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Experiences with System of Rice Intensification (SRI) in Cambodia

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Rice production in Cambodia, like in many other countries of the region, dominates the agricultural sector. Rice farming provides food, income and employment for about 77 % of the Cambodian population. However, yields of rice production with an estimated average of 1.9 t/ha are among the lowest in the South-East Asia region. Furthermore, about 89% of national rice production (89% of 4,041 tons in 1999) is largely the result of only one rain-fed crop per year. Under the Pol Pot regime, many irrigation canals were dug with huge amount of human labor. Many of them never functioned, because they were designed on the map not considering the actual situation in the field. Consequently the area under irrigation is still small in the national context.
To date national rice production relies on the wet season crop, which is cultivated between May to October. Apart from rainfall, the wet season rice crop in most parts of the country depends upon the floodwater from the Mekong river and the great Ton Le Sap lake. Flood levels higher than normal destroy large areas of rice crop like in the year 2000. With these natural conditions it is not uncommon to have flood and drought problems at the same time in different parts of the country. Farmers try to adapt to this rainfall and flood pattern by combining as much as possible short, medium and long-term varieties, so that they can possibly get two crops out of the wet season. Farmers traditionally use the great number of local varieties, including glutinous rice varieties. At the same time, recent development efforts resulted in a wide spread use of improved high yielding varieties,

Increasing rice production in Cambodia is an explicit goal of many development efforts from international and national projects during the last decade. The approaches to increase rice yields focus on the identification and dissemination of improved varieties, recommendation of correct fertilizer application, as well as on Integrated Pest Management (IPM). Although a substantial increase of yields can be observed in certain locations, a breakthrough on national level rice production cannot yet be acknowledged.

It is therefore not surprising, that since 2000, an increasing number of Cambodian farmers started to practice the system of rice intensification (SRI), which was originally developed in Madagascar. SRI entails rather unconventional cultivation practices, especially in plant and water management. SRI can be called a system rather than a technology. Thus in comprises of 5 major elements, that are early transplanting, transplanting one seedling only, transplanting with wider spacing, frequent weeding and no standing water during vegetative growth. Little is known yet with regard to underlying scientific explanations, but there seems to be evidence, that root system and the aeration of the soil has a positive effect in exploiting the rice plant's potential for tillering and grain production. A lot of the scientific evidence has yet to be established, but the experiences with SRI from more than 15 countries are very convincing.

Research questions focus on better understanding the positive and striking experiences. One has to kook into the elements of SRI separately, even though the ultimate success might lye in the combination of different elements of SRI. The important elements of SRI are:

Transplanting young seedlings

Following SRI recommendations seedlings should be transplanted at the age of 8-12 days. This is very much earlier than traditional practice, where the seedling is normally 1 month old or even more. Early transplanting is probably one of the single most important practice in SRI, but it is at the same time very difficult to adopt by the farmers. Although the results are convincing, farmers are not seldom laughed at by their neighbors, when applying this technology, especially in combination with transplanting one seedling only.

Fast and careful transplanting

Successful early transplanting should go hand in hand with a fast and careful transplanting. The root of the seedling should be exposed to the air and sun for a minimum of time, in order to minimize trauma to the root system during transplanting. Fast transplanting is normally not a problem, but it is much easier to achieve, if the nursery plot is close enough to the transplanted field. Seedlings should not be out of the soil for more than 30 minutes, better 15 minutes only. There are SRI farmers who grow their seedlings in bamboo frames near the house, so that they can carry the seedlings to the field and uproot them directly at the time of transplanting.

No of seedlings transplanted per hill

Transplanting one seedling per hill is one of the most popular single element in trying SRI. Although at the time of transplanting the one and sometimes very young seedling doesn't look promising for the farmer at all, the tillering achieved in this way is convincing. This one young seedling produces easily 50 tillers and more. To be on a safer side, many SRI farmers transplant 2 seedlings. There is enough evidence, that 3 or more seedlings per hill reduces growth due to competition (Uphoff and Fernandez, 2002).

Spacing of transplanted seedlings

Another important aspect of SRI is the spacing of transplanted seedlings. A wider spacing that traditionally practices is recommended. High yields have been obtained with spacing of 50 x 50 cm between seedlings. The spacing of seedling also depends on the soil type. The poorer the soil, the narrower the spacing could be. In very poor soils spacing can be 20 x 20 cm only, Many SRI test farmers try starting with a spacing of 30 x 30 cm.

Water management

To follow complete SRI recommendation, ideally water should be drained out from the field daily and fed back the next day. This SRI recommendation is probably the most difficult to follow under rain fed conditions. This requires adding water to the field daily. Hardly any farmers in rain fed areas have the possibilities and resources to practice this recommendation. The positive effect from this method is regular aeration of the soil and the root system. If a daily system cannot be practiced, a non-flooding should be practiced during the vegetative growth period. There is

a clear need of further research, as to how these different flooding techniques respond to the different soil types.

