but aerobic, i.e., oxygenated***.
7. Whenever paddy soils are not kept flooded, **weed growth** becomes a greater problem. Weeds can be removed by hand or with herbicides, but for best SRI results, we recommend use of a simple mechanical weeding implement -- a rotating hoe or conoweeder -- starting 10-12 days after transplanting. Additional weedings are done every 10-12 days until rice plant growth inhibits further weeds. ***Active soil aeration*** enhances plant performance in many ways.
8. SRI was initially developed with use of chemical fertilizers to enhance soil nutrient supplies. But this requires a cash outlay from the farmer, and plant performance is even better with ***organic fertilizers***. We recommend application of ***compost of decomposed biomass***, made from rice straw, weeds, crop residues, loppings from shrubs and trees, kitchen wastes, any available animal manure. Such organic matter is valuable not so only for its *nutrient content* but for what it can do to *stimulate the growth and services of soil organisms*. These services include improved soil structure, nutrient cycling, nitrogen fixation, phosphorus solubilization, better water absorption and retention, induced systemic resistance to soil pathogens, etc.

Other beneficial practices

These practices are mutually reinforcing. They nurture the growth of roots and canopies (leaves and tillers), and they reinforce each other through better nutrient acquisition and photosynthesis. There are a number of other practices that are beneficial when used together with any cultivation methods and thus complement SRI practices, including:

- **Land preparation:** Soil should be well worked and well-leveled so that there is good soil structure, and plant roots can grow easily. Correct leveling helps farmers to achieve uniform wetting of their soil through irrigation with a minimum application of water.
- **Varietal selection:** Choose a variety, improved or traditional, that is well-suited to local conditions (soil, climate, drainage, etc.), being resistant to anticipated problems like pests or irregular water supply, and having desired grain characteristics.
- **Seed selection:** Only the best seed, with good density and formation, should be used. Submerging the seed in a pail of water, with enough salt dissolved in it to make a salt solution in which an egg will float, enables farmers to separate and discard any light and inferior seeds as these will float. Just use the good seeds that sink to the pail's bottom.
- **Seed priming:** This practice of soaking seed before planting has been found to enhance the rate of germination and seedling emergence.
- **Nursery solarization:** Where there are soil health problems, such as fungal pathogens or root-feeding nematodes, it will be beneficial to cover the nursery for seedlings for 2-8 weeks before sowing with clear plastic in order to raise the soil temperature by as much as 10^{o}C. This can eliminate many organisms that have adverse impacts on young seedlings. It will enable the nursery to produce seedlings with greater health and vigor and this will improve subsequent crop performance (Banu et al., 2005).

Why SRI is not considered a new technology

We refer to SRI as a system or as a **methodology**, a system of practices based on a coherent set of concepts and principles that produce desired results. Why not call SRI a '*technology*'? This term implies something that is *fixed and final*, something to be used as instructed -- rather than as something still evolving and improving, season by season, as more experience is gained and as more farmers, scientists and others apply their intelligence and insights to making rice production more efficient and sustainable. Indeed, Some Indian colleagues have suggested the SRI stand for '**System of Rice Improvement**." SRI, we like to reiterate, is ***a work in progress***.

When SRI is presented not as a technology, i.e., as something to be *adopted*, but instead as an innovation -- based on new thinking about ***how to provide rice plants with an optimal growing environment*** – this presents SRI as something they can and should contribute to. Further, it makes explicit that farmers are expected to make their own *adaptations* to their local conditions. It is expected also that they can make improvements in the system. Thus, farmers are encouraged to engage in ***participatory technology development***, in contribute to a process of technological development, as *active partners* rather than as *docile adopters*.

Annex 1: A brief history of SRI

SRI was developed in **Madagascar** through the efforts of **Fr. Henri de Laulaniè, S.J.**, who spent 34 years of his life working with poor farmers there, to help them reduce their poverty and hunger by improving their production of rice, the source of more than half of Malagasies' calories. He sought to rely on simple methods that would not require purchase of external inputs.

Laulaniè was born in France in 1920 and attended its leading agricultural college before World War II, at which time he decided to change careers and entered a Jesuit seminary in 1941. Upon graduation in 1945, he worked in France until 1961, when he was sent by the Jesuit order to Madagascar as an agricultural missionary. Although he knew little about rice, he understood a lot about agriculture in general and decided to focus on this crop.

Over the next two decades, he observed and experimented with various practices. Some SRI practices he learned from farmers who had departed from traditional cultivation methods. A few **transplanted single seedlings** instead of clumps of 3-6 seedlings, and some others **did not keep rice fields continuously flooded**, only moist enough to meet crop needs. Fr. Laulanié himself adopted the use of **a rotating hoe** that aerates the topsoil at the same time it eliminates weeds. (These can become a big problem when farmers do not keep their rice fields always flooded.) He also introduced **planting in a square pattern**, 25x25cm, i.e., 10x10 inches, reducing plant populations by 80-90%. This radical change gives plants ample room for roots and above-ground parts to grow as they are better exposed to sunlight and air. Planting in a square pattern created opportunity for doing mechanical 'weeding' in perpendicular directions, enhancing soil aeration and plant growth, while at the same time reducing pest and disease problems.

