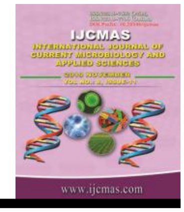
Int.J.Curr.Microbiol.App.Sci (2019) *8*(11): 1464-1482

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 8 Number 11 (2019)**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2019.811.172

Yield Evaluation of Rice through the Use of Different Machinery in Farming Practices at Agricultural Machinery Testing and Research Centre (AMTRC), Nawalpur, Sarlahi, Nepal

Ram Nath Jha*, Manish Thakur, Md. Shamshad Ansari and Sugriblal Mandal

Agricultural Machinery Testing and Research Centre (AMTRC), Nawalpur, Sarlahi, Nepal

**Corresponding author*

Keywords

Mainstay, Rice, Mechanization, Variable costs, Gross margin, Profitable

Article Info

Accepted:
12 October 2019
Available Online:
10 November 2019

A B S T R A C T

Agriculture is the mainstay of Nepalese economy. Nepal is an agricultural country with a lot of cultural, genetic and geographical diversity. Agriculture is also a main source of employment. Rice is a major staple crop of the country. During the year 2016/017, rice contributed 44.66 per cent to the total edible cereal grain production in the country. Rice is a labor intensive crop and youth migration has created a situation of labor scarcity. Introduction of mechanization in rice cultivation is one of the best solutions to get rid of labor scarcity and increase production of rice. AMTRC, Nawalpur, Sarlahi has been carrying out different research works on use of different machineries and cultivation practices in rice farming. It carried out a study in 2074/075 and 2075/076 on uses of different machineries in three replications with four treatments. The mean grain yield due to treatments was found significant at 1 per cent level in 2074/075 and at 5 per cent level in 2075/076. It was significant at 1 per cent level in pooled analysis of two years data. The highest mean grain yield from two years data was found in T_2treatment in which the rice was directly seeded with drum seeder. It produced 3227.50 kg/ha and the lowest production of 2576.33 kg/ha rice was produced in the trial where the rice was directly seeded with power tiller drill machine (T_1). The yield in farmer's practices was recorded as 3173.33 kg/ha. The average of two years data revealed only the 1.71 per cent more yield in the treatment of rice directly seeded with drum seeder (T_2) than the farmer's practices (T_4). Though there was not much different in rice yield between T_2 and T_4, the variable costs became high in farmer's practices due to more labor requirement in different cultural practices. The variable cost was 19.42 per cent more in T_4 than T_2 and it ultimately consequence the less gross margin under farmer's practices of rice cultivation. The total gross margin was 83.55 per cent more in T_2 than T_4. Thus, among the four treatments, the rice produced from directly seeded by drum seeder was found most profitable than other machines used in the trial including farmer's practices in this experiment.

Introduction

Agriculture is the mainstay of Nepalese economy which contributes almost one third of the national economy (NPC, 2017). It is a small, land-locked mountainous country with diverse agro ecologies. Agricultural crop productivity in Nepal is lowest among South Asian countries (FAO, 2018). During the year 2074/075 the contribution of agriculture, forestry and fishery to gross domestic product was 27.59 per cent which has been expected as 26.98 during the fiscal year of 2075/076 (MoF, 2019). The agricultural sector production during 2074/075 was increased by 2.7 per cent which has been estimated as 5.1 per cent in 2075/076 (MoF, 2019).

As a cereal grain, rice is the most widely consumed staple food for a large part of the world's human population, especially in Asia. It is the agricultural commodity with the third highest worldwide production (Rice, 741.5 million tones, in 2014), after sugarcane (1.9 billion tones) and maize 1.0 billion tones (FAO Stat, 2017). The rice in Nepal is transplanted by human labor and animal traction (Upadhyaya, 1996). During the year 2016/2017, rice contributed 44.66 per cent to total edible cereal grain production in the country (ASS, 2018).

Rice occupies major area in summer season. In Nepal, rice during the year 2007/2008 was grown in 1549262 ha which produced 4299246 metric ton with an average yield of 2775.00 kg/ha. The area, production and productivity in 2016/2017 reached to 1552469.00 ha, 5230327.00 mt and 3369.00 kg/ha (Table 1). The area increment in 2016/2017 over 2007/2008 has been counted as only 0.21 per cent while in production and productivity the increment is 21.66 and 21.41 per cent, respectively. The trend of increment in area is slow (Figure 1) while in productivity it is not in always positive trend (Figure 2). Since rice is a labor intensive crop, and migration of youth force from rural to urban and urban to gulf and other countries in search of opportunities have created a state of labor scarcity in the country. It has compelled to think over labor substitution technologies in rice farming. Mechanization in rice farming is one of the best solutions to replace labor, reduce drudgery and increase income of the farmer through the reduction of cost of cultivation and increase in the productivity and production in the farm.

The status of production and productivity is not straight linear since last decades. Although the production and productivity is increasing due to increase in adoption of improved rice cultivation practices like improved seed, application of fertilizers, improvement in farmers' knowledge and skill, availability of technical services etc. Chances of expanding land is minimum, therefore the technologies to increase productivity has been imperative. Mechanization also supports to increase production and productivity in rice cultivation.

Land preparation for rice planting needs repeatedly ploughed. Using traditional bullocks and laborers it takes 64 h per hectare to prepare land, while the scale appropriate farm mechanization can prepare the same land in approximately 20 h per hectare (Paudel *et al.,* 2019). Adoption and spread of agricultural and rural mechanization technologies are increasing recently in Nepal with liberal import policies, increased connectivity and acute labor scarcity resulting from youth migration (Gauchan and Shrestha, 2017). Rice is a labor intensive crop.

Mechanization of rice farming can increase rice production in hill area of Nepal. Paudel *et al.,* (2019) reported that rising on-farm rural wage rates and an emerging decline in draft animal availability are driving adoption of the mini-tiller. Among users, the mini-tiller increased rice productivity by 1110 kg/ha (27%). Further regression results suggested that mini-tiller non-adopters would be able to increase their rice productivity by 1250 kg/ha (26%) if they adopt. In recent years, Nepalese agriculture has experienced an accelerating trend of labor out-migration, particularly to middle-east countries in search of better job opportunities (Maharjan *et al.,* 2013a). This has created acute labor shortages in the agriculture sector that have affected timely crop establishment and other crop cultivation practices (ILO, 2017; Maharjan *et al.*, 2013b, 2013a). The labor scarcity and rising labor wages have forced farmers to think alternatives and many studies have also shown that the rising labor scarcity and/or increased labor wages as the major driver for adopting farm mechanization (Reddy *et al.*, 2014; Wang *et al.,* 2016; Win and Thinzar, 2016; Yang *et al.,* 2013 and Zhang *et al.*, 2014).

