Agri. Review, 32 (2) : 120- 126, 2011

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com / indianjournals.com

SYSTEM OF RICE INTENSIFICATION – A REVIEW

V. Sridevi, V. Chellamuthu[1] and S. Jeyaraman[2]

Department of Agronomy, Tamilnadu Agricultural University,
Coimbatore - 641 003, India.

Received : 10-11-2010 Accepted : 11-04-2011

ABSTRACT

Rice is the major source of food for nearly half of the world's population. As the production systems in rice are undergoing major adjustments in response to escalating scarcity of land, labour, capital and water, major change are needed in method of establishment and production of rice crop. System of Rice Intensification (SRI), an innovation in rice cultivation, is found to increase the factor productivity and reduce the cost of cultivation in ways that benefit the farmers especially of resource poor .Studies in many countries including India have demonstrated that there is enough scope to reduce the cost of cultivation, increase the yields and income per unit area by adopting SRI method of rice cultivation.

Key words : Rice intensification, System, SRI.

Rice is a staple food of India, providing 43 per cent of calorie requirement for more than 70 per cent of the Indian population. To meet the demands of increasing population and maintain self sufficiency, the present production level of 102 million tones needs to be increased up to 125 million tons by the year 2020. This increase in production has to be achieved in the back drop of declining and deteriorating resources base such as land, water, labour and also other inputs and without adversely affecting the quality of environment (Chandrasekaran, 2008).

The System of Rice Intensification (SRI), a new method of rice cultivation is found to increase the productivity by exploit the genetic potential of rice and create a better growing environment (both above and below ground); enhance soil health; reduce inputs (seeds, water, labour) and addresses the major constraints affecting the livelihoods of small and poor farmers (Gujja and Thiyagarajan, 2009).

Origin and History

SRI was first conceptualized as a complementary suite of rice management techniques in Madagascar during the early 1980s by Henri de Laulanie, a French missionary priest. Since the mid-1990s, SRI has been promoted as a sustainable route towards superior rice yields both within Madagascar, principally by the NGO Tefy Saina, and internationally, most notably through the leadership of the International Institute for Food, Agriculture, and Development at Cornell University (McDonald *et al*., 2006).

Major components of SRI

The SRI is a 'system' rather than a technology because it is not a fixed set of practices. SRI involves a number of specific techniques that are always to be tested and adapted according to

[1]Department of Agronomy, PAJANCOA & RI, Karaikal-3.
[2]Director of crop Management, TNAU, Coimbatore - 641 003.

local conditions, not simply adopted (Uphoff, 2002).

The main components include careful transplanting of young seedlings at wide spacing on a precise grid with only one seedling per hill, water management that keeps the soil moist but not continuously flooded, frequent manual or mechanical weeding before canopy closure (i.e. three to four times), and reliance on high rates of organic compost as manure . SRI advocates suggest that synergies among these unconventional management practices unlock the physiological potential of rice, with results that challenge prevailing notions of yield ceilings for this food staple (Stoop *et al.*, 2002).

The specific components of SRI, being followed at present is simply denoted by the acronym 'YOSCIM', where 'Y' stands for Young seedlings (14 days old seedlings), 'O' stands for One seedling hill^{-1}; 'S' stands for Square planting (22.5 cm x 22.5 cm); 'C' stands for Conoweeding; 'I' stands for Intermittent irrigation and 'M' stands for Manuring (Ramasamy *et al.*, 2003).

Nursery and seed rate

Ramasamy *et al.* (2004) reported that 15 days old seedlings of modified mat nursery performed well in the main field and recorded 16 to 20 per cent higher yield than rice crop planted with 25 days old seedlings of traditional wet nursery.

The seedlings obtained from the traditional wet bed nursery and dapog nurseries are naturally thin and delicate because of high seed rate and poor nursery management. The modified rice mat nursery offers a good scope to produce robust seedlings within 14 or 15 days. In modified rice mat nursery, soil + press mud and soil + rice husk were found to be the suitable nursery media. Farm Yard Manure (FYM) was not found suitable due to some toxicity effect on young seedlings. There was an overall cost saving of 50 per cent under modified rice mat nursery as compared to that under the conventional nursery (Rajendran *et al.*, 2005).