The biggest single step toward the development of SRI was the accidental discovery in 1983-84 that **transplanting very young seedlings**, just 15 days after seeds had been sown in the nursery, could greatly enhance yield (Laulaniè, 1993). By using young seedlings, the plants' potential for prolific growth of roots and tillers is preserved, as explained by understanding phyllochrons. SRI was developed using chemical fertilizer, but when the government removed its fertilizer subsidy in the late 1980s, and small farmers could no longer afford it, Laulaniè modified SRI to utilize **compost**, which proved even more beneficial for plant growth.

In 1990, together with several close Malagasy friends and colleagues, Laulaniè formed a small NGO called ***Association TEFY SAINA***. This Malagasy words 'improve the mind,' rather than 'grow more rice.' Association Tefy Saina has sought to promote broad-based agricultural and rural development in Madagascar (Laulaniè, 2003). In 1994, Tefy Saina began working with the **Cornell International Institute for Food, Agriculture and Development** (CIIFAD) on an integrated conservation and development project funded by USAID in and around Ranomafana National Park to protect rainforest ecosystems of the country's central-eastern escarpment.

Over the next three cropping seasons, farmers trained by Tefy Saina field staff achieved average yields of **8 tons/hectare**, where previously they had averaged only ***2 tons/hectare***. Some reached yields of 10, 12, even 14 tons. In 1997, CIIFAD began trying to get colleagues in other countries to try SRI methods for themselves. Sadly, Fr. de Laulaniè had died by this time, in June 1995 at age 75. It fell to Tefy Saina and CIIFAD to carry on his work, building on his insights and trying to share more widely the opportunities that his lifetime of selfless, innovative work had created.

Since then, other individuals and organizations have worked tirelessly to take SRI to various countries. Even though there are many skeptics, SRI has often been proved to be a success in countries where it has been tried. These include Madagascar itself, India, Philippines, Cambodia, Sri Lanka, Sierra Leone, Gambia, Cuba, Bangladesh, Nepal, Laos, Myanmar, Thailand, Mali and recently Rwanda. In Africa, several countries are interested in adopting SRI. They include Burundi, Tanzania and Malawi. In Kenya, SRI is currently under trials at the Mwea Irrigation scheme, beginning August 2009. Soon Kenya could too be a success case.

Annex 2: Promoting adoption of SRI in Kenya

The current initiative to promote the adoption of SRI in Kenya, is a multi-stakeholder, participatory 'project' combining research, capacity building and outreach activities. Spearheaded by IMAWESA, the partners include AICAD, WB, WBI, MIAD, JKUAT, NIB, MoA, MWI, KARI, Cornell University (of USA), Mwea Irrigation Scheme, the private sector and the farmers themselves. The goal is to facilitate out-scaling and up-scaling of SRI in Kenya, and hopefully, in sub-Saharan Africa in the near future. This initiative in Mwea is therefore designed to implement pilot trials of SRI by farmers in Mwea Irrigation scheme, alongside scientific research. In the short term (July-February 2009), we want to quantify some of the most important determinants, especially how SRI impacts on rice yields, water savings and socio-economic implications. Working with three of the major rice varieties that are grown in Mwea, rice is grown with SRI practice as compared with rice grown under conventional flooded paddies. The current initiative has three main activities:

(i) Scientific research on SRI conducted on-station at MIAD,

(ii) A concurrent set of trials implemented by volunteer farmers from the Mwea Irrigation scheme so as to achieve farmer-level results, and

(iii) Capacity building and out-reach activities targeting both the participating and non-participating farmers through targeted activities such as video conferencing, field days, posters, fliers, cross-learning by SRI experts from Rwanda, exchange-visits and bulletins.

These activities are during the rice crop season at Mwea from August 2009-February 2010, after which there will be a national stakeholder workshop to share the findings and officially launch SRI in Kenya. It is planned that a larger, more widely disseminated project will be developed to promote SRI within Mwea, and in all rice growing areas of Kenya, and hopefully, in other countries of sub-Saharan Africa.

(a) Young rice in conventional flooded paddy (b) Young rice with SRI practice, by Moses Kareithi at Mwea

Abbreviations

AICAD	African Institute for Capacity Development
BUF	Better-U Foundation
CKDAP	Central Kenya Dry Areas Project (of Kenya)
IMAWESA	Improved Management of Agricultural Water in Eastern & Southern Africa
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KARI	Kenya Agricultural Research Institute

MIAD	Mwea Irrigation Agricultural Development
MoA	Ministry of Agriculture
MWI	Ministry of Water and Irrigation
NIB	National Irrigation Board
SRI	System of Rice Intensification
WB	World Bank
WBI	World Bank Institute

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