SYSTEM OF RICE INTENSIFICATION (SRI): GROWING MORE WITH LESS WATER

Promoting the Adoption of SRI in Kenya

Brief Notes by:

Prof. Bancy M. Mati
IMAWESA

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 Video Conference is organized to raise awareness, and for learning.

About the System of Rice Intensification (SRI)

1. What is SRI?

The System of Rice Intensification (SRI) was developed as a "*set of insights and practices that change the management of plants, soil, water and nutrients used in growing irrigated rice*." These concepts and practices can be adapted for growing rice that is un-irrigated or rainfed as well as other crops. SRI methods, by promoting growth of more productive and robust plants:

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.

SRI IN PRACTICE

SRI involves some combination of the following changes in rice agronomic practices.

1. ***Transplant seedlings at a very young age*** – 8 to 12 days old, at most 15 days old, instead of the usual age for seedlings of 3-4 weeks or more.
2. ***Raise seedlings in un-flooded nurseries***, not planted densely and well-supplied with organic matter. There is an option of ***direct-seeding***, but transplanting is most common.
3. ***Transplant seedlings quickly, carefully and shallow*** – taking care to have minimum trauma to roots, *not inverting plant root tips upward* which delays resumption of growth.
4. ***Transplant seedlings at wider distance* and *singly*** *(one seedling only)* – instead of clumps of 3-4 seedlings per hole -- and ***in a square pattern***, usually 25x25 cm, giving roots and leaves more space to grow.
5. ***Do not continuously flood the soil*** – soil saturation causes plant roots to degenerate and suppresses soil organisms that require oxygen; either apply *small amounts of water* daily, to keep soil moist but not saturated, or *alternately flood and dry* the soil.
6. ***Weed control*** is preferably done with a simple mechanical hand weeder. This *aerates the soil* as it eliminates weeds, giving better results than either hand weeding or herbicides.
7. ***Provide as much organic matter as possible to the soil*** – while chemical fertilizer gives positive results with SRI practices, the best yields will come with organic fertilizers or manures. This does more than feed the plant: *it feeds the soil, so that the soil can feed the plant*.

ADVANTAGES OF SRI

- SRI gives ***higher yields*** -- more tons of rice per hectare, sometimes up to 200% increase over conventional flooded paddies
- Require ***less seed and less water*** –which can be by up to 50% water savings- because plant populations are reduced, and paddy fields are not kept continuously flooded,
- SRI ***makes use of what the farmer has***. It may not be necessary to purchase any extra external inputs, although they can be used with the other practices, and
- SRI does not require the purchase of ***new seeds*** – since practically all rice varieties give higher yield with SRI, but some high-yielding varieties respond better than others.

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.

WHAT ARE THE KEY SRI PRACTICES?

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 ISN'T SRI 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

ACKNOWLEDGEMENTS

Many thanks to **Prof. Norman Uphoff** of Cornell University, USA, who provided much of the material on SRI, and has been a source of inspiration to SRI team efforts in Kenya.