

## **Tour Report of Raj Gupta, Facilitator, RWC, CIMMYT-India to the International Conference on System of Rice Intensification (SRI), Sanya, Hainan Province, China, April 1-4, 2002.**

Catholic Relief Services (CRS) has been working in Madagascar for the last 40 years. Since 1998, it has operated a 'food security program' financed by USAID which targets vulnerable households in rural areas with an integrated package of maternal and child health assistance and for improvement in agriculture. The SRI technical package is based on the principles discovered by Fr. Père de Laulanié and extended by various organizations in Madagascar. The technical package being promoted consists of the following elements:

- *Early transplanting*: 8-day seedlings or seedlings with two leaves, with lot of care, preferably on texturally finer soils, puddled to variable levels,
- *Single seedlings*, carefully transplanted
- *Wide spacing*: 30 x 30 cm in the main season; 25 x 25 cm in the off season,
- Greater reliance on the use of compost/ FYM combined with minimal of external nutrient inputs,
- *Early, multiple weeding*: 3-4 times with mechanical weeder, starting 10 days after transplanting. This is necessary for growing rice when fields are not kept continuously flooded through use of (a) **rotary weeder**, (b) **manual weeding**, or (c) using **herbicides**. Some farmers in Cambodia are using (d) **simple hoes**, which loosen the soil as they remove weeds. *In Sri Lanka, some farmers who practice Kakulam control weed by ) **mulching the direct seeded rice**, this conserves water as it suppresses weeds and adds nutrients to the soil.*
- *Water control*: applying a minimum of water, Fr. de Laulanié recommended **keeping the soil moist but unsaturated** during the vegetative growth period. Alternating irrigation and drying until flowering.

SRI conference, convened by Norman Uphoff, was attended by participants from 19 countries, 4 IARCs and 60 experts from China. The participant were diverse background including the researchers, extentionists, policy makers, NGOs and Farmers. In his opening remarks Norman said that SRI is constrained by knowledge base, more “practice-led” and science seems to be “Catching Up” . To put the remarks in proper perspective, SRI practices are rooted in scientific principles but regular “experimentation is catching up” only now.

Most of the Conference papers were circulated earlier. All these papers were not read during the conference in the traditional sense. Authors were encouraged to read out the gist only. Following significant differences between SRI and other conventional practices were observed:

1. The enhanced root activity during the entire growth period, especially during late growth stage, was an important physiological characteristic of rice plants grown with SRI. Oxygenation of soil obtained by controlled water management and use of a rotating weeder contributes to the high performance of SRI. Zhang Xi et al. (1999) have earlier shown that

layers of ferro-hydroxide appear on the surface of paddy-field water under anaerobic conditions. Without  $O_2$ , this limits roots' access to nutrients. This can be a serious problem in Madagascar where, iron toxicity is more common, given the majority of *ferralitic soils*. High aluminum saturation of the soil complex can immobilize large amounts of  $P_2O_5$ . Under such conditions even stirring method during weeding ( hand, mechanical ) are likely to create significant differences in crop yields due to oxygenation of soils.

2. As main osmotic regulators in rice plant is - accumulation of soluble sugars and non-protein nitrogen would enhance rice ability for drought tolerance, which was another important physiological characteristic of SRI rice.

3. The absolute partitioning rate of stored matter from vegetative organs was remarkably higher than with W treatment. A higher translocation and conversion rate of stored matter from vegetative organs was of significant importance for enhanced grain filling and spike weight in SRI rice.

4. Under typical SRI cultivation of one seedling per hill and slight drought stress in paddy field, population tiller numbers including final spike number at all growth stages were obviously lower than those in conventional rice. In Madagascar study, the gains due to single transplant of the seedlings were more, however. .

5. There are obvious varietal differences between modern or local cultivars and the Hybrid rices. Cultivars having low propensity for tillering do not perform as well with SRI methods as varieties that have a high propensity to tiller (eg. IR-15, IR-46 and Taichung 16 in Madagascar; BG-358 in Sri Lanka). Cultivars with duration around 120-130 are favorable to SRI response.

