PARDYP's Experience on System of Rice Intensification[1]

People and Resource Dynamics Project (PARDP-ICIMOD)

1. Background

People and Resource Dynamics in Mountain Watersheds of the Hindu Kush Himalayas Project (PARDYP) commenced in October 1996 and is funded by SDC/IDRC/ ICIMOD. This project is implemented in five watersheds: two in Nepal namely Jhikhu and Yarsha Khola, one each in India, Pakistan and China namely BhetaGad Garur Ganga, Hilkot-Sharkul and Xi Zhuang respectively. In June 2001, project activities in the Yarsha Khola watershed were suspended due to security problems.

The project activities range from agronomic and horticultural initiatives, socioeconomic and market studies, rehabilitation of degraded lands and forests, soil fertility studies, participatory conservation activities to water and erosion studies. PARDYP has the following four main expected results: -

1. Option for improved farming systems productivity are developed and tested
2. Options to increase productivity of agricultural land are tested and dissemination
3. Water management options for equitable access are identified, tested and disseminated
4. Options and approaches to impact sustainable and equitable access to water land and forests are identified and disseminated.

Under expected result in testing and dissemination of the options for improved farming systems productivity, PARDYP has been testing the SRI since 2002 in JKW.

Jhikhu Khola Watershed

Jhikhu Khola watershed is located at Kabhrepalanchok District at the central middle hill region in Nepal at about 45 Km east from Kathmandu. It covers an area of 11,141 ha. This watershed represents humid sub-tropical agro-ecological zone with a distinct dry period between November to January and very wet monsoon characterized by high intensity long duration rainfall between June to September. The elevation ranges from 750 – 2,050 meters and is characterized by high vertical relief, steep slopes, and shallow soils.

About 25% of the watershed area has slopes greater than 50%. Agriculture land consists 54.8 % of total lands, whereas forest, grassland and shrub land consist 29.8, 5.5 and 7 percents of the total land. Similarly, other land use consists of 2.9 %.

Table 1. Land use characteristics (1996; Shrestha 2005)[2]

Watershed	Total area in ha	Irrigated land in %	Rainfed land in %	Forest in %	Grassland in %	Others in %	Shrubland in %
Jhikhu Khola	11141	16.5	38.3	29.8	5.5	2.9	7.0

Median land holding per household 0.56 hectare, whereas median irrigated and rainfed agriculture land holding per household are 0.36 and 0.15 hectare respectively. (PARDYP Livelihood Survey, 2005, unpublished).

[1] Report prepared for the "Exchange Workshop on SRI" organized by PARDYP-ICIMOD on 19 December 2005, Lalitpur. The research is conducted by the PARDYP in collaboration with the Spices Crop Development Center, Kavre.

[2] Bhuban Shrestha, 2005. Population dynamics in the Jhikhu Khola watershed. Unpublished Document. People and Resource Dynamics Project, ICIMOD.

2. Objective

Main objectives were to carry out SRI feasibility test studies in the middle mountain of the HKH, especially in the Jhikhu Khola Watershed and to observe the farmer's perception.

3. Methodology

3.1. Approach:

PARDYP started testing SRI in the Spice Crop Development Center (SCDC) at Tamaghat at pilot scale in 2002. As the result was positive, the technology was expanded to 6 and 24 farmer's fields in 2003 and 2004, respectively. Interaction programmes were also organized to share the results and experiences among farmers. Based on the farmer's interest and in order to promote the SRI systematically, PARDYP organized focus group discussion, farmers to farmer visits and farmer's field school. In 2002 and 2003, programme focused on individual farmers. 2004 onwards emphasis shifted to research with groups of farmers rather than with individuals. In this approach lead farmers were selected and trained as SRI trainers. These served as facilitators for conducting village level farmer's field school (FFS) to test and promote SRI. In 2005, SRI related farmer's field schools were established in 15 villages, covering about 100 farmers. In each school, a group of farmers implemented, observed, studied and analyzed the SRI results and compared them with traditional method (TM). In addition to the FFS, 20 individual farmers of JKW tested SRI in 2005.

3.2. Design

Observations were carried out in plots of upto 2 ropanies (1 ropani = 508.7m^2), with crop spacing of 25cm x 25cm and 50cm x 50cm. Testing was done under rainfed condition and with irrigation in case of dry spells. Generally 10-15 old days seedlings were used. SRI was tried with different varieties of monsoon rice. Full dose (NPK:100:30:30) chemical fertilizer and half dose (NPK::50:15:15) chemical fertilizer with half dose compost (3 tons per hectare) were applied. In one case rice was intercropped with soyabean.