Agricultural mechanization can more simply be defined as the use of any machine to accomplish a task or an operation involved in agricultural production. Such tasks or operations include reduction in human drudgery, improvement in the timeliness and efficiency of various agricultural operations, bringing more land under cultivation, preserving the quality of agricultural products, providing better rural living conditions, and markedly advancing economic growth (Odigboh, 2000; Azogu, 2009). Alam (2006) describes mechanization as the interjection of machinery between people and the materials handled by them. Based on the source of power, the technological levels of mechanization have been broadly classified as hand tool technology, draught animal technology, and mechanical power technology. Mechanization also includes irrigation systems, food processing and related technologies and equipment (Hegazy *et al.*, 2013). Rising rural wages in Nepal have increasingly put pressures on smallholder farmers, who tend to operate labor-intensive farming. Agricultural mechanization through custom hiring of tractors services has recently been considered as an option to mitigate the impact of rising labor costs for smallholders (Takesima *et al.,* 2016).

An agricultural mechanization strategy is part of any agricultural development strategy. Pellizzi (1992) describes The primary objectives and benefits of agricultural mechanization include minimization of production costs; optimization of product quality; protection of the environment; reduction of farm drudgery; timely provision of suitable conditions for plant and animal growth; better control of such production functions as seedbed preparation, drainage, cultivation, fertilizer application, planting, and weed and pest control; reduction of harvest losses; and postharvest quality preservation, storage, processing, distribution, and marketing, which in turn contribute to enhanced food security, employment opportunities, better rural living and working conditions, and thus reduced poverty.

Japan has been the strongest innovator and technology provider in terms of farm mechanization and farm machinery used in Southeast Asia. Many machinery designs found in Southeast Asian countries for transplanting, harvesting, and milling were first developed in Japan and later adapted in other countries. Also, the machines initially developed for rice farming were also adapted and modified by engineers for vegetables and other crops (Hegazy *et al.,* 2013).

Before 1962, the Republic of Korea (henceforth-Korea‖) was one of the poorest agricultural countries in the world. Korean agriculture was poor, small scale, and powered by animal and human labor. Agricultural mechanization was initially intended to overcome natural disasters due to drought, disease, and insects, and to free farmers from drudgery. Agricultural mechanization became a foundation stone not only for the development of rural areas but also for the economic development of the country as a whole.

People's Republic of China has made significant contributions to the transformation of the country's traditional farming in modern agriculture by both of the development of agriculture mechanization and the manufacturing of farm machinery.

Agriculture mechanization in India is continuously increasing. In 2007, India had 3.2 million agricultural tractors and 0.48 million combine harvesters and threshers. The density of tractors per 1000 ha of cropped area was about 16 compared with the world average of 19, and 27 in the US (Directorate of Economics and Statistics, 2013). Most of the earlier innovations in the rice mechanization sector in India were on tractors, drillers, mechanical transplanters, different type of irrigation machinery, and mechanical weed control as preharvest machines

The zero-tillage drilling of wheat after rice in North India is becoming popular, mainly due to savings both in cost and time. The use of laser land levelers on a custom-hire basis is growing, as it saves up to 30 per cent of irrigation water and helps increase productivity. Combine harvesters operating in custom-hire business models gained popularity (Mani *et al.,* 2008).

Rice is the largest and economically most important crop and serves as the staple food for the Thai people. Presently agricultural machinery is widely used among Thai farmers. Rice is major crop in Vietnam and highest level of mechanization is in rice production achieving 72 per cent in land preparation, 86 per cent in irrigation, 20 per cent in crop establishment, and 100 per cent in threshing (APCAEM, 2009). In Taiwan, the development of rice machinery started in the 1950s and reached a peak in the 1980s. A key milestone was the establishment of the Rice Seedling Nursery Center, which contributed indirectly to the Taiwanese custom of hiring out rice machinery and to the full mechanization of rice cultivation (Hegazy *et al.,* 2013).

In a study carried out in Bangladesh, Kamruzzaman *et al.,* (2009) reported that the maximum cost in rice cultivation was incurred in transplanting, weeding, harvesting and threshing but only transplanter, weeder, reaper and thresher can reduce the big amount of production cost.

Materials and Methods

There are different machines and cultural practices for rice farming. They were identified at AMTRC, Nawalpur, Sarlahi. The cultivation practices for rice cultivation by using different machineries were evaluated in four treatments (Table 2).

The experiment was carried out into three replications of four treatments in 2800 m^2 plot size for each treatment. The experiment was laid out in randomized complete block design (RCBD). The variety of rice was Hardinath-1.Seeds were sown in last week of Jestha (second week of June) at the rate of 30kg/ha. The crop was harvested in the last week of Ashoj (Second week of October).

The fertilizer doses supplied were at the rate of 100:30:30 kg NPK/ha. The full dose of phosphorous, potash and half dose of nitrogen were applied as basal dose during the time of land preparation while remaining half dose of nitrogen was top dressed. The source of phosphorous was Dia-ammonium phosphate (DAP) and that of potassium was muriate of potash and of nitrogen was DAP and urea. First irrigation was supplied after 25 days of sowing and the second irrigation after 75 days. Other intercultural practices were followed as per need and recommendation for this crop.

Data were recorded on date of sowing, date of harvesting, plant height, spike length, number of plant per square meter area and average number of grain per panicle. Similarly, average number of tiller per hill, thousand grains weight, grain yield and straw yield per hectare were also recorded.

The data were fed into computer and analyzed using ms-excel and Mstat package. The data recorded were analyzed for individual parameters separately for each year. Similarly, the combined analysis was performed for two years data.

Results and Discussion

Data of different parameters were recorded and analyzed statistically. The results of analysis varied with year and parameters. However, the result of pooled analysis was as conclusion for the study.

Plant height

The plant height was significant at 1 per cent level in 2074/075, while it was found non-significant in 2075/076. In pooled analysis, the plant height was significant at 1 per cent level (Table 3). The highest plant height among the treatments was observed in T_1 which was 104.77 cm followed by T_3 (100.70 cm) in 2074/075. The treatment T_2 obtained lowest plant height of 93.56 cm. Despite, non-significant result in 2075/076, the longest plant height was found in T_1 (105.43 cm) and the shortest height of plant was recorded in T_4 which was 98.22 cm. In combined analysis, the treatment was found significant at 1 per cent level while the effect of year and interaction between year and treatment was non-significant. In this analysis the average height of plant was highest in T_1 (105.10 cm) followed by T_3 (100.89 cm) and the lowest height of 95.78 was recorded in T_2 in the experiment (Table 3).

