System of Rice Intensification (SRI) Performance in Morang district during 2005 main season

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Introduction

Population of the world is still increasing. To feed the larger number of people, food requirement is rising day by day, while the land available for food production is decreasing, due to losses for new construction and declines in soil fertility. In some areas, the world is changing from chemical-based farming to more organic farming; but still most research and development organizations are promoting chemical input-based technologies. The prices for chemical fertilizers, high-yielding seeds and pesticides are all increasing. This is cutting into farmers' incomes, and slowly agriculture is becoming a less attractive profession. Many farmers are trying to shift to other businesses. This is the situation of Nepalese farmers and in the rest of the world.

Some decades ago, Nepal was exporting food products to India and other countries. Rice was the main commodity for export, and there was a government company operating for rice export. Today we are importing food items from India and other countries in high volume. Many of our districts are food-deficit. Despite the expenditure of about 200 million rupees for food transportation and other management costs, we are unable to provide sufficient food to all those districts. Every year we read stories of hunger and food deficiency from those districts. In Nepal, rice can be cultivated in most districts except Manang and Mustang. Average rice production in Nepal is low compared with other rice-growing countries around the world. There should be potential to increase yields to provide sufficient food for our people and for the export market.

Nepal has 1.56 million hectares of land under rice cultivation, and in 2004, we produced just 4.455 million metric tons rice at the rate of 2.86 tons/ha. Out of this area, 1 million hectares have irrigation facilities. The District Agricultural Development Office (DADO), Morang and some other organizations have been trying out the System of Rice Intensification (SRI) method for rice cultivation in Nepal. This method has been showing remarkable potential to reduce hunger and food-deficiency problems in Nepal. This report gives some results of main season rice 2005 of Morang and a few other districts.

Morang, located in the eastern terai, is the largest rice-producing district of Nepal. It cultivates rice in more than 94,000 hectares and produces more than 311,000 metric tons of rice. Nearly half of its agricultural lands have permanent irrigation facilities. Its average production during recent years has been slightly more than 3 metric tons/hectare. All rice-growing Village Development Committee areas are located in the terai. DADO/Morang has been trying SRI method for the last three years. Our focus is more on demonstration for disseminating this method than on research.

In Morang district, we started SRI three years ago on a small plot, just about 100 square meters, using a handful of rice seeds (Radha 12 variety). The result of that plot encouraged us to disseminate this method to other parts of the district. In the beginning, our pace has slow, but

after we got support from CIIFAD, we could speed up our activities and expand the areas of SRI cultivation. Last year, good SRI results made DADO/Morang a successful entrant in the 2005 Nepal Development Marketplace (NDM) competition, organized jointly by the Kathmandu Office of the World Bank and the Poverty Alleviation Fund. Out of 1037 applicants, our SRI Promotion Project was one of 20 selected for funding.

As project team leader, I have the challenge and opportunity now to prove the potentials and suitability of SRI methods for our climate and conditions. I have modest funds for project activity and some experienced extension workers and innovative leader farmers to work with. The organization and management of these resources (human and capital) have achieved good results in the first season of our project.

During our first season with NDM support, we hosted various visitors from the east (Mechi) to the west (Mahakali) of our country. Among the visitors of our SRI farmers' fields were the Hon. Minister of Agriculture and Cooperatives (Mr. Badri Prasad Mandal), Joint Secretaries of the Ministry of Agriculture and Cooperatives, Directors-General of the Departments of Agriculture and Livestock Services, the Executive Director and Directors of the Nepal Agriculture Research Council (NARC), the Executive Director and board members from the Poverty Alleviation Fund, visitors from the World Bank's Kathmandu office, and several other seniors officers, technicians and farmers from different organizations and districts. Besides these visitors, we also received renowned journalists such as Mr. Kunda Dixit (editor, *Nepali Times*), Mr. Rajendra Dahal (editor, *Himal Khabarpatrika*), Mr. Charles Haviland (Nepal correspondent, BBC World Service) and several others from NTV, Kantipur, Gorkhapatra, Channel Nepal, etc.

Methodology

Our activities have been focus on demonstration and dissemination of SRI method in larger areas. At the same time we have been collecting maximum information related with this method. Most of the new farmers start SRI in a small area (like 1-2 Kathas) and after the gain some confidence the areas under this method are increased. Information has been collected by DADO extension workers and lead farmers through designed format from the field.