4. Results

4.1 **On-station research**: At Tamaghat's SCDC research station, the effect of SRI on Makawnpur-1 rice variety was evaluated in the years 2002-2004. In 2002, the rice yields in SRI and traditional plots was 10 tons / ha and 8.25 ton/ha respectively. In 2003, the yield in SRI plots was the same as in 2002 (i.e. 10 tons/ha) it was about 25% more compared to the traditional. In SRI plots with soyabean intercropping, an additional 666 kg/ha of soyabean was harvested in 2003 (Table 2).

In 2004, in SRI plots with different treatments (Table 2) yield was increased by 6-23 %, with the maximum grains recorded in the plot that was irrigated in dry spells and applied with the full dose of chemical fertlisers (compared to TM). However, in rainfed plots the yield increase was only 10%. Combining irrigation in dry spells with half dose of chemical fertilizer resulted in a yield increase of 11 %. In the case of 50cmx50 cm spacing, the rice yield was 20 to 33 % less compared to the TM. Table 2.

Table 2. On-Station (SCDC) SRI Results (2002-2004)

Year	Method	Average Tiller		Production (dry weight 12-14% moisture in grain)		Remarks (Grain yield increased compare to traditional method in %)
		No	Height (cm)	Biomass (t/ha)	Grain (t/ha)	
Site	SCDC, Tamaghat, 880 m Makanwpur-1, Design: 25cmx25cm					
2002	TM	16	93	13.7	8.25	
	SRI	28	114	13.7	10	21
Site / Treatment	SCDC, Tamaghat, 880 m Makanwpur-1, Design: 25cmx25cm SRI-1: Irrigated weekly and mechanical weeding SRI-2 Soyabean inter-cropped, irrigated weekly and mechanical weeding SRI-3 Rainfed, no supplementary irrigation and drainage provided to avoid water logging					
2003	TM	11	102	9.7	7.9	
	SRI-1	22	104	11	10	26.5
	SRI-2	20	108	11.3	9.9	25.3% with 666 kg/ha dry soybean)
	SRI-3	24	106	10.8	10.1	28
2004	SCDC, Tamaghat, 880 m Makanwpur-1					
Site / Treatment	SRI-1	25*25 cm, Rainfed, Recommended dose				
	SRI-2	25*25 cm, Rainfed, Half of recommended dose + compost				
	SRI-3	25*25 cm, Soyabean intercropped, Rainfed, Recommended dose				
	SRI-4	50*50 cm, Rainfed, Recommended dose				
	SRI-5	25*25 cm, Weekly irrigated in dry spell, Half of recommended dose + compost				
	SRI-6	25*25 cm, Weekly irrigated in dry spell, Recommended dose				
	SRI-7	50*50 cm, Weekly irrigated in dry spell, Recommended dose				
	TM	18.3	106.9	9.0	7.0	
	SRI-1	16.1	68	6.9	7.7	10
	SRI-2	17.7	83.3	7.4	7.4	6
	SRI-3	18.3	91.9	6.8	8.1	16 % yield increased and 200 kg dry soyabean/ ha
	SRI-4	36.2	86.4	6.9	5.6	20
	SRI-5	17.2	75.3	7.5	7.8	11
	SRI-6	16.3	78	11.8	8.6	23
	SRI-7	35.9	83.4	7.4	4.7	33

4.2. On-farm research: The results of SRI on-farm research plots are given in Tables 3. In 2003, yields in the SRI plots with different rice varieties was 10 to 57% more compared to those recorded in the traditional plots. The highest yield increase of 57% was recorded for the Naya Parwanipur rice variety, followed by 54 % for Panta 10.

In 2004 the yield increase in SRI plots varied from 2 to 67 % (Table 4). This variation was found between and within the tested varieties. In case of Makwanpur-1 variety, 6% yield increased was observed; the yield increase in case of Parwanipur varied from 2 to 45 %; and in Japanese Mansuli it varied from 9 to 67%.

In 2005 the yield increase in SRI plots varied from 8 to 93 %. The highest yield was recorded in Markwanpur-1 and followed by Japanese Mansuli variety. In case of parwanipur variety yield varied from 14 to 38 %. Table 5.

