RAISING SMALLHOLDER FOOD CROP YIELDS WITH CLIMATE-SMART AGROECOLOGICAL PRACTICES

Booklet supplementing presentation by Norman Uphoff

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FEATURE - New farming method boosts food output for India's rural poor

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Written by: Nita Bhalla

Manna Devi from Ghantadih village in eastern India's Bihar state holds up her wheat plant (L) cultivated according to a new farming method compared to a plant cultivated traditionally (R).

GAYA, India (AlertNet) - A new farming technique is dramatically boosting wheat yields across parts of impoverished eastern India and, although still in its infancy, could be piloted in many other countries that are vulnerable to food shortages, experts say….

Jeevika [a $73-million Bihar government programme supported by the World Bank] introduced the System of Wheat Intensification or SWI in Bihar's drought-prone Gaya district in 2007, and 25,000 wheat farmers are [now] piloting the scheme throughout the state. The system, based on low-tech methods, may be more labour-intensive than traditional techniques, but it requires less seeds, water, pesticide and fertiliser, farmers and experts say….

In Ghantadih village in Gaya district, more than half of the 42 farming households have switched to SWI from traditional practices. Manna Devi, mother of three, was the first woman to use the technique in Bihar state. She says she decided to take a gamble despite jibes from neighbouring farmers who mocked her cultivation methods. "We were living a hand-to-mouth existence before and we just couldn't manage to eat, let alone put our children through school," she says. "We were only producing about 30 kg of wheat which lasted us four months and we had to take loans, and my husband had also taken a second job as a rickshaw puller in order to make ends meet." Devi says she now produces about 80 kg of wheat - enough to feed her family for a year - and hopes to start selling extra crop. In the nearby village of Nawadhee, villagers using SWI proudly display their plots filled with tall, bold and bulky wheat crops which stand alongside their shrunken and skinny traditionally cultivated counterparts. …

The fact that SWI does not require as much water is a key advantage for farmers in this drought-prone region where groundwater reserves are dwindling and vital monsoons are becoming less regular… [Reproduced with permission]

System of Wheat Intensification (SWI) panicles in Bihar state, India

RAISING SMALLHOLDER FOOD CROP YIELDS WITH CLIMATE-SMART AGROECOLOGICAL PRACTICES

Smallholding farmers in many countries are starting to get **higher yields** with **greater factor productivity** from their **land, labor, seeds, water** and **capital** — with their crops having more resilience to the stresses from climate change. They do this by adapting the principles and methods of **SRI** to other crops through what is being called the **SYSTEM OF CROP INTENSIFICATION (SCI)**. The concepts and practices of SCI are already proving to be beneficial for growing:

Wheat
Mustard (rapeseed/canola)
Sugarcane
Finger millet
Maize
Turmeric
Tef
Legumes: pigeon peas, lentils, mung beans, soya beans, kidney beans, peas
Vegetables: tomatoes, chillies, eggplant, etc.

FROM THE SYSTEM OF RICE INTENSIFICATION TO THE SYSTEM OF CROP INTENSIFICATION

Starting from Madagascar, 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 is thus adaptable to a wide range of agroecological settings.

With SRI management, **yields** are usually increased by 50-100%, but sometimes even more, with reduced requirements for **seed** (by 80-90%) and **water** (25-50%), with less or no requirement for **inorganic fertilizer use** if sufficient organic matter can be applied, and with little if any need for **agrochemical crop protection** against pests and diseases. SRI plants are generally healthier and better able to resist stresses such 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 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 in ways that favor plant-root and soil-microbial growth**, avoiding inundated, anaerobic soil conditions.

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

- Plant young seedlings carefully and singly, giving them wider spacing usually in a square pattern, so that roots and canopy have ample room to spread.
- Keep the soil moist but not inundated, with 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 small regular applications.
- Add as much organic matter as possible (compost, mulch, etc.) to the soil, 'feeding the soil' so that the soil can feed the plant.
- Control weeds with mechanical methods that incorporate weeds into the soil while breaking up the soil's surface, actively aerating the root zone in the process. This promotes root growth and abundance of beneficial soil organisms.

The cumulative result of these practices is to induce the growth of more productive and healthier plants -- i.e., **phenotypes** -- from any given variety -- i.e., **genotype**.

These SRI practices, initially developed to benefit smallholders growing irrigated rice, have been subsequently adapted by farmers, NGOs or other professionals to **rainfed unirrigated agroecosystems**, and to **larger-scale production**, with methods such as direct-seeding instead of transplanting, or mechanizing some operations.

