Journal of Crop and Weed, 5(2): 63-69 (2009)1

System of intensification: the alternate approach for increasing production of field crops

R. K. GHOSH, L. SHARMA, S. BARMAN AND A. K. DOLAI

Department of Agronomy, Faculty of Agriculture,
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, Nadia, West Bengal

ABSTRACT

The System of Rice Intensification (SRI), is a methodology for increasing the productivity of irrigated rice cultivation by changing the management of plants, soil, water and nutrients. At BCKV initiatives have been taken from 2006 to find out the sustainability of this technology at on station (Summer 2006 and 2007) and thereafter since 2008 at on farm through SRI. From 2008 attempts have also been taken to motivate some farmers (32) of 5 local villages of Chakdah block of Nadia for adopting this alternative technology with the help of the NGO Chandamari Sannidya Rural Welfare Society, Nadia. As a demonstration trial on paddy and follow up green gram crop this system was implemented at the farmer during 2008 summer (pre- kharif). The results of the field experiment on System of Intensification were impressive in regards to using lower seed rate, adopting seed treatment, soil health improvement due to use of lesser inorganic fertilizers, minimum use of water and more ITKs (Indigenous Technology Knowledge) for pest management instead of chemical pesticides. The rice grain yield was increased by 25 % N as inorganic N + 75 % N from organic sources by 27. 63 % at on station during 2006 and 2007 (pooled data) and 31.97 % at on farm during 2008 over the traditional NPK through inorganic sources. As a result during 2009 more than 30 % farmers of this village Chandamari and some more farmers of the surrounding villages have already adopted this technology in different field crops including vegetables. The leaflet about this system in local language was also distributed among the farmers of these villages. Training programmes have already conducted through farmers participatory method with small group of farmers and it has also planned to organize an awareness camp with the farmers of these villages during end of 2009 so that to adopt the System of Intensification technology the motivation programme could be started from Summer 2010 in these 5 villages.

Key words: Alternate management, environmental safety and **ITK**

Agriculture always depends on natural climate. Global warming has an important impact on present day's agriculture. Water use in the agricultural systems, primarily irrigation, account for almost 70 % of global water withdrawals and this amounts is expected to increase in the next thirty years to support the expected 20 % increase in the amount of land devoted to irrigation.

It is estimated that the demand of rice will be 100 million tones (m t) during 2010 and 140 m t in 2025 (The Hindu Survey of Indian Agriculture, 2004). This additional rice will have to be produced on less land with less water, less labour, and fewer chemicals (Zheng *et. al,* 2004). Current rice production systems are extremely water intensive and 90 % of agricultural water use in Asia is in rice production. For a kg of rice production now it uses 5000 litres water and 25 % methane gas is producing from the anaerobic rice culture. The less water intensive rice production systems like SRI should be practiced in more and more areas. System of Rice Intensification (SRI) offers oppurtunities to researchers and farmers as a means of both cost-cutting means and labour-saving procedure for growing rice is advocated in recent times for higher productivity with low inputs. Experience with SRI methods suggests that average rice yields can be about double the present world average without requiring a change in cultivar's or the use of purchased input (Wang *et al*., 2002)

The System of Rice Intensification (SRI) technique has received considerable attention globally including India due to its potential for yield improvement and water saving. The main features of this system include transplanting of young seedlings singly in a square pattern with wider spacing; using more of organic fertilizers; weeding through weeders to create more aeration and keeping the paddy field moist with intermittent drying and wetting during the vegetative growth of plants. SRI causes better plant growth and development and economizes upon the use of seed, irrigation water, labour, plant protection chemicals and fertilizers and hence increases the productivity of land, water, capital and labour significantly over conventional method of rice cultivation. The System of Rice Intensification technique is promoted under World Bank assisted project Irrigated Agriculture Modernized Water Bodies Restoration and Management (IAMWARM) in Tamil Nadu. During 2007-08, 912 demonstrations at the cost of Rs. 3.648 million were organized. In 2008-09, a sum of Rs. 12.204 million was spent for conducting 2034 demonstrations (Anon, 2009). The popularization and promotion of SRI through demonstrations at farmers' field is one of the important interventions of National Food Security Mission-Rice (NFSM-Rice) which is in operation since October, 2007 in 136 districts of 14 States (Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh and West Bengal) in the country. Presently in rice it covered 218 districts out of 564 rice districts. Monsoon failure is experienced in some parts of the country almost every year. The long-term trend shows that drought is experienced at least once in five years in all the states except in the north-east. The periodicity of drought is as high as once in three years in states like Rajasthan, Andhra Pradesh, Haryana, Tamil Nadu, Gujarat, Jammu and Kashmir and west Uttar Pradesh (Table 1). The recent trend of depletion of water level in global scenario may cause difficult to cultivate rainfed Rice particularly

