Meshing mechanization with SRI methods for rice cultivation in Nepal

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Abstract: *Currently rice is cultivated on 1.5 million ha in Nepal, producing about 4.5 million metric tons of rice (MOAC 2009). Nepalese rice productivity - about 3 tons ha^{-1} - is very low compared with leading rice-producing countries and lower than in most South Asian countries (IRRI 2006). While rice cultivation is very important for Nepal's farmers and its economy, high production costs together with continuing low productivity have made rice farming less profitable and less attractive in recent decades. Despite rapid population growth and considerable unemployment, in many rural areas labor shortages present an additional constraint for expanding agricultural production.*

To address some of the problems confronting rice farmers, the System of Rice Intensification (SRI) has been introduced to raise factor productivity and reduce water requirements. But even though SRI raises labor productivity, its labor requirements often limit its adoption. In this situation, labor-saving mechanization is being introduced in conjunction with SRI practices.

Farmers who have introduced mechanization into their rice farming have found that they can reduce production costs by 27% and increase their profits ha^{-1} by 36%. Those who have employed mechanization together with SRI methods have achieved 55% higher production ha^{-1} and earned 58% more profit. Mechanization with SRI methods, doubling plant-to-plant spacing and reducing seedling age by half, cuts farmers' seed requirements by 50%. Labor requirements are reduced by 60%, and the time required for all of the main rice-farming activities by 70%. Thus rice farmers in Nepal's terai could find mechanization to be a solution for labor shortages.

1. Introducing Mechanization

More than in most countries, Nepalese agriculture still depends on manual labor and animal power. Farmers presently use few machines (4-wheeled tractors, power tillers, threshers), especially for their land preparation and threshing. As a solution to labor shortages and to reduce the production costs of rice farming, Buddha Air, a private airline, has introduced mechanized rice production with a pilot project in Morang district, under the company's 'corporate social responsibility' scheme.

In the 2009 main season, 27 rice farmers associated with the local agriculture cooperative of Hattimuda Village Development Committee (VDC) undertook to test the suitability of machines on 24 hectares of land. The main machines made available to farmers were tractor-drawn land levelers, rotavators (rotary tillers), rice transplanter, and tractor-mounted combine harvesters. Farmers paid rent when using the machines in their farming operations. The charges per hour for tractor-drawn harrow, cultivator, and rotavator were, respectively US$9, 9, and 10. Rents for the transplanter and combine harvester were US$ 28 and 60 per hectare. The rent of machines as fixed includes the cost of machines, operational costs, repair-maintenance, and depreciation.

This report is based on information collected from monitoring the activities and expenses of all 27 pilot farmers involved in the mechanized rice-farming program. To compare conventional vs. mechanized rice farming, some secondary data were also considered. In addition, farmers' recalled memory of their previous year's activities was elicited for some comparisons. Detailed information was collected on land preparation, transplanting, and harvesting for the mechanized rice farming to compare this with conventional practices (manual and animal-power-based practices).

This study did not compare System of Rice Intensification (SRI) methods with conventional practice as such, but rather considered the effect that mechanization combined with a number of SRI practices could have on productivity and profitability of rice production under local conditions. SRI methods were introduced in this area in 2005 and have become widely used. The evaluation here focuses on costs of cultivation, yield and profitability of rice farming, with and without machines.

3. Results and Discussion

3.1. Land sizes of mechanizing farmers

Different-sized landholdings were involved in the mechanization evaluation. The acreage of rice land cultivated by farmers under mechanization varied from 0.13 hectare to 3.67 hectares (average 0.73 ha). This variation tested the suitability of mechanization for different kinds of farmers. Details of the farm size distribution are given in Figure 1. Most of the farmers who participated in mechanization were small farmers, who put their entire rice fields under mechanized practice.

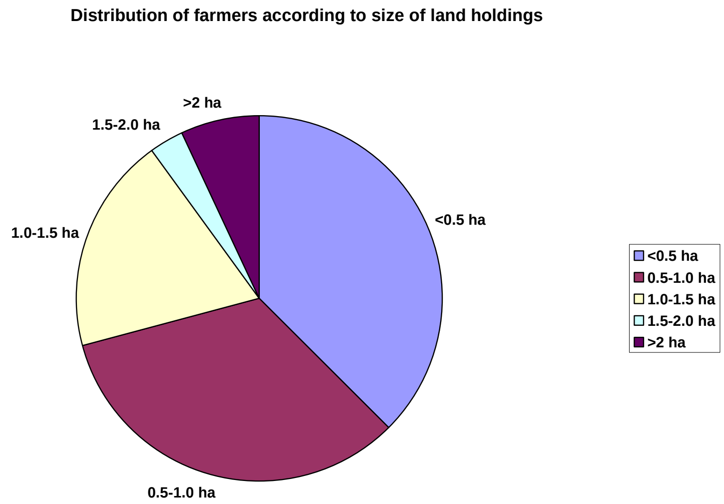

Figure 1. Distribution of farmers according to size of land holding under mechanization