Panicle length

The panicle length in all treatments was found non-significant in both of the years of 2074/075 and 2075/076. Similarly, the effect of year, interaction between year and treatment was also found non-significant (Table 4). Despite the non-significant result in panicle length, the highest length was 25.33, 26.22 and 25.78 cm respectively in 2074/075, 2075/076 and in pooled analysis of two years data.

Plant population

The number of plants when counted for one square meter area was found significant in whole experiments at 1 per cent level (Table 5). The number of plant per square meter was highest in T_1 which was 268.89 followed by T_4 (222.78) and T_2 recorded the lowest number of plant (183.78) in 2074/075. During 2075/076, the treatment T_4 obtained 271.44 number of plant/m^2 which was highest among the treatments followed by T_1 (270.00) and the lowest number of 197.50 was recorded in T_2.

In combined analysis the effect of year and interaction between year and treatment was found significant at 1 per cent level. The highest number of plant /m^2 was observed in T_1 which was 269.44 followed by T_4 (247.11) and the lowest number of plant was found in T_2 which was 190.64 (Table 5).

Number of grain/panicle

The number of grain per panicle was found non-significant in both of the years and also in combined analysis (Table 6). During the year 2074/075, the highest number of grain was found highest in T_3 (61.56) and the lowest of 59.33 in T_2. Similarly in 2075/076, the highest number was 64.66 found in T_3 and the lowest in T_2 (53.67). In combined analysis, the effect of year in treatments and the interaction between year and treatment was found non-significant. However, the treatment T_3 recorded the highest number of grain of 63.11 and the lowest number (56.50) in T_2 (Table 6).

Number of tiller per hill

The number of tiller was found significant at 1 per cent level. In combined analysis of two years (2074/075 and 2075/076), the treatment was also found significant at 1 per cent level (Table 7). During 2074/075, T_3 recorded the highest number of tiller per hill counting as 24.89 followed by T_4 (15.00). The minimum number of tiller was observed in T_2 (12.77) during the same year. In 2075/076, the highest number of tiller per hill was found in T_3 (26.11) followed by T_4 (19.22) and the lowest number of tiller per hill was recorded in T_2 (14.00) during the same year.

In combined analysis, the effect of year in treatments was non-significant. Similarly, the interaction between year and treatment was also non-significant. The number of tiller per hill due to treatments was significant at 1 per cent level. The treatment T_3 recorded the highest number of tiller in average of two years which was 25.50 and the average lowest number was observed in T_2 as 13.38 (Table 7).

Thousand grain weight

The weight of thousand grains when analyzed was found non-significant in whole experiment. In combined analysis too, it was found non-significant. Despite non-significant result, the highest weight of thousand grain was found in T_3 during two years and also in combined analysis which was 18.55, 18.17 and 18.36 respectively in the year of 2074/075, 2075/076 and in pooled recording (Table 8).

Grain yield

The mean grain yield was significant at 1 per cent level in 2074/075 and at 5 per cent level in 2075/076. It was also significant at 1 per cent in pooled analysis (Table 9). The highest mean grain yield of 3191.67 kg/ha was obtained in T_2 followed by T_4 which was 3016.67 kg/ha in 2074/075. The lowest mean grain yield was observed in T_1 which was 2473.67 kg /ha in the same year. In 2075/076, the same treatment T_2 recorded the highest mean grain yield of 3263.33 kg/ha followed by T_4 (2938.33 kg/ha) and the lowest mean grain yield was found in T_1 which was 2679.00 kg/ha.

In pooled analysis of two years (2074/2075-2075/076), the effect of year was significant at 5 per cent level while the interaction between year and treatment was non-significant. The average of two years mean grain yield was highest in T_2 which was 3227.50 kg/ha followed by T_4 (2977.50 kg/ha) and the lowest mean grain yield of 2576.33 kg/ha was recorded in T_1 (Table 9).

Straw yield

The mean straw yield was significant at 1 per cent level in 2074/075 and at 5 per cent level in 2075/076. It was also significant at 1 per cent level in pooled analysis (Table 10). The highest mean straw yield during 2074/075 was observed in T_3 which was 5436.67 kg/ha followed by T_4 (4093.33 kg/ha) and the lowest was in T_2 (3299.67 kg/ha).

Similarly, during 2075/076 the highest mean straw yield of 4521.67 kg/ha was recorded in T_3 followed by T_4 (4158.67kg/ha). The lowest straw yield in 2075/076 was observed in T_2 which was 2930.00 kg/ha.

In combined analysis of two years (2074/075-2075/076) data, the effect of year in treatment was non-significant and also the interaction between year and data. The mean straw yield of two years was highest in T_3 which obtained 4979.17 kg/ha followed by T_4 (4126.00 kg/ha) and the lowest mean straw yield was recorded in T_2 which was observed as 3114.83 kg/ha in the experiment (Table 10).

Gross margin

Gross margin is the difference between revenue and variable costs incurred in input expenditures. The gross margin is also calculated in percentage terms by dividing the gross margin amount by revenue. Gross margin = (Total revenue – Variable costs)/Total revenue. Thus it can be expressed in percentage too. Gross margin supports to measure the production costs related to the revenue of the farm. If gross margin is low, it may look for the processes that allow the farm to cut in use of the variable cost which seem less productive.

In this experiment, the gross margin was calculated based on the expenses incurred in different inputs and farm works related to the farm operations. The different methods of cultivation practices obtained varying quantity of production and thus gross margin was also different for different treatments.

The highest amount of revenue as an average of two years (2074/075-2075/076) was found in T_2 where the rice was directly seeded with drum seeder which was Rs. 72955.00/ha followed by the check treatment counting the total revenue of Rs. 71709.60/ha (Table 11).

The total variable cost was highest in check (Farmer's practices) which was Rs. 58779.25 followed by T_2 (Rs. 49221.25/ha). A gross margin of Rs. 23733.75/ha was found highest in T_2 followed by T_1 (Rs. 17129.77/ha). The lowest gross margin of Rs. 17016.70/ha was calculated in T_3. The gross margin for 2074/075 (Annex-1), for the year 2075/076 (Annex-2) and average of two years (Annex-3) are also calculated separately and presented accordingly.

Table.1 Area, production and yield of rice (2007/2008-2016/2017) in Nepal

Year	Area (Ha)	Production (Mt)	Yield (Kg/ha)
2007/2008	1549262.00	4299246.00	2775.00
2008/2009	1555940.00	4523693.00	2907.00
2009/2010	1481289.00	4023823.00	2716.00
2010/2011	1496476.00	4460278.00	2981.00
2011/2012	1531493.00	5072248.00	3312.00
2012/2013	1420570.00	4504503.00	3171.00
2013/2014	1486951.00	5047047.00	3394.00
2014/2015	1425346.00	4788612.00	3360.00
2015/2016	1362908.00	4299079.00	3154.00
2016/2017	1552469.00	5230327.00	3369.00

Source: GoN/MoALC/MESD/Agriculture Statistics Section, Singhdurbar, Kathmandu, 2018.