Studies at Karaikal (Union territory of Puducherry) indicated that transplanting of even very young seedlings of 10 days old out yielded the 15, 20, 25 and 30 days old seedlings raised from modified mat nursery. Moreover, transplanting 10 days old seedlings produced higher yields than 15-30 days seedlings, regardless of the types of nurseries of their origin *viz.*, modified mat nursery, conventional mat nursery and raised bed nursery (Shenbagavalli *et al.*, 2010).

Performance of different rice species / varieties under SRI

Shao-hua *et al.* (2002) reported that in *indica* rice the tiller number at effective tillering stage, spike number and yield were five per cent lower under SRI than under conventional cultivation. He also opined that in *japonica* rice, there was no difference in spike numbers between SRI and conventional cultivation. He further reported that under SRI, population quality and biomass partitioning efficiency were found to increase distinctively and the grain yield was higher (11,750 kg ha^{-1}) than that under conventional cultivation (11,497 kg ha^{-1}), irrespective of rice species.

SRI was not particularly variety sensitive and that advantage of the system can be well utilized by any variety during dry season as experienced at Maruteru, Andhra Pradesh, India (Satyanarayana *et al.,* 2004).

Contrary to the perception that SRI method is genotype neutral, significant differences were observed between the varieties under SRI. Quingquan (2002) reported that rice hybrid was found to have the highest yield potential when grown in SRI method, due to profuse tillering capacity, lodging resistance, greater stress resistance, enormous yield potential and wide ecological adaptability. Uphoff (2004) stated that high yielding varieties or hybrids produced more than 15 t ha^{-1}, while traditional varieties produced 6-12 t ha^{-1} with SRI methods, at Madagascar.

Among the cultivar groups, the performance of late and medium duration varieties, and hybrids was found to be better as compared to early duration varieties. It is imperative that under SRI method, due to wider spacing, varieties with high tillering ability perform better as compared to the shy tillering genotypes (Kumar, 2009).

Effect of SRI practices on growth characters

The SRI was found to facilitate larger individual plants and resulted in better light distribution, taller plants, higher base-internode weight bearing ability, larger total leaf area and higher plant dry weight than conventional method. The yellow leaf sheath in the base of the stem appeared later with SRI. This indicated that leaf senescence was delayed under SRI (Longxing *et al.,* 2002).

Barison (2002) opined that appearance of more nodal roots for every newly formed tiller led to a more developed root system which was the joint effect of better soil aeration by different water management practices and by transplanting of young seedlings. He also found greater root growth of plants under SRI at lower depth as well as below 30 cm depth due to alternate wetting and drying of soil which led to greater root penetration. Higher root dry weight per plant and extended growth of roots by 10-15 cm deeper was found under SRI by Longxing *et al.* (2002).

Shao-hua *et al.* (2002) found that at jointing stage, the dry matter accumulation under SRI (3,916 kg ha^{-1}) was lower than that of conventional method (4,096 kg ha^{-1}) while at heading and maturity stages, the DMP under SRI was higher than under conventional method.

During *kharif* season, the combination of young seedling, one seedling, square planting and conoweeding (YOSC) significantly shown its superiority by registering taller plants, more tillers m^{-2}, more DMP, more root length, root dry weight and root volume in short duration rice variety ADT 43 (Sridevi and Chellamuthu, 2008).

Effect of SRI practices on physiological attributes

Enhanced root activity during the entire growth period, especially during later growth stages; higher contents of soluble sugars, non-protein nitrogen and proline in leaves, higher translocation and conversion rates of stored matter from vegetative organs were observed in plants under SRI. This ultimately enhanced grain filling and spike weight in SRI (Shao-hua *et al.*, 2002).

Effect of SRI practices on phenology

Paladugu *et al.* (2004) observed that the rice varieties reached 50 per cent flowering early under SRI, compared to non SRI at Maruteru, Andhra Pradesh during dry season. The rice under SRI was found to mature 3-5 days earlier than traditional practice at China (Zhu *et al.,* 2004) and 7-10 days earlier than traditional practice at Andhra Pradesh, India (Illuri *et al.,* 2004). Sridevi (2006) reported that emergence of panicles in 50 per cent population was at least six days earlier than normal method of rice culture. Reduction in growth duration helps to reduce the water requirement and facilitates to avoid water stress, especially in rice grown in tail end areas and helps timely cultivation of succeeding crop.