6. Increasing seedling number per hill and nitrogen fertilization can promote the population development in SRI.. Population of tillers at effective tillering stage with two seedlings per hill was remarkably enhanced as compared to one seedling per hill. Thus, the combination of moderate nitrogen and two seedlings per hill was in favor of yield increase with SRI rice.

7. Experiment with normal Indica rice and hybrid rice showed that responses to SRI cultivation differed with genotypes. Since hybrid rice had strong tillering ability and vegetative growth advantage, tiller number at effective tillering stage and spike number were similar between SRI and conventional cultivation. In contrast, significant differences were observed with *indica* rice.

8. High performance of SRI is linked to the activities of aerobic microorganisms located in the root system. Isolation and identification of *Azospirillum* sp./ *Azolla* , which when associated with high yields can meet the needs for use of organics in SRI.

It was generally mentioned that SRI practices are still evolving and concerns are more about improving factor productivity of land, labor water, and nutrients etc.. SRI is about harnessing potential of soil biology for pushing up further the yield plateau of rice.

With SRI, there is an issue of more of fundamental research vs. complex factorial type standard experimentation, and identifying niches for the SRI as in all areas and domains SRI seems unsuitable. The key issues involved with the SRI there would be finding niches and extrapolation domains of the SRI technology. System of Rice Intensification (SRI) was deemed as a misnomer because it deals with intensive care of young tender seedlings, composting and weeding rather than intensification of rice based or rice system per se. Some one suggested why not to term it system of intensive cultivation of rice culture rather than system of rice intensification.

Any way, plants with wider spacing in SRI has the advantage of better light interception, higher water use efficiency and more yield potential.

### **Main limitations of the SRI: Technical and Bio-Physical problems of the SRI**

- 1. Water Management problems :** The water related problems associated with SRI can easily be listed as under:
  - a. Element of seasonality in rice growing and precipitation: Rice is grown round the season in several areas of South Asia and particularly during the monsoon season. Many participants pointed out that it is difficult to maintain alternate wetting drying cycles during the main rice growing season. This however not a problem as it is, because advancing the transplanting of rice ( nurseries raised in middle of May when planted in first half of June very well automatically get this cycle during the next 3 weeks. (In the IGP, this period will coincide with the sub-humid period when  $ET > \text{Rainfall}$ .)
  - b. In lowland situations of the rice ecologies water control is complex and alternate wetting-drying cycles are rather unreasonable to practice.
  - c. Texturally suitable soils. SRI- is primarily recommended for finer textured soils and pursuing alternate wetting dry cycles until panicle initiation stage. Cracking may lead to more nutrient and water losses through by-pass mechanism, may lead to iron chlorosis, requires puddling before transplanting of young tender rice seedlings of 8-12 days old. Puddling reduces ground water recharge. Also when rice is grown in boro season – growth of seedlings is slowed down due to low temperature and hence makes transplanting operations difficult.
  - d. Need for better definition of “drying process” and its intensity. In high evaporating conditions seedling mortality may itself be high if there is no water in early stages.
- 2. Weed management :** With SRI, weed management is problem.
  - a. Weed compete with crop for water and nutrients
  - b. SRI and weed management – More labor intensive.
  - c. Need for a weeder. IRRI cono-weeder has been improved

**Solutions:**

- a. Filtering irrigation water: weeds spread more with irrigation water in channels use straw plugs to manage weeds.
- b. Herbicide usage , but a problem in fish culture
- c. Grow *Sesbania* for GM and herbicidal property
- d. Use competitive cultivars
- e. Rotational cropping
- f. Maintain a thin layer of water for better weed control.