Table 3. On-Farm SRI Results 2003

Year	Description			Average Tiller		Production (dry weight 12-14% moisture in grain)		Remarks (Grain yield increased compare to traditional method in %)
	Method	Altitude	Variety	No	Height (cm)	Biomass (t/ha)	Grain (t/ha)	
	Panchkhal valley, 850m amsl							
Farmer 1	TM		Makwanpur-1			9.1	8	31
	SRI			39	115	12.8	10.5	
Farmer 2	TM		Naya Parwanipur			9.6	8.1	28
	SRI			18	109	11.7	10.4	
	TM		Naya Parwanipur			8.3	5.6	57
	SRI			27	99	9.4	8.8	
Farmer 4	TM		Malika			4.8	4.9	45
	SRI			21	91	5.2	7.1	
Farmer 5	TM		Malika			10.8	6.1	10
	SRI			29	101	11.1	6.7	
Farmer 6	TM		Panta 10			9	4.8	
	SRI			24	88	11.5	7.4	54

Table 4. On-Farm SRI Results 2004

Year	Description			Average Tiller / Panicle			Production (dry weight 12-14% moisture in grain)		Remarks (Grain yield increased compare to traditional method in %)
	Method	Altitude in meter amsl	Variety	Total No	Fertile No	Panicle Length (cm)	Biomass (t/ha)	Grain (t/ha)	
Lamdihi	SRI	850	Mankawanpur-1	20	19	19	12.5	7.12	
	TM			8	7		11.5	6.7	6
Kubinde	SRI	860	Parwanipur				8.5	8	
	TM						5.5	5.5	45
Patlekhet 1	SRI	1200	Parwanipur	11	9	19	4.7	5	
	TM						4.7	4.9	2
Dhotra 1	SRI	850	Parwanipur				6.5	5.9	
	TM						3.5	5.3	11
Dhotra 2	SRI	840	Japanese mansuli				7	6.6	
	TM						8.5	5.3	25
Kalchhe 1	SRI	875	Japanese mansuli	33	23	21	9.4	7	
	TM						9.4	6.4	9
Kalchhe 2	SRI	875	Japanese mansuli	35	23	20	4.48	7.13	
	TM						6.95	5.8	23
Patlekhet 2	SRI	990	Japanese mansuli	13	12	20	7	5	
	TM						7.5	3	67
Kalchhe 3	SRI	875	Japanese mansuli	20	16	19	7.5	7.8	
	TM						7	5.8	34
Kalchhe 4	SRI	865	Japanese mansuli	12	11	20	4.7	7.4	
	TM						4.6	5.2	42
Patlekhet 3	SRI	1150	Japanese mansuli	14	13	18	4.4	2.8	
	TM						4.8	2.5	12

Table 5. On-Farm SRI Results 2005

Year	Description			Average Tiller			Production (dry weight 14% moisture in grain)		Remarks (Grain yield increased compare to traditional method in %)
	Method	Altitude in meter amsl	Variety	Total No	Fertile No	Panicle length (cm)	Biomass (t/ha)	Grain (t/ha)	
ToT plot	SRI	820	Mankawanpur 1	26	25	18	13.5	8.3	93
	TM			14	13	16	5.3	4.3	
ToT plot	SRI	820	Parwanipur	28	27	27	14.7	6.8	28
	TM			16	15	16	10.7	5.3	
Dhotra group	SRI	840	Parwanipur	16	15	19	11.7	4.0	14
	TM						8.5	3.5	
Baluwa group	SRI	800	Parwanipur	20	19	18	5.6	4.3	16
	TM						4.1	3.7	
Pipaltar group	SRI	820	Parwanipur	30	28	17	9.9	4.6	35
	TM						5.2	3.4	
Hokse group	SRI	850	Parwanipur				10.2	5.5	22
	TM						8.2	4.5	
Patalekhet –8a group	SRI	1100	Parwanipur	11	10	16	3.6	2.2	38
	TM						3.4	1.6	
Ampghari group	SRI	860	Parwanipur				7.4	6.3	17
	TM						7.3	5.4	
Madyapur group	SRI	950	Parwanipur						*
	TM								
Bela group	SRI	1185	Parwanipur						Yield was not recorded.
	TM								
Kalchhe group	SRI	880	Japanese Mansuli.	14	12	18	5.5	6.6	74
	TM			11	10	16	4.3	3.8	
Chiuribot group	SRI	1100	Khumal 4	15	14	20	9.5	6.0	36
	TM						5.1	4.4	
Patlekhet-8b group	SRI	1250	Khumal 4	14	13	19	3.3	3	
	TM								
Patalekhet –4 group	SRI	1200	Jharuwa Mansuli	16	15	22	5.5	3.8	23
	TM							3.1	
Dhungana besi group	SRI	830	Chaite 4	9	8	18	1.95	0.54	
	TM								
Kharelthok group	SRI	860	Chaite 4	18	15		10.1	10.0	8
	TM						9.0	9.3	
Kabhre group	SRI	910	Anadhi						*
	TM								

* Due to late rain, transplanting was carried out late and fruiting did not take place. Therefore data was not collected at the harvest.