Weeding

The lower amount of water recommended under SRI, results in more weeds to grow. Therefore more weeding is required. The higher amount of labor is one of the most criticized SRI aspect. One way to reduce weeding efforts is the transplanting in rows, allowing the use for simple tools for weeding. On the other hand, the weeding also increases aeration of the soil, which is an important aspect in the SRI concept.

Soil and nutrient management

SRI works with chemical, natural and without fertilizer. Nevertheless it seems to work best with natural fertilizer such as compost. In any case, fertilization seems necessary not to deplete the soils in the long term. Kind and amount of fertilizer application depends not only on the soil type, but also on variety of seed used. While local varieties respond well to natural fertilizer, improved seed varieties often produce highest yields in combination with chemical fertilizer.

Land preparation

Proper leveling of the land is not only important with SRI, but even more crucial, because of the special water management required. So the may-be the labor requirement for leveling shouldn't be attributed to SRI only!

The system of rice intensification (SRI) is recently being experimented in many countries all over the world. Most of the tests aren't always scientifically designed, but nevertheless the results reported are very encouraging. The following table gives a summary of some of these reports.

Table 1. SRI Results reported from different countries (data adopted from Norman Uphoff, personal communication, 2002)

Country	**Average SRI yield (kg/ha)**	**Remarks**	**Source**
Bangladesh	6,400	Station and field trials from 3 different areas	CARE and Dept. of Agric. Extension
China	> 10,000	Field trials from 3 different areas and seasons	Agric. Universities and Nation. Hybrid Rice Center
Gambia	6,000	First season trials	Nat. agric. Research Ctr.
Indonesia	7,600	Yields in 1999 and 2000	Agency for Agric. R&D
Indonesia	5,750	First season yields	IPM program CIAMIS

Indonesia	11,623	Trials in West Timor 2001	ADRA communication 2002
Ivory Coast	5,000	Trials in wet season 2000	WARDA
Madagascar	8,000	Average of multiple ongoing programs	Association Tefy Saina
Madagascar	10,300	Factorial trials	University of Antananarivo
Philippines	5,000	Yields 2-3 times increased	University of Philippines, Los Banos
Sri Lanka	10,000	Yields from growing number of farmers	Ministry of Lands Nature farming Center
Sri Lanka	11,500	More than 2,000 farmers trained in SRI	
Thailand	5,000	Initial trials	Chiang Mai University

Farmers in Cambodia started to practice SRI or parts of it since about 3 years. The Rural Development Project in Kampong Thom, Cambodia, also encouraged farmers to try rice cultivation following the SRI principles. During the wet season 2001 twenty farmers successfully completed a trial plot using SRI principles. None of the farmers practiced all of the recommended elements yet, but all of them transplanted one seedling only. Age of seedling at transplanting ranged from 12-18 days. Spacing of seedlings were not recorded, but was around 30 cm. The results of the Kampong Thom farmers are shown in table 2.

Table 2. Yields of SRI plots during wet season 2001 in Kampong Thom province

Parameter	**Total**	**Average**	**Min**	**Max**
No of villages	**19**			
No of farmers	**20**			
Plot size (ha)	**5.7**	**0.3**	**0.003**	**1.0**
Yield (kg or kg/ha)	**16,362**	**4,140***	**1,920**	**14,400**
Yields for plot size class	**No of plots**			
< 0.1 ha (kg/ha)	**7**	**5,879**	**2,600**	**14,400**
0.1 - 0.5 ha (kg/ha)	**8**	**4,066**	**2,571**	**7,500**
< 1 ha (kg/ha)	**5**	**2,264**	**1,920**	**2,400**

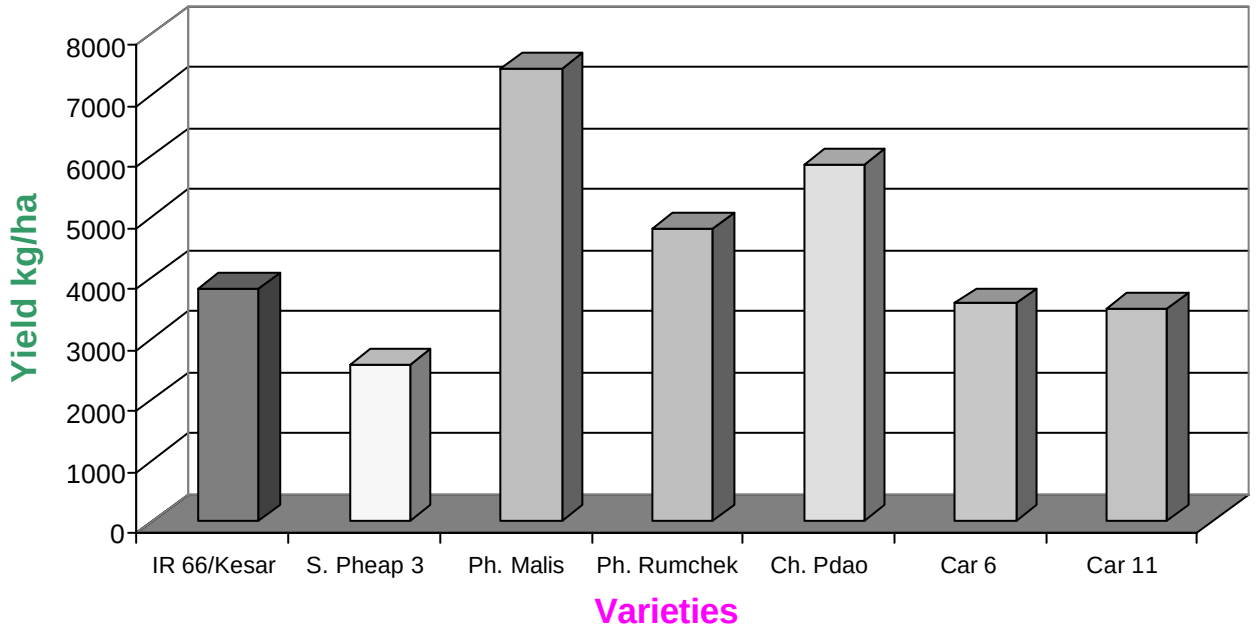
* The average yield is based on estimated ha yields from the actual plot yields