We recommend three spacings for transplanting: 30x30 cm, 25x25 cm, or 20x20 cm according to the crop cycle (duration) and tillering habits of the variety. Some farmers have used 25x20 cm spacing. Most farmers used seedlings within 12 days of age, but some farmers used older seedlings due to delayed monsoon. For water management, we generally used alternate flooding and drying system; in the case of clay soil, however, we recommended maintaining the soil's moisture level without drying during the vegetative stage (no stagnant water). Looser loam soil with high organic matter content can be allowed to dry up to surface cracking level 4-5 times. Fertilizer and manure doses used have been open for farmers to decide as most used same as with traditional methods. We have found 15 varieties of rice had been used with SRI methods. Information on the main varieties has been given in this report.

For yield reports from small plots, total crop harvest was measured; for larger plots, yield was calculated /from sample 5 m^2 crop cuts (2x2.5 meters), taken from 2-3 representative places. To standardize comparisons, we adjusted recorded yields to a 13-14 % moisture content; testing with a moisture meter has showed in general a 27-28 % moisture content in SRI rice.

Objectives

Basic objective of our activities are to increase rice yield of our small and marginal farmers who cultivate their land themselves. Besides this, we have some other objectives of our program, i.e.,

1. To disseminate SRI methods in a larger area of Morang and other parts of the country.
2. To acquire and evaluate maximum information related with SRI methods, and present appropriate packages of practices for different varieties and soil conditions.
3. To bring SRI method into the mainstream of agriculture development endeavors in Nepal.

Results and Discussion

In the previous year (2004), we had about 2 dozen farmers in 16 Village Development Committee (VDC) areas using SRI methods. In the early season of this year (2005), we had about 6 dozen farmers in 22 VDCs. Then in the main season 2005, with financial support from the NDM, we had more than than 1,400 farmers in 53 VDCs of Morang district, and about 100 farmers in 9 VDCs of neighboring Panchthar district participating. To evaluate performance of SRI methods, we collected data from >400 SRI farmers, and this information is presented here.

Table 1. Area under SRI methods in Morang district (2005)

SN	Category	Number	Percentage
1	<2 Kathas	35	8.5
2	2 Kathas	287	69.5
3	2.1-5 Kathas	70	16.8
4	>5 Kathas	21	5.2
Range: 1-65 Kathas **Average: 2.84 Kathas**		**413**	**100**

The System of Rice Intensification (SRI) is still new for Nepal and Morang farmers. But the number and area with SRI farming is increasing season after season, going in 5 seasons (two and a half years) from 1 farmer using the methods to 1,400 farmers in 53 VDCs, with farm size under SRI ranging from 1 Katha (360 square meters) to 65 Kathas (2.16 hectares). Generally new farmers try SRI first on a small scale, and after they have gained experience, they increase their area under SRI. Table 2 shows the varieties that farmers are using with SRI methods.

Table 2. Rice varieties used with SRI methods, Morang district (2005)

SN	Rice Variety	Number	Percentage	Average Production by SRI (Mt./ha)
1	*Bansdhan*	248	59.8	6.36 (2.5-11.0)
2	*Mansuli*	48	11.6	5.74 (3.6-9.9)
3	*Suwarna*	40	9.6	6.48 (3.5-11.0)
4	*Hardinath* 1	39	9.4	5.82 (3.6-8.4)
5	*Barse* 2014	13	3.1	5.5 (4.2-6.8)
6	*Suganda*	12	2.9	5.05 (3.0-7.5)
7	*Radha* 12	12	2.9	7.44 (5.2-10.0)
8	*Pusa* 834	1	0.2	6.0
9	*Barse* 3017	1	0.2	7.1
10	*Basmati*	1	0.2	3.9 (FP = 2.4)
		415	**100**	**Average: 6.3 Mt/ha**

Several varieties of rice have been used with SRI methods. Among them, *Bansdhan* (or *Kanchi mansuli*) was by far the most popular one in Morang district. SRI users' preference was also for *Mansuli*, *Suwarna*, and *Hardinath* (a recently released 120-day variety). Regarding average production, Radha-12 ranked first, followed by *Suwarna* and *Bansdhan*, respectively. But *Suwarna* and *Bansdhan* had the highest recorded yields, up to 11 Mt/ha. That *Radha*-12 showed the highest average yield may be due to a lesser number of farmers using this variety.