Fairly soon after the principles of SRI became understood and its practices were mastered, farmers began extending its ideas and methods to **other crops**. NGOs and some scientists have also become interested in and supportive of this extrapolation, so that a **process of innovation** has ensued. Results of this process are reported here. More information can be obtained from the SRI-Rice website: http://sri.ciifad.cornell.edu/aboutsri/othercrops/index.html

This is not a research report. The comparisons reported here are not experiment station data; they are the 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 so often repeated that they are certainly significant agronomically. **The SCI results in the following sections are being compared with farmers' current practices,** showing how much more production farmers could be achieving from their presently available resources.

This innovative management of many crops -- including wheat (SWI), sugarcane (SSI), finger millet (SFMI), maize (SMI), mustard (another SMI), tef (STI), turmeric (another STI), and various legumes and vegetables -- is being grouped under the broad heading of **System of Crop Intensification** (SCI), sometimes also referred to 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. The first three principles are followed usually closely. The fourth principle (reduced water application) is relevant for irrigated production, such as for wheat, sugarcane and some other crops. But 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 responds to the fourth SRI principle.

Agriculture in the 21st century must be practiced differently from the previous century; land and water are relatively scarcer, of poorer quality, or less reliable. Climatic conditions are in many places are 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, was fairly quickly seized upon by farmers and researchers in India, Ethiopia, Mali and Nepal. SWI was first tested in 2006 by People's Science Institute (PSI) in northern India with 40 farmers in 25 villages, obtaining a 66% yield increase over their traditional practices. Within three years the number of farmers using the new methods was over 12,000 in Himachal Pradesh and Uttarakhand states. Crop-cutting estimated showed 91% increase for unirrigated SWI plots and 82% increase for irrigated SWI.

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 4.5 tons/ha. With SWI management, net income per acre from wheat has been calculated by PRADAN to rise from Rs. 6,984 to Rs. 17,581. This expansion has been done under auspices of the **Bihar Rural Livelihood Promotion Society**, with IDA support from the World Bank. The extent of SWI use in Bihar was reported to be over 180,000 ha in 2011-12.

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. The differences in plant performance were very evident as seen below. Seven farmers in 2009 averaged **5.45 tons/ha** with SWI methods, the highest reaching 10 tons/ha, followed by a larger set of on-farm trials in South Wollo in 2010, with average SWI yields of **4.7 tons/ha** with compost and **4.9 tons/ha** with urea + DAP. (The 4% increase in yield with inorganic fertilizer was not enough to justify the cost of purchasing and applying fertilizer.) The control plots averaged **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. Applying SRI spacing of 25cm x 25cm proved to be too great for wheat. But getting 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 encouraged farmers to continue with their experimentation.

Comparison of wheat panicles in Gembichu woreda, Ethiopia:
usual methods on left, 39 grains; SWI on right 56 grains

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 transplanting method and 15x15 cm direct seeding gave the greatest yield response, **5.4 tons/ha**, an increase of 140%.

Comparison of SWI panicles on left and conventionally-grown wheat
panicles on right, from 2009/10 trials in Timbuktu region

Establishment method	Yield (t/ha)	% compared to control
10 cm x10 cm	**4.33**	92
10 cm x 15 cm	**5.22**	132
15 cm x 15 cm	**5.41**	140
20 cm x 20 cm	**4.9**	118
Line hand (20cm)	**4.26**	89
Line mach (20cm)	**5.13**	128
Seedlings	**5.41**	140
Control	**2.25**	0
5 farmers	**2.45**	9

Results of 2009-10 SWI evaluations in Mali and a picture of the test plots

SWI evaluations were been 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** with a local variety and using local practices. Growing a modern variety with local practices added 10% to yield, 3.74 tons/ha, whereas using SWI practices the same modern variety raised yield by 91%, with a yield of **6.5 tons/ha.**

Farmer in Muzzafarpur district, Bihar state, showing difference between plants of the same variety when using SWI management methods (on left). As with SRI, these methods promote root growth and beneficial soil organisms, resulting in more tillering, larger panicles, and more grains as seen from the reports above.

Manual on SWI practices as developed in Bihar state of India:

[http://sri.ciifad.cornell.edu/aboutsri/othercrops/wheat/In_SWI_Pradan.pdf]

MUSTARD (RAPESEED/CANOLA) (Brassica)

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 district started applying SRI practices to their mustard crop, which gave them an average grain yield of **3 tons/ha,** three times their usual **1 t/ha**.

Next 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 have been reduced by half, from **Rs. 50** per kg of grain to just **Rs. 25** per kilogram.