E mail: rkgbckv@rediffmail.com

Winter paddy (harvest in winter season). The SRI method out-performed the normal planting in terms of growth attributes, root growth and yield as observed by Thiyagarajan (2002) at Coimbatore and Bhanja *et.al* (2006) at West Bengal. The yield of the follow up rapeseed crop also showed increasing trend where the combination of organic and inorganic fertilizers were applied in SRI plot.

Table 1: Periodicity of occurrence of drought in various parts of the country

Frequency of deficient rainfall	Meteorological sub-division
Once in 2.5 years	West Rajasthan, Rayalaseema, Telangana, Haryana, Chandigarh and Delhi
Once in 3 years	East Rajasthan, Gujarat Region, Jammu and Kashmir, Tamil Nadu and Pondicherry, West Uttar Pradesh
Once in 4 years	North Interior Karnataka, Uttarakhand, Vidarbha
Once in 5 years	Bihar, Coastal Andhra Pradesh, East Uttar Pradesh, Gangetic West Bengal, Jharkhand Kerala, Orissa, South Interior Karnataka, Madhya Maharashtra, West Madhya Pradesh
Once in 15 years	Arunachal Pradesh, Assam and Meghalaya, Nagaland, Manipur, Mizoram and Tripura.

Source: Crisis Mangement Plan, Drought Management Division, Ministry of Agriculture, GOI, 2009

Increased intense rainfall with less of mode - rate rainfall could decrease groundwater recharge and soil moisture, affecting agriculture (Goswami, 2009). Rice production in the Gangetic plains has been decreasing in the past two decades (Anonnymous 2008). This is partially due to temperature changes (Agarwal, 2008). For managing pests more attention should always been on weed management as it causes the major losses (37 %) among pests. Mechanical management of weeding creates more aeration and thus plant growth will be more by reducing the weed biomass. Instead of using the more toxic insecticides or fungicides the use of green label like bioneem and the ITK are sufficient to manage most insects and diseases. Continuous application of neem cake in each crop could solve the problem of nematodes and many soil insects like termites. Some new findings are also helpful. Removal of *Artemisia herva-alba* is always urgent as it inhibits the growth of *Nitrosomonas* (oxidizes ammonium to nitrite) and *Nitrobacter* (oxidizes nitrite to nitrate) and thereby reduces the rate of N-fixation (Varma and Dube, 2005), whereas *Artemisia capillaries*, containing 'Capillin' is used against the fungal infections by the farmers. The use of extracts of *Andropogon spp*. and *Cymbopogon vardus,* (essential oil - repellent), *Ocimum basilicum* (essential oil), *Physalis minima* (withanoilides - antifeedants) etc., *Chenopodium ambrosiodes* (essential oil), *Ageratum haustonianum* (precocenes – anti allotropic- producing sterile insects) have been using as botanicals against pests in many intensification system.

The methanolic extracts of *Ipomoea carnea* or ethanolic extracts of *Artemisia absinthium* showed managing the insects' leaf roller. The 'Pyrethrums' obtained from Chrysanthemum has been widely using as organic insecticides. Combination with *Blumea lacera* gives more synergistic effect. Hildecarpan from *Tephrosia* is an antifeedant against pod borer, incorporation or cultivation as intercrop of *Tagetes patula, Datura fastuosa, Chrysanthemum spp* in different field crops reduce the incidences of soil nematode.

