The System of Rice Intensification (SRI) was developed as a methodology aimed at increasing the yield of rice produced in irrigated farming without relying on purchased inputs. Its main elements were assembled in 1983 by the French Jesuit Father Henri de Laulanie in Madagascar after 20 years of observation and experimentation.[1] However, systematic evaluation and then dissemination of the system did not occur until some 10-20 years later. The productivity and merits of SRI have been debated between supporters and critics of the system since 2004, but the controversy has waned in recent years.

History and Main Ideas of SRI
Assembly of the practices that culminated in SRI began in the 1960s based on Fr. de Laulanie's observations of 'deviant' farmer practices and his own experimentation. Principles included applying a minimum quantity of water, instead of continuous flooding, and the individual transplanting of very young seedlings in a square pattern to give plants more room for root and tiller growth.[1]

SRI concepts and practices have continued to evolve as they are being adapted to rain-fed (unirrigated) conditions and with transplanting being superseded sometimes by direct-seeding. Regarding the management of rice plants, the basic practices of SRI according to SRI-Rice at Cornell University are:[2]

- Rice plant seedlings should be transplanted very young (usually just 8-12 days old) with just two small leaves
- Seedlings should be transplanted carefully and quickly to inflict minimum trauma on the roots
- Seedlings should be transplanted singly, with only one per hill instead of 3-4 together to minimize root competition
- Seedlings should be widely spaced to encourage greater root and canopy growth
- Seedlings should be transplanted in a square grid pattern (25x25 cm, or wider in good quality soil)

Since SRI is not a recipe of precise things to do, but rather a menu of principles and practices for bringing out rice plants' potential, SRI-Rice at Cornell University recommends:[3]

- Soil is kept moist but well-drained and aerobic, with good structure and enough organic matter to support increased biological activity. The quality and health of the soil is the key to best production.
• Only a minimum amount of water is applied during the vegetative growth period, and thereafter only a thin layer of water is maintained on the field during flowering and grain-filling. Alternatively, to save labor time, some farmers flood and drain (dry) their SRI fields in 3-5 day cycles with good results. Best water management practices depend on soil type, labor availability and other factors, so farmers should experiment on how best to apply the principle of having moist but well-drained soil while their rice plants are growing.

• Soil nutrient supplies should be augmented, preferably with compost, made from any available biomass. Better quality compost such as with manure can give additional yield advantages. Chemical fertilizer can be used and gives better results than with no nutrient amendments, but it does not enhance soil structure and microbial communities in the rhizosphere as applying organic matter accomplishes. At least initially, nutrient amendments may not be necessary to achieve higher yields with the other SRI practices, but it is desirable to build up soil fertility over time. Root exudation, greater with SRI, enhances soil fertility.

• Since weeds become a problem in fields that are not kept flooded, weeding is necessary several times, starting 10-12 days after transplanting, and if possible, every 10-12 days until the canopy closes. Using a rotary hoe -- a simple, inexpensive, mechanical push-weeder -- has the advantage of aerating the soil at the same time that weeds are eliminated. (They are left in the soil to decompose so their nutrients are not lost.) Additional weedings beyond two can increase yield more than enough under most conditions to more than justify the added labor costs.

Spread of SRI
The spread of SRI from Madagascar to around the globe has been credited to Norman Uphoff, director of the International Institute for Food, Agriculture and Development at Cornell University, Ithaca, New York from 1990 to 2005. In 1993, Uphoff met officials from Association Tefy Saina, the non-governmental organization set up in Madagascar in 1990 by de Laulanie to promote SRI. After seeing the success of SRI for three years when Malagasy farmers previously averaging 2 tons/hectare averaged 8 tons/hectare with SRI, Uphoff became persuaded of the merits of the system, and in 1997 started to promote SRI in Asia. Today, the spread of SRI is supported by SRI-Rice at Cornell University, an organization devoted to advancing and promoting SRI knowledge globally.

Evaluating SRI
Proponents and critics of SRI have debated the claimed benefits, and many questions about it remain unresolved.[4] The International Rice Research Institute has published information on the challenges of evaluating SRI stating that, "the flexibility in SRI’s definition of practices renders SRI a challenge for evaluation and assessment of adoption." [1] Wageningen University has also published an article discussing the challenges of evaluating SRI in which one concluding sentence read: "Although the technical aspects of SRI have been contested, it clearly exists as a real social phenomenon".[6] The question at hand seems to be: is SRI better at delivering increased yield and other benefits to rice farmers, such as healthier soils, when compared with established recommended best management practices for rice production?