Table.2 Treatments followed in rice experiment at AMTRC, Nawalpur, Sarlahi

Treatment no.	Treatments	Practices	Remarks
T_1	Direct seeded rice by power tiller drill (DSRPTD)	In this treatment no pre land preparation was required. Before land preparation basal dose nitrogen and potassium fertilizer was applied in the field while DAP and Hardinath-1 variety of rice seed was sown by machine. The primary and secondary tillage was done in single action along with seed sowing fertigation. The field was leveled by planking in single move with power tiller operated seed drill machine. Within 24 hours of sowing, the herbicide pendimethylene @5ml/lt of water was sprayed for weed management.	
T_2	Direct seeded rice by drum seeder (DSRDS)	In this treatment, dry land was prepared in two-pass primary tillage with cultivators. The secondary tillage was performed by the disc harrow to break down the clods into fine soil. The wet land puddling and planking was done by rotavator.The basal dose of fertilizer was applied before puddling the field.The well prepared land by puddlingwas left overnight before ricetransplantation. The rice seed of Hardinath-1 was soaked in water for 24 hours and then rice seed was taken out to keep for shade drying in gunny bag for 8to 12 hours. The germinated seeds were sown by the drum seeder in the field. Weeds were managed through the application of herbicide pretilacholor at the rate 1lt/ha during the puddling of the rice field.	
T_3	Rice direct seeded with zero till drill (DSRZTD)	In Dry Land preparation two-pass primary tillage was performed by cultivators, and then secondary tillage was done by the disc harrow to break down the clods. Before land preparation basal dose of nitrogen and potassium fertilizers was applied in the field. After that rice seed of Hardinath-1 variety with phosphorous (DAP) was sown by the zero till seed cum fertilizer seed drill machine followed by the planking of the field. For the weed management, the herbicide pendimethylene 5ml/ltr of water was sprayed within 24 hours of seed sowing.	
T_4	Check (Farmer's practices	The dry Land was prepared with two-pass primary tillage with cultivators followed by the secondary tillage by the disc harrow to break down the clods in the field. The wet land puddling and planking was	

		operated by rotavator. The basal dose of fertilizers was applied before puddling of the field. The puddle field was left overnight before the transplantation of Hardinath-1 variety of rice. The seed-bed nursery was prepared 20 days before transplantation of seedlings. The seedlings were uprooted from nursery field and transplanted manually by labors. For the Weed management herbicide pretilacholor at the rate 1lt/ha was supplied during the puddling of the field	

Table.3 Average plant height of rice at AMTRC, Nawalpur, Sarlahi

Tr. no.	Treatments	Plant height (Cm)			Remarks
		2074/2075	2075/2076	Combined	
T_1	Direct seeded rice by power tiller drill (DSRPTD)	104.77[a]	105.43	105.10[a]	
T_2	Direct seeded rice by drum seeder (DSRDS)	93.56[c]	98.00	95.78[b]	
T_3	Rice direct seeded with zero till drill (DSRZTD)	100.70[ab]	101.10	100.89[ab]	
T_4	Check (Farmers' practices)	94.44[bc]	98.22	96.33[b]	
	F test	*	Ns		
	CV (%)	3.48	2.85		
	LSD (5%)	6.84	-		
	Pooled:				
	Grand mean	98.36	100.69	99.53	
	F test:				
	Year (Y)			Ns	
	Treatment (T)			**	
	Y x T			Ns	
	CV (%)			3.17	
	LSD for T (1%)			5.57	

Note: ** = Significant at 1 per cent level, *= Significant at 5% level, Ns=Non-significant. Any two means having a common letter in superscript are not significantly different at the given level of significance.

Table.4 Average length of panicle of rice at AMTRC, Nawalpur, Sarlahi

Tr. no.	Treatments	Panicle length (Cm)			Remarks
		2074/2075	2075/2076	Combined	
T_1	Direct seeded rice by power tiller drill (DSRPTD)	25.33	26.22	25.78	
T_2	Direct seeded rice by drum seeder (DSRDS)	23.89	26.00	24.95	
T_3	Rice direct seeded with zero till drill (DSRZTD)	24.65	25.80	25.23	
T_4	Check (Farmers' practices)	24.78	24.78	24.78	
	F test	Ns	Ns	-	
	CV (%)	6.63	4.95	-	
	Pooled:				
	Grand mean	24.66	25.70	25.18	
	F test:				
	Year (Y)			Ns	
	Treatment (T)			Ns	
	Y x T			Ns	
	CV (%)			5.81	

Table.5 Average number of plant of rice at AMTRC, Nawalpur, Sarlahi

Tr. no.	Treatments	Plant/m^2 (Number)			Remarks
		2074/2075	2075/2076	Combined	
T_1	Direct seeded rice by power tiller drill (DSRPTD)	268.89^a	270.00^a	269.44^a	
T_2	Direct seeded rice by drum seeder (DSRDS)	183.78^c	197.50^b	190.64^c	
T_3	Rice direct seeded with zero till drill (DSRZTD)	195.11^c	199.33^b	197.22^c	
T_4	Check (Farmers' practices)	222.78^b	271.44^a	247.11^b	
	F test	**	**	-	
	CV (%)	3.20	1.78	-	
	LSD (1%)	21.10	12.61	-	
	Pooled:				
	Grand mean	217.64	234.57	226.14	
	F test:				
	Year (Y)			**	
	Treatment (T)			**	
	Y x T			**	
	CV (%)			2.54	
	LSD for T (1%)			10.13	
	LSD for Y x T (1%)			14.32	

Note: ** = Significant at 1 per cent level, *= Significant at 5% level, Ns=Non-significant. Any two means having a common letter in superscript are not significantly different at the given level of significance.