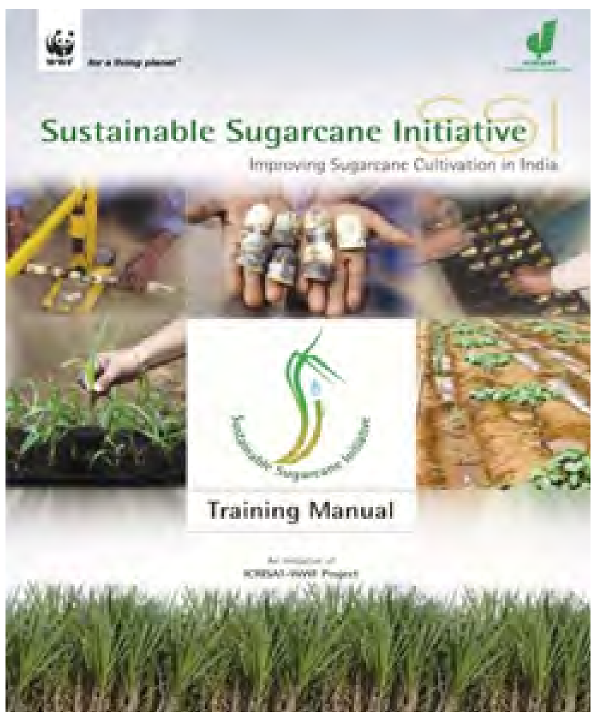
SMI mustard plot on land in a Bihar village, India; inset: large dried SMI mustard plant in front of a doorway.

Manual on SMI practices as developed in Bihar state of India:
[http://sri.ciifad.cornell.edu/aboutsri/othercrops/otherSCI/In_SMImustard_Pradan.pdf]

SUGARCANE (Saccarum officinarum)

Farmers in **Andhra Pradesh state of India** shortly after they began using SRI methods in 2004 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% as done with SRI, 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 health 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 (below) 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 water and for 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 above manual and an updated SSI training manual published in 2012 are both available on the AgSRI website: www.agsri.com. See feature article on AgSRI published by *Outlook Business*: http://business.outlookindia.com/article.aspx?282020 (Sept. 2012). See also SSI article: http://www.springerlink.com/content/fg32x113058rh413/?MUD=MP

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**. The pictures below show the first crop at 10.5 months. A senior sugar agronomist, Lauro Fanjùl from the Ministry of Sugar (see below), 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 applied SRI ideas to finger millet (ragi in local languages) or who 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 that 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.

Above, Haveri farmers with the inter-cultivating implements they use for weeding their Guli Vidhana finger millet. These are pulled by oxen between and across the rows, spaced 18 inches (45 cm) in both directions. By breaking up the soil and aerating it, these Yedekunte weeders stimulate the crops' root growth and enhance its yield significantly.

*http://sri.ciifad.cornell.edu/aboutsri/othercrops/fingermillet/InKar_Ragi_GreenFoundationPoster.pdf

In **Jharkhand state of India**, rainfed farmers working with the NGO **PRADAN** began experimenting with SRI methods for their finger millet (ragi) in 2005. 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 had a yield of **7.6 tons/ha**.

Differences in plant size and in size of panicles induced by SFMI management

Manual on SFMI practices as developed in Bihar state of India:
[http://sri.ciifad.cornell.edu/aboutsri/othercrops/fingermillet/In_SFMI_Pradan.pdf]

MAIZE (Zea mays)

Growing **maize** with 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 30x30 cm, having added compost and other organic matter to the soil, and then doing three soil-aerating weedings. Some varieties they have found performing best at 30x50 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**, 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.

Maize crop in Uttarakhand state grown with adapted SRI practices

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 (30x40 cm instead of 30x30 cm), and organic means of fertilization are used (green manure plus vermicompost, Trichoderma, Pseudomonas, EM, etc.). Water requirements are cut by two-thirds. With yields 25% higher and with lower costs of production, farmer's net income from their turmeric crop can be effectively doubled. It is reported that farmers in Cambodia have applied SRI ideas to **ginger,** another rhizome crop, but we have no detailed information on this.

A manual on STI as developed in Tamil Nadu state, available at:
http://sri.ciifad.cornell.edu/aboutsri/othercrops/otherSCI/InTN_STI_Baskaran092712.pdf

Above is Baskaran showing the mixing of organic inputs with coco-peat for filling the cups in which turmeric seedlings are grown for use in STI turmeric production.

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 writing 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 20x20 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).

Pictures from Dr. Berhe's presentation on 'Recent Developments in Tef: Ethiopia's Most Important Cereal and Gift to the World,' Cornell, July 2009.

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, and 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, the tef genome is quite responsive to management practices that do not crowd the plants together and that improve the soil conditions for abundant root growth.

