A GUIDE FOR FARMERS STARTING TO USE
THE SYSTEM OF RICE INTENSIFICATION (SRI)

INTRODUCTION Any person can use an understanding that SRI provides of how to help rice plants to produce more than with present irrigated cultivation practices. But SRI methods will be of most benefit to those who depend primarily upon their own labor and skill to provide for their families. The insights of SRI can be adapted to larger scale production, but we focus on the needs of small farmers.

The System of Rice Intensification (SRI) was developed in Madagascar to enable farmers who have small by 50 to 100 percent just by changing the ways that plants, soil, water and nutrients are managed in farmers' fields. Hundreds of farmers in Madagascar who were getting only 2-2.5 t/ha yields, on poor soils, are now getting an average yield of 8 t/ha, and some are getting twice as much. Similar results are being obtained with SRI methods in more than a dozen other countries around the world, so it is likely that SRI can be beneficial to farmers in
a wide variety of situations.

To get yield improvements with SRI, it is not necessary to use new varieties of rice or purchased inputs such as fertilizers and agrochemicals. The recommended changes in management practices bring out productive potential that has always existed in rice seeds but that is inhibited by standard practices. Yields with traditional

variety can usually be doubled, and with the most skillful management can go as high as 6-10 t/ha. A few skillful farmers using certain modern varieties have even gotten to twice this level.

SRI changes certain practices that farmers have followed for hundreds of years:

- **plant fairly mature seedlings, 3-4 weeks old,**
- **plant densely, 3-4 plants per hill, and 50 to 100 or more plants per square meter, and**
- **grow rice in fields that are kept continuously flooded during the growing season.**

In addition, farmers are currently recommended to maximize yields by increasing their use of:

- **chemical fertilizer. These practices do not capitalize fully on the biological potential of rice.**

These traditional practices have been followed to save labor and apparently reduce risk as well as to get most production. But these practices limit rice yield potential by inhibiting root growth and constraining the abundance and diversity of microorganisms in the soil that are crucial for supporting plant growth.

If farmers are willing to grow their rice plants differently, investing more labor initially, they can raise their yields and get more output per day of labor. With good use of SRI practices, risk is even reduced, because root systems are larger and healthier, and as farmers gain skill and confidence with SRI methods, the labor time required per hectare will become less. Eventually SRI can even become a labor-saving method for growing rice.

A NEW APPROACH

This sounds too good to be true. But farmer experience and scientific evaluation are showing that SRI methods capitalize on significant genetic potentials in rice. They also promote beneficial activity of microorganisms in the soil that help make nutrients available to the plants' roots. This guide introduces the System of Rice

Intensification to farmers so that they can try SRI for themselves, to see whether they too can bring out this potential in their own rice crops.

What are presented here are not just practices for farmer to adopt. We present first the principles behind the practices that are suggested below as "starting points." Farmers who want to increase their yields should be carefully observing and evaluating the effects of their actions. Farmers should always modify and change their practices so that these are most beneficial for their own conditions.

SRI is called a system rather than a technology because it is not something specific that is to be implemented in a fixed way. SRI is a methodology -- something flexible that should engage farmers' thinking and creativity. It is expected that the experience of working with SRI will enable farmers to become more innovative and more successful for their families.

SRI was developed by a French priest who spent 34 years of his life working with Madagascar farmers. Father Henri de Laulanié saw SRI as contributing to human resource development, not just to more rice production. Farmers are encouraged to try out this system for themselves and to adapt it, making it their own. We ask that anyone who finds this system beneficial for themselves and their families will share their experience and their knowledge with others, so that the benefits of this system can be spread, farmer to farmer, for many others.

PRINCIPLES

SRI is based on the following observations from experience with irrigated rice production where seedlings are transplanted. We note that the system can be adapted to direct seeding, but that is not yet common, so we focus on methods starting with transplantation of seedlings.

- **Rice plants will produce more at harvest time when their cycle is started with:**
  - **careful transplanting of**
  - **young seedlings that are**
  - **widely spaced.**

This will preserve the plants' greatest growth potential and opportunity for more tillering and root growth. Quick and careless transplanting of large seedlings is easier, but it reduces plants' eventual yield. Plants crowded close together cannot achieve their full growth potential.

- **Rice plants will produce more when they are grown in soil that is:**
  - **well-drained and aerated during their growth (tillering) period, and**
  - **biologically active, full of abundant and diverse microorganisms.**

Rice plants like all living creatures require oxygen. Soil that is kept continuously flooded deprives the roots of oxygen that they need to live. Also, many of the microorganisms that are most beneficial for rice plants require oxygen to survive.