The results show a significant increase over the national average rice yield of 1,900 kg/ha, although the lowest yield is hardly above this figure. From the above table it becomes evident also, that the highest per hectare yields were achieved on very small plot sizes. This points to the increased labor intensity for SRI cultivation, which is probably easier realized on smaller plots. More investigations are currently planned to show similar yield increases also on larger SRI plots. Furthermore one should not only look at the ultimate yield, but also that the yield increase results from a significant higher number of tillers and panicles. Both these effects are clearly attributed to the SRI recommendations. In the ongoing wet season there are about 2000 farmers trying out SRI elements. Most of these farmers are monitored more systematically, so that more knowledge on SRI, also on larger plots will be available from Cambodia soon.

Another factor influencing the results of SRI practices are related to the varieties. The following graph shows the results of the SRI plots according to varieties.

The graph shows, that apart from one of the traditional local varieties (S. Pheap 3) all others showed higher yield increases with SRI, when compared with the improved varieties, such as IR66, Car 6 and Car 11. Although the database is very limited, it underscores the recommendation, that the response to the SRI cultivation practices is most favorable with local varieties. However, one should not draw this conclusion without looking at the type of fertilizer application in combination with the variety used.

Graph 1. Result of SRI demonstrations in rainy season 2001 (n=20)



To summarize the observations from SRI experiences, one can highlight the following advantages and disadvantages.

The most obvious advantage from SRI appears to be the yield increase. They have been reported to be from 50% to 200%. Yields of 4-8 tons/ha are common, but often can exceed 10 tons/ha. The higher yields correspond with an overall increase in factor productivity, especially to labor, land, water and seed. Although the SRI is more labor intensive, the higher yields usually outscore the higher labor requirement for higher returns to labor. The return per unit of land is of special interest for farmers producing rice for subsistence. They usually own land less than 1 ha, and if they need less land to produce rice for the family, the remaining land can potentially be used for other food or cash crop production. Water is another important factor in rice production. With SRI up to 50% of water could be saved. However the crucial aspect here is the control of water, which is often not the case under rain-fed agriculture conditions. Using SRI recommendation requires significant lower amount of seed rice. While traditionally 50 kg or 60 kg of seed rice are being used per hectare, only 5-10 kg/ha are used with SRI. This also makes use of improved seed for farmers much cheaper. Overall the requirement for purchased inputs is lower, yet giving the farmer a higher income. Under certain conditions, the environmental beneficial production due to lower purchased inputs, can even be combined with higher prices of sale from organic or traditional rice.

On the other hand there are number disadvantages or critical aspects to be discussed with SRI. Foremost the increased labor requirement is critical. Often additional labor is not available on farm, and if available, the opportunity cost for the additional labor might not be in favor for SRI. Both, main labor requirements for transplanting and weeding, are largely performed by women. In this respect, SRI needs be screened carefully, as to what extent it might cause extra burden specially for women. SRI does not only demand more labor, but also greater skills from the labor, for example for transplanting. Once certain skills are acquired, transplanting might not take much more time units of labor compared to traditional transplanting. Another important constraint is the required water control. Most farmers producing under rain-fed conditions do not have this water control, and therefore farmers might get less or little benefits from SRI practices. On the whole, SRI demands a drastic change of traditional rice farmer practices. This is certainly a constraint for quick adoption of SRI, but at the same time a challenge for researchers and extension workers in this field.

Overall the approach seems promising enough to promote it among many poor farmers in rural rice cultivating areas, as a better option to improved varieties and fertilizer recommendations only. Further research and experiences are needed, and should be distributed through the web-site http://ciifad.cornell.edu/sri/.

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