Lessons from SRI studies
Results from the field studies of Directorate of Rice Research (DRR) conducted in four seasons and also AICRIP trials as present in the Rice Knowledge Management Portal, indicate good scope for saving irrigation besides improving rice growth and production. However, water saving could be attributed to reduction in water losses through percolation/seepage/ runoff/evaporation that are common with flooded rice culture. Increased productivity is associated with improved plant growth, yield attributes and higher grain output has been apparent[7].
Cases of success
Proponents of SRI claim its use increases yield, saves water, reduces production costs, and increases income, and that benefits have been achieved in almost 50 countries.[8] Uphoff published an article in the International Journal of Agricultural Sustainability that states that SRI "can raise irrigated rice yields to about double the present world average without relying on external inputs, also offering environmental and equity benefits."[9] A special issue on SRI in the scientific journal Paddy and Water Environment collected recent findings in support of SRI.[10] SRI principles have been applied in many regions to various other important crops for increasing productivity and establishing food security besides rice. Through the work of various NGO partners working in the SDTT-supported SRI [1] programme, India today has emerged as the largest adopted System of Crop Intensification (SCI) efforts in the world. As spill-over effect, innovations on wheat, kidney beans, millets, mustard, sugarcane, grams, vegetables even have been extensive with several thousands of farmers in states like Bihar and Uttarakhand extending SRI ideas and methods to other food crops. This phenomenon of extending beyond rice is significant and merits closer attention by policy makers.

Criticism
Critics of SRI suggest that claims of yield increase in SRI are due to unscientific evaluations, and further that the definition of SRI is a vague moving target, and therefore difficult to evaluate. They object that there is a lack of details on the methodology used in trials and a lack of publications in the peer-reviewed literature.[11][12] Some critics have suggested that SRI success is unique to soil conditions in Madagascar.[13] The scientific literature on SRI has burgeoned, with over 250 articles now, which can be easily accessed [14].

SRI picture gallery
Below is a picture gallery of SRI farming in Chattisgarh, India:
Crop with weeds

Weeding

Weeding

Weeding

Weeding

References

1. ^ Evaluating SRI, IRRI website.

Others

- 2. ^ Core SRI principles, SRI-Rice
- 3. ^ Core SRI principles, SRI-Rice
- 5. ^ Evaluating SRI, International Rice Research Institute
- 8. ^ More rice for people, more water for planet: System of Rice Intensification (SRI) by Africare, Oxfam and WWF.
How Millions of Farmers are Advancing Agriculture For Themselves

December 3, 2012
by Jonathan Latham

The world record yield for paddy rice production is not held by an agricultural research station or by a large-scale farmer from the United States, but by Sumant Kumar who has a farm of just two hectares in Darveshpura village in the state of Bihar in Northern India. His record yield of 22.4 tons per hectare, from a one-acre plot, was achieved with what is known as the System of Rice Intensification (SRI). To put his achievement in perspective, the average paddy yield worldwide is about 4 tons per hectare. Even with the use of fertilizer, average yields are usually not more than 8 tons.

Sumant Kumar’s success was not a fluke. Four of his neighbors, using SRI methods, and all for the first time, matched or exceeded the previous world record from China, 19 tons per hectare. Moreover, they used only modest amounts of inorganic fertilizer and did not need chemical crop protection.

SRI-GROWN RICE IN CHINA
Using SRI methods, smallholding farmers in many countries are starting to get higher yields and greater productivity from their land, labor, seeds, water and capital, with their crops showing more resilience to the hazards of climate change (Thakur et al 2009; Zhao et al 2009).

These productivity gains have been achieved simply by changing the ways that farmers manage their plants, soil, water and nutrients.

The effect is to get crop plants to grow larger, healthier, longer-lived root systems, accompanied by increases in the abundance, diversity and activity of soil organisms. These organisms constitute a beneficial micro-biome for plants that enhances their growth and health in ways similar to how the human micro-biome benefits Homo sapiens.

That altered management practices can induce more productive, resilient phenotypes from existing rice plant genotypes has been seen in over 50 countries. The reasons for this improvement are not all known, but there is a growing literature that helps account for the improvements observed in yield and health for rice crops using SRI.

The ideas and practices that constitute SRI were developed inductively in Madagascar some 30 years ago for rice. They are now being adapted to improve the productivity of a wide variety of other crops, starting with wheat, finger millet and sugarcane. Producing more output with fewer external inputs may sound improbable, but it derives from a shift in emphasis from improving plant genetic potential via plant breeding, to providing optimal environments for crop growth.

The adaptation of SRI experience and principles to other crops is being referred to generically as the System of Crop Intensification (SCI), encompassing variants for wheat (SWI), maize (SMI), finger millet (SFMI), sugarcane (SSI), mustard (rapeseed/canola)(another SMI), teff (STI), legumes such as pigeon peas, lentils and soya beans, and vegetables such as tomatoes, chillies and eggplant.