3.2. Land preparation

A tractor-drawn harrow or cultivator was used for the first tilling, followed by puddling using a rotavator in the second round. Conventionally, farmers have used an animal-drawn plow 3-5 times for the land preparation. Comparison of these costs is given in Annex 1. Usually, the cost of land preparation is about 25% of total cost of rice production (Figure 2). With machines, the average cost of land preparation could be reduced by 50%. Over and above these cost considerations, mechanization greatly reduced the time needed for land preparation. With machines, a one-hectare rice field can be prepared in only 4.4 hours (range: 3.3- 5.7 hours). This is <10% of the time required previously.

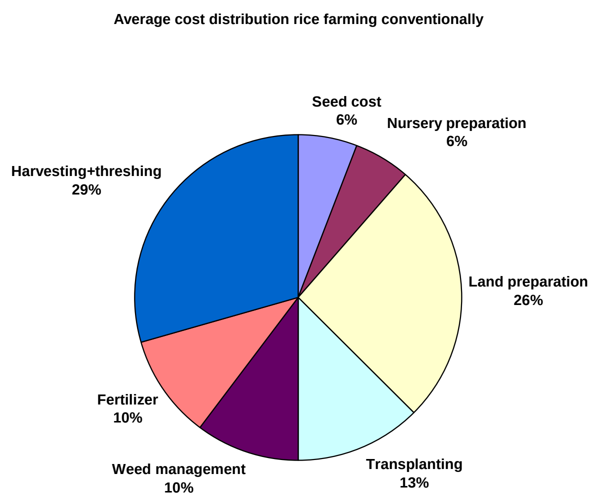

Figure 2: Distribution of average rice-farming costs

3.3. Nursery management

Nursery management cost of mechanized rice farming was more than with conventional method (US\$ 20 ha^{-1} vs. US\$ 17 ha^{-1}) due to the expense for plastic sheets used for the nursery. Seedling preparation was done on a one-inch thick soil bed put on the plastic sheet. Such seedlings are suitable for transplanting by machine. A 17% increase in average cost of nursery management for mechanized rice farming did not increase farmers' rice-production costs very much.

3.4. Transplanting

Transplanting of rice by machine was found to be cheaper and time-saving compared with manual transplanting. In Nepal, most farmers transplant into puddled fields. Puddling is a time-consuming process with an animal-drawn plow used for land preparation. Tractor-drawn harrows and rotavators make this process easier and quicker.

If sufficient water is available on the field, farmers can prepare their land within a week. In a hurry, farmers can even prepare their field and transplant rice all in the same day. This is not possible without mechanical power. With machines, the average reduction of transplanting cost was more than 30% (range: 11-59%). Besides reducing costs of transplanting, mechanical transplanting maintains regular spacing between rice plants at 30x15 cm. This made using a rotary weeder easier and further reduced the cost of weeding. With a rotary weeder, one hectare of land can be weeded by just 7-8 laborers in one day, whereas this operation conventionally requires 20-30 manual laborers.

3.5. Harvesting

Harvesting became much easier, quicker and cheaper by combine-harvester compared with manual harvesting. Comparative details of harvesting cost are given in Annex 1. Average reduction of harvesting costs was 30% (range: 17-65%). In the 2009 season, eight farmers were not able to use a combine harvester due to early ripening of their rice crops. These were farmers who had transplanted their fields earlier than the other farmers around them, so there was no way for a combine-harvester to get to and enter their fields. Their crops hus had to be harvested manually. This has prompted the project to begin planning for next season, so that all farmers can use machines for harvesting.

3.6. Yield

Average production of mechanized rice farmers was 4.8 t ha^{-1}, 15% more than last year's production with conventional methods, and 2 t ha^{-1} more than the district's average rice yield in 2009. This year the district's overall productivity for rice was decreased by 15% due to drought. Detailed yield distribution figures are given in Figure 3.

