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Feasibility of Laser Land Leveling in Rice–Wheat Systems of the Central Indo-Gangetic Plains

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ABSTRACT

Precision land leveling is to produce a best-fit uniform and plain soil surface that makes optimum use of soil and water resources for agricultural purpose. Precision land leveling is made with the help of laser technology. The personal study is to find out the impact of laser land leveling on the changes in output level and to determine the extent of water saving. The study is based on primary data collected from the farmers' fields leveled with traditional methods and with laser leveling technology. Partial budget technique has been employed to determine benefit cost ratio. The perusal of crop yield data crop yield and total irrigation time required per season between laser levelled (LLL) and traditionally levelled (TLL) fields. Laser levelling in rice fields reduced irrigation time by 47–69 h/ha/season and improved yield by approximately 7 per cent compared with traditionally leveled fields. In wheat, irrigation time was reduced by 10–12 h/ha/season and yield increased by 7–9 per cent in laser levelled fields (J. P. Aryal et al., 2015).

Key words: *Laser land leveling, precision leveling, water saving, Incremental Benefit Cost Ratio, IBCR*

INTRODUCTION

The development, use and distribution of the physical resources, namely water and land have played a major role in the process of agricultural development in Pratapgarh. The use of both land and water has increased over the years. The lack of high quality agricultural land has been partly overcome through greater intensity of land use and multiple cropping. Greater water use has been mainly through larger supplies from both surface water and ground water sources. Further increase in production and productivity will probably not be possible without the expanded water availability, increase in the intensity of land use as well as in the total cropped area and the cropping intensities.

Land leveling is important in terms of saving of land, saving water and labour. It improves drainage and helps to avoid crop damage. It also helps in the efficient use of other farm resources[1].

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Precision land levelingmay increase the water use efficiency and consequently the yield of crops. Keeping in view of the soil conditions, Sources of water, drainage facility, cost of leveling and farmer's choice, the field is designed for earth moving operation either on zero level or on certain gradient. At first, a tractor drawn soil scraper is used for earth moving and rough grading. Then land laser is used to remove small undulations and irregularities in the field. The process of surface smoothing can best be performed with the help of laser equipment. This equipment has a high initial cost but it reduces the operation cost and ensures the field level to desired gradient. Therefore, this study was undertaken with the objective to determine the impact of laser land leveling on the productivity of various crops over the farmers practice and to find out the extent of water saving as result of laser or precision land leveling.

Rising demand for food production due to increased population will further amplify the energy consumption by the agriculture sector. Considering the existing consumption pattern, India will need to produce at least 37 per cent more rice and wheat by 2025 as compared to the year 2000, with nearly 10per cent less water available for irrigation[5]. Therefore, there is a need of technologies that can conserve water resources, increase the efficiency of energy use and enhance agricultural productivity[9,10].

Low efficiency of irrigation and poor recovery of water charges are the major problems associated with agricultural water management in India (GOI 2013). In the rice–wheat (RW) system of the Indo-Gangetic Plains (IGP), about 10–25 per cent of irrigation water is lost due to poor water management and uneven fields[11]. Laser land leveling (LLL) is an alternative land leveling technology that has the primary benefit of a reduction in the loss of irrigation water occurring due to highly undulating land. Therefore, applying LLL rather than traditional land leveling (TLL) can help reduce the use of irrigation water and save energy through reduced duration of irrigation[6,5,7].

MATERIAL AND METHODS

The study was based on primary data, which was collected from different villages from Lalganj, Kunda, Kalakankar and Rampur Sangramgarh blocks of district Pratapgarh. A list of farmers, who have got their fields leveled with traditional methods and with laser technology was taken from "On Farm Trails" Krishi Vigyan Kendra, Kalakankar, Pratapgarh. A Sample of 40 farmers was taken at randomly belonging to different categories *i.e.* large, medium and small farmers. A well designed, comprehensive and pre-tested questionnaire was used to collect required data from farmers. In the sampled area, data were collected about Paddy and wheat crops grown by the farmers, under both practices *i.e.* Farmers, Practices of land leveling and laser land leveling.

The data were analyzed by using partial budgeting method described by CIMMYT[2] and Chaudhry *et. al.*. For the preparation of partial budget, calculations were made by using following formulas:

a. Average yield of the crop = $\sum Y_1 / n$

Where: Y_1 = Average yield of the crop

N = Number of the farmers

b. Field price of output = Sale price of the output (Transport cost + Bagging cost + Loading costs + Marketing costs)

c. Gross field benefits = Average yield x Field price of output

d. Estimation of costs that vary

Costs that vary are the costs of purchased inputs and machinery that vary between new technology and current farmer practices. These costs have been calculated as under:

Costs of laser leveling: For land leveling, laser equipment was provided to the farmers by Krishi Vigyan Kendra, Kalakankar, Pratapgarh. Cost of laser land leveling was charged on the basis of meter reading of the tractor which took the laser equipment to the farmer's field. One side cost was borne by the farmer and that of the other side by the Krishi Vigyan Kendra, Kalakankar, Pratapgarh.

Cost of laser land leveling = Time required for laser land leveling x Rate (Rs.) /hour

With the consultation of scientist, Krishi Vigyan Kendra Rs. 500.00 per hour was decided as average cost of laser land leveling.