Effect of SRI practices on nutrient use efficiency and soil available nutrients

Barison (2002) reported that modification of plant, soil, water and nutrient management practice under SRI could enhance plant uptake by 91 per cent for N and K and 66 per cent for P. He also observed that the nutrient accumulation ratio for plants grown with SRI methods was higher (5: 1: 4.9) than conventional practices (3.9: 1: 4.1). The higher nutrient accumulation lead to more vigorous plant growth and higher yields due to changes in capacities of the plant itself, particularly its root system. SRI resulted in higher productivity during *Kharif* with comparable nutrient uptake and marginally higher nutrient use efficiency without depleting the soil available nutrients compared to standard transplanting, after two seasons (Kumar *et al.*, 2009).

Effect of SRI practices on yield and yield attributes

Thiyagarajan *et al.* (2002) opined that the maximum yield (7,612 kg ha^{-1}) was obtained for the modified SRI practice with young seedlings, restricted irrigation, addition of green manure and incorporation of weeds, soil aeration with conoweeder during *rabi* (*samba*) season in rice hybrid CORH 2 at Coimbatore, Tamil Nadu.

Balasubramanian and Devaraj (2004) recorded higher grain yields of 7,314 and 8,424 kg ha^{-1} during *kharif* (*kuruvai*) and *rabi* (*samba*), respectively, as compared to conventional method of cultivation at Aduthurai, Tamil Nadu, which were mainly because of more number of productive tillers in SRI (545 and 488 m^{-2} in *kharif* and *rabi,* respectively).

A yield advantage of 922 kg ha^{-1} with SRI as compared to non SRI was realized at Maruteru, Andhra Pradesh during dry season. This was attributed to increased number of fertile tillers (167.5 % higher), filled grains panicle^{-1} (29 % higher), spikelet fertility (6.4 % higher) and test weight (1.7 % higher) with SRI as compared to non SRI (Satyanarayana *et al.,* 2004).

Samidurai *et al.* (2004) reported that SRI with the combination of five practices *viz.,* young seedlings (14 days old), one seedling hill^{-1}, square planting (22.5 cm x 22.5 cm), use of conoweeder and intermittent irrigation produced higher yield of 7,061 and 7,546 kg ha^{-1} with 48.81 and 55.20 per cent increase over conventional practices during dry and wet seasons, respectively. This was mainly attributed to more number of lengthy panicles with increased number of filled grains panicle^{-1} and less number of unfilled grains.

Vijayakumar *et al.* (2004) stated that grain yield and water productivity were significantly increased by the package of planting of 14 days old dapog seedlings at 25 cm x 25 cm spacing, water saving irrigation (i.e., irrigation after disappearance of water) and SRI weeding (Conoweeding) to achieve the grain yield of 7,009 and 5,655 kg ha^{-1} and water use efficiency of 0.610 and 0.494 kg m^{-3} with water saving of 34.6 and 34.9 per cent, respectively, during wet and dry seasons at Coimbatore, Tamil Nadu.

When all the four components of SRI were combined (YOSC), it gave the highest number of panicles hill^{-1} , panicle length , panicle weight , test weight ,number of spikelets panicle^{-1} ,number of filled grains panicle^{-1}, which ultimately resulted in higher grain and straw yield and improved harvest index in short duration rice variety ADT 43 during *kharif* season (Sridevi and Chellamuthu, 2007).

Effect of SRI practices on quality characters

Satyanarayana *et al.* (2004) reported that milling percentage and head rice recovery were significantly higher (4.4 and 4.8 % during wet and dry season, respectively) under SRI compared to non-SRI. When the rice cultivated under SRI is milled, a high proportion of milled rice (74 %) is turned out due to higher grain weight (Pinjari *et al.,* 2007). Babu *et al.*, (2008) reported that SRI had very high and significant effect on milling and head rice recovery.

Effect of SRI on incidence of insect pest

Low pest incidence in rice grown under SRI due to vigorous and healthy growth of plant coupled with wider spacing has been reported by Ravi *et al.* (2007). The results of the experiments conducted at DRR indicated that yellow stem borer damage was high at all the crop growth stages and its damage (dead hearts) was low in the cultivar "Shanti" grown under SRI (7.0%) as compared to standard transplanted condition (11.4%). At reproductive stage, the damage (white ear heads) was high in SRI (28.3%) than conventional method (21.2%). The survey in the villages adopted by DRR also indicated that SRI had low pest incidence resulting in lower or no pesticide application (Kumar *et al.*, 2009). Total abundance and species richness was high in SRI as compared to conventional method. Among various guilds, natural enemies were found more in SRI than conventional method of rice cultivation (Kumar *et al.*, 2009).