That similar results are seen across such a range of plants suggests some generic processes may be involved, and these practices are not only good for growing rice. This suggests to Prof. Norman Uphoff and colleagues within the SRI network that more attention should be given to the contributions that are made to agricultural production by the soil biota, both in the plants’ rhizospheres but also as symbiotic endophytes within the plants themselves (Uphoff et al. 2012).

The evidence reported below has drawn heavily, with permission, from a report that Dr. Uphoff prepared on the extension of SRI to other crops (Uphoff 2012). Much more research and evaluation needs to be done on this progression to satisfy both scientists and practitioners. But this gives an idea of what kinds of advances in agricultural knowledge and practice appear to be emerging.

Origins and Principles

Deriving from empirical work started in the 1960s in Madagascar by a French priest, Fr. Henri de Laulanié, S.J., the System of Rice Intensification (SRI) has shown remarkable capacity to raise smallholders’ rice productivity under a wide variety of conditions around the world: from tropical rainforest regions of Indonesia, to mountainous regions in northeastern Afghanistan, to fertile river basins in India and Pakistan, to arid conditions of Timbuktu on the edge of the Sahara Desert in Mali. SRI methods have proved adaptable to a wide range of agroecological settings.

With SRI management, paddy yields are usually increased by 50-100%, but sometimes by even more, even up to the super-yields of Sumant Kumar and his neighbors. Requirements for seed are greatly reduced (by 80-90%), as are those for irrigation water (by 25-50%). Little or no inorganic fertilizer is required if sufficient organic matter can be provided to the soil, and there is little if any need for agrochemical crop protection against pests and diseases. SRI plants are also generally...
healthier and better able to resist such stresses as well as drought, extremes of temperature, flooding, and storm damage.

SRI methodology is based on four main principles that interact in synergistic ways:

- Establish healthy plants early and carefully, nurturing their root potential.
- Reduce plant populations, giving each plant more room to grow above and below ground and room to capture sunlight and obtain nutrients.
- Enrich the soil with organic matter, keeping it well-aerated to support better growth of roots and more aerobic soil biota.
- Apply water purposefully in ways that favor plant-root and soil-microbial growth, avoiding flooded (anaerobic) soil conditions.

These principles are translated into a number of irrigated rice cultivation practices which under most smallholder farmers’ conditions are the following:

- Plant young seedlings carefully and singly, giving them wider spacing usually in a square pattern, so that both roots and canopy have ample room to spread.
- Keep the soil moist but not inundated. Provide sufficient water for plant roots and beneficial soil organisms to grow, but not so much as to suffocate or suppress either, e.g., through alternate wetting and drying, or through small but regular applications.
- Add as much compost, mulch or other organic matter to the soil as possible, ‘feeding the soil’ so that the soil can, in turn, ‘feed the plant.’
- Control weeds with mechanical methods that can incorporate weeds while breaking up the soil’s surface. This actively aerates the root zone as a beneficial by-product of weed control. This practice can promote root growth and the abundance of beneficial soil organisms, adding to yield.

The cumulative result of these practices is to induce the growth of more productive and healthier plants (phenotypes) from any given variety (genotype).

Variants of SRI practices suitable for upland regions have been developed by farmers where there are no irrigation facilities, so SRI is not just for irrigated rice production any more. In both settings, crops can be productive with less irrigation water or rainfall because taking up SRI recommendations enhances the capacity of soil systems to absorb and provide water (‘green water’). SRI practices initially developed to benefit small-scale rice growers are being adapted now for larger-scale production, with methods such as direct-seeding instead of transplanting, and with the mechanization of some labor-intensive operations such as weeding (Sharif 2011).

From the System of Rice Intensification to the System of Crop Intensification

Once the principles of SRI became understood by farmers and they had mastered its practices for rice, farmers began extending SRI ideas and methods to other crops. NGOs and some scientists have also become interested in and supportive of this extrapolation, so a novel process of innovation has ensued. Some results of this process are summarized here.

The following information is not a research report. The comparisons below are not experiment station data but rather results that have come from farmers’ fields in Asia and Africa. The measurements of yields reported here probably have some margin of error. But the differences seen are so large and
are so often repeated that they are certainly significant agronomically. The results in the following sections are comparisons with farmers’ current practices, showing how much more production farmers in developing countries could be achieving from their presently available resources.

This innovative management of many crops, referred to under the broad heading of System of Crop Intensification (SCI), is also sometimes aptly referred to in India as the ‘System of Root Intensification,’ another meaning for the acronym SRI.

The changes introduced with SCI practice are driven by the four SRI principles noted above. The first three principles are usually followed fairly closely. The fourth principle (reduced water application) is relevant for irrigated production such as for wheat, sugarcane and some other crops. It has less relevance under rainfed conditions where farmers have less control over water applications to their crops. Maintaining sufficient but never excessive soil moisture such as with water-harvesting methods and applications corresponds to the fourth SRI principle.