Table.6 Average number of grain/panicle of rice at AMTRC, Nawalpur, Sarlahi

Tr. no.	Treatments	Grain/panicle (Number)			Remarks
		2074/2075	2075/2076	Combined	
T_1	Direct seeded rice by power tiller drill (DSRPTD)	60.78	56.55	58.66	
T_2	Direct seeded rice by drum seeder (DSRDS)	59.33	53.67	56.50	
T_3	Rice direct seeded with zero till drill (DSRZTD)	61.56	64.66	63.11	
T_4	Check (Farmers' practices)	61.55	63.78	62.67	
	F test	Ns	Ns	-	
	CV (%)	17.54	7.58	-	
	Pooled:				
	Grand mean	60.80	59.66	60.23	
	F test:				
	Year (Y)			Ns	
	Treatment (T)			Ns	
	Y x T			Ns	
	CV (%)			13.60	

Table.7 Average number of tiller/hill of rice at AMTRC, Nawalpur, Sarlahi

Tr. no.	Treatments	Tiller/hill (Number)			Remarks
		2074/2075	2075/2076	Combined	
T_1	Direct seeded rice by power tiller drill (DSRPTD)	14.79^{b}	18.44^{bc}	16.61^{b}	
T_2	Direct seeded rice by drum seeder (DSRDS)	12.77^{b}	14.00^{c}	13.38^{c}	
T_3	Rice direct seeded with zero till drill (DSRZTD)	24.89^{a}	26.11^{a}	25.50^{a}	
T_4	Check (Farmers' practices)	15.00^{b}	19.22^{b}	17.10^{b}	
	F test	**	**	-	
	CV (%)	9.37	7.75	-	
	LSD (1%)	4.78	4.56	-	
	Pooled:				
	Grand mean	16.86	19.44	18.15	
	F test:				
	Year (Y)			Ns	
	Treatment (T)			**	
	Y x T			Ns	
	CV (%)			8.51	
	LSD for T (1%)			2.72	

Note: ** = Significant at 1 per cent level, *= Significant at 5% level, Ns=Non-significant. Any two means having a common letter in superscript are not significantly different at the given level of significance.

Table.8 Thousand grain weight of rice at AMTRC, Nawalpur, Sarlahi

Tr. no.	Treatments	Thousand grain weight (Gram)			Remarks
		2074/2075	2075/2076	Combined	
T_1	Direct seeded rice by power tiller drill (DSRPTD)	17.88	17.86	17.87	
T_2	Direct seeded rice by drum seeder (DSRDS)	18.01	17.86	17.94	
T_3	Rice direct seeded with zero till drill (DSRZTD)	18.55	18.17	18.36	
T_4	Check (Farmers' practices)	18.07	18.15	18.11	
	F test	Ns	Ns	-	
	CV (%)	2.13	2.25	-	
	Pooled:				
	Grand mean	18.13	18.01	18.07	
	F test:				
	Year (Y)			Ns	
	Treatment (T)			Ns	
	Y x T			Ns	
	CV (%)			2.19	

Table.9 Mean grain yield of rice at AMTRC, Nawalpur, Sarlahi

Tr. no.	Treatments	Mean grain yield (Kg/ha)			Remarks
		2074/2075	2075/2076	Combined	
T_1	Direct seeded rice by power tiller drill (DSRPTD)	2473.67^{b}	2679.00^{b}	2576.33^{b}	
T_2	Direct seeded rice by drum seeder (DSRDS)	3191.67^{a}	3263.33_{a}	3227.50^{a}	
T_3	Rice direct seeded with zero till drill (DSRZTD)	2514.33^{b}	2905.00^{ab}	2709.67^{b}	
T_4	Check (Farmers' practices)	3016.67^{a}	2938.33^{ab}	2977.50^{a}	
	F test	**	*	-	
	CV (%)	2.77	6.70	-	
	LSD (1%)	234.90	-	-	
	LSD (5%)	-	394.3	-	
	Pooled:				
	Grand mean	2799.08	2946.42	2872.75	
	F test:				
	Year (Y)			*	
	Treatment (T)			**	
	Y x T			Ns	
	CV (%)			5.22	
	LSD for T (1%)			264.50	

Note: ** = Significant at 1 per cent level, *= Significant at 5% level, Ns=Non-significant. Any two means having a common letter in superscript are not significantly different at the given level of significance.

Table.10 Mean straw yield of rice at AMTRC, Nawalpur, Sarlahi

Tr. no.	Treatments	Mean straw yield (Kg/ha)			Remarks
		2074/2075	2075/2076	Combined	
T_1	Direct seeded rice by power tiller drill (DSRPTD)	4049.67[bc]	3873.33[ab]	3961.50[b]	
T_2	Direct seeded rice by drum seeder (DSRDS)	3299.67[c]	2930.00[b]	3114.83[c]	
T_3	Rice direct seeded with zero till drill (DSRZTD)	5436.67[a]	4521.67[a]	4979.17[a]	
T_4	Check (Farmers' practices)	4093.33[b]	4158.67[a]	4126.00[b]	
	F test	**	*	-	
	CV (%)	5.98	14.32	-	
	LSD (1%)	763.30	-	-	
	LSD (5%)	-	1108	-	
	Pooled:				
	Grand mean	4219.83	3870.92	4045.37	
	F test:				
	Year (Y)			Ns	
	Treatment (T)			**	
	Y x T			Ns	
	CV (%)			10.65	
	LSD for T (1%)			759.50	

Note: ** = Significant at 1 per cent level, *= Significant at 5% level, Ns=Non-significant. Any two means having a common letter in superscript are not significantly different at the given level of significance.

Table.11 Average gross margin of two years data from different cultivation practices of rice at AMRTC, Sarlahi

Particulars	T_1 DSRPTD	T_2 DSRDS	T_3 DSRZTD	T_4 Check
Land preparation cost (Rs/ha	**0.00**	**8385.75**	**3750.00**	**8385.75**
Sowing/transplanting machine hire cost(Rs/ha)	**3600.00**	**1000.00**	**4500.00**	**0.00**
Seed Cost (Rs/ha)	**1800.00**	**1800.00**	**1800.00**	**1800.00**
Total fertilizer cost (Rs/ha)	**8100.00**	**8100.00**	**8100.00**	**8100.00**
Herbicide cost (Rs/kg)	**750.00**	**750.00**	**750.00**	**750.00**
Total labor cost	**28066.60**	**29185.50**	**28226.60**	**39743.50**
Total variable cost	**42316.60**	**49221.25**	**47126.60**	**58779.25**
Grain yield at 10% m.c. (Kg/ha)	2576.34	3227.50	2709.67	3173.33
Straw yield (kg/ha)	3959.84	4202.50	4975.00	4121.50
Return from Grain (Rs/ha)	51526.70	64550.00	54193.30	63466.60
Return from straw (Rs/ha)	7919.67	8405.00	9950.00	8243.00
Total Revenue	**59446.37**	**72955.00**	**64143.30**	**71709.60**
Gross margin	**17129.77**	**23733.75**	**17016.70**	**12930.35**

Source: Rice experiment data of 2074/075 and 2075/076.