SRI in the Jhikhu Khola Watershed has proven to be a potential agronomic option to grow rice in the Middle Mountain, especially under the control irrigation management. However, the increase in the production does not seem to be as promising as reported in some of the literatures as multiple of 2 or 3 times.

5. Problems with SRI

In SRI rice is grown without flooding, except during the flowering period. Therefore, weeds grew extensively and the first weeding was very labor intensive. It was difficult to carry out first weeding operations. Since the weeds will be very tender (first ten days) it breaks when weeding without uproot completely. However, the labour required for subsequent weedings in SRI plots was about the same as that for the TM plots.

SRI requires keeping the field alternatively moist and dry. This needs regulating irrigation, which was practically difficult in situations where irrigation facilities were uncertain. Under monsoon condition and in waterlogged area, drying the field was also practically difficult.

Transplanting 8-12 days young seedlings, especially under rainfed condition, was also practically difficult. Seedlings became old and unfit for transplanting when there was no rain during the transplanting time. Many JKW farmers had to prepare nursery 2-3 times in such situations.

Transporting delicate seedlings from the nursery beds to the field required extremely careful handling and proper skills. Therefore, in the beginning the farmers had difficulty implementing this activity. However, in the following years they learned to do by raising seedling in dry seed bed so that they could remove the seedling along with patch of soil without disturbing the roots by using trowel / spade.

6. Farmers' Perception

Farmer's perception plays an important role in the promotion of the technology. Since 2002, PARDYP is promoting SRI in the Jhikhu Khola watershed by establishing observation plots, in cooperation with the Spice Crop Development Center, Tamaghat, and through farmer's field school. Farmers have developed affirmative perception on the SRI. PARDYP carried out farmers' perception survey in 2005. Detail of the survey is given in Annex 1. Following are some of the main findings:

- Compared to traditional method, SRI requires only 25 % of seeds, required 50% less labor for transplanting; 50-60% less labor for irrigation and less use of pesticide. This was considered as advantageous for a smallholder farmer. But, first weeding was difficult and cost for weeding was more by 50-60%. The cost of fertilizer and harvest remained same.
- About 40-50% increase in grain and 20-25% increase in biomass production in the SRI. Generally overall expenditure was either the same or slightly less for growing rice with traditional or SRI methods but SRI gave more yields. Therefore, increase in yield (biomass and grain) was the net benefit.
- Farmers perceived that SRI consumed 50 to75 % less water compared to TM. Therefore, SRI reduced frequency of irrigation, conflict among irrigation water users and riser failure caused by the stagnant water.
- Generally 15 days old seedling is better and spacing depends on location and soil condition but in general 30 cm in lower altitude (BESI) and 20 cm in higher altitude (LEKH).

7. Future Research Recommendations

7.1. Water requirement:

One of the main principles of the SRI is to dry and wet the land rather than continuous flooding. The gaps between dry and wet and the amount of the irrigation water to be used to wet the land for better production is not fully known. Therefore, research on the amount of water and watering frequency need to be researched.

7.2. Soil nutrient uptake

More production definitely means more nutrients uptake from the soil. Nutrient uptake status from the soil with each harvest is the area to be researched so that amount of fertilizer or compost to be used will be known to sustain the high production in perpetuity.

PARDYP used full dose (NPK: 100:30:30) chemical fertilizer and half dose (NPK::50:15:15) of chemical fertilizer with half dose of compost (3 tons per hectare). Full dose chemical fertilizer has shown more increase in the yield but because of limited number of plot the result cannot be generalized.

7.3. Mosquito Breeding
Water logging is favorable condition for the mosquito to breed resulting more malaria and Japanese encephalitis. Malaria and Japanese encephalitis time and often became an epidemic in Nepal especially in Terai. Therefore, effects of SRI in reducing these diseases need to be explored.

7.4. Variety
PARDYP experienced different yields in various varieties of the paddy. However, the increase in yield from different varieties is yet to be statistically proven. Therefore, future research must be devoted to the variety so that proper policy and strategies could be formulated to promote the SRI in order to safeguard the country's food security.

7.5. Upland rice
Rice is one of the important staple foods in Nepal. Upland rice is also grown in the country. Since flooding is not required for growing rice with SRI technique. Sloping land could also be potential area for growing rice. Appropriateness of SRI in the sloping agriculture land is to be researched.

7.6. Spacing
PARDYP tested SRI with spacing 25cmx25cm and 50cmx50cm, and 25cmx25cm showed more yield than 50cmx50cm. However, it has not been verified statistically. Different spacing for better production is yet to be confirmed.