Agriculture in the 21st century must be practiced differently from the previous century; land and water resources are becoming relatively scarcer, of poorer quality, or less reliable. Climatic conditions are in many places becoming more adverse, especially for smallholding farmers. More than ever, they need cropping practices that are more ‘climate-proof.’ By promoting better root growth and more abundant life in the soil, SCI offers millions of insecure, disadvantaged households better opportunities.

**Wheat (Triticum)**

The extension of SRI practices to wheat, the next most important cereal crop after rice, was fairly quickly seized upon by farmers and researchers in India, Ethiopia, Mali and Nepal. SWI was first tested in 2008 by the People’s Science Institute (PSI) which works with farmers in Himachal Pradesh and Uttarakhand states. Yield estimates showed a 91% increase for unirrigated SWI plots over usual methods in rainfed areas, and a 82% increase for irrigated SWI. This has encouraged an expansion of SWI in these two states.

The most rapid growth and most dramatic results have been in Bihar state of India, where 415 farmers, mostly women, tried SWI methods in 2008/09, with yields averaging 3.6 tons/ha, compared with 1.6 tons/ha using usual practices. The next year, 15,808 farmers used SWI with average yields of 4.6 tons/ha. In the past year, 2011/12, the SWI area in Bihar was reported to be 183,063 hectares, with average yields of 5.1 tons/ha. With SWI management, net income per acre from wheat has been calculated by the NGO PRADAN to rise from Rs. 6,984 to Rs. 17,581, with costs reduced while yields increased. This expansion has been done under the auspices of the Bihar Rural Livelihood Promotion Society, supported by the International Development Association (IDA) of the World Bank.

About the same time, farmers in northern Ethiopia started on-farm trials of SWI, assisted by the Institute for Sustainable Development (ISD), supported by a grant from Oxfam America. Seven farmers in 2009 averaged 5.45 tons/ha with SWI methods, the highest reaching 10 tons/ha. There was a larger set of on-farm trials in South Wollo in 2010. SWI yields averaged 4.7 tons/ha with compost and 4.9 tons/ha with inorganic nitrogen (urea) and phosphorus (DAP). The 4% increase in yield was not enough to justify the cost of purchasing and applying fertilizer. The control plots averaged wheat yields of 1.8 tons/ha.

In 2008-09, farmer trials with SWI methods were started in the Timbuktu region of Mali, where it was learned that transplanting young seedlings was not as effective as direct seeding, while SRI spacing of 25cm x 25cm proved to be too great. Still, obtaining a 10% higher yield with a 94% reduction in seed (10 kg/ha vs. 170 kg/ha), a 40% reduction in labor, and a 30% reduction in water requirements encouraged farmers to continue with their experiments.
In 2009/10, the NGO Africare undertook systematic replicated trials in Timbuktu, evaluating a number of different methods of crop establishment, including direct seeding in spacing combinations from 10 to 20 cm, line sowing, transplanting of seedlings, and control plots, all on farmers’ fields. Compared to the control average (2.25 tons/ha), the SWI transplanting method and 15×15 cm direct seeding gave the greatest yield response, 5.4 tons/ha, an increase of 140%.

SWI evaluations were also done in 2010 in the Far Western region of Nepal by the NGO Mercy Corps, under the EU-FAO Food Facility Programme. The control level of yield was 3.4 tons/ha using local practices with a local variety. Growing a modern variety with local practices added 10% to yield (3.74 tons/ha); however, using SWI practices the same modern variety raised yield by 91%, reaching a yield of 6.5 tons/ha.

**Mustard (Rapeseed/Canola)**

Farmers in Bihar state of India have recently begun adapting SRI methods for growing mustard (aka rapeseed or canola). In 2009-10, 7 women farmers in Gaya district working with PRADAN and the government’s ATMA agency started applying SRI practices to their mustard crop. This gave them an average grain yield of 3 tons/ha, three times their usual 1 t/ha.

The following year, 283 women farmers who used SMI methods averaged 3.25 tons/ha. In 2011-12, 1,636 farmers practiced SMI with an average yield of 3.5 tons/ha. Those who used all of the practices as recommended averaged 4 tons/ha, and one reached a yield of 4.92 tons/ha as measured by government technicians. With SMI, farmers’ costs of production were reduced by half, from Rs. 50 per kg of grain to just Rs. 25 per kilogram.

**Sugarcane (Saccharum officinarum)**

Shortly after they began using SRI methods in 2004, farmers in Andhra Pradesh state of India began also adapting these ideas and practices to their sugarcane production. Some farmers got as much as three times more yield, cutting their planting materials by 80-90%, and introducing much wider spacing of plants, using more compost and mulch to enhance soil organic matter (and control weeds), with sparing use of irrigation water and much reduced use of chemical fertilizers and agrochemical sprays.