Fig.1 Area and production of rice (2007/2008-2016/2017) in Nepal

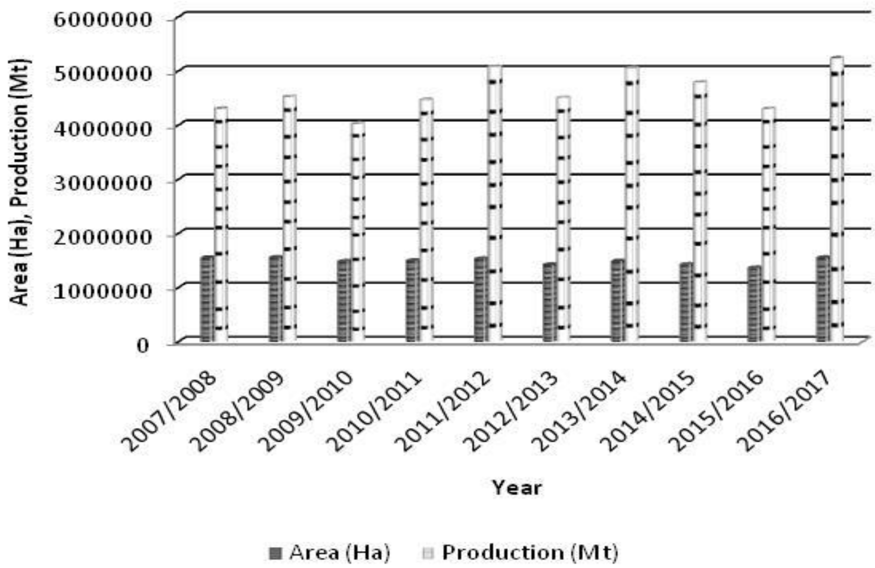
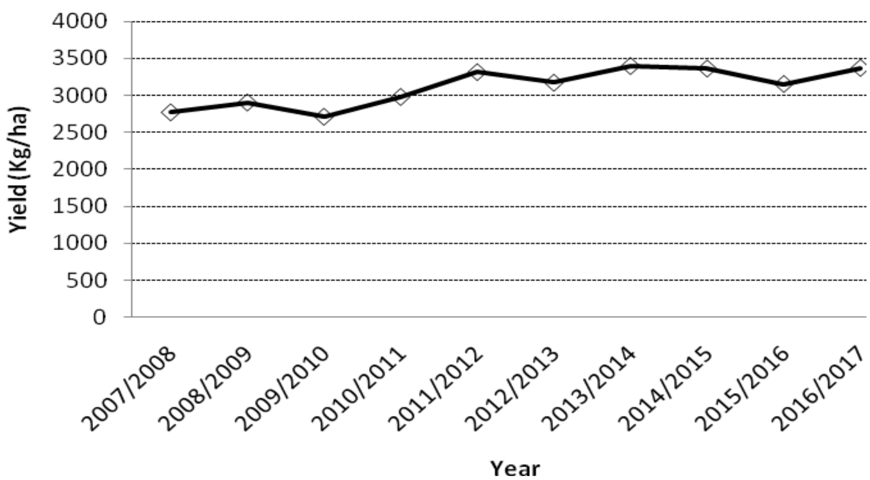


Fig.2 Yield of rice (2007/08-2016/17) in Nepal



There are many cultivation practices and machines for mechanization in rice farming. The cultivation practices through the use of different machines in this experiment have revealed the better gross margin in practices where the minimum cost is incurred in rice cultivation. The rice directly seeded by drum seeder (T_2) yielded highest (3191.67 kg/ha) followed by T_4 the farmer's practices (3016.66 kg/ha) in 2074/075. It was only 5.80 per cent more production than farmers' practices. The variable cost was 19.88 per cent more in farmer's practices than T_2.The gross margin in 2074/075 was 130.42 per cent more in T_2 than T_4 in the experiment. It was due to more labor costs incurred in farmers' practices

During the year 2075/076, the highest mean grain yield of 3330.00kg/ha was produced in T4 (Check) followed by T_2which recorded3263.33 kg/ha. In this year the rice grown through farmer's practices was 2.04 per cent more than the rice directly seeded with drum seeder (T_2). But the variable costs due to more labor was 18.97 per cent more in farmer's practices than T_2 and thus the gross margin was 52.82 per cent more in T_2 than the gross margin of T_4, the farmer's practices. Despite more yield, the gross margin was fewer due to more variable costs incurred in cultivation practices.

The average of two years data on yield, variable cost and gross margin was found in favor of T_2(Rice directly seeded with drum seeder).

The highest mean grain yield of rice (3227.50 kg/ha) was obtained in T_2 while in T_4 it was 3173.33 kg/ha. The T_2 produced only 1.71 per cent more than T_4, while the variable cost was 19.42 per cent more in farmer's practices than T_2.Thus the gross margin was 83.55 per cent more in T_2 than farmer's practices. It was due to high cost incurred in farmer practices from labor services.

The result showed that the mechanization in rice cultivation could be one of the best solutions to scope up with labor scarcity. Although there are many machines and tools used in rice cultivation, the costs are also incurred according to their efficiency. The labor cost is very high due to scarcity of manpower and thus farmers' have to pay more for labor causing comparatively high variable costs in rice farming. It has ultimately affected the gross margin of the farmers with less return than cultivating rice with different machines. In this experiment, the rice directly seeded with drum seeder has been found efficient in production among the practices included in the trial. These practices reduced the number of labors and thus minimized the variable costs adding to more farm income.

References

Alam, A. 2006. Future requirements of agricultural machines for mechanizing agriculture. Status of farm mechanization in India. Report, Indian Council of Agricultural Research, India. Pp 175-196

APCAEM, 2009. (Asian and Pacific Centre for Agricultural Engineering and Machinery). 2009. 5th APCAEM Technical Committee Meeting and Expert Group Meeting on Application of Agricultural Machinery for Sustainable Agriculture, Ohilippines, 14-16 October. 2009.

ASS, 2018. Statistical information on Nepalese agriculture. 2073/2074 (2016/2017). GoN/Ministry of Agriculture, Land Management and Cooperatives/Monitoring, Evaluation and Statistics Division/Agriculture Statistics Section, Singhdurbar, Kathmandu, Nepal.2018.

Azogu, I. I. 2009.Promoting appropriate Mechanization Technologies for Improved Agricultural Productivity in Nigeria: The role of the National Centre for Agricultural Mechanization. Journal of Agricultural Engineering and Technology, Vol. 17(2), pp. 5-10.

Directorate of Economics and Statistics. 2013. State of Indian Agriculture 2012-13. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.

FAO Stat, 2017. Crops/Regions/World list/Production Quantity (pick lists), Rice (paddy), 2016". UN Food and Agriculture Organization, Corporate Statistical Database (FAOSTAT). 2017. Retrieved November 9, 2018.

FAO, 2018. FAO, 2018. Statistical database. Retrieved on 24 August 2018 from: http://www.fao.org/faostat/en/#compare.

Gauchan, D. and S. Shrestha. 2017. Agricultural and Rural Mechanization in Nepal: Status, Issues and Options for Future, In book: Rural Mechanization: A Driver in Agricultural Change and Rural Development, Chapter 4, Publisher: Institute forInclusive Finance and Development (InM), Dhaka, Bangladesh, Editors: Manual M. A. S., S. D. Biggs, and S. E. Justice, pp 97-118.