SOME NEW WAYS OF THINKING ABOUT RICE

These principles go against the way that rice has been understood and grown for a long time. Previously it has been thought that:

- **Rice grows best under continuously flooded conditions. This is incorrect. Continuous flooding causes rice roots to begin dying after 1-2 weeks, and by the time of flowering, about three-fourths of the rice plant's roots will have degenerated, limiting its uptake of nutrients and making the plant vulnerable to lodging.**

- **Planting more plants will increase yield. Actually, crowding interferes with the growth of plants' roots and canopy and makes them less vigorous, able to resist pests and disease. Having fewer but larger plants that are healthier will give better results.**
- **Larger, more mature seedlings will grow more vigorously. But in fact, smaller, younger seedlings will give greater root growth and more tillers, being better able to withstand water shortages and produce more grain.**

SRI gives new ideas about how farmers can help rice plants to perform its best. The practices that it promotes create what is called synergy -- a dynamic relationship where increases in one factor contribute to increases in another factor, and where the second factor also contributes to the first. In the case of rice, having more roots supports the growth of more tillers and leaves, and having more tillers and leaves in turn supports more root growth. Each promotes the other, and together, the increase number of roots, tillers and leaves will support more production of grain.

PRACTICES
The practices that are recommended with SRI are all simple, and none require the purchase of any inputs. They require labor and skill to benefit from this new understanding of rice plants.
The nursery will be discussed below as a specific subject.

Land Preparation: No change is required in this, except that *the field should be made as level as possible* so that *water can be applied very evenly and in small amounts* during the growing period. This will save water and enable farmers to keep the soil properly moist without having any standing water that can suffocate the plant roots.

Transplanting: Seedlings should be transplanted when they are still very young, preferably between 8 and 12 days old, and certainly before 15 days after emergence. (For rice growing at high altitudes in colder climates, the maximum may be up to 18-20 days.) The physical indicator is that the seedlings should still have only two leaves, not more.

Seedlings should be transplanted very carefully:

- **There should be only 15-30 minutes between the time that seedlings are removed from the nursery and are planted into the field, so the roots will not become dried out.**
- **Seedlings should be removed from the nursery carefully, keeping the seed sac still attached to the root. Soil should not be removed from the roots.**
- **Seedlings should be laid into the field carefully, about 1-2 cm into muddy, not flooded, soil.**
- **The root tip should be laid in horizontally not be pushed into the soil. If the root tip is pointing upward, this will delay the plant's resumption of growth in its new soil environment.**

Such careful transplanting is impractical if large numbers of seedlings are being transplanted, but with SRI, many fewer seedlings are planted. The seeding rate is 5-10 kg/ha instead of the more common rate of 50-100 kg/ha. Fewer plants can produce much more yield if the SRI practices are followed. Farmers who use these methods most carefully and successfully have been able to get 2,000 to 3,000 kg of rice harvested from just 1 kg of seed.

Seedlings are transplanted with wide spacing.

- **This means planting only one seedling per hill instead of planting 3, 4, 5 or more seedlings together in a clump. Single seedlings have more room for their root system to grow; many plants together will have competing and stunted roots. In some soils, 2 seedlings per hill will give better results than 1 or 3, but we recommend starting with single seedlings. Farmers should experiment with some hills having 2 seedlings to see if this is advantageous on their soils.**
- **With SRI, plants are planted in a square pattern rather than in rows or at random. This gives both the tillers and leaves and the roots more space to spread and capture sunlight and nutrients. We recommend starting with 25x25 cm (10x10 inches) spacing. But if the soils are good (healthy, with rich microbial activity), wider spacing and fewer plants will give even higher yields -- 30x30 or 35x35 or 40x40 cm spacing. The highest yields have been obtained with 50x50 cm spacing, but that is on soil that has been improved over several years with SRI practices. It is best to start with 25x25 cm and then try out wider spacing.**

Spacing of seedlings can be guided by stretching strings across the field that have been marked or knotted at the desired intervals (25 cm or more). These are tied to sticks put into the edge of the field at the desired intervals (25 cm or more). Farmers have found that they can transplant more quickly and easily by using a simple wooden rake that has teeth spaced at the desired interval (25 cm or more). This rake is pulled across the field once it is ready for transplanting, in two directions. This creates a grid of squares 25x25 cm, or more if the teeth are more widely spaced. If the soil in the field is the right degree of muddiness, the lines on the field surface will hold up well for transplanters to see. If the field is too wet, they will not last. There is a new implement designed by Lakshmana Reddy in Anaparti village, East Godavari, Andhra Pradesh, a 'roller-marker' that is made out of simple, light metal rods, which can imprint on the muddy surface of the field a 25x25 cm 'grid' to guide planting and make it quicker. The implement can be built for any desired spacing.