Among fine-quality varieties, the scented rices *Suganda*, *Basmati* and *Pusa*-835 produce good yield with SRI compared with farmers' practice. This shows the possibility of getting more profitability with lower-yielding but high-quality, high-priced rice. Such varieties have lodging problems with usual management practices; but with SRI, lodging problems are solved. Single seedlings have produced 21.8 panicles/hill (maximum 46 and minimum 13) with an average of 159 grains/panicle; highest average number of grains/panicle (213) in black Basmati rice.

Table 3. Age of seedlings used with SRI methods, Morang district (2005)

SN	Seedling age (in days)	Number	Percentage	Average Production by SRI methods (Mt/ha)
1	8	22	5.4	6.94 (4.0-9.0)
2	9-10	123	30.0	6.32 (3.6-11.0)
3	11-12	169	41.3	6.41 (2.5-11.0)
4	13-14	64	15.6	5.77 (3.0-9.0)
5	15 and above	32	7.8	5.52 (3.7-7.0)
Range: 8-21 days Average: 11.4 days		**410**	**100**	**Average: 6.3 Mt/ha**

SRI method generally recommends 8-12 day-old seedlings. But this year, due to a late monsoon and lack of irrigation facilities, some of our farmers have planted older seedlings while using the other SRI practices (single seedling, spaced planting, active weeding, with less water). Still, the majority of SRI farmers have transplanted their crop within the age of 12 days. Highest average production has harvested from the lesser-aged seedlings, and the lowest average was from the older-aged seedlings. The highest individual yields were achieved in the 9-12-day range due to damage of some of the younger seedlings from the heavy rain during transplanting time and because farmers didn't fill the gaps later on. From our experience, we see that if we undertake timely weeding and do good water management, we can produce improved yield from seedlings up to 15 days old with SRI methods. Besides seedling age, rice yield has influenced by weed management, organic manure, water management, soil structure, and soil fertility. The premium from using younger seedlings is quite substantial, almost 1.5 t/ha.

Table 4. Number of times of weeding by SRI farmers, Morang district (2005)

SN	Times of weeding	Number	Percentage	Productivity of SRI method Mt/ha
1	One	32	8.0	5.16 (range 3.6-7.6)
2	Two	366	88.6	5.87 (range 3.5-11.0)
3	Three	14	3.4	7.87 (range 5.85-10.4)
Average: 1.9 times		**412**	**100**	**Average: 6.3 Mt/ha**

Weeding is a very important practice for SRI method as it directly influences rice yield and earlier maturation. The average production of rice by those who used SRI methods was highest with three weedings, followed two weedings and a single weeding. The highest yield 11 Mt/ha was found with 2 weedings, due to other factors like soil quality and other management practices. That an additional weeding, going from 2 weedings to 3, added an average of 2 t/ha to yield makes this additional investment of labor very profitable.

In general we found less weed problems in soil with high organic matter content. But undertaking weed control with the rotating hoe give benefits most of the time with SRI because of its effect on soil aeration. Early weeding enhances production of more primary tillers, which ultimately produce larger panicles having more grains and giving higher yield. If weeding is begun late, then the number of weedings may not be so beneficial. If we keep our crop weed-free for the first month after transplant, weeding has a positive influence on rice yield. What is not measured and evaluated in these data is the effect that soil-aerating weeding may have on soil biota which provide numerous services to the growing rice plants. This is an area for future investigation.

Table 5. Distribution of yields from using SRI methods, Morang district (2005)

SN	Yield of SRI method (Mt/ha)	Number	Percentage
1	Below 4	21	5.1
2	4.1-5	69	16.7
3	5.1-6	107	26.0
4	6.1-7	112	27.3
5	7.1-8	64	15.5
6	8.1-9	26	6.3
7	9.1-10	9	2.2
8	10.1 and above	4	0.9
Range: 2.5-11.00 Mt/ha Average: 6.3 Mt/ha		**412**	**100**

With SRI methods, farmers in Morang district using them produced about twice as much as much rice as with usual methods in the 2005 main season. Previously these farmers produced 3.1 metric tons of rice on average with conventional methods. The range of SRI production was 2.5 metric tons to 11.0 metric tons, with an average production of 6.3 metric tons by SRI methods. The majority of SRI farmers produced more than 6 metric tons yield, and very few got less than 4 metric tons.