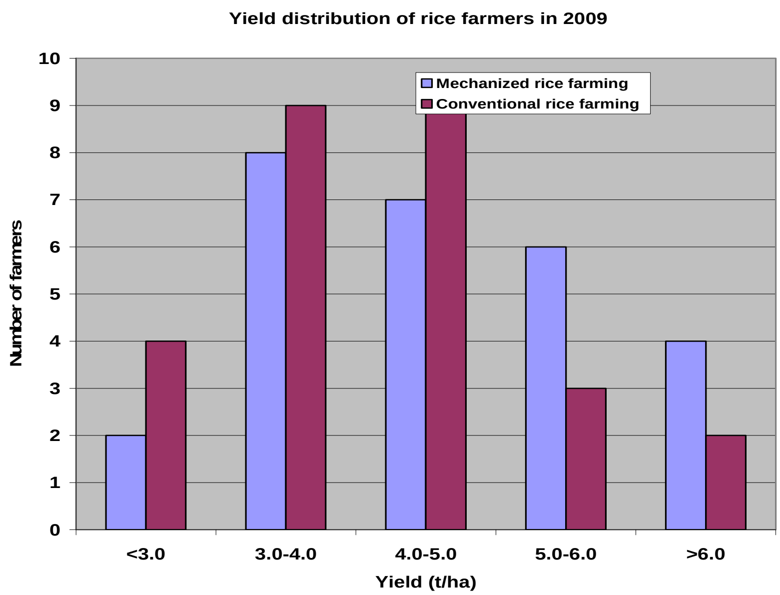

Figure 3. Yield distribution of different rice farmers

3.7 Weeding

One operation not systematically mechanized in these on-farm experiments was weeding. Farmers used mechanical and/or manual weed management on their rice fields in 2009. The 7 farmers who did mechanical weeding with a rotary weeder had yields that averaged 5.8 t ha^{-1} (range: 4.3-7.2). The 19 farmers who weeded manually had an average harvest of 4.4 t ha^{-1} (range: 2.0-6.9). One farmer who cultivated Chaite 2 rice variety with full SRI methods produced 7.5 t ha^{-1}.

Farmers reported that mechanical weeding is a real labor-saver and very effective in controlling weeds. It was also found useful for increasing rice production, although no controlled comparisons could be made. Studies in Madagascar, Mali and Afghanistan have shown the hand push-weeder significantly increasing yield compared to manual weed removal, apparently because of greater soil aeration (Thomas and Ramzi 2010).

As reported already, a number of the Hattimuda farmers were already familiar with SRI, having been regularly using these alternative methods since 2005. The average production of the 6 farmers with the most previous SRI experience was 6.5 t ha^{-1}. They reported that use of machines made their work easier, faster and better. They have been facing problems of labor scarcity during transplanting and weeding operations in their SRI fields.

Machines also made it easy to transplant seedling in lines with proper spacing, which is necessary to use a rotary weeder. Farmers were satisfied that the use of these machines while incorporating SRI components into their rice farming can enable them to achieve better yields with lower production costs.

4. Conclusions

Mechanization of rice farming can be a very effective solution for Nepalese rice farmers who are faced with labor shortages and high production costs, especially in the terai region. Mechanization can reduce the costs of land preparation, transplanting, and harvesting. Besides this, farmers can cut down on their labor costs for weeding if and when they have access to appropriate weeders at an affordable cost. Given the small size of rice farms, forms of farmer organization/cooperatives should be part of a mechanization effort to reduce the costs and risks involved.

Those farmers who are familiar with SRI methods were able to scale-up their SRI areas with some modification. The result shows that a combination of mechanization and SRI methods can bring positive changes in rice cultivation in Nepal. It will increase production and further enhance income by reducing production cost. Mechanization will be a good option to the problem of labor scarcity. Besides this, Nepalese farmers who can save valuable time by mechanization can take on other additional work for bettering their livelihoods.

References

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Annex 1. Descriptive statistics of mechanized rice farming in Morang, Nepal, 2009

Particular	N	Minimum	Maximum	Mean	Std. Dev.
Seed cost (conventional)	27	4	24	17.70	7.00
Seed cost (mechanical)	**27**	**12**	**12**	**12.00**	**0.00**
Land preparation cost (conventional)	27	45	138	80.69	18.91
Land preparation cost (mechanical)	**27**	**29**	**59**	**40.38**	**7.68**
Nursery cost (conventional)	27	7	36	17.17	7.66
Nursery cost (mechanical)	**27**	**9**	**39**	**20.45**	**8.28**
Transplanting cost (conventional)	27	29	105	46.41	15.21
Transplanting cost (mechanical)	**27**	**25**	**84**	**32.31**	**11.07**
Cost for fertilizers (both)	27	10	46.7	31.93	10.04
Weeding cost (conventional)	27	0	40	29.70	11.55
Weeding cost (mechanical)	**27**	**0**	**40**	**22.24**	**8.50**
Harvesting cost (conventional)	27	60	127	90.48	14.60
Harvesting cost (mechanical)	**27**	**38**	**90**	**62.81**	**9.91**
Crop yield last year (conventional)	27	2	6.7	4.19	1.02
Crop yield (with mechanization)	**27**	**2**	**7.5**	**4.81**	**1.38**
Production cost (conventional)	27	240	457	312.78	48.65
Production cost (mechanical)	**27**	**175**	**360**	**226.30**	**36.91**
Net-profit by conventional method	27	202	984	625.68	217.15
Net-profit by mechanized method	**27**	**300**	**1392**	**829.19**	**270.51**