Effect of SRI practices on disease incidence

Shengfu *et al.* (2002) reported that the incidence of rice sheath blight was lesser under SRI than the conventional method. Planting at 33.3 cm x 33.3 cm spacing or 40 cm x 40 cm spacing under SRI recorded only 58.4 and 54.6 per cent of disease incidence, respectively and this was lower than that of conventional method (70%). Zhu *et al.* (2004) found that the practice of intermittent irrigation in SRI reduced the humidity in the canopy, which reduced the disease, especially sheath blight by 70 per cent.

Effect of SRI practices on economics

Illuri *et al.* (2004) reported that there was no significant difference in cost of cultivation between SRI and non SRI but significant difference was found in terms of net returns between SRI (Rs. 27,923 ha^{-1}) and non SRI (Rs. 9,222 ha^{-1}) at Andhra Pradesh during wet season. A net benefit of Rs. 18,700 ha^{-1} was obtained in SRI. SRI method registered higher net return (Rs. 12, 574 ha^{-1}) and B: C ratio (1.87) compared to normal practice (Sridevi, 2006). The net income was higher in SRI method of cultivation than the farmer practice. In Dharmapuri district of Tamil Nadu, SRI method of cultivation recorded higher net income of Rs. 21,415 ha^{-1} over farmers' practice (Rs. 16,288 ha^{-1}), thus income increase was 31.5 per cent (Budhar and Mani, 2008).

Effect of SRI practices on water saving

Using intermittent irrigation, water saving of 50 per cent was achieved in SRI over the traditional flooding without any adverse effect on grain yield (Thiyagarajan *et al.*, 2002). Murthy *et al.* (2006) revealed that SRI cultivation utilized 1130 mm of water which was 11.3 per cent lesser compared to recommended transplanting using 1270 mm. Water saving in SRI was to the tune of 30-40 per cent over conventional rice cultivation has also been reported in India(Kumar *et al.*, 2006). Total water productivity of the SRI was 29 per cent higher as compared to conventional method (Kumar *et al.*, 2009).

Constraints in SRI

Certainly there are some limitations on the use and adoption of SRI. The most objective one is effective water management to get best results (Uphoff, 2004). Initially, SRI methods require more labor, as they need to be learned and mastered. However, the returns to labor are increased. In fact, this requirement is reduced in subsequent seasons, and SRI labor demand eventually becomes less than with conventional cultivation (Barrett *et al.*, 2003). Although the initial increase in labor requirements can be a barrier to adoption (Moser and Barrett, 2003), over time SRI can even become labor-saving.

A remaining argument against SRI could be that it will lead to soil depletion. SRI is not inherent, only pragmatically 'organic'. If any point depletion of nutrients becomes a problem, inorganic soil amendments can be made. Different practices should maximize the nutrient contributions that can be mobilized and sustainable through biological processes (Uphoff, 2004).

If SRI planting coincides with the onset of peak rains, then establishment of seedlings becomes a major problem resulting in death of seedlings due to excess moisture or stagnant water. The death of seedlings creates lot of gaps in the field and results in reduced plant population. Repeated gap filling is needed to ensure the specified population. As a result, the spread of SRI is at a low magnitude in river delta areas, especially during rainy season. Because of its labor-intensity, SRI is only suitable for small-scale production and not suitable for large scale production.

CONCLUSION

SRI is the "designer" innovation that not only improves the rice productivity but also efficiently uses the scarce resources *viz.*, land, labor, capital and water, protects soil and groundwater, and is more accessible to poor farmers.

REFERENCES

Babu, V.R. *et al.,* (2008). Grain quality parameters of cultivars as influenced by SRI in rice. **In:** Extended summaries of National Symposium on System of Rice Intensification (SRI) in India – Policies, Institutions and Strategies for Scaling up, Coimbatore. p 22-24.