**3. Nutrient management:**

- a. SRI may reduce CH<sub>4</sub> but may increase N losses
- b. Need information o dynamics of Nutrients fro crop rotations/ systems
- c. Better documentation of effective microbes used in compost making for SRI. Inoculants needed.
- d. Availability of organics for composting limited and always not available.
- e. Sustainability of SRI need more testing.
- f. Is there a possibility for *in situ* decomposition of crop residues. Soils are best laboratory for residue decomposition. How can we come out of the “Compost Pits” for quick decomposition of residues in FYM/ compost making, is an area of great interest and a challenge to microbiologists and agronomists ?

**4. Seedling raising, establishment and transplanting:**

- a. In SRI rice is transplanted on puddle soils, why do we need to puddle the finer textured soils having very low infiltration rates, high water tables or both? Puddling adversely affects ground water recharge and rooting in for the succeeding crop. How do we maintain system yields? Can we establish rice with out puddling and transplanting through direct dry seeded rice? Preliminary results of the field trials already suggest that it is possible.
- b. In boro rice – low temperatures reduces seedling growth and hence seedling age must be increased. It is difficult to transplant boro rice with seedlings which are 15 days old. How can we overcome this problem for boro rice?
- c. Transplanting is labor intensive, can DSR is good enough to facilitate SRI

**5. Crop diversification:**

- a. SRI reportedly does not promote crop diversification. What adjustment need to be made in SRI that it facilitates crop diversification

**Problems in adaptation and diffusion of the SRI**

- a. SRIable lands, geo-referenced information not available.
- b. SRI campaign lack forward-feed and feed-back mechanism between Farmer, researcher-extensionists chain.
- c. Structural mechanism for technology adaptation/ dissemination lacking, no net work for exchange of information.
- d. Farmers need options for establishing rice and possibly another option. But within SRI system there are no variants and hence no options to practice with in socio-economic resource endowments of the farmers.

- e. Entry points for the SRI are relatively unknown as is knowledge about the *SRIable* lands. Confidence building measures are available.
- f. SRI need hydro-tiller and cono-weeder equipment, not available locally and local artisans in the region of SRI origin re also not available.
- g. Paucity of the manpower and funds do not allow intensive and quality interaction with the farmers. Negative experiences of farmers spread faster in absence of the any published information.
- h. Conflicting interests of NGOs and donors lead to contradicting messages for the farmers.
- i. Training of the staff is low
- j. Element of credibility problem for the SRI with established rice research institutions and lack of flexibility on the part of the scientists to experiment with this technology.
- k. Paucity of funds and donors for the SRI technology.
- l. SRI does not diversification with intercropping hence little risk coverage for the experimenting farmers – technology more driven by local farmer experiences rather than science / knowledge base. Brilliant examples of high productivity (rice yields > 21 t/ ha not emulated by farmers. Failures donot provide lessons as no research efforts are currently going on in SRI.
- m. Inadequate “forward-feed and feed beck” mechanisms are lacking or non-existent.
- n. Technical literature is lacking.

Several speakers mentioned about the response of the SRI were more when rice cultivars of 120- 130 days duration were chosen for evaluation of the SRI technology. Wider spacing reduces plant height and produces more tillers. With SRI, most participants reported more number of in-effective tillers. are. This seems to be compensated by more number of total panicles, spike lets per panicle and seed test weight. Chinese scientists were of the view that it is always better to transplant healthy seedlings having 3-4 tillers. *In a presentation interaction of plant spacing, paired planting and unsaturated soil moisture regimes on the number of primary, secondary and tertiary tillers, number of ineffective tillers and phyllochron numbers etc. explained taking example of hybrid rice. Language problem did not allow a better understanding. Write up will be provided later on.*

***Relevance of the SRI information with RCTs works in RWC in (a) Unpuddled transplanted rice on raised beds, and (2) direct dry seeded rice situations on Raised beds or on flat systems.***

In order to draw parallel and to learn lessons whatever from the SRI it is essential that we first discuss the bio-physical environment for the technology in Madagascar where farmers developed or evolved this technology and the driving variables for it.