The System of Intensification is, therefore, the best alternative approach with BMP techniques for increasing field crops in present agricultural scenario. China has joined with this new system of wheat-rice intensification. In global level the system of intensification has been started with rice (SRI) and now wheat (SIW), oilseeds, (SIO), pulses (SIP) and in sugarcane (SIS) in different countries. In India and in our state the West Bengal attempts have already taken in few crops like SRI, SIW, SIP, SIO etc. in some selected areas. The network mapping is continuing in this regard throughout the world (Clarke, 2006).

With this view at BCKV since 2006 field experiments were conducted about the sustainability of this technology in rice and further during 2008 this technology was demonstrated at farmers' field on paddy – green gram crop sequence. The major objective was to increase the decision making thoughts of the farmers of this region about the best management of the resources by demonstrating the advantages of this system on rice production using lesser inorganic resources but more organics and ITK besides low input cost like seed, labour, pesticides etc.. The choice of paddy – green gram crop sequence as for initiating this technology in this region was because of the farmers' acceptance and scientists – farmers discussion.

MATERIALS AND METHODS

The field experiments were conducted at the farmers' field Uttar Chandamari, Nadia, West Bengal during Summer 2008 on the basis of the on station experiment conducted during 2006 and 2007. At on station the 14 days rice seedling cv. M-Sankar (115 days) was directly dibbled in the field in 25 cm. (P-P) x 25 cm. (R-R) in 2006 and 20 cm. (P-P) x 25 cm. (R-R) in 2007 spacing in a plot size of 5 × 6 m. At on farm the 12 days old seedlings cv. IET 4786 (Satabdi) were planted in a spacing of 20 cm. (P-P) x 25 cm. (R-R). The Randomized Block Design replicated thrice was used in all on station and on farm experiments.

The following 9 treatments *viz.,* two different combinations of the organic bio-fertilizer Enrich Adhar and Neemcake with inorganic Urea (25 % ing. + 75 % org. and 50% ing. + 50% org.), the sole treatments of full and 75 % doses of the organic biofertilizer Enrich Adhar and the standard Neemcake and the rest one is sole inorganic was followed in both on station during 2006 and 2007 and at on farm during 2008 summer. The

fertilizer doses were N:P: K:: 80:40:40 kg ha^{-1} in rice. No nitrogen was applied as basal and only the organic manures and full PK were applied at final land preparation. Two hand weeding at 20 and 40 days after transplanting (DAT) and two paddy weeders at 30 and 50 DAT were done including the spraying of biopesticides as against the insect and disease attack besides using *Trichoderma viridae* @ 4 g kg^{-1} for the seed treatment. Neem cake at final land preparation was applied @ 1 t ha^{-1} in both rice and follow up crop green gram cv. B- 1 (Sonali) planted in minimal tillage technique with a spacing of 30 x 15 cm using only 5 t FYM, 10 kg N, 20 kg each of P and K ha^{-1}. The soil microbial analysis was also done to find out the fungi and total bacteria status of the experimental soil to find out the soil health improvement status. Only life saving irrigations in green gram and as per minimum requirement in paddy irrigation was applied and for plant protection mostly ITK was used.

In the awareness programmes, it attempted to update villagers with participatory methods about about the System of Intensification in order to increase their thinking power as well as to convince that resources should make available instead of depending on the resources for cultivation.. As seeds hold key to crop productivity, varietal improvement, timely sowing, proper plant population and seed treatment, were discussed. Thus, production of own seeds will be helpful to farmers to reduced the problem of weed plant *Phalaris minor* in wheat for timely sowing as there will be no anxiety to them about the availability good seeds in proper price. The zero / minimal tillage is one of the suitable techniques for achieving the same where depth of sowing depending on moisture status and then proper covering the planting materials with soil are most important factors. Treating seeds with growth regulators for improved crop health, organic fungicides like *Trichoderma* to reduce the pathogenic diseases, biofertlizers PSB (Phosphate Solubilizing Bacteria) *and Azotobactor* for more nutrient release through soil health improvement by increasing the soil microflora status or inoculation of *Rhizobium* culture for legume plants to reduce the N- fertilizer were also focused to implement on priority basis. Maintaining of plant population is another important factor and for this it is better to use proper seed rate. This will reduce the input cost of seeds. It was pointed out that unnecessary 4-5 seedlings using in transplanted rice (1-2 seedlings are sufficient to produce the same yield) only increasing the input cost. Management will also be easy 1-2 seedlings and thus, the yield will be more. In many other crops like mustard, linseed, lentil high seed rates are unnecessarily using as then due to lack of proper timely thinning the yields are lower.

