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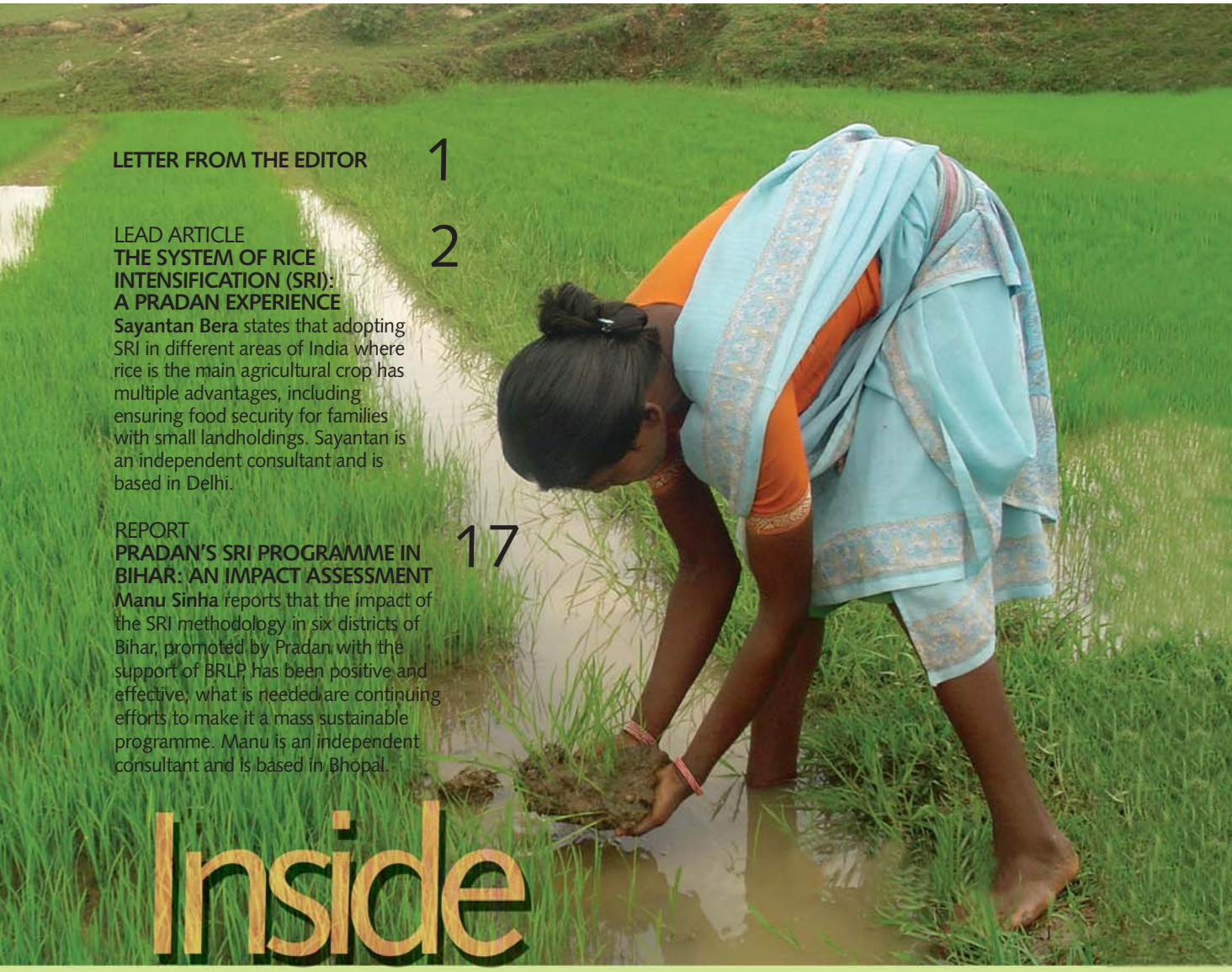

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LETTER FROM THE EDITOR

During the period 2003–2004 to 2007–2008, agriculture recorded an annual growth of 3.7 ssper cent. The share of agriculture in the GDP has registered a steady decline from 36.4 per cent in 1982–83 to 18.5 per cent in 2006–07. During the period 1990–2007, the rate of growth of food grain production was 1.2 per cent — much lower than the annual growth rate of population averaging 1.9 per cent during the same period. This implies a decline in per capita availability of food grains during this period.

Figures from the India State Hunger Index 2008, released by International Food Policy Research Institute (IFPRI), show the continued overall severity of the hunger situation in India while revealing the variation in hunger across states within India. The report also suggests a close link between the poverty ratio and the prevalence of hunger in the states. A possible remedial measure to lessen the incidence of hunger is to strengthen agriculture, along with measures to increase overall food availability and access to all segments of the population. For states with rice as the principal food crop, augmenting the status of paddy production (such as increasing the area under food grains and higher paddy yield with improved methods of cultivation) can go a long way in ensuring year-round food security for families. The System of Rice Intensification, a radically innovative way of paddy cultivation that has become popular in India (and the rest of the rice growing parts of the world) holds out great promise for the expected enhancement in rice production.

As mention by Sayantan Bera in the artilce "The System of Rice Intensification (SRI): A Pradan Experience" – for a country like India where rice is the main agricultural crop (23 per cent of the gross cropped area falling under rice cultivation), adopting SRI will bring multifold advantages. SRI can ensure year-round food security for small families with small landholdings (less than an acre of land). Components of this technology have worked well under rainfed conditions; it is a boon for areas with little or no access to irrigation. This technology also ensures efficient water management, without compromising productivity. SRI is a solution to distress migration and alienation from agriculture because it ensures year-round food security, resulting in the migrants coming back to agriculture.

The System of Rice Intensification (SRI) has become immensely popular in the past few years. Farmers, Universities, Research Institutions, NGOs and many others are now engaged in reaching SRI to all the rice growing areas as they see a potential in the technology for addressing the issue of enhancing food production. Drawing on the fundamentals of SRI, the technology has been extended by practitioners and researchers to other crops as well, albeit in a limited manner. Thus technologies such as Syetem of Wheat Intensification (SWI), Sugarcane Intensification System (SIS) and System of Mustard Intensification (SMI) have emerged.

In this special issue of NewsReach we are focusing on these systems of crop intensification, where we are showcasing the experiences of practitioners who have tried out the various technologies and have achieved results, highlighting the successes, innovations, impact, emerging issues, of reaching out to the farmers with the new technologies.

The System of Rice Intensification (SRI): A Pradan Experience

SAYANTAN BERA

Adopting SRI in different areas of India where rice is the main agricultural crop has multiple advantages, including ensuring food security for families with small landholdings

INDIA'S FOOD SECURITY AND POVERTY SITUATION

In recent years, the Indian economy has seen unprecedented high rates of growth: the gross domestic product (GDP) recorded a growth of over 9 per cent for three consecutive years from 2005–2006 to 2007–2008. However, during the period 2003–2004 to 2007–2008, agriculture recorded an annual growth of 3.7 per cent. The share of agriculture in the GDP has registered a steady decline from 36.4 per cent in 1982–83 to 18.5 per cent in 2006–07. Yet the agriculture sector continues to support more than half a billion people and provides employment to 52 per cent of the workforce.

During the period 1990–2007, the rate of growth of food grain production was 1.2 per cent — much lower than the annual growth rate of population averaging 1.9 per cent during the same period. This implies a decline in per capita availability of food grains during this period.

The poverty figures from the National Sample Survey reveals that the rural (urban) poverty rate declined from 46 per cent (41 per cent) in 1983 to 28 per cent (26 per cent) in 2004–2005. The real cause for this decline lies in the change in the parameters that are used to calculate the poverty rate. Initially, poverty lines were defined in terms of calorie norms. All subsequent poverty lines were calculated in terms of the expenditure required to purchase those calories rather than the actual calorie intake. Therefore, official poverty figures have declined over the years as the per capita expenditure has moved upwards. Nevertheless, an increase in per capita expenditure does not necessarily mean that households can buy those calories because they have other expenses to bear. In 2004–05, the fraction of households living in rural areas with a per capita calorie consumption of less than 2,400 is 79.8 per cent, up from 66 per cent in 1983. All India figures (calculated by actual calorie intake) suggest that the proportion of the poor (consuming less than 2,400 calories in rural areas and less than 2,100 calories in urban areas) has increased from 64.8 per cent in 1983 to 75.8 per cent in 2004–2005.

In mid-2008, the World Bank revised the global poverty line from $1 a day to $1.25 a day, causing many to wake up to newfound alarming statistics on global poverty trends. The recent World Bank study by Martin Ravallion and Shaohua Chen (August 2008), based on the average poverty line of 15 of the world's poorest countries, stated that the number of poor people in India has increased from 421 million in 1981 to 456 million in 2005. The Asian Development Bank revised the poverty line at $1.35 a day, putting the India poverty figures at 55 per cent of the population. Whereas everyone else is sweating over the financial crisis and its impact on India's growth prospects, few words, if at all, are spent on the homegrown crisis in food. The per person grain demand in India has come down from 178 kg in early 1990s to 157 kg in 2004–2005. This, according to some, is due to the drastic fall in the purchasing power of the poor masses.

Figures from the India State Hunger Index 2008, released by International Food Policy Research Institute (IFPRI), show the continued overall severity of the hunger situation in India while revealing the variation in hunger across states within India. The report reveals that not a single state in India is either low or moderate in terms of its index score and most states have a 'serious' hunger problem, with the situation in Madhya Pradesh categorized as 'extremely alarming'. The report also suggests a close link between the poverty ratio and the prevalence of

hunger in a particular state (with exceptions such as Gujarat and Karnataka, which should have performed better on the hunger index, given their levels of poverty). States performing the worst in the hunger index — Madhya Pradesh (MP), Jharkhand and Bihar — have poverty ratios much higher than the other states. Linking hunger and poverty to the status of paddy production in states where rice is the principal food crop throws up interesting results. States that are better ranked in terms of hunger are mostly those with paddy yields substantially higher than the all-India average paddy yield (such as Punjab, Kerala and Andhra Pradesh).

All India figures (calculated by actual calorie intake) suggest that the proportion of the poor (consuming less than 2,400 calories in rural areas and less than 2,100 calories in urban areas) has increased from 64.8 per cent in 1983 to 75.8 per cent in 2004–2005

A possible remedial measure to lessen the incidence of hunger is to strengthen agriculture, along with measures to increase overall food availability and access to all segments of the population. For states with rice as the principal food crop, augmenting the status of paddy production (such as increasing the area under food grains and higher paddy yield with improved methods of cultivation) can go a long way in ensuring year-round food security for marginal and small farm households.

INTRODUCTION OF SRI

Le systeme de Riziculture Intensive, or the System of Rice Intensification (SRI), is a simple 'process' innovation developed by Fr. Henri de Laulanie in Madagascar in 1983. Slowly, over the last decade, this technology has been adopted by rice growing economies of South Asia to ensure food security for its fast increasing population.

The basic principle on which this process works can be summarized as deliberate modifications in the environment on a micro scale, especially in the root zone, which rekindles and energizes the existing genetic potential, resulting in manifold increase in the yield. These modifications are in terms of the level of water near the roots, transplantation period from nursery to field, reduced trauma to the seedling during the transplantation, spacing, weeding and aeration. The changed practices with lower inputs result in improved productivity, with yields of 7–8 tonnes per hectare: about double the present world average of 3.8 tonnes per hectare and more than thrice the Indian average of 2 tonnes per hectare.

For a country like India where rice is the main agricultural crop (23 per cent of the gross cropped area falling under rice cultivation), adopting SRI will bring multifold advantages. SRI can ensure year-round food security for small families with small landholdings (less than an acre of land). Components of this technology have worked well under rainfed conditions; it is a boon for areas with little or no access to irrigation. This technology also ensures efficient water management, without compromising productivity. SRI is a solution to distress migration and alienation from agriculture because it ensures year-round food security, resulting in the migrants coming back to agriculture.

Despite its potential and glaring advantages, until date, the SRI outreach has been rather limited in India. Almost 46 countries from

Asia, Africa and America have been using this technology and reaping benefits.