Table 6. Distribution of yields by using farmers' method, Morang district (2005)

SN	Yield of farmer's method (Mt/ha)	Number	Percentage
1	Up to 3	258	62.6
2	3.1-4	131	31.8
3	4.1-5	21	5.1
4	5.1 and above	2	0.5
Range: 1.8-6.0 Mt/ha Average: 3.1 Mt/ha		**412**	**100**

The range of production achieved with farmer's usual methods was 1.8 to 6.0 metric tons (Table 6). But a majority of them (62.6 %) produced under 3 metric tons and less than 1 percent of farmers (0.5 %) produced more than 5 metric tons by using farmers' method.

Table 7. Yield differences between SRI and farmers' methods, Morang district (2005)

SN	% Yield difference in favor of SRI	Number	Percentage
1	Up to 50%	27	6.6
2	51-75%	63	15.3
3	76-100%	142	34.5
4	101-125%	96	23.3
5	126-150%	64	15.5
6	151-175%	10	2.4
7	> 175%	10	2.4
Range: 11.1-205.6% Average: 99.8%		**412**	**100**

Yield differences between SRI and farmers were found to be very large. The yield difference between these two methods ranged from 11 to 205 percent, and the average was 99.8%. Only 6.6% farmers had less than 50% difference, and almost 5% farmers produced more than 150% more by using SRI method. Table 7 gives details.

Table 8. Age of seedlings and crop duration (var. *Bansdhan*) with SRI method, Morang district (2005)

SN	Seedling age (days)	Farmers Number	Average crop duration (days)	Crop duration with usual methods (days)	Earliness in maturity with SRI (days)
1	8-9	5	123.6	145	21.4
2	10-11	14	129.7	145	15.3
3	12-14	23	131.6	145	13.4
4	15 and above	9	138.5	145	6.5
		51			

Bansdhan is the most widely planted variety of rice in Morang and the eastern terai of Nepal. We analyzed earliness in maturity of rice with respect to seedling age. According to data in Table 8, we see a direct relationship between seedling age and earliness with SRI practices. Younger seedlings earlier maturing may be due to early initiation and completion of vegetative stage and entering into reproductive stage. This can be verified by research in the next season.

Table 9. Age of seedling and yields of rice by SRI methods, Morang district (2005)

S N.	Age of Seedling	Yield of rice (Mt/ha)							
		Up to 4	4.1-5	5.1-6	6.1-7	7.1-8	8.1-9	9.1-10	>10
1	8	1	1	2	6	5	6	0	0
2	9-10	5	21	34	29	25	4	5	2
3	11-12	11	18	40	54	29	12	4	2
4	13-14	2	16	22	17	2	4	0	0
5	15 & above	2	12	6	6	3	0	0	0
Total		**21**	**68**	**104**	**112**	**64**	**26**	**9**	**4**

Age of seedling is a very important component of the SRI methodology. In this study, the effect of age of seedling on the yield of rice was analyzed. The above table shows the relationship between age of seedling and yields of rice produced by use of SRI methods. A majority of farmers who used younger seedlings produced more than 6 metric tons per hectare (81.9% of those using 8-day-old seedlings, and 52.8% of those with seedlings 9-10 days old). On the other hand, a majority of those farmers who used older seedlings produced less than 6 tons per hectare. The data in the above table indicate that seedling age between 8-12 days is best for SRI methods. While older seedlings, up to 15 days, can also produce more yield compared to traditional methods, their yield improvement is generally less.

Table 10. Number of weedings and yields of rice by SRI method, Morang district (2005)

S N.	Numbers of weeding	Yield of rice (Mt/ha)							
		Up to 4	**4.1-5**	**5.1-6**	**6.1-7**	**7.1-8**	**8.1-9**	**9.1-10**	**>10**
1	1	6	5	11	8	2	0	0	0
2	2	15	64	95	100	57	26	6	3
3	3	0	0	1	4	5	0	3	1
Total		**21**	**68**	**107**	**112**	**64**	**26**	**9**	**3**

Weeding is another important operation to increase yields with SRI methods. The relationship between number of weedings and rice yield is shown in Table 10. With a single weeding, the majority of SRI farmers (68.75%) produced at least 6 tons per hectare. But with two weedings, a majority of farmers (52.2%) produced more than 6 tons yield. More impressive, most of the farmers (92.8%) doing three weedings produced more than 6 tons yield, while 28.6% of them produced more than 9 tons yield per hectare. Next season, we will encourage some farmers to do four weedings if possible, to see what further gains in yield might be possible as a result of active soil aeration.