**A. SRI -Evolution patterns- Matching the Rainfall pattern with plant growth patterns by advancing the transplanting dates.**

Rice is grown in Madagascar from September end onward. Rainy season which is very short, begins in November and ends up by December. Photosynthetic activity between panicle initiation to flowering stage is known to correlate directly with grain production and therefore, it is best avoid any water stress during this period. Advancing the transplanting dates thus allows farmers to make best use of the rain water during panicle initiation stage to flowering stage.

Late planting or transplanting of rice invariably result in low productivity. Late planted crop had more blast and other disease and pests. Falling temperature during November/ December (in Madagascar) causes yet another problem due to grain sterility. Late transplanted crop had very high sterility in the spike lets and resultant low grain filling. In eastern IGP (boro rice) falling temperatures reduces the seedling growth significantly. Early planted rice crop helps overcome all these problems. So some kind of alternate wetting drying cycles is experienced by the September planted crop ( it is assumed here that it is low intensity drying 70% of the water holding capacity, it needs better definition, no one in the conference, could define it in quantitative terms!!). Such moisture regime cycles mobilize organic P (Nature report 2001?) and also the mineralization of N etc., thereby possibly reducing the need for external inputs.

#### **B. Water Management and weed control practices**

Rice nurseries are grown in pre-monsoon season and transplanted young before the onset of rainy season so that the seedlings are well established and ready to make maximum use of rain water. During the intervening period farmers only keep field moist (unsaturated). This promote development of a more intensive root system in search of water to meet the ET demands of the plants and help overcome drought like situations in the intervening period. Weed management during the period (September- November/ December) is by far through manual or mechanical weeding operations. By the time crop is 60-65 days old, almost 4-hand weeding operations are done. Burying the weeds in the fields rather than removing them improve the crop yields. Several trials even in IGP on this aspect confirm the importance of burying weeds in rice production.

**C. Plant attributes and their roles in yields:** Rice requires good watering or flooded conditions to avoid any adverse effect on the tillering and more importantly during the panicle initiation to flowering and grain filling stage. Photosynthates assimilated between the PI to flowering stages have a direct correlation to grain yield. So any stress during the period is to be avoided and flooding is thus preferred by the farmers and advocates of SRI during this period. Drainage is provided 10 days before panicle initiation (70 DAS). This practice controls the number of in-effective tillers and thus significantly influences the rice productivity. Drainage is again provided to crop for a period of 10-12 days before harvesting.

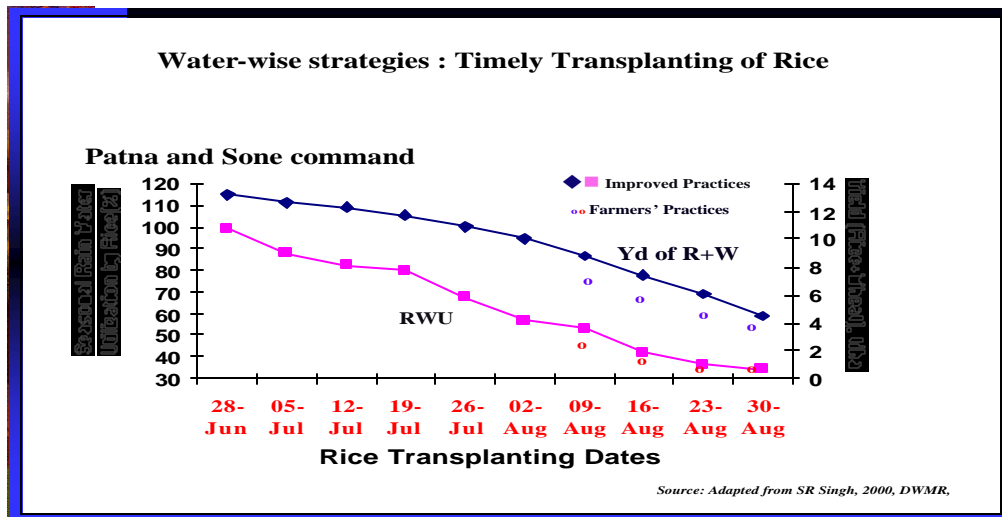
#### **Rationalizations of contributions of the components of the SRI:**