By 2009, there had been enough testing, demonstration and modification of these initial practices, e.g., cutting out the buds from cane stalks and planting them in soil or other rooting material to produce healthy seedlings that could be transplanted with very wide spacing, that the joint Dialogue Project on Food, Water and Environment of the World Wide Fund for Nature (WWF) and the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderabad launched a ‘sustainable sugarcane initiative’ (SSI). The project published a manual that described and explained the suite of methods derived from SRI experience that could raise cane yields by 30% or more, with reduced requirements for both water and chemical fertilizer.

The director of the Dialogue Project, Dr. Biksham Gujja together with other SRI and SSI colleagues established a pro bono company AgSRI in 2010 to disseminate knowledge and practice of these ecologically-friendly innovations among farmers in India and beyond.

The first international activity of AgSRI has been to share information on SSI with sugar growers on the Camilo Cienfuegos production cooperative in Bahia Honda, Cuba. A senior sugar agronomist, Lauro Fanjúl from the Ministry of Sugar, when visiting the cooperative to inspect its SSI crop, was amazed at the size, vigor and color of the canes, noting that they were ‘still growing.’

**Finger Millet (Eleusine coracana)**

Some of the first examples of SCI came from farmers in several states of India who had either applied SRI ideas to finger millet (ragi in local languages), or by their own observations and
experimentation devised a more productive cropping system for finger millet that utilized SRI principles.

The NGO **Green Foundation** in Bangalore in the early ’00s learned that farmers in Haveri district of Karnataka State had devised a system for growing ragi that they call Guli Vidhana (square planting). Young seedlings are planted in a square grid, 2 per hill, spaced 18 inches (45 cm) apart, with organic fertilization. One implement they use stimulates greater tillering and root growth when it is pulled across the field in different directions; and another breaks up the topsoil while weeding between and across rows. In contrast with conventional methods, which yield around 1.25 to 2 tons/ha, with up to 3.25 tons using fertilizer inputs, Guli Vidhana methods yield 4.5 to 5 tons/ha, with a maximum yield so far of 6.25 tons.

In Jharkhand state of India in 2005, farmers working with the NGO PRADAN began experimenting with SRI methods for their rain-fed finger millet. Usual yields there were 750 kg to 1 ton/ha with traditional broadcasting practices. Yields with transplanted SFMI have averaged 3-4 tons/ha. Costs of production per kg of grain are reduced by 60% with SFMI management, from Rs. 34.00 to Rs. 13.50. In Ethiopia, one farmer using her own version of SRI practices for finger millet is reported by the Institute for Sustainable Development to have obtained a yield of 7.6 tons/ha.

**Maize (Zea mays)**
Growing maize using SRI concepts and methods has not been experimented with very much yet; but in northern India the People’s Science Institute in Dehradun has worked with smallholders in Uttarakhand and Himachal Pradesh states to improve their maize production with adapted SRI practices.

No transplanting is involved, and no irrigation. Farmers are planting 1-2 seeds per hill with square spacing of 30×30 cm, having added compost and other organic matter to the soil, and then doing three soil-aerating weedicings. Some varieties they have found performing best at 30×50 cm spacing. The number of farmers practicing this kind of SCI went from 183 in 2009 on 10.34 hectares of land, to 582 farmers on 63.61 ha in 2010. With these alternative methods, the average yields have been 3.5 tons/hectare. This is 75% more than their yields with conventional management, which have averaged 2 tons/hectare.

Because maize is such an important food crop for many millions of food-insecure households, getting more production from their limited land resources, with their present varieties or with improved ones, should be a priority.

**Turmeric (Curcuma longa)**
Farmers in Thambal village, Salem district in Tamil Nadu state of India were the first to establish an SRI Farmers Association in their country, as far as is known. Their appreciation for SRI methods led them to begin experimentation with the extension of these ideas to their off-season production of turmeric, a rhizome crop that gives farmers a good income when sold for use as a spice in Indian cooking.

With this methodology, planting material is reduced by more than 80%, by using much smaller rhizome portions to start seedlings. These are transplanted with wider spacing (30×40 cm instead of 30×30 cm), and organic means of fertilization are used (green manure plus vermicompost, Trichoderma, Pseudomonas, and a biofertilizer mixture known as EM, Effective Microorganisms, developed in Japan by T. Higa). Water requirements are cut by two-thirds. With yields 25% higher and with lower costs of production, farmers’ net income from their turmeric crop can be effectively doubled.