COST EFFECTIVENESS OF SRI

SRI is a very cost effective technology. In SRI, the seed requirement is less, with only one seedling per hill; the increased spacing between these results in reduction in the expenditure incurred on seed. Additionally, SRI largely does not require the purchase of new seeds or the use of new high-yielding varieties. Less time is required to transplant the saplings into the main field, which results in saving of labour charges. Besides saving on seed, the savings on chemical fertilizers depends on the existing practice in a particular area.

SRI fields require at least two weedings, with substantial turning of the soil. This is done by using a hand-operated weeding machine. The use of a weeder machine saves around 150 hours of work compared to manual weeding in an acre of land.

The relatively short 7–12 days nursery period in SRI (compared to the over–21 days in traditional transplantation) also comes with its inherent benefits. In rainfed areas, the farmer can decide on when to prepare the nursery with the availability/arrival of rains. This gives them an advantage of manoeuvering the nursery, something akin to 'playing with the rains'. Moreover, since SRI nursery plots are relatively small in size, they can be prepared within a short duration as and when the rain settles.

SRI: PROCESS COMPONENTS

Pradan has been promoting SRI in eight states of central and eastern India since 2003. A

detailed study helps us classify the SRI process into components such as land selection and land preparation, seed selection and seed treatment, nursery bed preparation, and transplantation. The components are as follows:

- **Land selection and preparation:** Medium and lowlands most suitable; drainage channels around the main field to control flow of water. Augmentation of soil nutrient using compost and, if required, chemical fertilizers.
- **Seed rate:** Only 5 kg of seeds per hectare of land.
- **Seed selection and treatment:** Improved short duration varieties such as 1001, Lalat, Swarna masuri and Super rice. After seed selection, brine water test and Bavistin treatment.
- **Nursery period and transplantation:** Nursery period of 7–8 days after which transplantation in rows maintaining an equal distance of 10 inches to 1 foot between hills. Only one sapling per hill as against multiple saplings per hill in traditional transplantation. Saplings to be transplanted within two hours from nursery to main field ensuring that minimum damage is caused to the roots.
- **Soil and water management:** In SRI method, soil has to be kept moist but well drained and aerated with a liberal application of organic matter to support biological activity.
- **Weeding and hoeing:** Three weedings, first after 10–12 days after transplantation and then in gaps of 12–15 days before the canopy closes. Weeding to be done with a hand-operated weeder machine, which will perform hoeing alongside, thus aerating the soil.
- **Regular monitoring:** Frequent visits to the field are required to monitor the

Components of this technology have worked well under rainfed conditions; it is a boon for areas with little or no access to irrigation

water level; soil should be moist and aerated at all times and alternative wetting and drying may be practised if possible.

SRI: THE PRADAN EXPERIENCE

Pradan, a non-government, non-profit organization, has been working in eight states across India to promote livelihood opportunities for the poor. The major interventions includes promoting self help groups (SHGs) and introducing households to locally suitable economic activities (such as poultry and goat rearing, vegetable cultivation, tasar production and lac cultivation, siali leaf plate making, etc.). Since 2003, Pradan has been instrumental in introducing paddy farmers to improved techniques of cultivation such as SRI. Overall, the broad objective is to develop and build sustainable income generation activities for both farm and non-farm households in rural areas. SRI has been useful in meeting the said objective as a technology with widespread application, utility and long-term advantage for the resource-deprived section of society. Pradan has taken the SHG route to promote SRI in all its field locations.

BENEFITS

- SRI has been successful in rainfed areas, with little or no access to irrigation.
  - o Average productivity stands at 6 tonnes/ha, almost three times the national average.
  - o Increased savings due to reduced expenditure on seeds, labour, etc.
- As compared to traditional method, SRI results in an increased yield by two-three times, leading to food security.
- Substantial savings at each stage such as low expenditure on seed and labour.
- Farmers experience indicates that SRI technology is simple to adopt.

The broad objective is to develop and build sustainable income generation activities for both farm and non-farm households in rural areas. SRI has been useful in meeting the said objective as a technology with widespread application, utility and long-term advantage for the resource-deprived section of society.

Hurdles, Pitfalls and Solutions

- Initial hurdle to overcome the disbelief in a technology, which sounds 'too good to be true'. To tackle these issues, Pradan organizes
  - o Exposure visits at different phases of operation and plant growth
  - o Video shows
  - o Intensive discussions with farmers, etc.
- The intensive nature of the technology (intricate use of labour, strict scheduling and high level of care) seems more suited to small and marginal households. The challenge, therefore, lies in implementing SRI in large patches of land owned by a single family.
- Constant hand-holding and technical support is necessary so that farmers do not drop out.
- Timely availability of workable weeder machines, adequate supply of organic manure and integration with government schemes such as NREGS and Agricultural Technology Management Agency (ATMA) can facilitate the strengthening and further extension of the movement.

EXPONENTIAL SUCCESS: THE GAYA TIE-UP

To promote SRI in the Gaya and Nalanda districts of Bihar, Pradan went into an

agreement with Bihar Rural Livelihood Promotion Society (BRLPS), a government body aided by World Bank. The primary task of BRLPS is to promote SHGs in backward communities; for livelihood promotion activities, they tied up with Pradan, specifically to promote SRI among small and marginal farm households belonging to these SHGs.

Some key components of the project are:

- The work took place with the understanding that government support will be crucial to the project.
- The use of demonstrations sessions, skilled extension workers and extension materials, workshops and exposure visits, collective planning, shared learning and intensive reviews, peer pressure to perform formed crucial components.
- Constant hand-holding and timely technical support.

The results showed in the figures for 2008 kharif. Six thousand one hundred six households started SRI in about 2,080 acres of land. The average yield in Gaya was recorded as 8.9 tonnes/ha (for a sample of 103 households) whereas in Nalanda it was 7.3 tonnes/ha (for a sample of 25 households). The strategy followed by the Gaya team was a phenomenal success since SRI was initiated here as a pilot project in 2007 kharif with only 128 households in 75 acres.

CHALLENGES

Weeders

- SRI fields are characterized by large number of weeds because the fields hold relatively less water than in traditional transplanted paddy fields. Timely weeding, therefore, is a necessity. In Pradan locations, weeder availability remains a crucial problem. Often 15 to 20 households have one weeder at their disposal and as such have to do manual weeding, which takes considerable time.
- Weeders do not work in all kinds of soils.
- Locally manufactured weeders are heavy to operate for the women, who are traditionally allotted the task of weeding.

Availability of Organic Manure

- SRI needs high replenishment of soil nutrients because the intake is very high.
- Non-availability of organic manure is a problem.
- Some farmers are apprehensive about using chemical fertilizers.
- Lack of a working supply chain model for timely availability of inputs.

Land Husbandry and Irrigation

- Promoting SRI in an undulating terrain is often contingent on levelling the land in addition to bunding because it is difficult for a small household to level its own land.
- Different types of land pose constraints to taking up SRI.

Government initiative and participation should increase. There are several ways by which the government can rovide a boost to promote improved ways of paddy cultivation.

- Most of Pradan locations undertaking SRI fall under the rainfed areas. Although SRI crops are resistant to dry spells, it has been noted that minor irrigation facilities such as wells and ponds prove beneficial.

Partnering with the Government

- Government participation in promoting SRI is mostly limited to some fertilizer and seed subsidies to first time farmers.
- Until date, very little has been done by government agricultural departments to replicate the SRI experience in non-Pradan locations.

COURSE OF ACTION NEEDED

- There is an urgent need to integrate land husbandry activities with the NREGS scheme.
- Government initiative and participation should increase. There are several ways by which the government can provide a boost to promote improved ways of paddy cultivation. These include:
  - Helping farmers to create minor irrigation facilities.
  - Supporting farmers by providing fertilizers and seed subsidies during the initial years (through government departments such as ATMA).
  - Helping farmers in land husbandry (such as levelling and bunding).
  - Watershed activities through government programmes such as NREGS.
  - Using existing government infrastructure to penetrate new areas with SRI technology can also be a successful strategy.
- Use of research and technology to overcome technical difficulties such as effective and efficient weeders.

FINDINGS, CHALLENGES AND FUTURE STRATEGIES

Pradan, in its journey to meet the objective of ensuring sustainable development to the underprivileged, resource-crunched sections of the society through farm and non-farm activities, is constantly learning and improving. Given below are the compiled insights gathered from case studies conducted at various locations (Orissa, Bihar, West Bengal, Madhya Pradesh, and Jharkhand) that are trying to promote SRI through Pradan's support.

EXPERIENCES

Among the initial hurdles noted by the field personnel, 'belief' in the veracity of a new technology (especially in the distance between the hills and transplanting one seedling per hill) was most prominent. Even after exposure visits to standing crops and the cultivation procedure, farmers initially tend to believe that the SRI process will take more time and care. For a household to take up more land under SRI can be difficult because the process requires adhering to timely transplantation, water management, weeding and fertilizer application, and requires more care when preparing the nursery and monitoring the entire process. In spite of working closely with the departments, government initiation and participation still takes time to be more pro-active. The difficult terrain, migration and lack of financial support add to the challenges.

AREAS OF CONCERN AND FUTURE STRATEGIES

Supply of Inputs Timely availability of fertilizer and pesticides remains a problem. To address this:

- The future plan is to supply the inputs through the SHGs by way of a package
- Among the practices to be introduced, the Pradan team plans to shift towards using more organic fertilizers as opposed to chemical fertilizers. These include vermi-compost, and a mixture prepared from cow dung, cow urine, jaggery and three types of leaf (arak, karanj and neem)
- Partnership with government departments could prove to be of immense scope in the proper taking up of this technology

Availability of weeders: The quality and availability of weeders remain major hindrances. Whereas the Kono weeder is costly, weeders made locally, resembling the Japanese paddy weeder, have severe quality issues. More often than not, the teeth are broken and rusted, angles are not made properly and the weeder is very heavy. Pradan is encouraging and helping SHGs to purchase weeders from the sales centre of the agriculture departments (at Rs 720).

Dropouts: In some areas, it was observed that there was considerable number of dropouts over the years. Inadequate monitoring by staff especially during the planning phase, involving close interaction with the SHG groups could be possible reason. Stringent monitoring and addressing the problems of the people involved in SRI on priority basis would help in addressing the problem.

Migration and transportation: In some areas, migrant farmers come back to their

native place only during the kharif season because it is the peak time for agriculture. Therefore, promotion of SRI to these 'new' farmers through demonstrations becomes a problem. Sometimes the landholdings are scattered, leading to problems during transplantation of the seedlings from nursery to field.

Low cost irrigation systems and funding constraints: Although SRI has drought resistant crops, prolonged dry spells lead to low yields in some of the areas. Therefore, the future plans are:

- To promote low-cost irrigation structures, which the team is planning
- To organize the farmers into a collective to coordinate farm activities
- To extensively promote the practice of green manuring and composting to prevent soil nutrient depletion

Promoting land husbandry activities through available government schemes such as NREGS: In many areas, this has been one of the prime concerns. Tying up with the government to bring the benefits of the various schemes to the beneficiaries in a systematic manner is to be worked upon. Apart from this, the team plans to develop agri-horticulture cooperatives to facilitate smooth supply of inputs to SRI farmers.

POLICY PERSPECTIVES

The National Food Security Mission (NFSM) was launched in 2007-08 as a centrally sponsored scheme to increase production and productivity of rice, wheat and pulses on a sustainable basis to ensure food security. The focus is on the districts with high potential but low levels of productivity at present. At the district level, NFSM is implemented through ATMA, with funds from the designated state-level agency. For enhancing paddy productivity under NFSM, first-time farmers can be reached with an improved package of practices with an assistance of Rs 2,500 (towards seed, fertilizers, plant protection chemicals, etc.) per demonstration. For a demonstration

of SRI technology under NFSM, an assistance of Rs 3,000 is allotted for a plot of 0.4 ha. The total target area for SRI is set at 5 million ha, about 12 per cent of the area under rice production.

Although NFSM has tried to incorporate in its policies the factors that would help in promotion of SRI, there are areas that need urgent attention and remediation.