7.7. Age / Number of seedling
PARDYP generally used 10-15 days old seedlings. Generally one seedling per hill was adopted. Age of the seedlings and number of seedlings in each hill need to be researched and statistically verified for the better outreach strategy.

8. Conclusion
SRI in the Jhikhu Khola Watershed has proved to be a potential agronomic option to grow rice in the Middle Mountain. This has proved to be an appropriate technological option especially under the control irrigation management. However, research on the water requirement, fertilizer management, best variety, optimal spacing and number of seedling per hill yet to be conducted to understand fully the chemistry of the SRI.

SRI is recommended to integrate in the national agriculture strategy to ensure food security of the country especially where the water is a constraint and where mosquito is a problem.

Annex 1. Farmers perception on SRI

Madhav Dhakal

PARDYP conducted a survey to assess the farmers' perception. Structured questionnaire survey was conducted to 15 lead farmers and using same questionnaire focus group discussion was conducted in 3 groups consisting of 4 to 5 lead farmers after 2005 harvest. The overall perceptions of the farmers are presented as follows: -

How you feel the SRI technique?

SRI is a scientific technique of growing rice without any additional material, labor and cost. SRI gives more production (biomass and grain), saves seeds and produces bold grains.

Comparative analysis of cost between TM and SRI Method?

Compared to traditional method, SRI requires only 25 % of seeds, requires 50% less labor for transplanting, 50-60% less labor for irrigation and cost of pesticide is less. However, cost for weeding is more by 50-60% and cost of fertilizer and harvest remain same.

What are the major differences between TM and SRI Method?

Compared to traditional method, weeding and water control is difficult in SRI. Number of tillers, diameter and depth of root are two times more and there is less insect and diseases attack in case of SRI.

What are the major reasons for the difference in production?

More production in the SRI due to vigorous root growth and more nutrient uptake because of planting young seedlings at wide spacing and good air circulation on the field because of cracking caused by drying.

How much more is the average increase in grain production?

Farmers feel 40-50 % increase in grain production in SRI compared to traditional method.

How much more is the average increase in biomass production?

Farmers feel 20-25 % increase in biomass production in SRI compared to traditional method.

What are the difficult aspects of SRI?

First weeding and water management (timely irrigation and drying of the land) are difficult aspects of the SRI. While transplanting young seedling first time, maintaining the spacing and handling young seedling are difficult.

Do you have any alternative method of weeding?

No except manual weeding. Herbicide doesn't work in the dry and moist field condition.

What and when are the risks if field cannot be moisten in short of irrigation?

Production risk is significant when land cannot be irrigated after first weeding, flowing and fruiting stages.

How difficult is to control water during monsoon in water logging area to dry the land?

Draining the water to dry the field is difficult and it is more severe in the flat lands and during monsoon period.

What age of seedling did you find better?

Generally 15 days old seedling is better.

In future what do you prefer, Traditional method with hybrid variety or SRI with local variety. why?

Farmers prefer local variety with SRI method. Because, traditional method with hybrid variety requires more seeds, seed is more expensive, and second generation hybrid seeds cannot be used.

Do you think production will be more in SRI with hybrid seed?

No experiences, but they think production must be more.

Use of chemical fertilizer or compost: In which you think production will be more?

Farmers think that more production will be with chemical fertilizer, but if improved compost is used production must be more than in the chemical fertilizer because compost improves soil environment *(mato Khukulo hunchha)* easing ploughing.

What are the advantages of getting more tillers?

More tillers produce more grain and more straw. Therefore, more forage will be available for the livestock.

What are the difference in the productive tillers between the traditional method and SRI?

Out of total tiller 90 % of the tiller are fertile incase of SRI and only 77% in case of TM.

How do you perceive water saving in SRI compare to TM?

Farmers perceived that SRI consumed 50 to75 % less water compared to TM.

Disease and pest resistant capability of SRI?

SRI is found to be more resistant to disease and pest, because of vigorous growth as a result of less competition for nutrient and sunlight because of wide spacing.

What would be the appropriate spacing for SRI?

It depends on location and soil condition. 30 cm spacing seems appropriate in low altitude (BESI) and 20 cm in high altitude (LEKH).

What you have observed on the lodging of the rice plants?

Lodging is observed less due to longer root in SRI.

In the long run, what would you think about the soil nutrient status?

Must be same as in traditionally planted rice because rice plants get residual fertilizer from other crops, fertilizer is also added to rice plants during its vegetative period.

Can you convince others easily about SRI?

It will be easy to convince neighbors who have seen the results but not others who have not seen. Convincing through on-farm demonstration would be easier.