Balasubramanian, B.C., and Devaraj, S.D.S. (2004). Effect of system rice intensification practices on rice productivity in Cauvery delta zone of Tamil Nadu state in India. In Proc. World Rice Research Conference 2004, Tsukuba International Congress Center, Tsukuba, Japan.

Barison, J. (2002). Evaluation of nutrient uptake and nutrient use efficiency of SRI and conventional rice cultivation methods in Madagascar. . **In** Proc. Intl. Conf. 'Assessments of the System of Rice Intensification (SRI), Sanya, China. p. 143-147.

Barrett, C. B. (2003). Better technology, better plots, or better farmers? Identifying changes in productivity and risk among Malagasy rice farmers. Paper presented to the American Agricultural Economics Association meetings, July 27-30, Montreal.

Budhar, M.N. and Mani, A.K. (2008). Farmers Participatory Extension: A case study of SRI technology adoption in North Western Agro Climatic Zone of Tamil Nadu. **In:** Extended summaries of National Symposium on System of Rice Intensification (SRI) in India – Policies, Institutions and Strategies for Scaling up, Coimbatore. pp 51-53

Chandrasekaran, B. (2008). Rice research programme in Tamil Nadu**. In** Souvenir of 3rd National symposium on System of Rice Intensification in India – Policies, Institutions and Strategies for Scaling up, Coimbatore, India. 1-3 Dec. 2008.

Chellamuthu, V. and Sridevi, V. (2006). Relative contribution of different components of System of Rice Intensification (SRI) to the yield of rice (*Oryza sativa*). p 477-478. **In:** Abstracts of Second International Rice Congress, New Delhi, India. 2006.

Gujja, B. and Thiyagarajan, T.M. (2009). *Gate keeper Series*, **143** : 4-5.

Illuri, R. *et al.,* (2004). System of Rice Intensification (SRI): An innovative method of rice cultivation and its performance in A.P., India. **In** Proc. World Rice Research Conference 2004, Tsukuba International Congress Center, Tsukuba, Japan p. 381.

Kumar, D. *et al.,* (2006). Agronomic evaluation of the System of Rice Intensification (SRI) and Conventional Rice Culture (CRC) under varying nutrient management practices in aromatic rice (*Oryza sativa*). **In:** Extended summaries of National Symposium on Conservation Agriculture and Environment, BHU, Varanasi. *p. 276 – 277.*

Kumar, R. M. *et al.,* (2009). *Journal of Rice Research*, **2**(2): 61-73.

Longxing, T. *et al.,* (2002). Physiological effects of SRI methods on the rice plant. **In** Proc. Intl. Conf. Assessments of the System of Rice Intensification (SRI), Sanya, China. p. 132-136.

Makarim, A.K. *et al.,* (2002). System of Rice Intensification (SRI): Evaluation of seedling age and selected components in Indonesia. p. 129-139. **In** B.A.M. Bouman, H. Hengsdijk, B. Hardy, P.S. Bindraban, T.P. Tuong, and J.K. Ladha (ed.) Water-wise Rice Production. IRRI, Philippines.

McDonald, A.J. *et al.,* (2006). *Field Crops Research* 96, 31-36.

Moser, C. M. and Barrett. C. B. (2003). *Agricultural Systems*, 76, 1085-1100.

Murthy, K.D. *et al.,* (2006). Water management and varietal response of rice under System of Rice Intensification (SRI) in Godavari Delta of Andhra Pradesh. p. 98. **In:** Abstracts of National Symposium on System of Rice Intensification (SRI): Present status and future prospects, Hyderabad, India. 17-18 Nov, 2006.

Namara, R.E. *et al.,* (2003). The prospects of System of Rice Intensification adoption in Sri Lanka: A microeconomic and sociopolitical perspective. Paper from the International Water Management Institute, Colombo, presented to meetings of the International Commission on Irrigation and Drainage.

Paladugu, S. *et al.,* (2004). Studies on varietal performance under System of Rice Intensification (SRI) and normal system of rice cultivation (Non-SRI). p. 382. **In** Proc. World Rice Research Conference 2004, Tsukuba International Congress Center, Tsukuba, Japan. 5-7 Nov. 2004.

Pinjari, S.S. *et al.,* (2007). *Agricultural Update,* **2**(3): 66-67.

Qingquan, Y. (2002). The System of Rice Intensification and its use with hybrid rice varieties in China. p. 109-111. **In** Proc. Intl. Conf. 'Assessments of the System of Rice Intensification (SRI), Sanya, China. 1-4 Apr. 2002.