- The intervention guideline in NFSM for SRI notes, "SRI demonstration will be conducted under upland conditions on the fields of progressive farmers having assured irrigation facilities." As for kharif 2008, Pradan has successfully introduced SRI under rainfed conditions to around 20,000 farmers in 20 districts from eight states. It is therefore crucial for NFSM to recognize the potential of SRI under rainfed conditions. Several process components of SRI can work well under rainfed conditions and give an average yield of 4-8 tonnes/ha, much higher than the national average of 2.1 tonnes/ha.
- Pradan's experience of promoting an improved technology such as SRI in agriculturally backward districts of several states such as Jharkhand and MP needs to be taken into account.
- The benefits of a simple process innovation such as SRI need not be limited to 'progressive farmers' or only 'under upland conditions with assured irrigation'. Various government departments can boost SRI activities:
    - o By creating minor irrigation facilities
    - o Providing fertilizer and seed subsidies during the initial years (through schemes from ATMA)
    - o Helping in land husbandry (such as levelling and bunding) and watershed activities through programmes such as NREGS.

In addition to the experiences that SRI has performed well under rainfed conditions, there are several other encouraging aspects:

- In retrospect, most farmers have understood the benefits of higher yield and cost savings involved. The major initial hurdle, therefore, is to make new farmers take up this technology that sounds 'too good to be true'. The solution to this has been intensive exposure and input subsidies during the initial years.
- One noteworthy learning from the farmer's perspective is that SRI process requires more 'care' and is, therefore, most suited for small and marginal farms. The challenge is to help farmers expand SRI into large farms, which often hire wage laborers for transplantation.
- On the equipment side, the availability and quality of weeders remains a major bottleneck to SRI expansion.
- Experience also shows that handholding technical support to SRI farmers for 2-3 cropping seasons is essential to check dropouts and dilution of the process components.
- The lack of availability of organic fertilizers to replenish soil nutrients is another area of concern.

The massive work of bringing the long-term and sustainable benefits to the people needspolicies and interventions supporting and complementing each other.

SRI: Steps Followed in Rainfed Kharif

Pradan has been promoting SRI in eight states of central and eastern India since 2003. SRI process can be broadly classified into four components – land selection and land preparation, seed selection and seed treatment, nursery bed preparation, and transplantation. Within these four components there are input related requirements like seed rate, fertilizer and pesticide application, and care related components like weeding and hoeing.

LAND SELECTION AND LAND PREPARATION

SRI under rainfed conditions is mostly taken up in medium uplands and medium lowlands. As alternative wetting and drying is not possible under rainfed conditions, normally a shallow film of water is maintained in the field. But in case of excess rains, it would be necessary to drain out the excess water, which is possible in the medium and uplands. Since lowlands remain submerged during the rainy season, SRI may not produce the best results. After land is selected it is ploughed twice before the onset of monsoon.

SEED SELECTION AND SEED TREATMENT

Medium uplands dry up as the monsoon recedes by October, as such, the paddy should be ripened by end of October (the rough cropping duration being 120 days, from July to October). Thus short term varieties of duration 90-120 days are selected for the Kharif season. The varieties include 1001, lalat, IR64, swarna masuri (longer duration 130-140 days variety), super rice, etc. Seed rate in SRI is considerably lower than other processes: to prepare a nursery to transplant in a hectare of land only 5 kg of seed is required. However, to cover for any possible losses one may use 20 percent more seeds, i.e. 6 kg.

The first step of the seed treatment is the brine water test. An egg is placed into a bucket of water and common salt is mixed till the egg floats on the surface. Seeds are then soaked in the bucket. The chaffy grains which would not germinate float on the surface of water and are removed. The seeds from the bottom of the solution are then removed and washed twice thoroughly in fresh water to remove any remaining salts. The soaked seeds are then mixed with 10 grams of Carbendazim (e.g. Bavistin 50WP). After the Carbendazim treatment the seeds are placed inside a moist jute bag for 24 hours. The bag is kept in a shady place and under covered condition so that the seeds can get adequate warmth to facilitate germination. To facilitate germination optimum moisture has to be maintained inside the sack. This could be managed by sprinkling water time to time. The condition of the seeds is checked twice daily (to prevent over growth of sprouts) and when the sprouts appear it is the right time to sow.

NURSERY BED PREPARATION

The nursery plot is ploughed 2-3 times during the summer. With the arrival and settling of monsoons another 2-3 ploughing is required along with the removal of weeds. The plot has to be puddled and before leveling DAP (0.75 kg) and MOP (0.5 kg) is broadcasted into the soil. However, in quality soil with organic matter as in low lands, there is no need to apply fertilizers.

To transplant in a hectare of land, the nursery area is split into 10 small plots of 100 square feet (20 ft in length and 5 ft in width) each. Around each plot 1.5 ft wide and 6-9 inches deep drainage channels are prepared. For raising the nursery bed to sow 5 kg of seeds an area of 1000 sq ft is sufficient.

After the germinated seeds are broadcasted into the nursery plots cow dung is applied on top in a thin layer. For this purpose, well decomposed and fine (9 to 12 months old) cow dung without any clods is required. SRI requires transplantation of young and healthy seedlings. When seedlings are at the two leaves stage (usually 7-8 days during the Kharif season) it is optimum for transplantation. Since the SRI nursery plots are considerably smaller than the traditional ones (due to the low seed rate) they can be prepared in a short time as and when the monsoon settles.

Regular monitoring of the nursery bed is required after sowing. During the monsoons, there is a chance of water stagnation due to heavy rainfall. The field should ideally have no stagnant water and has to be kept in moist condition. If required, water from the drainage channels can be sprinkled on the plots.

PREPARING THE MAIN FIELD

During the 7 days period required for the seedlings to get to the two leaves stage in the nursery plot, the main field has to be readied for transplantation.

An inch of standing water is sufficient during the last ploughing of the main plot. Ideally, the field has to be well puddled with no standing water after leveling. This would prevent any loss of soil nutrients after applying the basal dose of fertilizers. After the puddling the plot has to be leveled and split by drainage channels. The drains channels are around each split plot with sub drainage channels after each 20 to 25 feet distance. A spillway has to be there to drain out the excess water from common channels. This helps in easy management of water. Each individual plot is leveled in such a way that it will be slightly concave rather straight. This facilitates uniform draining out of water from the entire field.

To augment soil nutrients compost application, made from available bio mass, gives better results. Quality compost like vermin compost or cow dung manure ensures yield advantages. Application of chemical fertilizers is also preferred but contributes less to good soil structure and active microbial communities when compared to organic fertilizers.

Generally, to ensure good yields (when adequate compost is not available), it is advised to apply 60 quintals of cow dung manure, 52.5 kg of DAP, 52.5 kg of MOP, and 82 kg of urea per acre of land. The compost is applied 7-10 days before the final plough, while the entire DAP and MOP are applied in basal doses during the final ploughing. The urea is best applied in 4 equal splits during weeding and hoeing at an interval of 10 to 15 days with the final application during the panicle initiation stage. Pest and diseases infestation in SRI has to be addressed as in low land paddy.

TRANSPLANTATION

Young saplings of 8-15 days are carefully lifted along with soil from the nursery bed to be transplanted in the main field within 2 hours. Normally, the saplings are scooped from the nursery bed with care and quickly transplanted to ensure minimum damage to the roots.

Single saplings are transplanted in a square grid pattern with a distance of 8 to 10 inches between saplings maintained from both sides. One seedling is transplanted per hill instead of 3-6 done in traditional transplantation to prevent root competition. Wide spacing between saplings ensures greater root and canopy growth and also eases weeding and hoeing operations. To transplant in a line a rope of 50-100 feet is required with markers to demarcate the spacing of 8-10 inches on the rope. The rope can be placed end to end across the field and single seedlings transplanted along the markings. This would ensure equal spacing between every sapling from all sides.

WEEDING AND HOEING

Since SRI fields are not submerged in water weeding becomes an imperative without which weeds will compete for nutrients alongside the main crop. Three weeding is recommended with the first one within 10-12 days of transplantation and thereafter in gaps of 12-15 days before the canopy closes. In SRI process, weeding is done with help of a mechanical weeder which during operation performs hoeing as well. This simultaneous hoeing keeps the root zone sufficiently aerated and helps the roots to remain fresh and healthy.

SOIL AND WATER MANAGEMENT

In SRI method, soil has to be kept moist but well-drained and aerated with liberal application of organic matter to support biological activity. The quality and health of the soil is the key to optimum production. It is advised to have minimum water during the vegetative growth period and only a thin layer (maximum 1 cm) of water during the ripening stage.

Alternatively, the fields can be flooded and drained (dried) in 3-5 day cycles for better results. But this alternate wetting and drying is contingent on the availability of an assured irrigation source.

HARVESTING

The process of harvesting the SRI crop is similar to low land paddy cultivation practice.

REGULAR MONITORING AND SUPERVISION

Although SRI is a simple technological invention, the process is time bound and requires regular monitoring on part of the cultivator. With the onset and settling of monsoon nursery bed has to be prepared. After this main field has to be prepared within a week and transplantation has to done when the saplings are young. Weeding has to be done on specified intervals to achieve best results. The process demands frequent visits to the field to monitor water level, soil condition and check for possible pest attacks. Treatment of pest attacks in SRI fields is similar to that of low land paddy.

Pradan's SRI Programme in Bihar: An Impact Assessment

MANU SINHA

The impact of the SRI methodology in six districts of Bihar, promoted by Pradan with the support of BRLP, has been positive and effective; what is needed are continuing efforts to make it a mass sustainable programme

INTRODUCTION

The rural livelihoods project titled 'Bihar Rural Livelihoods Project (Jeevika)' is being implemented by the Government of Bihar through the Bihar Rural Livelihoods Promotion Society (BRLPS), with financial support from the World Bank. BRLPS, an independent society under Department of Finance, Government of Bihar, has undertaken a five-year project in six selected districts, namely, Gaya, Nalanda, Muzaffarpur, Madhubani, Purnea and Khagaria. The aim of BRLP is to improve rural livelihoods by enhancing the social and economic empowerment of the rural poor.

Around 70% of the poor families in Bihar are small and marginal farmers. For these families, the options in agriculture are limited to the production of cereals and pulses for subsistence. Productivity is low, with an average return of Rs 4,500 per ha in rainfed conditions, and food security of 3 to 5 months a year.

Efforts to push productivity frontiers need to start with the main staple crop. Kharif paddy has the largest crop coverage in the state, with a vast majority of farmers growing paddy for household consumption. The current productivity level of 2-3 tonnes of paddy per ha in Bihar is among the lowest in the country.

Following the action research, BRLPS launched a large-scale intervention based on SRI with a beneficiary base of 2,000 (however, the project could reach out to 6,000 families) small and marginal farm households in Gaya and Nalanda districts. The intervention aimed at building and equipping Community Resource Persons (CRPs) to spearhead the initiatives in the long run and create mechanisms for future expansion of practices among a large number of farmers in the adjoining areas.

Given the encouraging results through the SRI methodology and its potential, the methodology has much to contribute to the livelihood and, thereby, to the food security of the participating families. This mid-term evaluation looks at various aspects of the intervention to provide inputs for defining future strategies.

RESEARCH DESIGN, OBJECTIVES AND KEY AREAS OF INQUIRY

The research design incorporated the standard research procedures with an experiment sample, a control group, defined objectives, key areas of enquiry, research instruments (surveys through questionnaires, in-depth interviews, personal interviews, focused group discussions) and key sources of information (target and control households, village resource persons VRPs, implementation teams, SHGs, village organizations, selected farmers, government and NGO functionaries), sampling (comprising 300 SRI and 150 SRI non-beneficiaries), analysis and final conclusion.

The objective of the entire research may be classified broadly as related to productivity, sustainability, knowledge, perception and impact of the SRI technology.

FINDINGS AND ANALYSIS

The research findings are based on both qualitative and quantitative data gathered from the seven clusters, and analysed cluster-wise. They were re-grouped under the following headings:

1. Profile of SRI participating families
2. Productivity under SRI
3. Impact of SRI
4. Sustainability

PROFILE OF THE SRI PARTICIPATING FAMILIES

Social and landholding parameters

The SRI participating families belong to the socially and economically marginalized sections of society. Sixty per cent of the families are OBCs (primarily Yadavs) whereas 40% are Scheduled Castes, (including maha-dalits). None of the families belongs to the Scheduled Tribes category. The analysis

also revealed that a substantial number of families belonging to the maha-dalit community are still to adopt the methodology because the intervention is just one year old.