Transplanted tef ready for harvest

Field of growing young tef plants

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, according to botanical classification, and members of the broad category of grasses or grass-like plants whose stalks and leaves grow from their base. That mustard would respond very well to SRI kinds of management was unexpected, because it is a dichocotyledon, i.e., a flowering plant with its leaves growing from stems. It is now being found that a number of **leguminous crops**, also dicotyledons, can benefit from practices inspired by SRI experience.

A farmer in Karnataka state of India holding a pigeon pea (redgram) plant grown with adapted SRI practices. The NGO **Agriculture-Man-Environment Foundation** in Bangalore reports yields are being increased by 70%, from the usual 800-900 kg/ha to 1.5 tons/ha with modifications in management.

See: http://sri.ciifad.cornell.edu/aboutsri/othercrops/otherSCI/InKarnSCIRedGram_AME2011.pdf

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 30x30 cm for most of these crops, and as much as 15/20x30/45cm 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 particular 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 is certainly 'intensive' but the households are seeking to get maximum yield from the small areas of land available to them. The resulting crops are more robust, resistant both to pest and disease damage and to adverse climatic conditions.

SCI lentils in Uttarakhand

SCI soya beans in Uttarakhand

Pictures from presentation on 'Addressing Food Security in the Western Himalayan Region through System of Crop Intensification,' People's Science Institute, Dehradun, Jan. 2012

VEGETABLES

The extension of SRI concepts and practices to vegetable has been a farmer-led innovation, most developed in **Bihar State of India**. The **Bihar Rural Livelihoods Promotion Society** (BRLPS), working under the state government and with NGOs such as PRADAN leading the field operations, and having financial support from the IDA of the World Bank, has provided as rubric for 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 shallow 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.

Tomatoes under SCI management

Brinjal under SCI management

Differences between yields of chillies, tomatoes and brinjal (eggplant) through System of Crop Intensification (SCI) and conventional methods, Bihar, 2010-11

	Unit	**No. of smallholders**	**Conventional Practices**	**SCI Practices**	**Increase**
Chillies	**Kgs/plant**	**69**	**1.5-2.0**	**4.5-5.0**	**170%**
Tomatoes	**Kgs/plant**	**168**	**3.0-4.0**	**12.0-14.0**	**270%**
Brinjals	**Kgs/plant**	**42**	**5.0-6.0**	**10.0-12.0**	**100%**

Conclusion: "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."

The table of data and the conclusion above are from a background paper prepared for a
National Colloquium on System of Crop Intensification (SCI), Patna, March 2, 2011:
www.brlp.in/admin/Files/Concept%20Note%20on%20National%20Colloquium%20on%20SCI.pdf

PLANTING WITH SPACE

These innovative systems of crop management are each a little different, but they all got their impetus from experience with the System of Rice Intensification (SRI). With upland crops, reducing the flooding of fields through irrigation management is not an issue. But soil aeration that promotes root growth and the abundance of aerobic soil organisms is part of the strategy.

The NGO **Institute for Sustainable Development** (ISD) in Addis Ababa working with farmers in the northern Ethiopian province of Tigray has adapted SRI ideas under the rubric of 'planting with space,' described in a booklet on the web: www.isd.org.et/Publications/planting%20with%20space.pdf

Farmers have begun adapting and using the methods of transplanting young seedlings, carefully and widely spaced in a square pattern, with abundant use of compost or other organic matter and with soil-aerating weeding, for a wide range of their crops: wheat, finger millet, maize, sorghum, barley and tef; several legumes; onions, chillies, tomatoes, lettuce, cabbage, often with intercropping of grains.

Where this process will end, nobody knows, but farmers are gaining confidence in their ability to get 'more from less' and to provide for their families' food security while enhancing the quality of their soil resources and also buffering their crops against the temperature and precipitation stresses of climate change.

Summary of Results Reported from Farmers' Fields:

Crops	Yield increases
Finger millet	3-4x
Legumes	50-200%
Maize	75%
Mustard	3-4x
Sugarcane*	20-100%
Tef	3-5x
Turmeric**	25%**
Vegetables	100-270%#
Wheat*	10-140%

*** 30% irrigation water savings were reported; most SCI crops are rainfed.**
**** 66% water saving; farmers' net income is doubled**
 # Increases per plant, not adjusted for area production

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Vanaja Ramprasad (Green Foundation, Bangalore, India)
Debashish Sen (People's Science Institute, Dehradun, India)
Willem Stoop (Stoop Consult, Netherlands)
Anoop Tiwari (Madhya Pradesh Rural Livelihoods Project, India)

*previous affiliation

Farmer and son in Tigray, Ethiopia showing the high tillering capacity obtained from tef plants when grown by transplanting (father) compared with traditional broadcast sowing (son).

Photo: Courtesy of Dr. Hailu Araya, Institute for Sustainable Development