If farmers are concerned about possible death of seedlings, they can plant some extra ones along the edges of the field and transplant these into any gaps they observe during the first weeding. Farmers who have learned these methods well find that they have very little mortality of seedlings, maybe a few percent, not enough to make it worthwhile to do such filling in. Rice seedlings if grown in a nursery that is not flooded and if transplanted carefully into soil that is well prepared and not flooded are very tough, even though they look very fragile.

At first, farmers will be fairly nervous about handling such tiny plants and will work very slowly. But as they gain skill and confidence, they will find that transplanting with SRI methods is quicker and easier because many fewer plants are involved. (Also, some report that they get less back ache because the plants are fewer and lighter.)

WARNING: For the first month, the field will look very disappointing. There will be little green to see because the plants are few and small; there will be no blue to see because the sky is not reflecting off standing water. Neighbors may joke and criticize. But from about the fifth week, the plants will show accelerated growth that attracts neighbors' curiosity and even complements.

Water Management: To ensure that rice plant roots remain healthy and vigorous, there should be no continuously standing water on the field, at least through the period of tiller growth -- up to the time when flowering begins. After flowering, a thin layer of water is kept on the field, 1-2 cm, and the field is drained 10-20 days before harvesting according to local practice.

There are two ways for managing water during the tillering period:

- **Continuous Careful Management: The best method appears to be to apply small amounts of water daily, preferably in the late afternoon, unless there has been rain during the day in which case no more water is usually needed. The objective is to keep the soil moist but not saturated (waterlogged). If there is standing water on the field the next morning, this should be drained off, so that the field is exposed to the sun during the day, and both warmth and air can get into the soil. Standing water reflects and thus loses much of the sun's energy. During the tillering period, the field should be left unirrigated for several periods of 2 to 6 days, even to the point of surface cracking. This will encourage the roots to grow more deeply into the soil.**

Such management requires monitoring of the water status in the field and thus more labor. We think it will give best results, giving plants as much water as they need for good growth but no more. However, many farmers may wish to economize on their labor and are not trying to get the maximum obtainable yield. For them, a simpler method is possible.

- **Alternate Flooding and Drying: After transplanting, farmers can follow a schedule of flooding their field for 3-5 days and then draining and leaving it dry for 3-5 days. Indeed, depending on the qualities of the soil, the periods of flooding and drying can range from 2 to 7 days. The principle is to give the plant enough water for good growth but not to keep the soil saturated for so long that the roots begin to die. Farmers should experiment with water management methods to see what gives best results on their fields.**

The main limitation for SRI utilization is ability to control water and to be able to apply water to the field when it is needed. The practice of continuously flooding fields has been justified by its ability to reduce weeds and by the fear that water supply may be unreliable, so farmers try to store as much water as possible in their field. The cost of this strategy is reduction in root growth and performance.

If farmers do not have a reliable supply of water, they may benefit from using some of the other SRI practices, but they cannot achieve the best results obtainable.

Weeding: When fields are not kept flooded, there will be opportunity for greater weed growth. Doing manual weeding or using herbicides is suitable, but we recommend the use of a simple mechanical hand weeder (cono-weeder or rotating hoe). This not only controls weeds, but it aerates the soil and incorporates the weeds into the soil so that their nutrients are not lost.

The first weeding should be done 10-12 days after transplanting, before weed growth is much, and thereafter every 10-12 days until the canopy closes and weeding is no longer possible or necessary. A minimum of two weedings may be sufficient, but we find that a third and a fourth weeding increase yield, because of the soil aeration. So this is a profitable investment of labor.

Farmers who are have limited labor available are encouraged to start with two weedings only, but to weed a part of their field a third time, and to weed half of that part a fourth time. This will show them how much increase in production per plant is obtainable by additional weedings. Farmers can then decide for themselves whether this increase justifies investing extra labor.

The square pattern of planting was originally intended to permit use of the hand weeder in two directions (at right angles). It turned out that the wide spacing this provided was also beneficial for plant growth and productivity. A farmer in India, Gopal Swaminathan in Kadiramangalam village in Cauvery Delta, Tamil Nadu state, has designed a four-row weeder so that one person can weed four rows simultaneously, practically cutting labor time in half. Another farmer in Sri Lanka, Ariyaratna Subesinghe, has motorized a two-row weeder

so that he can weed very quickly, and without getting tired. Further innovations will surely be made to save labor and make weeding (soil aeration) more effective.

Fertilization: SRI was originally developed with the use of chemical fertilizers, but when these became too expensive for small farmers to use, compost was used instead, with even better results. Fertilizer can be used with SRI, but we recommend the use of compost or green manures if possible because of their greater benefit for soil microbial growth.

The compost can be made very simply. Any decomposed biomass will beneficial, although enriched compost can be made by using cuttings of leguminous plants like tephrosia or crotalaria (adding N), banana leaves (adding K), and weeds like wild ginger or sunhemp (adding P). Putting the rice straw and husks into the compost is a good idea.