Three-fourths of the participating families, that is, about 76% are marginalized farmers, followed by small farmers who constitute 16%, medium farmers are around 4%, landless farmers constitute 2% and large farmers approximately 1% of the total participants. There has been a mixed response to the methodology. The landless (sharecroppers) have slowly started showing confidence in the methodology and intend to take it up properly in the coming years.

Given the encouraging results through the SRI methodology and its potential, the methodology has much to contribute to the livelihood and, thereby, to the food security of the participating families.

Medium and large farmers have started taking interest and have started understanding the huge potential of thismethodology.

They are expected to take it up at least on trial basis in the coming years. Pradan has designed a unique plan, based on an incentive, for the selection of beneficiaries. In this scheme, the VRPs are paid a differential incentive on the number of farmers belonging to the different sections of society that take up SRI. The participation of more underprivileged families ensured more incentive to the VRPs. This deliverable-based system has not only ensured quality work but also proper targeting. In terms of inputs also (such as seed, fertilizer and weeder), preference has been given to the marginalized groups and members of the SHGs.

Status of irrigation

The land is irrigated through rain, the water supply by local operators or by water through canals. Sixty-three per cent, that is, two-thirds of the participants, have semi-irrigated lands whereas 37% have irrigated lands. A large number of families avail of the supply of water through the local operators, who charge anywhere between Rs 5 to Rs 50 per hour based on the source of power (electricity/diesel). Besides this, there is also water available through the canal for a small percentage of families paying a nominal charge of Rs 50 per year.

Type of land

The analysis shows that a majority of the farmers (approx. 50%) have plain land, which is considered sui for paddy cultivation. The rest of the farmers have mixed lands.

The SRI methodology has a much higher productivity potential than the traditional methodology

Based on SHG membership
The analysis of data on this query revealed a very crucial aspect. To make it sustainable, the design made provisions for the entire intervention to be handed over to the SHGs eventually. However, it was found that this approach had a limiting effect because most of the primary target families were not part of SHGs. Also, it hampered the promotion of the intervention. So, it was decided to do away with this approach. Yet, 77% of the participating families have a member (usually a woman) in the SHGs.

PRODUCTIVITY UNDER SRI

Factors of production

There are several factors of production such as type of seeds, weeding, seed treatment, irrigation, etc., that affect the productivity of the crop.

Type of seed utilized: Almost all the participating families utilized the high yielding variety of seeds, for example, Rajendra-1 Mansuri, Sarju Baman and Sonam varieties. The farmers understood the seed treatment aspect thoroughly and 97% of the farmers treated the seeds before sowing.

Weeding: SRI fields are characterized by weeds. Hence, weeding is required at least twice during a crop cycle. The analysis shows that 72% of farmers did the weeding twice. Nevertheless, the effectiveness of the weeders is a crucial problem. Also farmers found weeding laborious and difficult in soils with high clay content.

Irrigation status: SRI methodology does not prescribe a flooded field but continuous

moisture in the fields. Of the farmers using the SRI methodology for paddy cultivation, 56% reported sufficient irrigation, 27% reported partly sufficient and 17% insufficient water for irrigation.

Critical Factors for Productivity

This was a very crucial query that came up and gave great insights after analysis. The farmers across the area of study chose irrigation as the most critical factor of productivity and labour and fertilizer as the second. The quality of land and quality of seeds have been given relatively very little emphasis in terms of their criticality in adding to the productivity.

Change in Productivity

Compared to the Pre-SRI: The average increase in productivity of 300 sampled farmers across the seven clusters comes to about 65%. The intervention aimed at achieving an incremental yield of 1.25 tonnes/ha or 500 kg/acre.

The productivity results in the SRI phase as compared to the pre-SRI phase with the same set of farmers revealed the following key findings:

- About 9% of the families completely lost their produce.
- Twenty-one percent got less productivity than the traditional methods.
- Twenty percent got an increase of less than 500 kg/acre over the traditional methods.
- The remaining 50% families got more than 500 kg/acre as incremental yield over the traditional method.

Compared to the control: Comparison between the productivity of SRI participating farmers and control farmers shows that the average increase in productivity across the seven clusters came to about 41%.

The analysis shows that beyond two tonnes per acre, the SRI methodology has a much higher productivity potential than the traditional methodology.

The intervention aimed at building and equipping CRPs to spearhead the initiatives in the long run and create mechanisms for future expansion of practices

Productivity Trends across Farming Segments

Compared to Pre-SRI: Interesting results were obtained in this case. In case of both SRI and pre-SRI, there is an increasing trend in productivity with an increase in land size. The analysis shows the average increase in productivity across the landless farmer is 35%, the marginal farmer is 22%, the small farmer is 111% and the medium farmers is 59%.

Compared to Control: The analysis clearly shows an increase in productivity in both control and SRI, with increased size of landholding. The average increase in productivity for the landless farmer is 31%, the marginal farmer is 6%, the small farmer is 53% and the medium farmer is 260%.

IMPACT OF SRI ON VILLAGE SATURATION

- A small change was observed in percentage of land devoted to SRI methodology per participating family.
- The number of families adopting the methodology increased during the first year between 30% and 70% of the total families in these villages as against less than 5% families during the pilot phase.

On food security

Most of the families participating in the intervention have taken up the SRI methodology as trial and, hence, only a small portion of the land was committed to this intervention. Therefore, the impact on food security has been differential and varied. The analysis shows only a slight increase in the number of families in the food security category. The result also got impacted by the loss incurred by the families due to floods and a dry spell during the period. Interestingly, substantial improvement in food security has been witnessed among the farmers (mainly marginal), who have utilized a major portion of their land for SRI.

On land lease market

Impact of SRI Methodology on Share Cropping/Land Leasing: There has not been any change as yet in the systems of sharecropping/land leasing discussed above as a result of SRI intervention. The reasons are as follows:

- The SRI methodology was taken up on a trial basis by most of the beneficiary families during the last year.
- In the existing systems of land leasing, in most of the areas, there is very little to negotiate. In general, the regular leaseholders feel that sharing of produce would remain the same.

On government and non-government organizations

The intervention was started in close cooperation with the government functionaries. Pradan ensured regular visits by government officials and functionaries of non-governmental organizations. These interactions revealed that the government functionaries are positive about the intervention and understand the immense potential of the methodology. The intervention got encouraging response from other organizations working in the same field.

Non-SRI farmers: In case of non-SRI farmers, the awareness level about SRI was found to be low. Forty-four per cent were not aware about the intervention. Fifty-six per cent of the farmers, who were aware, were not able to try it due to various reasons. Ninety per cent of respondents plan to try the method in the coming season.

Cost-benefit analysis

The cost-benefit analysis undertaken for three categories of farmers, that is, SRI farmers with inputs, SRI farmers without inputs and non-SRI farmers are presented in the table.

The detailed cost-benefit analysis shows that the returns for SRI farmers are substantially higher as compared to non-SRI farmers. It is also found that the SRI farmers with inputs also show better productivity as compared to the SRI farmers without inputs.

TABLE
COST-BENEFIT ANALYSIS

S. No.	Type	Cluster	Cost of Cultivation (per kattha)	Price of Produce	Profit Margin (per kattha)
1	SRI Farmer - With Input	Rajgir	260.00	720.00	460.00
2	SRI Farmer - With Input	Dobhi	460.00	840.00	380.00
3	SRI Farmer - Without Input	Kurmama	307.50	640.00	332.50
4	Non- SRI Farmer	Chiro	446.50	600.00	153.50
5	Non- SRI Farmer	Jhikatiya	307.00	560.00	253.00

SUSTAINABILITY

Confidence in the methodology

The response analysis shows an encouraging trend, regarding the effectiveness of the methodology. Of the sampled SRI participating families, 99% showed confidence that the methodology will be effective in the long run.

Capacities of the SRI participating families

The response of the participants shows that only 30% of them are confident of following the methodology without support from Pradan whereas the rest need some support from Pradan to do it.

- Seventy-seven per cent of the participating families had a good understanding about the concept behind the SRI methodology.
- Twenty per cent showed average understanding.
- Three per cent had no understanding with respect to the concept.

Institutional Arrangement

- **Pradan:** The responses of the participants on the performance of Pradan and the VRPs are quite encouraging. Ninety-six per cent of the SRI participating families rated the work done by Pradan as good. Three per cent rated it as average and 1% as bad. The majority of the participating families appreciated Pradan's quality of work, commitment, timeliness and equitable and fair distribution of resources. They also appreciated the way they have targeted the marginalized groups.
- **Village Resource Persons:** Ninety-one per cent of the participating families were satisfied with the VRPs work and rated them as good. Five per cent rated them as average and only 4% rated their work as poor. They have been appreciated by the participating families for their timely, handholding support, regular monitoring and input supply.

Input Supply

The VRPs played a crucial role in input supply. Eighty-five per cent of the input was provided by them. Pradan procured all the inputs that were channellized by the VRPs.

Maintenance of Equipment/Machines

Equipment such as weeders were managed by the VRPs across the villages. In most cases, the equipment was stored by the VRP. In some cases, it was placed with a member of the SHG. As there is no user charge on its utilization, there is no fund for maintenance of the equipment.

However, village organizations are in the process of being formed across the sampled villages; the members were quite agreeable to the idea of transferring the equipment to the SHG or to the village organization. In instances in which the equipment has been transferred to the SHGs/VOs, the agency is yet to take charge of the same.

STRENGTHS AND WEAKNESSES

An analysis of the response shows the following:

- Participating families feel that paddy crop cultivated through the SRI methodology increases the yield.
- It yields more fodder.
- It requires less seed.
- It is more resistant to drought condition.
- Thirty-two per cent feel that the SRI methodology requires more labour during transplanting, weeding and harvesting (it requires about three sickle cuts to harvest one plant).
- Sixteen per cent of the participating families feel that the workload on women has increased and 36% feel that it has reduced.

CONCLUSIONS AND RECOMMENDATIONS

In the two years of project implementation, the first year was devoted to piloting and the second year focused on expansion. The trends and responses from the participants are encouraging.

- Intervention has been successful in terms of its reception and adoption by the communities.
- The project has been able to target the marginalized groups in the area effectively.
- The impact is visible across the landscape.

However, there is need to take care of certain key aspects in order to make it a mass and sustainable programme.

- Setting up systems at the community level so that the processes sustain after the project withdraws.
- Setting up systems for paying the VRPs and maintenance of equipment.
- Hand-holding by the organization for at least another two years in the villages covered.
- Technical support should be available at the local level for both the existing SRI farmers and the new SRI farmers.
- VRPs need to be used optimally for effective and efficient model.
- Support needed regarding irrigation, the most crucial aspect for theintervention.

These steps will ensure that this efficient and effective SRI method will become a mass programme, owned by the people, and with multiple benefits.

System of Rice Intensification: Experience of Tribal Farmers from South Gujarat

J.P. TRIPATHI AND JIBRAJ SUTHARIYA

The strength of SRI lies in the fact that it is not a rigid technical practice but a system of principles that allows for experimentation and adaptation

In India, the System of Rice Intensification (SRI) is a continually evolving dynamic system with new actors entering the system every agricultural season. SRI was initially assumed to have originated from research trials at the agricultural universities. Studies have, however, revealed that there is a richer and more complex unofficial history of SRI in India that shows a greater involvement of civil society groups, who though not successful initially were at the forefront of experimentation.

An important feature of SRI in India is that it has no uniform characteristic nor any single agency or organization driving it. It has been carried out by both government agencies and civil society, with a varying combination of collaboration amongst them in the regions. In fact, it might even appear that speaking of a national system of SRI innovation is a misnomer, with each state and region showing very distinct and diverse characteristics. There is no single SRI in India; SRI actually involves diverse practices of the basic principles, and farmers and other actors in the system have adopted it to mean different things. They have extended it by providing diverse interpretations, even within the formal scientific establishment. So far there has been no comprehensive estimate of SRI performance even in a single state. There is a need to view the performance in the context of diverse applications in each state.