In absence of any quantitative numbers that apportion the contribution of different components of the SRI technology to the increased productivity, it is difficult to say which is more important but rationalizations can still be made on the basis of experiences gained in rice and other crops else where. For example, in wheat, results on a regional scale show that

two-third of the productivity gains (66% of the total) in zero-till planted wheat in Haryana, were mainly due to early or timely planting of wheat and rest 34% were ascribable to efficient use of inputs and better weed control ( Mehla et al. 2000). Also, results of the farmer participatory trials conducted in Bihar have shown that advancing the planting dates of rice a month before the actual monsoon season resulted in a very efficient use of rain water and improved the total productivity of the Rice + Wheat system to almost 13-14 t/ ha from the current productivity levels of 4-6 t/ha under farmer practices (DWM, Patna report 2001). Currently farmers in Bihar and Bangladesh and in parts of Nepal Terai, transplant rice till middle of August. Thus not only do the farmers waste 300-500mm of rain water in tillage operations but end-up the crop in terminal droughts, low yields of rice and delayed planting of wheat and thus low overall system productivity. ( see fig. 1).

Where as advantage of SRI seemingly could be due to advancing transplanting time, the merits in SRI might have assigned to water saving and lower use external inputs!. (Unfortunately, language has been a big problem with French speaking participants, however, I am not sure about my accurate understanding of the seasonality in Madagascar, although I spend many hours discussing with Bruno, one of the champion for SRI !)

Fig. 1.



### Weeds and intensive use of organics

Another issue is about intensive use labor on weed management and organics in SRI. Unless sufficient nutrients are added to the soils through use of organics there is no way, high reported yields, can be sustained. It was mentioned by one of the participants and also by Buresh (IRRI) in his hand out, that some farmers spend as much as 100 man days in collecting organics from nearby waste lands. A common observation to rice growing areas in IGP had been that it is better to incorporate weeds in rice soils than remove them. Yet another view is that why not to create competition even for weeds. The key question is how

to do this. Are there some companions crops that grow quickly in ponded conditions and help rice quickly develop canopy cover such as prevent weeds to grow? Sesbania could be good candidate. There might be some self regenerating legumes. Farmers in certain parts of Tamilnadu, India are known to grow these legumes. These legumes come up well with rice and drop seed before rice harvest and germinate again during rice season. Stubbles of this legume are removed with rice straws. Incorporate the cover crop/ green manure crop at appropriate time to meet demand of the rice crop for nutrients. It is worth trying if some equipment for incorporation is available.

The another key issue is how we can overcome the drudgery of transplanting very young and tender rice seedlings of 8-12 days old. Relevant to IGP, is try to plant rice through direct dry seeding in flats or raised bed system. Then, transplanting shock could be completely eliminated. In our trials, excellent results were obtained and yield as high as 7.4 Mg/ha were obtained even in late sown rice on Jun 20<sup>th</sup>. Timely sown rice could have given much higher productivity.

**An important key question could be “Can we control weed without adversely affecting tillering by manipulating the water management practices?” To my mind there are several OPTIONS with the farmers and researchers and this is possible and already incorporated in raisedbed / flat DSR using the Zero-till machine. The answer is – Yes .** We can control weeds in direct dry seeded or transplanted rice grown in flat or raised- bed systems of land configuration like the SRI farmers who control the weed manually or through ponded water conditions in early stages (which also alleviate iron chlorosis problems) or through use of butachlor or roundup or paraquat etc. as per situations.

The problem with SRI is of better weed control and use of organics to meet N and other nutrients on a sustainable basis for high levels of crop productivity and more dry matter retained in stem and sheath portions ( Chinese report) . It is also apparent that there are several other means available to us for weed control such as use of mulch as is done in Kakulam method of rice cultivation ( see LIESA, 1997) in SrLanka. Farmers