Hegazy, R., A. Schmidley, E. Bautista, D. Sumunistrado, M. Gummert, and A. Elepano, 2013. Mechanization in rice farming-Lessons learned from other countries. Asia Rice Foundation (ARF) publication, 2013. https://www.researchgate.net/publication/258951878_Mechanization_in_rice_farming_lessons_learned_from_other_countries

ILO. 2017. Nepal Labor Market Update. Country office for Nepal, Kathmandu, Nepal, 2017.

Kamruzzaman, M., M. A. Mannan, U. K. Mohanta, M. A. Hossain and T. K. Sarkar. 2009. Scope of Mechanization in Rice Cultivation: A Case Study in a Village "Joshpur" Under Comilla District of Bangladesh. Intl. J. BioRes. 7 (1): 1-6, July 2009.

Maharjan A., S. Bauer, and B. Knerr. 2013 $_a$. Migration for Labor and Its Impact on Farm Production in Nepal Working Paper IV. Center for the study of labor and mobility, Kathmandu, Nepal (2013).

Maharjan, A., S. Bauer, B. Knerr. 2013$_b$.International migration, remittances and subsistence farming: evidence from Nepal. Int. Migr., 51 (2013), pp. 249-263

Mani, I., J. S. Panwar, and S. K. Adlakha. 2008. Custom-hiring of Agricultural Machine – A major drift. In: Proceedings of the 42nd ISAE Convention held at CIAE, Bhopal, 1-3 February, 2008.

MoF, 2019. AarthikSarvekshan, 2075/76 (Economic Survey, 2018/2019). Government of Nepal, Ministry of Finance, Singhdurbar, Kathmandu, Nepal.

NPC, 2017. Sustainable development goals. Government of Nepal, National Planning Commission (NPC), Kathmandu, Nepal.

Odigboh, E. U. 2000. Mechanization of the Nigeria Agricultural Industry, pertinent notes, pressing issues, pragmatic options. A public lecture delivered at the Nigeria Academy of Science, International Conference Centre, Abuja, April 15.

Paudel, G. P., D. B. K. C., D. B. Rahut, S. E. Justiceonald.2019. Scale-appropriate mechanization impacts on productivity among smallholders: Evidence from rice systems in the mid-hills of Nepal. Land Use Policy, Volume 85, June 2019, Pages 104-113.

Pellizzi, G. 1992. Development and Role of Agricultural Engineering. Machinery World No. 3, Sept-Oct. 1992, pg. III-XI, Rome, Italy

Reddy, A. A., C. R. Rani, G. P. Reddy. 2014. Labor scarcity and farm mechanization: a cross state comparison. Indian J. Agric. Econ., 69(2014), pp. 347-358.

Takeshima, H., R. B. Shrestha, B. D. Kafle, M. Karkee. S. Pokhrel and A. Kumar.2016. Effects of agricultural mechanization on smallholders and their self-selection into farming: An insight from the Nepal Terai. IFPRI Discussion Paper, 1583, Washington, DC: International Food Policy Research Institute (IFPRI). http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/130996

Upadhyaya, H. K. 1996. Rice Research in Nepal: Current state and future priorities. Rice Research in Asia: progress and Priorities, CAB International, Wallingford (1996), Pp 193-216.

Wang, X., F. Yamauchi, K. Otsuka and J. Huang. 2016. Wage growth, landholding, and mechanization in Chinese agriculture. World Dev., 86(2016), pp.30-45.

Win, M. T., and A. M. Thinzar. 2016. Agricultural Mechanization and Structural Transformation in Myanmar's Ayeyarwady Delta. Project Paper. International Food Policy Research Institute, Washington, DC (2016).

Yang, J., Z. Huang, X. Zhang, T. Reardon. 2013. The rapid rise of cross-regional rices in China. Am. J. Agric. Econ., 95 (2013), pp. 1245-1251.

Zhang, X., S. Rashid, K. Ahamad, A. Ahmed. 2014. Escalation of real wages in Bangladesh: is it the beginning of structural transformation? World Dev., 64 (2014), pp. 273-285).

How to cite this article:

Ram Nath Jha, Manish Thakur, Md. Shamshad Ansari and Sugriblal Mandal. 2019. Yield Evaluation of Rice through the Use of Different Machinery in Farming Practices at Agricultural Machinery Testing and Research Centre (AMTRC), Nawalpur, Sarlahi, Nepal. *Int.J.Curr.Microbiol.App.Sci.* 8(11): 1464-1482. doi: https://doi.org/10.20546/ijcmas.2019.811.172

Annex.1 Gross margin of rice cultivation in different cultural practices with machines, 2074/075

Particulars	T_1 DSRPTD	T_2 DSRDS	T_3 DSRZTD	T_4 Check
Dry land preparation cost (Rs/ha)	0.00	5610.00	3750.00	5610.00
Soil puddling and planking cost (Rs/ha)	0.00	2551.50	0.00	2551.50
Land preparation cost (Rs/ha)	**0.00**	**8161.50**	**3750.00**	**8161.50**
Sowing/transplanting machine hire cost(Rs/ha)	**3600.00**	**1000.00**	**4500.00**	**0.00**
Seed Cost (Rs/ha)	1800.00	1800.00	1800.00	1800.00
DAP (60 kg/ha)	3300.00	3300.00	3300.00	3300.00
Urea (150kg/ha)	3000.00	3000.00	3000.00	3000.00
M/P (45 kg/ha)	1800.00	1800.00	1800.00	1800.00
Total fertilizer cost (Rs/ha)	**8100.00**	**8100.00**	**8100.00**	**8100.00**
Herbicide cost (Rs/kg)	**750.00**	**750.00**	**750.00**	**750.00**
Lob our for sowing/seedling uprooting/ transplanting cost (Rs/ha)	1350.00	1350.00	1350.00	18297.00
Labor cost for weeding (Rs/ha)	13500.00	13500.00	13500.00	6750.00
Labor cost for fertilizer application (Rs/ha)	450.00	450.00	450.00	450.00
Labor for irrigation Cost (Rs/ha)	675.00	675.00	675.00	1350.00
Labor for harvesting Cost (Rs/ha)	9000.00	9000.00	9000.00	9000.00
Labor for threshing and cleaning Cost	2968.40	3830.00	3017.20	3619.99
Total labor cost	**27943.40**	**28805.00**	**27992.20**	**39466.99**
Total variable cost	**42193.40**	**48616.50**	**46892.20**	**58278.49**
Grain yield at 10% m.c. (Kg/ha)	2473.67	3191.67	2514.33	3016.66
Straw yield (kg/ha)	4049.67	4190.00	5430.00	4093.00
Return from Grain (Rs/ha)	49473.40	63833.40	50286.60	60333.20
Return from straw (Rs/ha)	8099.34	8380.00	10860.00	8186.00
Total Revenue	**57572.74**	**72213.40**	**61146.60**	**68519.20**
Gross margin	**15379.34**	**23596.90**	**14254.40**	**10240.71**