Table 11. Age of seedlings and early maturity by SRI method, Morang district (2005)

	Age of Seedlings (in days) (N)	Earliness in maturity (in days)					
		Up to 5	6-10	11-15	16-20	21-25	>25
	8 (22)	0 (0)	2 (9)	2 (9)	10 (46)	8 (36)	0 (0)
	9-10 (123)	1 (1)	16 (13)	36 (29)	31 (25)	27 (22)	12 (10)
	11-12 (169)	5 (3)	21 (12)	44 (26)	49 (29)	38 (23)	12 (7)
	13-14 (64)	1 (1)	9 (14)	17 (27)	23 (36)	11 (17)	3 (5)
	15 or more (32)	11 (34)	6 (19)	7 (22)	5 (16)	3 (9)	0 (0)
Total		18	54	106	118	87	27

Shorter crop duration is one benefit we have found from using SRI methods. Most varieties will mature earlier with SRI than when grown with conventional methods. A majority of the SRI rice crop (81.8%) with 8-day-old seedlings matured 16 days and more earlier, and >36% of the crop matured more than 20 days earlier compared with traditional methods. Similarly, 56.9% of SRI crops with 9-10-day-old seedlings matured more than 16 days earlier. But, with older-aged seedlings (15 days and above), only 25% of the crops are matured 16 or more days earlier, while 34.3% of such SRI crops were earlier by up to 5 days. Details on this are presented in Table 11.

It is a real benefit for farmers to be able to harvest their crop sooner, reducing risks of loss or damage, and to permit earlier planting of the next crops if they can still grow something else.

Table 12. Time of first weeding and early maturity by SRI method, Morang district (2005)

SN	Time of first weeding (days)	Earliness in maturity (days)					
		≤ 5	6-10	11-15	16-20	21-25	26 & more
1	Up to 10th day	0 (0%)	3 (23%)	3 (23%)	4 (31%)	2 (13%)	1 (8%)
2	11th-15th day	0 (0%)	8 (18%)	11 (25%)	15 (33%)	9 (20%)	2 (4%)
3	16th-20th day	2 (2%)	10 (10%)	23 (23%)	29 (29%)	30 (30%)	5 (5%)
4	21st-25th day	6 (7%)	13 (16%)	24 (30%)	19 (24%)	10 (13%)	8 (10%)
5	26th day or later	8 (12%)	5 (8%)	18 (27%)	17 (25%)	17 (25%)	2 (3%)
Total		**16**	**39**	**79**	**84**	**68**	**18**

Early start of weeding has been useful for promoting early maturity and more production. In Table 12, the relationship between date of first weeding and early maturity is presented. Data indicate that early weeding enhances earlier maturation of the crop. Early weeding helps stimulate early tillering, and early tillering helps the early vegetative stage and ultimately earlier maturity in SRI crops. This can be verified through systematic research in the coming season.

Table 13. Number of weedings and early maturity by SRI method, Morang district (2005)

SN	Numbers of weeding	Earliness in maturity (days)					
		≤ 5	6-10	11-15	16-20	21-25	26 & more
1	One	1 (3%)	6 (18%)	11 (34%)	8 (24%)	6 (18%)	0
2	Two	17 (5%)	48 (13%)	93 (26%)	104 (28%)	77 (21%)	25 (7%)
3	Three	0	0	2 (14%)	6 (43%)	4 (29%)	2 (14 %)
		18	**54**	**106**	**118**	**87**	**27**

Getting more rice production from more weedings is often reported with SRI crops around the world. When using a rotary hoe, this does not only control weeds but it aerates the top horizon of the soil, which stimulates the growth of aerobic bacteria and fungi in the soil. In Table 13, we relate the number of weedings with earliness of maturity for rice crops. The data show a definite relationship between the number of weedings and earliness/short crop duration in rice crop.

With a single weeding, a difference in crop duration between SRI and traditional farming methods is observable, but not so great as when the number of weedings is increased. This could become one of the most cost-effective components of SRI practice, since normally farmers have been applying expensive fertilizer to raise yield, when with some labor and skill they could get as large or larger increments by stimulating the services of soil biota, usually suppressed under the anaerobic conditions of continuous flooding which is farmer practice.