The potential of sustainable production and increased choices for farmers is what makes SRI attractive to farmers. Several farmers, who have traditionally been growing rice and have conserved traditional varieties, now have in SRI the possibility of increased yields and greater marketability of their crop, a choice that was open to few in recent times. This potential is yet to be tapped but civil society organizations such as the Aga Khan Rural Support Programme, India (AKRSP I) working in the villages of Dediapada, Umarpada, Songadh and Mandavi talukas (Narmada, Bharuch and Surat districts of Gujarat) have seen in SRI this possibility of increased choices. Farmers owned and cultivated 151 hectares of land in the selected area. Of the total cultivated area, on an average, 55% is irrigated. Ever since the SRI method of paddy cultivation was introduced to farmers by the implementing agency, farmers have shown interest in adopting this technique of

cultivation. Last year, 53% of the total land cultivated in the area under study was appropriated for paddy and more than half of it was irrigated. Of the total land under paddy cultivation, nearly 33% of the area is using SRI techniques of cultivation. Hence, it is essential to understand the impact of capacity building and training exercises on the rate of adoption of this improved method of rice cultivation.

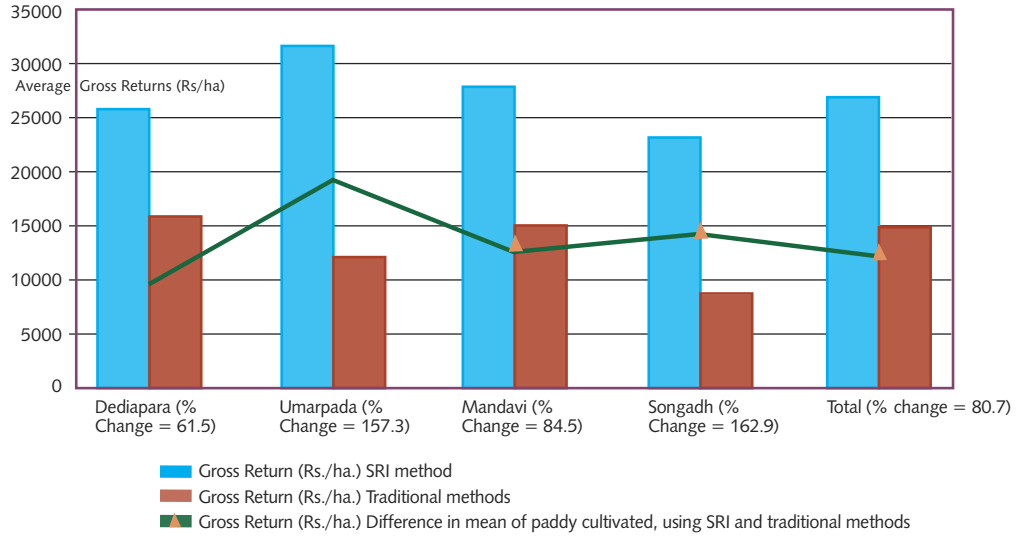
The net returns earned by farmers using the SRI method of paddy cultivation were higher than those earned using conventional methods

An analysis of the cost of cultivation data of paddy grown, using the traditional method and the SRI method, showed that the net returns earned by farmers using the SRI method of paddy cultivation were higher than those earned using conventional methods. The average returns per hectare obtained from paddy cultivated using the SRI method is Rs 26,830. This is nearly 81% higher than that earned from paddy cultivated using traditional methods (Figure 1).

The average gross returns of paddy cultivated using SRI methods varies from Rs 23,093 per hectare earned by farmers from Songadh to Rs 31,587 per hectare earned by farmers of Umarpada taluka (Figure 1). The percentage increase in value of gross returns of paddy earned by farmers of Dediapara using SRI method is 67% more than the returns earned by farmers who stuck to the traditional method cultivating paddy and the same figure for Songadh taluka is 163% more (Figure 1). This means that the gross output per hectare of paddy cultivated using the SRI method seems

Figure 1

Average Gross Returns Earned Using SRI and Traditional Methods of Paddy Cultivation



Note: Figures in parentheses indicate percentage increase in gross returns from the SRI method of paddy cultivation to the conventional method

to be significantly higher compared with that obtained by cultivating paddy using conventional techniques of cultivation.

Because paddy is the staple food of this area, farmers preferred to experiment in only a small portion of their land. The difference in returns earned by the farmers by cultivating paddy using the SRI method as against that earned by them by cultivating paddy using conventional methods have motivated them to prefer the SRI method of cultivated paddy. There exists a high potential for increasing the area under SRI paddy in the future because of the above reasons.

The advantage of the SRI not being a rigid technological practice but a system of principles that needs adaptation has allowed for experimentation and adaptation. The implementing agency had conducted a series of training programmes to educate farmers about different aspects of this new method of cultivating rice. Detailed analysis showed that training and awareness programmes have definitely made a positive impact in modifying the practice of cultivation. To some extent, it has helped farmers use the correct dose of inputs such as seeds, fertilizers and pesticides. From the earlier discussion, it is apparent that farmers practise transplantation of seedlings even when they cultivate paddy using conventional methods. The SRI method of paddy cultivation relies largely on this method of sowing. Thus, due to their exposure to some of these methods, farmers were able to implement recommendations given by AKRSP (I) in preparing nursery and transplanting seedlings easily.

Promoting SWI in the Mountain Farms

Introducing SWI in the mountainous regions of Himachal Pradesh and Uttarakhand, PSI has initiated a change from traditional and conventional method of cultivation

INTRODUCTION

In 2006, People's Science Institute (PSI) introduced the System of Rice Intensification (SRI) in seven mountain watersheds of Himachal Pradesh (HP) and Uttarakhand, to study its potential. The trials involved 40 farmers in 25 villages. The results showed an average increase of about 66 per cent in paddy yield from the SRI plots compared to the conventional plots. Inspired by the results obtained for the paddy crop in *rabi*, PSI carried out crop intensification trials on wheat (SWI) at its Niranjanpu farm in 2006. The field trial on research farms gave encouraging results. More farmers used the methodology in 2007 and were successful in getting a substantial increase in the yield. Based on the experiences of the last two years, PSI decided to further popularize the technique in the two mountain states in 2008.

In the 2008 *rabi* season, PSI formulated a practical strategy for promoting the SWI technique in HP. PSI made a commitment to cover about 500 farmers under SWI in three districts (Bilaspur, Kangra and Sirmour) of Himachal Pradesh. WWF-ICRISAT, Hyderabad, provided the financial assistance for the proposed expansion of the SWI experiment. PSI successfully undertook the SWI programme from November 2008 to May 2009, in which about 470 farmers experimented with the SWI technique in the three selected districts. In all the areas, the farmers have expressed immense satisfaction with the results. The perceived benefits are:

- Less seed requirement
- Less water requirement
- High grain and straw yield

OBJECTIVES AND OUTCOMES

PSI aimed at being a support institution for popularizing the SWI technique and promoting it in the selected villages of HP.

The goal of the programme was to help mountain farmers enhance their food and livelihood security through the adoption of the SWI technique. The major objectives of the proposed programme were to:

- Build capacities of farmers in HP to adopt the SWI technique for wheat cultivation
- Build capacities of voluntary organizations in HP by creating a talent pool of master trainers for promoting SWI

- Influence state agricultural policy for promoting the extension of the SWI technique

PSI proposed the adoption of the SWI method of cultivation by 500 farmers in HP and the following important outcomes:

- Create a talent pool of five master trainers from among five voluntary organizations and progressive farmers, who will continue to promote SWI in the future.
- Increase production of organic wheat, with a minimum average grain yield of 2.5 tonnes/ha.
- Initiate advocacy with agricultural extension officers and state government to promote in the state and increase the project's impact.

PROGRAMME DETAILS

PSI conceptualized a two-pronged approach.

- To enroll 500 farmers of about 64 villages in training workshops on the SWI technique.
- Initiate advocacy with farmers and the state so that the application takes off across the entire region.

PSI commenced its programme activities by selecting five partner organizations (POs) in three districts of HP. These included Society for Environment and Rural Awakening (ERA), Chinmaya Organization for Rural Development (CORD), Gramin Seva Ashram (GSA) in Kangra district; Social Awareness Through Human Involvement (SATHI) in Sirmour district and Manvav Vikas Sansthan (MVS) in Bilaspur district. Each PO deputed one person as Master Trainer, who was exclusively dedicated to the SWI promotion programme.

PSI and its partners organized 32 one-day farmers' orientation workshops, focusing on informing and educating the farmers in the procedures of the SWI method.

Field support activities started in mid-November 2008 to provide support to the

SWI farming communities during the various stages of wheat cultivation. The PSI staff along with the Master Trainers extended field support to the SWI farmers of the selected villages, right up to the harvesting stage in April-May 2009. Four hundred sixty-eight farmers finally adopted SWI in 8.64 ha of farmlands.

Information regarding the SWI technique was provided in the six-monthly newsletters produced by PSI, which is also currently preparing a manual on SWI (in Hindi), based on the demonstrations and experiences of SWI farmers.

The following steps are being taken for extension and policy advocacy:

- **Linkage with other institutes:** Throughout the course of the programme, PSI has ensured the involvement of the district- and block-level government officials from various departments as well as institutions conducting research on wheat. Selected representatives from these institutions were also included as members of the Programme Advisory Committee.
- **Experience-sharing workshops:** During the harvesting phase of the wheat crop, PSI encouraged its partners to organize field visits of other farmers to SWI farms to get direct feedback from the SWI farmers. Field trips to SWI fields were also organized on the occasion to conduct crop-cutting exercises for data gathering and comparing the yields by the SWI and conventional methods. The overall analysis of the results of the crop-cutting exercises showed that under un-irrigated conditions, whereas the non-SWI yields stood close to 17 quintals per ha, the SWI yields were around 33 quintals per ha (average increase of 90%). And under irrigated conditions, the SWI yield was about 50 quintals per ha as compared to non-SWI yield of around 28 quintals per ha (average increase of about 82%).

During the harvesting phase of the SWI wheat crop, most farmers expressed satisfaction with the results. Some of the other benefits perceived by the SWI farmers include seed saving, less lodging and high grain quality

During the harvesting phase of the SWI wheat crop, most farmers expressed satisfaction with the results. Some of the other benefits perceived by the SWI farmers include seed saving, less lodging and high grain quality.

1 gives details of the crop-cutting results of the SWI crops, undertaken through different methods (direct seed sowing, line sowing and transplanting at different spacing) under irrigated and unirrigated conditions.

- Under irrigated conditions, the results showed 71 per cent increase in grain yields with 8″ x 8″ spacing.
- There was a 60 per cent increase in grain yield with 6″ x 6″ spacing.

PSI also carried out trials in transplanting single wheat saplings with 6″ x 6″ (9 farmers) and 8″ x 8″ spacing (5 farmers) under irrigated conditions. The results are very encouraging, showing 110 per cent and 71 per cent increase in grain yields for 6″ x 6″ spacing and 8″ x 8″ spacing, respectively.

About 19 farmers undertook the line sowing of seeds at 6″ spacing (without maintaining plant-to-plant spacing) under irrigated conditions. The results from their farms

TABLE 1
CROP CUTTING RESULTS OF SWI (2009)

Method	No. of Tillers/ Plant (Avg.)	Average Plant Height (cm.)	Average Panicle length (cm)	Average no. of grains/panicle	Average straw yield (Q/Ha)
Conventional	2	70	6.0	31	21.6
SWI (8"x8") 119 Farmers	12	103	13	62	42.2 (96% increase)
SWI (6"x6") 32 Farmers	10	90	14	61	47.7 (121% increase)
Conventional	2	84	8.6	33	36.1
SWI (8"x8") 256 Faarmers	13	92	11	66	52.3 (45% increase)
SWI (6" x6") 26 Farmers	13	96	13	69	57.3 (59% increase)

showed 68 per cent increase in grain yield (the SWI crop yield was about 47 quintals per ha as compared to conventional yield of 28 quintals per ha).

PSI undertook a comparative study of inputs required, benefits obtained by the conventional and the SWI methods. The data has generated information regarding seed savings, water savings, labour requirement, and cost-benefit analysis.