Particulars	Rate
Farm gate price of rice grain (Rs/kg)	20.00
Farm gate price of straw (Rs/kg)	2.00
Labor RateRs/day	450.00
Seed price (Rs/Kg)	60.00
DAP price (Rs/Kg)	55.00
Urea price (Rs/Kg)	16.00
Potash price (Rs/Kg)	40.00
Herbicides price (Rs/lr)	600.00
Rotavator hire cost (Rs/h)	3750.00
Cultivator hire cost (Rs/h)	1860.00
MRT Hire Cost (Rs/h)	3750.00
Zero till seeddrill Hire Cost(Rs/h)	3750.00

Annex.2 Gross margin of rice cultivation in different cultural practices with machines, 2075/076

Particulars	T_1 DSRPTD	T_2 DSRDS	T_3 DSRZTD	T_4 Check
Dry land preparation cost (Rs/ha)	0.00	5610.00	3750.00	5610.00
Soil puddling and planking cost (Rs/ha)	0.00	3000.00	0.00	3000.00
Land preparation cost (Rs/ha	**0.00**	**8610.00**	**3750.00**	**8610.00**
Sowing/transplanting machine hire cost(Rs/ha)	**3600.00**	**1000.00**	**4500.00**	**0.00**
Seed Cost (Rs/ha)	**1800.00**	**1800.00**	**1800.00**	**1800.00**
DAP (60 kg/ha)	3300.00	3300.00	3300.00	3300.00
Urea (150kg/ha)	3000.00	3000.00	3000.00	3000.00
M/P (45 kg/ha)	1800.00	1800.00	1800.00	1800.00
Total fertilizer cost (Rs/ha)	**8100.00**	**8100.00**	**8100.00**	**8100.00**
Herbicide cost (Rs/kg)	**750.00**	**750.00**	**750.00**	**750.00**
Lob our for sowing/seedling uprooting/ transplanting cost (Rs/ha)	1350.00	1350.00	1350.00	18474.00
Labor cost for weeding (Rs/ha)	13500.00	13500.00	13500.00	6750.00
Labor cost for fertilizerapplication (Rs/ha)	450.00	450.00	450.00	450.00
Labor for irrigation Cost (Rs/ha)	675.00	1350.00	675.00	1350.00
Labor for harvesting Cost (Rs/ha)	9000.00	9000.00	9000.00	9000.00
Labor for threshing and cleaning Cost	3214.80	3916.00	3486.00	3996.00
Total labor cost	**28189.80**	**29566.00**	**28461.00**	**40020.00**
Total variable cost	**42439.80**	**49826.00**	**47361.00**	**59280.00**
Grain yield at 10% m.c. (Kg/ha)	2679.00	3263.33	2905.00	3330.00
Straw yield (kg/ha)	3870.00	4215.00	4520.00	4150.00
Return from Grain (Rs/ha)	53580.00	65266.60	58100.00	66600.00
Return from straw (Rs/ha)	7740.00	8430.00	9040.00	8300.00
Total Revenue	**61320.00**	**73696.60**	**67140.00**	**74900.00**
Gross margin	**18880.20**	**23870.60**	**19779.00**	**15620.00**

Price rate

Item	Rate
Farm gate price of rice grain (Rs/kg)	20.00
Farm gate price of straw (Rs/kg)	2.00
Labor Rate/day	450.00
Seed price (Rs/Kg)	60.00
DAP price (Rs/Kg)	55.00
Urea price (Rs/Kg)	16.00
Potash price (Rs/Kg)	40.00
Herbicides price (Rs/l)	600.00
Rotavator hire cost (Rs/h)	125.00
Cultivator hire cost (Rs/h)	1860.00
MRT Hire Cost (Rs/h	3750.00
Zero till seeddrill Hire Cost(Rs/h)	3750.00

Annex.3 Average gross margin, revenue and variable costs of rice production at AMTRC, Sarlahi (2074/075-2075/076)

Particulars	T_1 DSRPTD	T_2 DSRDS	T_3 DSRZTD	T_4 Check
Dry land preparation cost (Rs/ha)	0.00	5610.00	3750.00	5610.00
Soil puddling and planking cost (Rs/ha)	0.00	2775.75	0.00	2775.75
Land preparation cost (Rs/ha	**0.00**	**8385.75**	**3750.00**	**8385.75**
Sowing/transplanting machine hire cost(Rs/ha)	**3600.00**	**1000.00**	**4500.00**	**0.00**
Seed Cost (Rs/ha)	**1800.00**	**1800.00**	**1800.00**	**1800.00**
DAP (60 kg/ha)	3300.00	3300.00	3300.00	3300.00
Urea (150kg/ha)	3000.00	3000.00	3000.00	3000.00
M/P (45 kg/ha)	1800.00	1800.00	1800.00	1800.00
Total fertilizer cost (Rs/ha)	**8100.00**	**8100.00**	**8100.00**	**8100.00**
Herbicide cost (Rs/kg)	**750.00**	**750.00**	**750.00**	**750.00**
Lob our for sowing/seedling uprooting/ transplanting cost (Rs/ha)	1350.00	1350.00	1350.00	18385.50
Labor cost for weeding (Rs/ha)	13500.00	13500.00	13500.00	6750.00
Labor cost for fertilizerapplication (Rs/ha)	450.00	450.00	450.00	450.00
Labor for irrigation Cost (Rs/ha)	675.00	1012.50	675.00	1350.00
Labor for harvesting Cost (Rs/ha)	9000.00	9000.00	9000.00	9000.00
Labor for threshing and cleaning Cost	3091.60	3873.00	3251.60	3808.00
Total labor cost	**28066.60**	**29185.50**	**28226.60**	**39743.50**
Total variable cost	**42316.60**	**49221.25**	**47126.60**	**58779.25**
Grain yield at 10% m.c. (Kg/ha)	2576.34	3227.50	2709.67	3173.33
Straw yield (kg/ha)	3959.84	4202.50	4975.00	4121.50
Return from Grain (Rs/ha)	51526.70	64550.00	54193.30	63466.60
Return from straw (Rs/ha)	7919.67	8405.00	9950.00	8243.00
Total Revenue	**59446.37**	**72955.00**	**64143.30**	**71709.60**
Gross margin	**17129.77**	**23733.75**	**17016.70**	**12930.35**