Table 14. Number of fertile tillers and number of grains of different rice varieties with SRI method, Morang district (2005)

SN	Rice Variety	Average number of fertile tillers/hill			Average numbers of grains/panicle		
		Average	Maximum	Minimum	Average	Maximum	Minimum
1	*Bansdhan*	19.7	47	7	195.0	404	62
2	*Mansuli*	19.6	48	7	195.5	390	50
3	*Suwarna*	17.5	30	9	197.0	352	60
4	*Hardinath* 1	11.9	16	7	168.6	257	51
5	*Barse* 2014	20.0	37	9	179.5	286	57
6	*Suganda*	12.5	17	7	159.0	230	105
7	*Radha* 12	18.7	33	10	211.7	345	68
8	*Pusa* 834	17.0	22	12	149.0	200	52
9	*Barse* 3017	28.0	-	-	199.0	271	96
10	*Basmati*	21.8	46	11	158.5	213	102
		18.67	**29.6**	**8.77**	**182.3**	**291**	**70**

SRI method has found very helpful to increase fertile tiller numbers, numbers of grain per panicle. Table 14 shows the number of fertile tillers (panicles/hill) and of grains/panicle. With SRI method, we have found larger panicles, more numbers of grains, and also larger grains. From observation, we found that earlier tillering produces larger panicles and more grain numbers compared to secondary and tertiary tillers. To encourage more early tillers, early weeding has been found very useful. To verify this relationship between weeding and panicles, however, we need to conduct more systematic research in the coming season.

Conclusions

Three years of results and experience have shown that SRI methods are very useful for small and marginal farmers who cultivate their land themselves. It has reduced their need for seed, water, and pesticides while giving them more production. By using locally-available seed and other inputs, farmers can produce about doubled production from the same land with a reduction in their costs. With better management, farmers can triple their production. Besides these benefits, farmers can harvest their rice crop 15-25 days earlier, which will help them in early planting of the next crop, such as wheat, maize, oil seed, and vegetables, as well as enhance the yield from those crops as soil quality is improved.

Weed management was found to be the main constraint for SRI methods. About 20-30 more man-days of labor are necessary for SRI methods compared to traditional methods. But this will be reduced next season since if we properly manage weeds this year, the weed population in the next season is automatically reduced (due to less weed seed for germination). Besides this, some farmers used chemical control with one manual weeding to reduce labor time. Wider use of the mechanical weeder (rotary hoe) will be another means for the reduction of labor cost with SRI.

Recommendations for SRI users

Based on our experience, we can recommend these practices for farmers' application.

1. Age of seedling should be within 10-12 days for better yield and earlier harvesting. But we can successfully use seedlings up to 15 days old in this method.

2. A dry seedbed is always useful for seedling raising. Additionally, the technique of solarization will be very helpful for earlier, more vigorous and healthy seedlings.

3. Spacing of plants should be adjusted according to variety used (duration, tillering habits), soil and water management. The same spacing for all varieties and situation will not be useful. We are learning more about what is optimum spacing for different varieties. But all respond positively so far.

4. In the case of clay soil, some moisture should be maintained during the vegetative stage. With loam soil having high organic matter content, we can use the practice of wetting and drying (letting the soil dry up to cracking level) for better results.

5. Weed management in the early stage of vegetative growth has been found very useful for getting more fertile tillers as well as for more and larger grains. Farmers should keep their SRI field weed-free for the first 4-6 week after transplanting. Soil aeration during this period can stimulate soil biota which facilitate plants' nutrient access in the soil.

6. Organic matter or manure is found to be very beneficial for SRI methods, but in the case of less fertile soil, farmers should use a balanced dose of fertilizer for more yield.

Recommendations for future research

Some very interesting findings have emerged from our observations and data, such as the relationship between SRI practices and the yield and earliness of the rice crop. To verify these relationships we need to conduct some more systematic research in the coming season. Some focuses for study are as follows:

1. The relationship between seedling age at transplanting and crop yield and earliness of crop maturity.

2. The relationship between the timing and numbers of weedings and crop yield and earliness of crop maturity.

3. The relationship between application of organic manure and fertilizers and crop yield and earliness of crop maturity.

4. The relationship between water management and crop yield of SRI methods.