- The cost-benefit analysis of the SWI crop showed that the SWI crop gave far better returns to the farmer as compared to the conventional wheat crop.
- The cost-benefit ratio of the SWI crop is 1:1.8 as compared to 1:1.2 of conventional broadcasted wheat crop. Analysis of farmers' level data showed 70 per cent saving in seed.

PSI and its partners documented the various processes involved in the implementation of the programme. The documentation and sharing of experiences of the various activities have led to adequate learning outcomes. These outcomes will be taken into account for devising suitable strategies, which will serve as useful inputs for extension of the SWI technique in future in the entire state.

For its Programme Advisory Committee (PAC), PSI constituted a panel of experts, including members of its senior staff and experienced persons, and a representative from WWF-ICRISAT for regular appraisals of the programme. The role of the PAC was to review the programme through field visits and meetings with the programme staff.

PROBLEMS ENCOUNTERED AND LESSONS LEARNT

Some of the problems encountered include:

- **Manual sowing of seed:** The manual sowing of seeds proved to be too labour intensive. An analysis of the data showed that this hiked the labour cost by about Rs 850 per ha in the case of SWI. PSI is designing a seed drill, therefore, to reduce the labour input.
- **Rainfall Aberration:** The lack of rains under rainfed conditions resulted in problems during field preparation, germination of seed, crop growth and operation of weedier.
- **Variation in Adaptability of SWI:** There are many variations in the adoption of SWI by farmers in terms of:
  - The number of seeds sown per hill
  - The line-to-line and seed-to-seed spacing
  - The use of weeders
  - The application of manure

Farmers have applied SWI to very small plots (200 sq m on an average). This is mainly due to the fear of reduced yield through SWI.

- **Use of Equipment:** According to some farmers, the hand-operated marker and Mandava weeder are difficult to handle in dry conditions. The use of a rake is recommended for weeding under rainfed conditions. PSI has modified the design of the Mandava weeder (by reducing the width) for the wheat crop.
- **Problem of animals and pests:** Farmers reported damage to wheat crops due to animals such as monkeys, pigs, rats and birds as well as pests. This also resulted in low yield.

Certain specific actions need to be undertaken for effective promotional activities on SWI in the state.

Flexibility in Adaptation: When adopting SWI, there has to be some flexibility in terms of spacing, sowing time, etc.

- Initially, the farmers should be couraged to adopt line sowing instead of the broadcasting method to reduce the seed rate.
- Thereafter, they can be motivated to adopt 6″ x 6″ spacing under un-irrigated conditions and 8″ x 8″ spacing under irrigated conditions.
- Under irrigated conditions, transplanting of wheat saplings can also be done to obtain higher yields.

The following needs to be done to ensure productivity:

- There is need to develop a seed drill and weeder as per the requirement of SWI.
- Farmers should be urged to use rake

instead of the Mandava weeder for weeding under rainfed conditions.

- Some of the SWI farmers ignored the regular use of Mandava weeder because some farmers found three weedings too labour intensive in the first year. Farmers should be urged to use rake instead of Mandava weeder for weeding under rainfed conditions.
- The cost of equipment should be made affordable to the farmers and adequate outlets of seed drill and weeders provided.
- Local fabricators need to be trained for manufacture of equipments in adequate numbers.
- A cadre of master trainers at the village level needs to be created for mobilizing farmers to adopt SWI.
- Experienced SWI farmers can take on the role of village level resource persons in the future.

The total area under SWI is only 8.64 ha for 468 farmers. In the first year, the farmers were reluctant to adopt SWI. Each farmer had to be motivated to bring at least 0.1 ha of land under SWI. Expansion in other non-SWI districts in Himachal Pradesh also needs consideration.

Several further steps need to be undertaken. These include:

- There is a need to come up with a package of recommendations for the farmers for different agro-climatic zones of mountains.
- There is need for research institutions to keep conducting continuous research.
- The performance of transplanted wheat saplings needs to be further tried under SWI.
- Similarly, applications of SWI on different disease-resistant and high-tillering varieties also need to be tried.
- Non-SWI farmers need exposure to the SWI wheat fields prior to the harvesting of crops as well as during harvesting. This will help in the expansion of area coverage.
- Officers and scientists from Agriculture Departments and KVKs need to be exposed to the SWI technique for policy advocacy. This will help in strengthening partnership with the government machinery.

There is need to prepare training material in the form of manuals and posters on SWI, which will help the Master Trainers to explain the technique to the farmers.

There is need to formulate a practical strategy to make the technique popular in the mountain state. The government should develop a policy for the promotion of SWI in the state. Giving incentives for growing SWI wheat in the form of equipment, manure, organic pesticide, etc., will help in the promotion of SWI.

Package of Practices for the System of Wheat Intensification as followed by Pradan in Bihar

The System of Wheat Intensification, or SWI, is an adaptation of techniques used in the System of Rice Intensification (SRI). This Package of Practices of the System of Wheat Intensification is for 1 acre of cultivable land.

TABLE
ITEMS REQUIRED FOR SEED TREATMENT

S.No	Items	Unit	Quantity
1	Hot Water(boiled at 60 degree Celsius)	litre	20
2	Wheat Seeds	kg	10
3	Vermicompost	kg	5
4	Cow Urine	litre	6
5	Jaggery	kg	4
6	Bavistin(Fungicide)	gm	20

The procedure for Seed Treatment is as follows –

- Bold seeds are graded out separately from the purchased lot of improved seeds using standard sieves
- 10 kg of improved variety wheat seeds is soaked in an earthen pot with 20 litres of hot water (at 60° Celcius)
- The seeds which float in the water are removed
- Vermicompost, Cow Urine, Jaggery is mixed with the seeds (quantity as suggested in the table)

The mixed material is kept for 6 to 8 hours after which it is filtered so that solid materials along with the seeds and liquid get separated. Fungicide is then mixed with the solid ingredients and is left for 10 to 12 hours. Then the wheat seed germinates. The germinated seeds is then used for sowing in the tilled land.

LAND PREPARATION

The land is ploughed with a desi plough or power tiller. Compost of 80 qn/acre is mixed where trichoderma is added. It is then covered properly for a day before its application in the field. If there are termites in the field, then termicides are applied during land preparation. All the grasses and weeds from the field need to be removed. Proper irrigation channels are prepared and the field is divided in to small plots to avoid flood irri gation.

Fertilizers to be used as basal dose
DAP-27 kg Potash-13.5 kg

SOWING OF SEEDS

Sowing of seeds should be done at proper moisture level in the field.

Two seeds are sown in a hill
Spacing – 20 cm X 20 cm
Depth of sowing – 1 to 1.5 inches

GAP FILLING

The gap should be filled within 10 days of sowing of seeds. Similar germinated seeds should be sown to fill the gaps. Care should be taken to ensure two seeds per hill. More than two seeds per hill should be uprooted properly to facilitate proper growth of the plants.

IRRIGATIONS

First irrigation should be provided at 15 days after sowing so that the sown plots can be weeded by using a spade or SRI weeder at 20 days after sowing.

Just before weeding urea is used at 40 kg and vermicompost at 4 quintals should be added.

Second irrigation should be provided at 25 days after sowing to ensure second weeding at 30 days after sowing. Again, third irrigation should be provided at 35 days after sowing to ensure third weeding at 40 days after sowing. Before the third weeding, 15 kg of urea and 13 kg of potash should be top-dressed in the field.

The other irrigations should be given at 60 days, 80 days and 100 days after sowing.

Sugarcane Intensification System: An Innovative Method Developed by Farmers in Medak District

V. SHASHI BHUSHAN, NORMAN UPHOFF,
K. SURESH AND M. SUDARSHAN REDDY

Using the SIS methodology, the farmers in Andhra Pradesh were able to reduce costs of production and increase the sugarcane yield

INTRODUCTION

Sugarcane Intensification System (SIS) is a new methodology developed by Indian farmers, which is becoming popular in certain states such as Karnataka and Andhra Pradesh, mainly in some *mandals* (sub-districts) of Medak district of Andhra Pradesh. This production system is similar to System of Rice Intensification (SRI); some of the early SIS farmers were also practitioners of SRI. Elsewhere in Andhra Pradesh, sugarcane-growing practices similar to SIS are followed under the name of Sugarcane Renewed Intensification, patterned after SRI and with the same acronym. Other adaptations of SRI concepts and practices to produce other crops too are being worked out by farmers and researchers in the state and in the country.

Here, we report on SIS as it has evolved thus far. In the traditional cultivation of sugarcane, a major cost is the expenditure on planting material. A typical planting rate is 10 tonnes of cane per hectare, costing around Rs 12,000 per hectare. When all costs of production are taken into account (cane transportation, ploughing, making furrows, planting setts, etc.), growing 1 hectare of cane costs about Rs 5,00,000 (US$ 1,200). With conventional yields of 60-65 tonnes per hectare, the net income expected from a hectare of cane at prevailing prices is around Rs 75,000 (US$ 1,600), which is not much in return.

Various new methods of cultivation such as the polybag method of nursery raising and transplanting after 45 days have been tried previously for increasing the yield but these methods increased the cost of cultivation without sufficient compensatory returns. SIS, on the other hand, is gaining popularity because its combination of practices reduces the cost of production whereas, at the same time, increasing the yield by 100 to 300%. This innovation may become of greater interest around the world because sugarcane is being valued more as a raw material for bio-fuel.

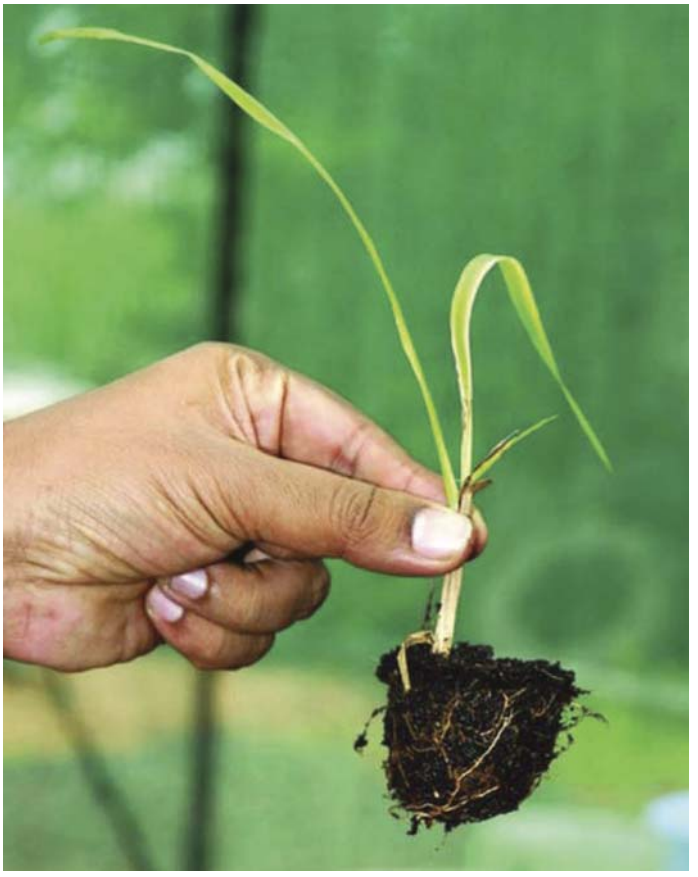
The SIS method's greatest departure from conventional cane culture is that it requires less than 1 tonne of cane for planting. This reduces the significant cost

straightaway by more than 90%. This is possible because SIS cane fields are established differently, and the number of plants per hectare grown is greatly reduced.

The SIS method's greatest departure from conventional cane culture is that it requires less than 1 tonne of cane for planting

MATERIALS AND METHODS

Demonstrations and experiments have been conducted on farmers' fields and also at the Basanthpur research station to study the impact of the new methods initiated by certain progressive farmers in Medak district. The bud-extraction process and the polybag method along with the pit method of planting were tested in farmers' fields as well as at the experimental farm. Planting potato and watermelon as inter-crops were evaluated, and farmers reaped excellent benefit from these crops.