Rajendran, R. *et al.,* (2005). Early production of robust seedlings through modified rice mat nursery for enhancing rice productivity (*Oryza sativa*) productivity and profit. *Indian J. Agron.* **50**(2):132-136.

Ramasamy, C. *et al.,* (2003). *Thirunthiya nel sagupadi.* Tamilnadu Rice Research Institute, Aduthurai, India.

Ramasamy, R. *et al.,* (2004). Modified rice mat nursery for producing robust young seedlings in 15 days for early transplanting and enhancing productivity of irrigated rice. p. 226. **In** Proc. World Rice Research Conference 2004, Tsukuba International Congress Center, Tsukuba, Japan. 5-7 Nov. 2004.

Samidurai, R. *et al.,* (2004). System of Rice Intensification (SRI): An innovative crop establishment technique to boost the rice yield. p. 380. **In** Proc. World Rice Research Conference 2004, Tsukuba International Congress Center, Tsukuba, Japan. 5-7 Nov. 2004.

Satyanarayana, P.V. *et al.,* (2004). On-farm evaluation of the System of Rice Intensification (SRI) in Andhra Pradesh, India. p. 382. **In** Proc. World Rice Research Conference 2004, Tsukuba International Congress Center, Tsukuba, Japan. 5-7 Nov. 2004.

Shao-hua, W. *et al.,* (2002). Physiological characteristics and high yield techniques with SRI rice. pp. 116-125. **In** Proc. Intl. Conf. Assessments of the System of Rice Intensification (SRI), Sanya, China. 1-4 Apr. 2002.

Shenbagavalli , P. *et al.,* (2010). Effect of age of seedlings on the productivity of rice (*Oryza sativa* L.) p.61 . In Proc. National seminar on sustainable food supply , agro-biodivrsity and rural livelihoods (SFARL 2010), Annamalai University, Tamilnadu, India.18-19 Feb.2010

Shengfu, A. *et al.,* (2002). Assessment of using SRI with the super hybrid rice variety Liangyoupei 9. p. 112-115. **In** Proc. Intl. Conf. Assessments of the System of Rice Intensification (SRI), Sanya, China. 1-4 Apr. 2002.

Sridevi, V and Chellamuthu, V. (2007). Effect of System of Rice Intensification (SRI) practices on the yield and yield attributes of rice. p. 74. **In** Papers and Extended summaries of 2nd National symposium on System of Rice Intensification in India-Progress and prospects, Agartala, India. 3-5 Oct. 2007.

Sridevi, V and Chellamuthu, V. (2008). Impact of different components of system of rice intensification (SRI) to the yield and growth attributes of rice. p. 154-155. **In** Extended summaries of 3rd National symposium on System of Rice Intensification in India – Policies, Institutions and Strategies for Scaling up, Coimbatore, India. 1-3 Dec. 2008.

Sridevi, V. (2006). Relative contribution of individual componenets of system of rice intensification (SRI) to the yield of rice crop. M.Sc.(Ag.) Thesis. Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, India.

Stoop, W. *et al.,* (2002). *Agricultural Systems* **71**, 249-274.

Thiyagarajan, T.M., *et al.,* (2002). *J. Agric. Resource management* **1**(4):169-181.

Uphoff, N. (2002). *J. Agric. Resource management* **1**(1):43-49.

Uphoff, N. (2004). The System of Rice Intensification: Capitalizing on existing yield potentials by changing management practices to increase rice productivity with reduced inputs and more profitability. p. 109. **In** Proc. World Rice Research Conference 2004, Tsukuba International Congress Center, Tsukuba, Japan. 5-7 Nov. 2004.

Vijayakumar, M. *et al.,* (2004). System of Rice Intensification (SRI) practices on yield attributes yield and water productivity of rice (*Oryza sativa*). p. 289. **In** Proc. World Rice Research Conference 2004, Tsukuba International Congress Center, Tsukuba, Japan. 5-7 Nov. 2004.

Zhu, D. *et al.,* (2004). Effects of SRI methods on yield and water saving in China. p. 111. **In** Proc. World Rice Research Conference 2004, Tsukuba International Congress Center, Tsukuba, Japan. 5-7 Nov. 2004.