**Tef (Eragrostis tef)**
Adaptations of SRI ideas for the increased production of tef, the most important cereal grain for
Ethiopians, started in 2008-09 under the direction of Dr. Tareke Berhe, at the time director of the Sasakawa Africa Association’s regional rice program, based in Addis Ababa. Having grown up in a household which raised tef, and then written theses on tef for his M.Sc. (Washington State University) and Ph.D. (University of Nebraska), Berhe was thoroughly knowledgeable, both practically and theoretically, with this crop.

Typical yields for tef grown with traditional practices, based on broadcasting, are about 1 ton/ha. The seed of tef is tiny — even smaller than mustard seed, about 2500 seeds making only 1 gram — so growing and transplanting tef seedlings seemed far-fetched. But Berhe found that transplanting young seedlings at 20×20 cm spacing with organic and inorganic fertilization gave yields of 3 to 5 tons/ha. With small amendments of micronutrients (Zn, Cu, Mg, Mn), these yields could be almost doubled again. Such potential within the tef genome, responding to good soil conditions and wider spacing, had not been seen before. Berhe is calling these alternative production methods the System of Tef Intensification (STI).

In 2010, with a grant from Oxfam America, Dr. Berhe conducted STI trials and demonstrations at Debre Zeit Agricultural Research Center and Mekelle University, major centers for agricultural research in Ethiopia. Their good results gained acceptance for the new practices. He is now serving as an advisor for tef to the Ethiopian government’s Agricultural Transformation Agency (ATA), with support from the Bill and Melinda Gates Foundation.

This year, 7,000 farmers are using STI methods in an expanded trial, and another 100,000 farmers are using less ‘intensified’ methods based on the same SRI principles, not transplanting but having wider spacing of plants with row seeding. As with other crops, tef is quite responsive to management practices that do not crowd the plants together and that improve the soil conditions for abundant root growth.

Legumes: Pigeonpeas (Red Gram – Cajanus cajan), Lentils (Black Gram – Vigna mungo), Mung Beans (Green Gram – Vigna radiata), Soya Beans (Glycine max), Kidney Beans (Phaseolus vulgaris), Peas (Pisum sativum)

That SRI principles and methods could be extended from rice to wheat, finger millet, sugarcane, maize, and even tef was not so surprising, since these are all monocotyledons, the grasses and grass-like plants whose stalks and leaves grow from their base. That mustard would respond very well to SRI management practices was unexpected, because it is a dicotyledon, i.e., a flowering plant with its leaves growing from stems rather than from the base of the plant. It is now being found that a number of leguminous crops, also dicotyledons, can benefit from practices inspired by SRI experience.

The Bihar Rural Livelihoods Support Program, Patna, has reported tripled yield from mung bean (green gram) with SCI methods, raising production on farmers’ fields from 625 kg/ha to 1.875 tons/ha. With adapted SRI practices, the People’s Science Institute in Dehradun reports that small farmers in Uttarakhand state of India are getting:

- 65% increase for lentils (black gram), up from 850 kg/ha to 1.4 tons/ha;
- 50% increase for soya bean, going from 2.2 to 3.3 tons/ha;
- 67% increase for kidney beans, going from 1.8 to 3.0 tons/ha;
- 42% increase for peas, going from 2.13 to 3.02 tons/ha.

No transplanting is involved, but the seeds are sown, 1-2 per hill, with wide spacing – 20x30cm, 25x30cm, or 30×30 cm for most of these crops, and as much as 15/20×30/45cm for peas. Two or more weedings are done, preferably with soil aeration to enhance root growth.
Fertilization is organic, applying compost augmented by a trio of indigenous organic fertilizers known locally as PAM (panchagavya, amritghol and matkakhad). Panchagavya is a mixture of five products from cattle: ghee (clarified butter), milk, curd (yoghurt), dung and urine, which particularly appears to stimulate the growth of beneficial soil organisms. Seeds are treated before planting with cow urine to make them more resistant to pests and disease.

This production strategy can be considered ‘labor intensive’ but households seeking to get maximum yield from the small areas of land available to them find that the additional effort and care give net returns as well as more security. The resulting crops are more robust, resistant both to pest and disease damage and to adverse climatic conditions.

Vegetables
The extension of SRI concepts and practices to vegetables has been a farmer-led innovation, and has progressed farthest in Bihar State of India. The Bihar Rural Livelihoods Promotion Society (BRLPS), working under the state government, with NGOs such as PRADAN leading the field operations and having financial support from the IDA of the World Bank, has been promoting and evaluating SCI efforts among women’s self-help groups to raise their vegetable production.

Women farmers in Bihar have experimented with planting young seedlings widely and carefully, placing them into dug pits that are back-filled with loose soil and organic soil amendments such as vermicompost. Water is used very precisely and carefully. While this system is labor-intensive, it increases yields greatly and benefits particularly the very poorest households. They have access to very little land and water, and they need to use these resources with maximum productivity and little cash expenditure.