SIS was started initially with the transplanting of fewer young cane plants from very short lengths of cane. SIS farmers put setts just 3-4 inches long (with just one bud rather than the usual three) into plastic bags filled with compost. These bags were kept moist and warm so that vigorous roots and shoots sprouted during the 45 days before the setts were transplanted. This timing typically saved farmers the cost of three irrigation cycles and one herbicide application compared to the conventional practice of planting longer setts directly into the field.

The SIS practice has been evolved to reduce the cost of establishing sugarcane further with more intensive management. Farmers now remove seed buds from the cane by a simple cutting tool, and grow these buds into seedlings by planting them separately in plastic trays. Each bud is put into a 'cup' filled with coco or coir pith to which some manure may be added for nourishing the plants. Since farmers can sell the remaining cane after bud removal to a factory for pressing, there is negligible expense for the cane needed to establish the crop. Most of the expenditure on seed production goes for labour. In any case, with either methodology, the amount of planting material required is reduced by 90% or more, similar to the SRI practice for rice.

RESULTS AND CONCLUSIONS

In traditional practice, longer canes (10 to 12 inches) are set out rather densely. With a spacing of 2–3 ft x 1 ft. around 90,000 to 1,20,000 plants are generated per

hectare from 30,000 three-budded setts. After 110 to 120 days, there can be 3,00,000 plants per hectare. By the time of harvest, the population per hectare is reduced to almost 75,000 millable cane of 1 kg due to lack of sunlight and nutrients. This indicates the need to maintain more distance between rows.

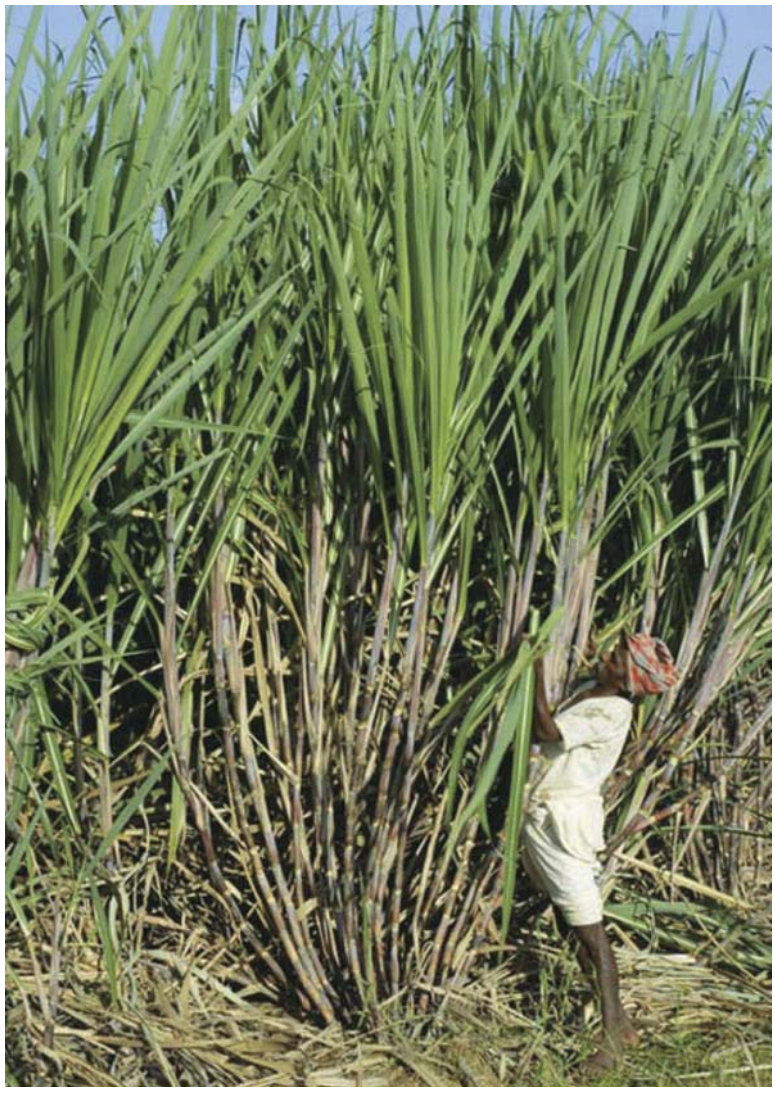
The SIS method involves raising cane plants grown from buds in a nursery. This management methodology produces very healthy seedlings, which reduces the plants' mortality rate and increases the ultimate weight of each cane grown. Twelve thousand five hundred seed buds are sufficient per hectare.

Transplanting is done at 15 to 30 days at a spacing of 4–6 ft x 2 ft. Plant population is reduced by three-fourths. Tillering is greatly increased, giving a cane yield of 125 to 235 tonnes per hectare compared to 60-75 tonnes per hectare in the conventional method. Although the number of canes per hectare is less in the SIS practice, the weight of each cane increases substantially. When 12,500 plants are transplanted under the SIS practice, these generate at least 72,000 plants, each sett producing on an average 6 tillers. The weight of each cane can be 2.5 to 3 kg. If the weight of each cane is just 2 kg on an average, the area yield will be 144 tonnes per ha.

The added advantages with these alternative practices are that with a lesser number of plants and wider spacing, the need for fertilizers is reduced because fertilizers are utilized at an optimum level and the pest damage is less. More healthy growth is observed in SIS cane. About 40% saving of water is possible because less irrigation is needed when setts are raised in the nursery and grown with wider row spacing. Weed growth is potentially more with the SIS compared to traditional methods because of the wider spacing. However, this can be offset by mulching, which both suppresses weeds and reduces soil water evaporation.

An attractive option for SIS farmers needing to control weeds is to intercrop their cane with wheat, green gram, black gram, potatoes, vegetables or beans. These cash crops can be harvested within 100 days, giving more income and also reducing weed growth by about two-thirds. With leguminous or green-manure crops as intercrops, more nutrients are mobilized from the soil system to benefit the sugarcane plants, further reducing the need for fertilizers.

For every hectare planted with the SIS method, there is a saving of up to 9.5 tonnes of sugarcane from the 10 tonnes of sugarcane used for standard planting since less than half a ton of sugarcane is needed to establish enough plants, given the increase in inter-row and intra-row spacing. And if buds are extracted and grown in plastic trays, even this small amount of cane used as a source of buds can be subsequently sold for sugar crushing. With saving in water and reduced costs for weeding and fertilization, additional income from an inter-crop serving as a cover crop, this methodology becomes very advantageous economically for farmers.



In Andhra Pradesh, sugarcane is planted in around 1,10,000 ha. Just saving 9 to 9.5 tonnes of cane per ha by adopting SIS methods would increase the net cane production by 9,90,000 tonnes, worth almost Rs 150 million (over US$ 3 million). This financial gain is in addition to the achievement of higher yield with reduced costs of production and water saving. The benefits produced far outweigh any costs of additional labour and management needed to grow sugarcane in this more intensive manner.

The agronomic and economic success of farmers cooperating with the research station has inspired many others to try the new methods. Farmers have made their own bud-removing devices locally. The fact that so much cane, otherwise used for replanting, can be saved has been a big encouragement to them. Information on the new methods has been passed on to others through the electronic media, the press, and government-organized farmer awareness programmes called *Rytu Chaitanya Yatras.*

By organizing field and exposure visits, with the help of Cane Development Council, training to disseminate skills for the preparation of nurseries, transplanting, etc., the method has become popular. The pit method of planting was also tried by some

farmers after their visits to Karnataka and Maharashtra states. After the success among elite farmers was evident, training and awareness programmes have been organized to attract more farmers to these new methods. The sugar industry is further assisting with technical improvements and by promoting the availability of plastic trays, bud-removing machines, polybags, etc.

The SIS method's greatest departure from conventional cane culture is that it requires less than 1 tonne of cane for planting

Farmers see that soil fertility is built up by the application of trash mulch to conserve water, control weeds and ESB, by inter-cropping with leguminous crops, and/or by incorporating the crop residues into the soil. This strategy of changing the management of plants, soil, water and nutrients, paralleling what is done with the SRI, can thus make long-term capital improvements in farmers' soil resources.

The System of Mustard Intensification

PRAVASH CHANDRA SATPATHY

Good management, adequate spacing and appropriate fertilization of Manikya, a variety of mustard, has a high-potential yield and proves profitable

The designation, System of Mustard Intensification, or SMI, is an afterthought. I found out only recently that my system of transplanting mustard seedlings with wide spacing is similar to the System of Rice Intensification (SRI) developed in Madagascar some 25 years ago and now being used increasingly in India. Both systems, SRI and SMI, depend on low density of crops and seek to utilize the full potentiality of each plant, rather than on communities of plants as done in high-density planting.

The mustard variety that I use is of medium duration, expressing very high yield potential when transplanted with adequate space, good management and appropriate fertilization, etc. In order to distinguish this variety from other promising varieties, I have given it the name of Manikya, which means 'jewel'.

Manikya is a local variety. I first saw this mustard plant in an exhibition held in the year 1984, and it impressed me very much. Its siliques (the narrow, elongated seed capsule peculiar to the mustard family, Cruciferae) were in clusters, and the plant was fully laden, heavy with the pods. It was awarded the first prize in the competition; I managed to obtain the plant, which contained 150 gm of seed. Thus my journey began.

Its remarkable potential was observed when about a thousand plants were transplanted in an F1 cabbage field as a catch crop (a fast-growing crop that is grown simultaneously with, or between successive plantings of a main crop) in the ratio of 10:2. The catch crop of Manikya could tolerate and absorb a fertilizer dose as high as 170-70-70 kg NPK per hectare. It showed no symptoms of over-fertilization and reflected this in an unbelievable yield. The spacing was wide, 60 x 25 cm. Seedlings about 20 days old were transplanted. The computed yield was 35 Q/ha (3.5 t/ha). The year was 1985.

The medium tall Manikya grows to one metre in height and one metre in breadth when widely spaced. It is very sturdy and compact and it does not lodge. Thus it is capable of bearing a heavy load of seeds. The leaves are comparatively small and narrow. Its harvest index is high and the plant type is almost ideal. Branches start at a height of 15-20 cm above the ground when sown and 5-10 cm when transplanted, and form at an angle of 45°. Branching is profuse, with about 7 to 10 branches from the main stem.

The sown crop takes 100 to 105 days to mature when sown broadcasted; but with alternative management, it matures in 90-95 days after transplanting, excluding the nursery period. The siliques come in bunches, each silique about 5 cm long, containing about 12-15 brown-coloured seeds. The seeds are rather small as 1,000 seed-weight is 2.13 gm (4,40,000 seeds/1kg). But it compensates for this very amply with a very high number of siliques, as high as 2,000-3,000 per plant.

A single widely-spaced plant may contain more than 100 gm of seed but in a community of 50,000 to 70,000 plants/ha, the average performance remains between 40 and 75 gm/plant. This productivity, however, depends on many interacting factors.

As I have mentioned, Manikya responds to heavy fertilization. The application of less than 60 kg N/ha, however, may not show any significant yield advantage. In order to achieve its full potential, a suitable package of practices must be followed, which do/not differ from other high-yielding varieties, except that this variety can be transplanted very beneficially. While this variety may be sown by broadcasting, as is common, to get highest yield, the crop must be thinned. This aspect is outside the scope of this article.

TRANSPLANTING METHOD

For one hectare, nursery raising requires about 200 gm seed, which contains about 80,000 seeds. The seed should be thinly sown @ 8 to 10 gm/m^2. The nursery area should be heavily manured, as in the case of raising cabbage/cauliflower seedlings. Mustard seedlings may be affected by damping-off disease. So Redomil/Captan should be sprayed as a preventive measure. Seedlings are ready for planting within 15-20 days.

It may not be possible to proceed according to schedule, of course. There might be so many unforeseen difficulties. To meet such eventualities, a second nursery may be raised after a week's interval. Seedlings must be transplanted at a tender age, as with SRI, leaving a gap of 15-20 days for the flowering stalks to emerge.

Seed Dressing: The seed should be soaked for 15 minutes in a 10% garlic solution, (10 gm crushed garlic in 100 ml water), dried in the shade and sown in the seedbed. This has proved to be better than the use of conventional chemical fungicides.