In nutrient management it was discussed that the base strategy is to increase the population of the soil microflora, which is responsible for nutrient availability. Huge amount of nutrients are lost when the weeded materials are simply thrown in the bunds instead making a pit in nearby areas and use these green plants helps to get some organic nutrients readymade for basal application. It was also pointed out that basal application of N- fertilizer should be stopped as this will only encourage the weed growth instead of using by the crop plants, thus, 7- 10 days after planting of the seeds application of N- fertilizers will be more helpful to crops. Farmers were encouraged growing of wonder plant NEEM at home as every part of the plants is useful in agriculture and human health. Application of neem cake as basal and neem oil would be able to solve many pest problems including the nematode problems. Growing of *Azolla* in rice culture, cultivation of senji, cowpea, sesbania and other legume crops in crop sequences need to be done in both aerobic and anaerobic ecosystems as this also reduces the input cost of fertilizers. Farmers were aware about the use of PSB, *Azotobactor*, vermicompost, *Parthenium* compost etc. to increase the carbon content of the soil.

Water use pattern needs to be changed, pointed out in discussion. The diversification of crops with groundnut, soybean, white sesame, black / greengrams are more useful in this season instead of boro rice in uplands. The most important part is to make crop planning keeping water resources of a region and the water intake by various crops. Example is paddy, sugarcane etc. high water consuming crops should be grown in high rainfall region while pulses, oilseeds, millets should be grown in low rainfall areas.

In managing pests excepting weed management mostly the ITK was considered. Seed treatment with *Trichoderma viridae*, application of neem cake at land preparation in each crop, using of some tree branches or hanging of rope above the field, spraying of botanicals as more as possible, using of only green label pesticides etc. were the strategies. Some common ITKs which were discussed were use of cattle urine and tobacco soaked water to control aphid and fruit borer, pegging sticks in cultivated field to facilitate bird sitting – eating the insects, spraying of *Calotropis* juice 5% to reduce grassy weeds (Ghosh, 2007), spraying of custard apple leaf extract to reduce borer insects, leaf extracts of wood apple with cattle litter to reduce insects.

For selecting crops the farmers' acceptance and choice had given the priority. All the basic principles mentioned above were also followed in this experiment. On the basis of above the leaflet was prepared in local language and was distributed among the farmers of these villages.

RESULTS AND DISCUSSION

The data as presented in table 2, for on station and table 3, for on farm revealed that the combination of organic and inorganic showed significantly higher tiller numbers and grain yield of paddy. At on station number of tillers m^{-2} remarkably enhanced with the combination of 25% inorganic (urea) + 75% org (Enrich adhar) closely followed by the same combination of 25% inorganic (urea) + 75% organic (Neemcake). Similar trend was recorded in filled grain percentage and panicle length. Though the highest plant height was observed in the treatment where all the required amount of nitrogen

was supplied through inorganic. The highest grain yield of 4.85 t ha^{-1} at on station was recorded from the treatment T_3 *i.e.* 25% inorganic + 75% organic (Enrich Adhar). The maximum yield of paddy and pod yield of follow up crop green gram followed by the sole application of neemcake @ 80 kg ha^{-1}at on farm experiment during 2008. 75 % organic (Enrich adhar or Neemcake) applied in combination with 25 % inorganic urea recorded higher effective tiller numbers (589.31and 575.97, respectively), grain yield of paddy (5.82 and 5.58 t ha^{-1}, respectively) and follow up green gram (1.45 and 1.40 t ha^{-1}, respectively). The soil microflora studies particularly the total fungi and total bacteria showed that application of organic biofertilizers were better for increasing the microflora population than that of the inorganic fertilizer application. Thus, it proves the better soil management in System of Intensification for which the follow up crop green gram also recorded higher production in combination treatments. Similar results was also obtained by Bhanja *et al.*, (2006) and Ghosh (2008) working with organic manures in paddy. Weeder in paddy and wheel hoe in green gram created more aeration and this helped in enhanced growth of the crops. This also proved the advantages of another major component in this system, the weed management. The average irrigation in these types of rice cultivars (120–130 days duration) at Inceptisol of West Bengal during summer requires 125 - 150 cm (25 - 30 irrigations each with 5 cm) and the amount of water use in these three experiments were 69.56 cm including the rainfall 3.73 cm (2006), 71.80 cm including the rainfall 6.69 cm (2007) and 73.65 cm including the rainfall 8.62 cm (2008). This showed the savings of water in this system. The data collected from 30 farmers of these areas reveled that neemcake was most effective. The observations are in conformity with the findings of Gasparillo, 2002; Uphoff, 2004 and Uphoff *et al.*, 2005 in regards to yield advantage, low seed input cost, better soil health, less labour input cost, savings of water, low pest infestation and ultimately more profit along with more use of biodiversity.