A recent article on using SRI methods with vegetables concluded: “It is found that in SRI, SWI & SCI, the disease & pest infestations are less, use of agro chemicals are lesser, requires less water, can sustain water-stressed condition; with more application of organic matter, yields in terms of grain, fodder & firewood are higher.” (from a background paper prepared for the National Colloquium on System of Crop Intensification (SCI), Patna, India, March 2, 2011).

Trials in Ethiopia conducted by the NGO ISD have also shown good results. Readers can learn more about how these ideas are being adapted for very poor, water-stressed Ethiopian households in Tigray province here (Brochure at: http://www.isd.org.et/Publications/Planting%20with%20space%2020brochure.pdf).

Conclusion
Philosophically, SRI can be understood as an integrated system of plant-centered agriculture. Fr. Laulanié, who developed SRI thinking and practice during his 34 years in Madagascar, in one of his last papers commented that he did this by learning from the rice plant; the rice plant is my teacher (mon maître) he wrote. Each of the component activities of SRI has the goal of maximally providing whatever a plant is likely to need in terms of space, light, air, water, and nutrients. It also creates favorable conditions for the growth and prospering of beneficial soil organisms in, on and around the plant. SRI thus presents us with the question: if one can provide, in every way, the best possible environment for plants to grow, what benefits and synergisms will we see?

Already, approximately 4-5 million farmers around the world are using SRI methods with rice. The success of SRI methods can be attributed to many factors. They are low risk, they don’t require farmers to have access to any unfamiliar technologies, they save money on multiple inputs, while higher yields earn them more. Most important is that farmers can readily see the benefits for themselves.
Consequently, many farmers are gaining confidence in their ability to get ‘more from less’ by modifying their crop management practices. They can provide for their families’ food security, obtain surpluses, and avoid indebtedness. In the process, they are enhancing the quality of their soil resources and are buffering their crops against the temperature and precipitation stresses of climate change.

Where this process will end, nobody knows. Almost invariably SRI results in far greater yields, but some farmers go beyond others’ results to achieve super-yields for reasons that are not fully clear. Although experience increasingly points to the contributions of the plants’ micro-biome, it also suggests that the optimization process is still at the beginning.

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### SCI YIELD INCREASES REPORTED

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finger Millet</td>
<td>200-300%</td>
</tr>
<tr>
<td>Legumes</td>
<td>50-200%</td>
</tr>
<tr>
<td>Maize</td>
<td>75%</td>
</tr>
<tr>
<td>Mustard</td>
<td>200-300%</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>20-100%</td>
</tr>
<tr>
<td>Tef</td>
<td>200-400%</td>
</tr>
<tr>
<td>Turmeric</td>
<td>25%</td>
</tr>
<tr>
<td>Vegetables</td>
<td>100-270%</td>
</tr>
<tr>
<td>Wheat</td>
<td>10-140%</td>
</tr>
</tbody>
</table>
intensification on rice yield and nitrogen and water use efficiency with different N application rates. Experimental Agric. 45: 275–286.

Further Reading: *What lies beyond ‘Modern Agriculture’* the Bunting lecture of 2007 given by Norman Uphoff at Reading University, UK


**CURRENTLY THERE ARE "11 COMMENTS" ON THIS ARTICLE:**

**chandrasekaran** says:  
**December 3, 2012 at 4:15 pm**  
good article for rice cultivation. Is there any project report describing the entire cultivation by this SRI? We the new generation farmers in Tamilnadu can try this and show way to traditional farmers to adopt new techniques.  
*Reply*

**dianabuja** says:  
**December 4, 2012 at 5:37 am**  
Good / advice on rice, which I'm passing on both to agronomes at the NARs and to our local farmers here in Burundi.  
*Reply*

**Bernard O'Connor** says:  
**December 4, 2012 at 7:50 am**  
Very interesting. Thanks.
Has there been any experience of SRI in mechanized rice producing areas such as Northern Italy? As productivity increases has there been any fall in price in local/regional markets?  
*Reply*

**jrlatham** says:  
**December 4, 2012 at 8:01 pm**  
Dr Uphoff says: Re: mechanized SRI in northern Italy, there has been a request for technical assistance from someone in northern Italy who is interested in trying out the methods, whom we have put in touch with the SRI farmer in Pakistan who has developed a very promising set of machines designed to combine SRI with conservation agriculture (no-till) and organic agriculture. Discussions are going on regarding a possible visit to northern Italy, or vice versa to Punjab, Pakistan. We hope that there can be some trials in the coming year. If Mr. O'Connor would like to get in touch with me, I could put him in touch with the Italian rice farmer who is interested.  
*Reply*