Both systems, SRI and SMI, depend on low density of crops and seek to utilize the full potentiality of each plant, rather than on communities of plants as done in high-density planting

MANURING AND FERTILIZATION

Two to three tonnes of good-quality Farmyard Manure (FYM)/ha should be adequate. The mustard crop is a heavy feeder of boron and sulphur. Usually, 6 kg borax and 200-250 kg/ha of super phosphate takes care of the needs of the seed. The potash requirement is about 20-30 kg/ha. Nitrogen (N) may be applied at 100-120 kg/ha. If Azotobacter is used as a biofertilizer, the N application should not exceed 100 kg N/ha.

Fifty per cent of N and all other fertilizers, including borax, may be broadcasted along with FYM at the time of land preparation. Better still is to apply 50% N (urea coated with Nimin for slow release of N is recommended) with the full dose of Phosphorous (P) and Potassium (K) at the bottom of the furrow. The remaining 50% N is to be applied along with the irrigation at the time of first flowering.

LAND PREPARATION

We need not go into details of landpreparation because this is fairly standard. The land is prepared by means of power-tiller/tractor/bullock drawn implements. The soil need not be pulverized. But after land preparation, a country plough and a pair of bullocks is very much needed to facilitate the layout of plants in a geometric pattern on the field.

After land preparation, the field is marked with straight lines 50 or 60 cm apart (depending upon fertility status, age of seedlings and time of the season) by means of a country plough. Nylon threads may be used for the purpose to advantage. Two women workers could manage and guide the threads as in the case of line-transplanting in rice. Understanding the purpose leads to innovation and improvement of technique.

The fields are prepared according to ridge-and-furrow method. The plough is run fairly deep while making the furrows. Then, inside the plough furrow, ripened manure (if inadequately broadcasted) and the recommended quantity of fertilizer mixture calculated for each metre-length of the furrow line is added. This is a kind of precision farming. Then a plank is run lightly along the furrow lines in order to partially cover the fertilizers, but leaving still a line of depression. When this is done, the plough is again run alternatively between the furrow spaces. This is called skip-furrow method. Finally, furrows are cut crosswise across the field at proper distances to form irrigation and drainage channels.

An interesting aspect of this cultivation method is the flexibility it gives for farmers in terms of schedule. Manikya can be either broadcast or transplanted like paddy; its full potential can be achieved either way. In Punjab and in some places in Haryana, varieties known as Govi Sarson and Karan Rai are now being transplanted rather late, even in the month of December. Farmers transplant about 40-50 day-old seedlings after rice, and harvest this crop in April. The duration of

these varieties is 140-145 days, getting about 12-14 quintals of seed/ha. The winter season is prolonged there, which is an advantage.

In Orissa, *rai* (Indian mustard) needs to be sown between October and mid-November to get good yield. But most rice fields are not vacated by this time. Therefore, the time factor becomes a constraint. However, if the mustard crop can be transplanted late in the year, at a time that is unfavourable for sowing, the scope of cultivation for this crop is increased. Manikya can be transplanted successfully up to the end of November; however, the earlier, the better.

The medium tall Manikya grows to one metre in height and one metre in breadth when widely spaced. It is very sturdy and compact and it does not lodge. Thus it is capable of bearing a heavy load of seeds

TRANSPLANTING

Once the field is ready, the tender seedlings are uprooted with care, without injuring their roots. They may usefully be treated with bio-fertilizers. Then, water is let into the field from one end, and male/female workers begin to transplant the seedlings just like rice seedlings. There is only one plant per hill, following the fertilizer line at a distance of 30, 35 or 40 cm from plant to plant, according to the soil situation. The roots should go straight down into the wet soil, having standing water in the furrow bottom (but not on the ridges), guided by two fingers to place the roots downward and then withdrawing the fingers. Workers should use nylon threads to keep the line straight. This will facilitate mechanical weeding later on. In a well-prepared field, one person can plant about 1,800 seedlings within 6 working hours. So 40-50 persons may be needed to transplant a one-hectare field. When transplanting is completed, any excess water is let out through the drainage channels to dry out the field and to avoid water-logging. So, a proper layout is important. Gap-filling is not necessary. A plant density of 40,000 to 80,000/ha, adapted according to different situations, is enough. An average yield of 50-70 gm/plant may be expected.

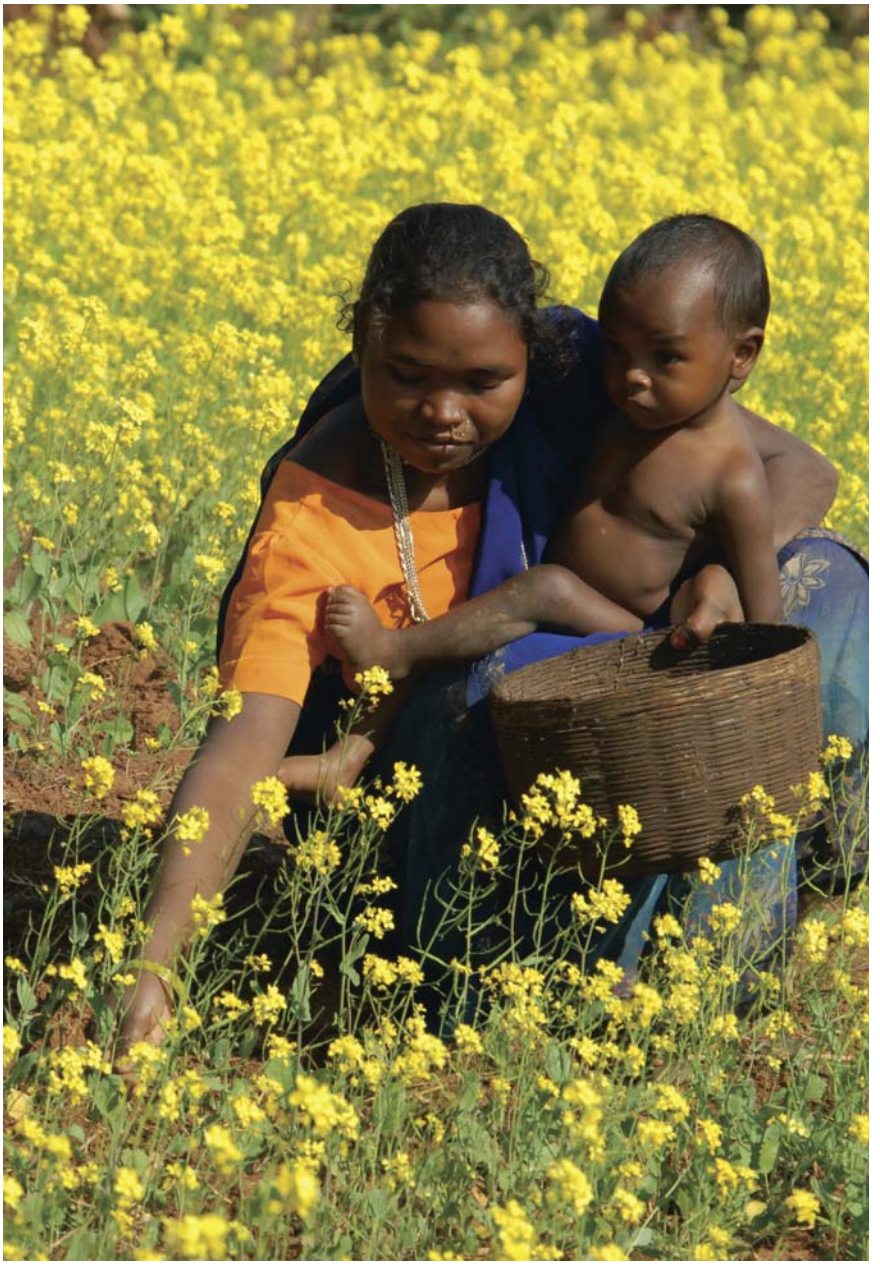
IRRIGATION

In total, three irrigations may be needed at critical stages, approximately at intervals of every 20-35 days — at pre-flowering, at full bloom and pod-formation stages.

PEST ATTACK

Sowing or transplanting early helps to minimize aphids and saw fly attack. Towards the end of January and afterwards, pest attack may be noticed. Then, suitable insecticides may be sprayed. But there is an alternative method. I no longer use highly poisonous substances to control aphids and other pests because garlic-extract solutions do the job efficiently.

This is how the extract is prepared (ingredients/ha): Take garlic cloves (5 kg), kerosene (2 litres) and liquid detergent such as Sandovit, Genteel, or Teepol (100 ml). Crush and grind the garlic fine, preferably in a grinder, with some water. Press firmly to squeeze out all the water. Store the garlic water in a tightly closed bottle. Put the crushed garlic in a container with just enough kerosene to cover it. Allow this to stand overnight and squeeze out the kerosene oil in the morning. The kerosene oil contains the active volatile principles of garlic, which act against aphids and other pests. Mix the garlic water extract solution to it. Add the required amount of liquid detergent to the kerosene-garlic extract to make a liquid spray. Usually



DISEASE REACTION

Diseases such as rust, downy mildew or alternaria blight have been noticed in several years of cultivation. So the crop might be resistant to those diseases. However, seed-dressing with 10% garlic extract solution is probably beneficial.

WEEDING

Weeding at least once is very helpful. I use a hand-drawn wheel-hoe quite effectively. There is some merit in the soil-aerating properties of this kind of weeding.

COMPARING METHODS OF CROP ESTABLISHMENT

Transplanting the crop rather than broadcasting it may seem to be a costlier method of crop establishment. However, the labour requirement for sowing and then thinning the crop twice, to remove subsequently thousands and thousands of plants, may be more expensive. When transplanting the crop, the plant population may be kept correct with mathematical precision, resulting in some time benefit. As explained earlier, transplanting helps realize the full potential of individual plants.

30-50 ml of detergent liquid is required per litre of kerosene oil. This stock solution is to be diluted by about 200-250 times for spraying. The spent garlic may also be broadcasted in the mustard field.

Differences in the cost of seed are roughly 200-400 gm of seed/ha with transplanting vs 6-10 kg of seed required for broadcasting. Two to four selected plants may be grown in a secluded place for seed purposes.

CHIEF CHARACTERISTICS

Parentage	Local selection (Mayurbhanj)
Duration - Broadcasted crop	100-105 days maturity
Duration - Transplanted crop	85-90 days after transplanting
Height	1 metre
Branching	Branching is profuse, about 7-10 from the main stem
Silique length	4-5 cm
Seed content	12-15 seeds/silique
100-seed weight	2.13 gm
Seed yield (optimum)	25 Q/ha
Harvest Index	28.2
Oil content	not verified

HARVESTING

This must be done at the right time to avoid the shading of seeds.

COST CONSIDERATIONS

The total cost comes to about Rs 12,000 per ha. With a yield of 20 Q/ha, that sells at/ Rs 2,200/Q, the B:C (Benefit and Cost) ratio would be about 3.5:1, which is quite high.

CONSTRAINTS

I have been using the same seed for the last 22 years because I have found no source of foundation seed. I collect seed from the ideal plants by pedigree selection. Of late, I do not find the original vigour and productivity, so I am at a disadvantage. There are many high-yielding varieties of mustard released recently. They are all bred for high-density planting, however. Some varieties are of the desired plant types. But I have not tried them for fear of cross-pollination of the Manikya mustard variety.

Sreema Seeds Pvt. Ltd. of Cuttack and Nature Seeds of Balasore have been marketing this variety of mustard for the last 15 years or so. Sreema has published detailed instruction about cultivation, but I do not know how many have adopted the transplanting methods.

Pradan is a voluntary organistaion registered under the Societies' Registration Act in Delhi. We work in selected villages in 7 states through small teams based in the field. The focus of our work is to promote and strengthen livelihoods for the rural poor. It involves organising them, enhancing their capabilities, introducing ways to improve their incomes and linking them to banks, markets and other economic services. Pradan comprises professionally trained people motivated to use their knowledge and skills to remove poverty by working directly with the poor. Engrossed in action, we often feel the need to reach out to each other in Pradan as well as those in the wider development fraternity. News*R*each is one of the ways we seek to address this need. It is a forum for sharing our thoughts and a platform to bui ld solidarity and unity of purpose. News*R*each was supported in the past by Sir Dorabji Tata Trust and Ford Foundation.

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