Table 2: Growth and yield parameters *and* yield of paddy at on station during 2006- 07 (pooled data)

Treatments	Plant height (cm)	Tiller no. (m^{-2})	Filled grains (%)	Panicle length (cm)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Test weight (g)
80 kg N (Inog.) ha^{-1}	96.50	440.76	75.50	20.30	3.80	4.97	20.35
50% N (Inog.) + 50% (Org.- EA)	93.80	460.51	79.60	21.20	4.32	5.08	21.44
25% N (Inog.) + 75% (Org.- EA)	94.30	521.52	82.40	21.50	4.85	5.72	21.96
50% N (Inog.) + 50% (Org. – NC)	92.40	464.48	77.70	21.00	3.91	4.39	20.94
25% N (Inog.) + 75% (Org. – NC)	90.30	509.71	80.90	20.50	4.61	5.45	21.34
80 kg N (Org.-EA) ha^{-1}	91.70	470.35	76.80	20.60	4.37	5.33	20.99
60 kg N (Org.-EA) ha^{-1}	90.80	446.73	79.90	19.60	4.09	4.93	20.70
80 kg N (Org.-NC) ha^{-1}	88.70	488.06	73.80	20.40	4.14	5.17	20.92
60 kg N (Org.-NC) ha^{-1}	86.20	454.60	68.80	19.20	3.76	4.83	20.72
SEm(±)	**2.475**	**5.473**	**2.792**	**0.582**	**0.076**	**0.159**	**0.321**
LSD(0.05)	**7.405**	**16.371**	**8.352**	**1.742**	**0.223**	**0.476**	**NS**

Table 3: Number of tillers, grain yield of paddy and pod yield of follow up greengram at on farm during summer 2008

Treatment	Effective tiller no. (m^{-2})	Grain yield (t ha^{-1})		Farmers' ranking
		Paddy	Greengram	
80 kg N (Inog.) h^{-1}	498.06	4.41	1.10	9
50% N (Inog.) + 50% (Org.- EA)	520.38	5.01	1.25	4
25% N (Inog.) + 75% (Org.- EA)	589.31	5.82	1.45	3
50% N (Inog.) + 50% (Org. – NC)	524.86	5.07	1.27	2
25% N (Inog.) + 75% (Org. – NC)	575.97	5.58	1.40	1
80 kg N (Org.-EA) ha^{-1}	531.50	4.54	1.13	7
60 kg N (Org.-EA) ha^{-1}	504.70	4.74	1.18	8
80 kg N (Org.-NC) ha^{-1}	551.50	4.92	1.22	5
60 kg N (Org.-NC) ha^{-1}	513.09	4.60	1.15	6
SEm(±)	**6.182**	**0.088**	**0.044**	
LSD(0.05)	**18.499**	**0.258**	**0.065**	

Inog. – Inorganic, Org. – Organic, EA- Enrich Adhar, NC- Neem cake

There is an urgent need to increase the global production as the population is gradually increasing and in India inspite of implementing green, black, blue, white, yellow etc. revolutions the present agriculture technology is failed to increase the productivity of crops to the desired level rather the soil and water qualities are

degrading, the environment is more and more polluting, the quality of the produce is also decreasing as has been observed during the last five years. In such situation the System of Intensification, the alternate BMP with diversification of crops and more consideration of ITK, is one of the safest sustainable technologies to increase our productivity using the available resources and also to save our global food crisis.