**jrlatham** says:  
**December 4, 2012 at 8:06 pm**  
Also in Reply to Mr O'Connor  
Dr Uphoff also says:  
Re: effects on market prices, we haven’t seen adoption on a large enough scale that there have been price impacts. But we can anticipate this in the future, and we already encourage small paddy farmers to think about diversification, taking some or much of their paddy land out of rice production, and (starting with a fish pond for water reserves) growing fruits and/or vegetables and/or legumes, etc. This has been started by innovative farmers in Cambodia working with our NGO partner CEDAC. This can be done even in unirrigated areas but there needs to be enough monsoon rain and a high
enough water table to maintain a diversified operation. The investments for small farmers are modest (about $300) and net incomes can be increased several fold. One main benefit is that farmers can get income throughout the year this way with good planning, rather than rely just on the results of one or two grain harvests. This strategy improves both income and family nutrition, as with SRI methods, farmers are getting 2-3 times more yield per ha. There is a manual on this posted at: [http://sri.ciflad.cornell.edu/countries/cambodia/cambSidMPREng.pdf](http://sri.ciflad.cornell.edu/countries/cambodia/cambSidMPREng.pdf)

Every rice-producing country is currently putting more of its land, its labor, its water and its capital into growing its staple food. Once basic cereal needs can be met with less of the country’s land, labor, water and capital, this opens up possibilities for greater and more diversified production. There would need to be adjustments in cropping patterns, but more income and better nutrition would follow from such a shift. Smaller farmers may find this transition easier to make than mono-cropping larger farmers. If prices come down, the main beneficiaries will be consumers, and particularly the poorest households, who are now spending 60-70% of their pitifully small incomes on basic staples. Enabling them to spend more on other things, like more nutritious food, school fees, health costs, etc. will have many wider benefits.

Tim Peters says:

January 23, 2013 at 7:51 am

I was excited to know that others have noticed the same things I have noticed over the years. And I was so glad to see this published here to encourage more of us to try this composite of methods.

...For my part, most recently, I used methods of this order in the Dallas-Fort Worth area of TX, USA this last year during a tree-killing drought on unirrigated land (About 1/2 acre or 1/4 hectare). On about 1/8 acre beside that plot on otherwise similar ground but not so treated I planted the same things. The contrast was life and death. The melons, squash, and tomatoes produced well on the 1/2 acre but couldn’t quite surmount the stresses on the 1/8th acre to make a crop.

...I saw similar results in Africa over 30 years ago where I was using student labor at a teachers college. A few teachers (and student labor groups under them) followed my instructions in dealing with the fields,... and the rest rebelled and followed a more tradition method. The soil was not the best and needed every ounce of care one could devise to give it, and the contrast between the teachable and the rebels was,... well, GREEN and YELLOW, a corn crop on one hand, and not quite enough health to make an ear on the other. It was quite an object lesson. ...Further driving the contrast home to the mind was the surprise currency change and reduction of available food (to less than a meal a day) to the students over the 4 or so months following harvest before the money situation normalize and food could be purchased. ...quite an experience.

nancy baggett says:

January 23, 2013 at 10:06 pm

The article title is unfortunate, as it suggests that millions of farmers are engaged in these practices for some selfish gain, not what the story is about at all.

F says:

January 24, 2013 at 5:47 am

Has anyone grow two diff. crops using SRI methods. Maybe planting in an alternating pattern like a chessboard? Maybe with a crop that fixes nitrogen alongside one that needs nitrogen.
Lee in Iowa says:
February 17, 2013 at 10:17 pm
This is quite a contrast to the “French intensive” and “Japanese deep-bed” methods we highly focused home gardeners have been revering in the US for the past 30 years–because of the wider spacing. Our earlier methods including deep-digging or even double-digging, plus feeding our soil microbes (read Teaming with Microbes, if you haven't already), but part of the object was to cram more plants into less space.

For the past three or four seasons, we’ve seen more floods, then water shortages, and more sudden extreme shifts in temperatures, along with the loss of both our honeybees AND, since the 2009 virus, our bumblebees–and the intensive methods that had filled my freezers and pantry for years just quit working.

I plan to try this system, particularly in starting my seedlings. No more six-packs that compress root systems; instead, the babies will get gallon-sized pots of their own 8 to 10 days after they appear (see http://sustainableagriculture.blogspot.com/2011/01/root-intensification-technologies-for.html).

Reply

jrlatham says:
February 17, 2013 at 11:21 pm
Please let us know what success you have. All the examples seem to be from the tropics and you may be breaking new ground.

Reply

Lee in Iowa says:
February 18, 2013 at 12:39 am
Jonathan, I will. (I'm a college teacher, in another field entirely, but I tend lately to treat some of my gardening as if it were experiments–with notes and photos. So I will share what I learn.)

Reply