Farmers in Madagascar, who alternate growing rice with another crop like potatoes, beans or other vegetables, have found that the best results come from applying their compost to a preceding crop, not to the rice crop itself. This benefits the preceding crop and the compost is well decomposed and incorporated into the soil by the time that the rice is planted. This also shows that the benefit from compost is not just in the nutrients it adds to the soil but in what it does to improve soil microbial populations.

It should not be necessary for farmers to use any of their arable land to produce the plant material needed for compost. Good compost can be made using household wastes, residues from gardens, weeds and other plant material gathered from along roadsides or wasteland areas (where crotalaria often grows wild). It is often possible and beneficial to plant leguminous shrubs like tephrosia or sesbania.

The labor required to gather plant material and make compost can be considerable. If the benefits from compost are limited, the effort will not be worthwhile. But if the full set of SRI methods is used and rice yields are being raised by several tons per hectare, and especially if the household has less than a hectare of rice land and needs to get the maximum yield from its small holding, then the investment of labor in making compost is well repaid as part of the SRI strategy.

Crop Protection: Farmers using SRI methods usually report that they have much reduced incidence of pests and diseases. (Some have even reported that rats are less inclined to go into their SRI fields because of the wider plant spacing, whereas birds are more likely to go into SRI fields in search of insects.) Farmers say that the use of insecticides and fungicides is less needed because the plants are stronger and better able to resist damage. However, this will depend partly on local conditions. In Bu Tou village, Tian Tai county, Zhejiang province in China, farmers have found that SRI methods (wider spacing, dryer soil and canopy) are reducing their worst disease problem, sheath blight, by 70%.

If there are pest or disease attacks, we suggest use of natural biocides if possible, to have less adverse effect on soil microorganisms. But farmers should do whatever is necessary to protect their crops. One problem that has emerged in Thailand, when soils are not kept flooded, is an increase in nematodes in the soil, which reduce plant productivity. This may be limited to Thailand (and neighboring Laos, where SRI yields have not been as high as elsewhere). Possibly water management that floods the fields for short lengths of time could control this problem, as well as weeds. Continuing experimentation will improve the system over time.

Harvesting: Even though yields are higher, farmers find that they do not spend much more time on harvesting because the panicles are bigger and easier to gather. Also, less care is required when cutting the panicles because the grains are more secure and do not drop so easily. While threshing can take more time, threshing a larger harvest is a happy event.

Nursery: This is the critical first step. A much smaller nursery is needed with SRI because many fewer seedlings are required. The seeding rate is only about 5-10 kg/ha. The nursery is managed like one manages a garden, not being submerged or flooded.

It is important that the soil be light so that the seedlings can be easily removed and separated from each other without damage to the root or loss of the seed sac. One mixture that has been very successful is one-third soil, one-third compost, and one-third chicken manure (or some other source of nutrients). If the soil is heavy, some mixture of sand can make it easier to handle. If the nursery is built up above ground, for example, with bamboo sides, it is easier to manage the soil and keep it well-drained.

Some farmers plant their seedlings on trays so that these can be easily transported to the field. Others plant their small nurseries on the edge of their rice field, needing just to keep the soil moist, never flooded. We encourage farmer experimentation and innovation on nursery management, following the principle that the soil should be well supplied with nutrients and be favorable to root growth while the seedling roots themselves should have air as well as water.

ENCOURAGEMENT

These are the basic ideas and practices behind SRI. They will make most sense to farmers who have experience with rice production and who understand the relationships among plants, soil, water and nutrients from their own practice -- and who want to improve their production and who are open to new ideas.

We do not expect anyone to accept SRI without trying it for themselves or seeing the results of others' practice. SRI is a big departure from present practices and thus will often encounter resistance. We encourage farmers to try out these practices and to evaluate their results for themselves. We also encourage farmers to make adaptations and modifications according to the principles that they think might make the methodology more suitable to their conditions. We also encourage farmers to share experience among themselves so that whatever improvements can be achieved by some will also help others to be able to secure their livelihoods.

Although SRI methods can double production or more, we do not expect that farmers will all produce much more rice. This could have adverse effects on prices. Rather, we encourage farmers who raise the productivity of their land, labor and water devoted to rice production to diversify their agriculture.

If farmers can meet their family's basic food needs and even have some rice to sell by using less of their limited land, labor and water, they can then put the land, labor and water that is saved into the production of other crops that have higher profit and also higher nutritional value to improve health. Such diversification is part of the process of agricultural modernization through increased productivity of land, labor, capital and water. Since SRI does not require any use of capital, except for the hand weeder, it frees up money for use in other productive activities.