The integrated approach of nutrient application which is the slogan of today's agriculture needs to be implemented with more care and for this target should be fixed to convert in full organic within a decade. Encouraging neem like organic products as a must, diversification of crops specially inclusion of legume crop in crop sequences, more use of bio-fertilizers etc. should be major strategies in nutrient management. Fertigation can also improve the irrigation efficiency and therefore, reducing the water consumption by increasing the crops ability to withstand drought stress. The micro irrigation needs to be promoted along with the watershed programmes to increase as more areas as possible. The use of the sewage water after depollution by natural plants like *Typha, Eicchornia, Pistia, Lemna* etc.; roof water in different areas should be harvested and collected. The development of marketing facility should be needed in each block with priority basis to adopt the diversification of crops. All these technologies and policies will help to strengthen the System of Intensification, the alternate Best Management Practice technology to increase the production, safe crop produce *and* environment and more farmers' innovation to agriculture development in our nation as well as in the world.

REFERENCES:

Bhanja, A. Ghosh R. K., Ghosh P. and Khuntia. A. 2006. Prospects of aerobic rice (*Oryza sativa*) cultivation in the Gangetic inceptisol. *Nat. Symp. Conservation Agri. Env.* BHU, Varanasi. 26-28 Oct., 2006. pp. 162-63

Anonymous.2009. Asia Pulse Data - Source via COMTEX http://www. tmcnet.com/ usubmit/2009/02/24/4009010.htm, New Delhi, Feb 20, 2009

Clark Louise.2006. Network mapping as a diagonistic tool. *Centro International de Agricultural Tropical*- CIAT, La Paz, Bolivia, 958-694-086-1

Ghosh A., Rao K. S., Pandey M.P.,and Poonam, A. 2007. SRI- A holistic management towards enhancing rice production in future. Towards a learning Alliance-SRI in Orissa

Ghosh, R.K., L. Sharma, P. Biswas and S. Mallick 2008. Nutrient management of SRI at Inceptisol of West Bengal. 3rd *Nat. Symp. SRI* 1st – 3rd December, 2008 at Coimbatore, Tamil Nadu, pp-146

Goswami, B. N. 2009. Director, IITM, Pune,; sriindia+unsubscribe @googlegroups.com

Narain Pratap 2009. Study at Central Arid Research Institute, Jodhpur, Rajasthan sriindia + unsubscribe @googlegroups.com.

Sarma Ramani Kanta. 2009. Coordinator, RGVN-SRI, Orissa, Googles group 2009

Subramanian S. 2009. New Delhi, sriindia + unsubscribe @ googlegroups.com

Thiyagarajan, T.M.2002.Experiments with a modified System of Rice Intensification (SRI) in India *Proc. Int. Conf. on "Assessment of the System of Rice Intensification"* Sanya, Chian, April 1-4, 2002

Uphoff, N. 2004. SRI- The System of Rice Intensification: An opportunity for raising productivity in the 21st Century. *Int. Year Rice Conf.,* FAO, Rome, Feb. 12-13, 2004

Uphoff, N., Satyanarayana, A., and Thiyagarajan, T.M. 2005. Prospects of rice sector improvement with the system of Intensification, considering the evidence from India. *16th Int. Rice Conf.,* Bali, Indonesia, Sep. 10-14, 2005

Varma Jaya and N. K. Dubey 2005. Prospective of botanical and microbial products as pesticides of tomorrow by BHU –www. iisc.ernet.in/currsci./jan25/articles22.htm – pp. 1-8

Wang. S, Cao. W, Jiang. D, Dai. T and Zhu. Y. 2002. Physiological characteristics and high-yield techniques for SRI rice. *Proc. Int. Conf. on "Assessment of the System of Rice Intensification"* Sanya, Chian, April 1-4, 2002 pp. 116-24.

Zheng. J, Lu. X, Jiang. X and Tang Y. 2004. The system of rice intensification (SRI) for super-high yields of rice in Sichuan Basin. *Proc. 4th Int. Crop Sci. Cong*. Brisbane, Australia, 26 Sep – 1 Oct., 2004