Labour Costs of Irrigation: Farmers generally had their own labour for irrigating their fields. But for the purpose of calculation in this study, we assumed casual hired labour for irrigation. Time taken by the casual hired labour for one day was assumed as 08 hours. The rate of casual labour prevailing in sampled area was taken Rs. 120 - 150 per day (8 hours). Labour cost for irrigation was calculated as:

Labour cost for irrigation **=** labour cost for one irrigation X No. of irrigation for the crop

No. of irrigation for various crops: Number of irrigation was different with respect to the respondents for various crops in the sampled area. So, average was taken for the number of irrigation.

Time for irrigation: Time taken to irrigation one acre varied among the farmers depending upon the location of the farms with respect to outlet. Average time was calculated using the following formula:

Average time spent in irrigation for one acre in one irrigation –

$$= \sum t_1/n$$

Where, t = Total time spent by the farmers in irrigating one acre for one Irrigation

n = No. of farmers

Net field benefits:

Net benefits were obtained by subtracting total costs that vary from gross field benefits.

Net field benefits = Gross field benefits – Total costs that vary

Incremental Benefit-Cost Ratio (IBCR): It is a profitability indicator, which expresses the relationship between the net benefits and costs that vary. Incremental benefits- cost ratio (IBCR) is determined by dividing change in benefits of both farmer's practices and laser land leveling with change in their respective costs. It shows the returns from additional costs made on laser land leveling over the farmer's practice of land leveling.

(Net benefits in laser land leveling- Net benefits in farmer's practice)

IBCR =

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……

(Costs that vary in laser land leveling – Costs that vary in farmers practices)

RESULTS AND DISCUSSION

The result of the study as depicted in Table - 1 Shows that the average yield under farmer's practice of land leveling for the crops of wheat and paddy was 12.26 and 19.2 qt. compared with 16.80 and 24.90 qt. under laser land leveling respectively. In terms of percentage yield increased by 16.8 and 74 percent for the abovementioned crops respectively with the employing of precision leveling with laser technology. The Gross field benefits under farmer practice of wheat and paddy crops was 12260 and 22080 as compared with 14250 and 28520 Rs. /acre. The percentage increased by 16.23 per cent and 29.17 per cent. The Hrs. spent in irrigation (hrs. /acre) under farmer practice of wheat and paddy crops 7.2 and 8.0 as compared with 3.4 and 4.5 hrs. /acre. This increase in yield was attributed to improved germination and seedling survival by laser land leveling. Farmer's field condition, seed quality, management practices are the factors contributing to higher yield.

The results in Table 2 reveals that costs varies significantly when farmers employ laser technology for leveling purpose due to increasing shift in cost of harvesting (threshing). This increase is due to the fact that harvesting and threshing costs are function of output. Precision leveling resulted in significant increase in yield of the crops and farmers had to pay extra for harvesting and

threshing of that increased output. Under farmer's practices costs inclusive of labor charges for irrigation was Rs. 480 and Rs 450 for wheat and rice. Fields leveled with laser technology; total costs that varied were Rs. 1500 and Rs. 1500 for the above mentioned crops respectively. The incremental benefit cost ratio (IBCR) in wheat crop 20.50 percentages and in paddy 28.80 percentage saves water in laser land leveling in comparison with farmer's practice.

Table 1: Partial Budget for crops:

Sl. No.	Particulars	Wheat		Rice	
		Farmer's practice	Laser land leveled	Farmer's practice	Laser land leveled
1	Average Yield (qt./acre)	12.26	14.32	19.2	24.9
2	Gross field benefits (Rs./acre)	12260	14250	22080	28520
3	Cost of Laser Land Leveling (Rs./acre)	-	1500	-	1500
4	Hours spend in irrigation (hrs./acre)	7.2	3.4	8.0	4.5
5	Cost of irrigation (Rs./acre)	720	340	800	450
6	Cost of hired labour for irrigation (Rs./acre)	200	100	200	100
7	Total cost that vary (Rs./acre)	3690	5190	3220	4720
8	Net benefit (Rs./acre)	8570	9060	18860	23800
9	IBCR	0.32		3.2	

Fig: Incremental Benefit-Cost Ratio (IBCR) of Laser Land Leveling for crops:

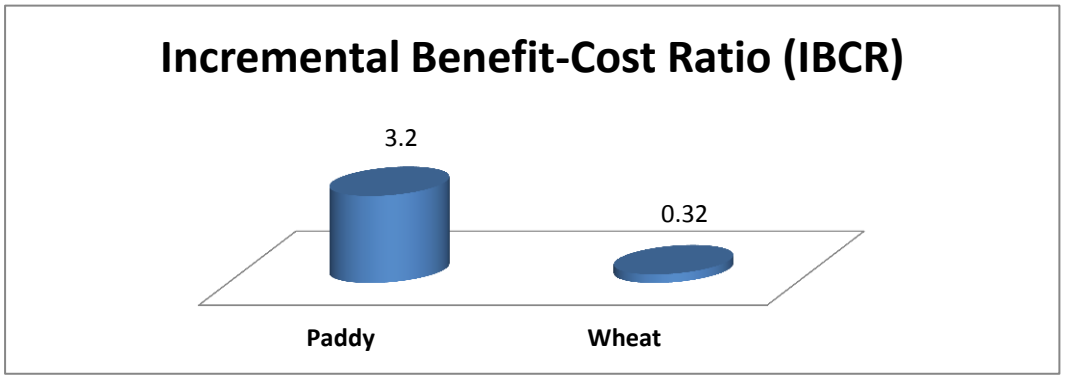

Table 2: Water saving (%):

Crop	Water saving (%)
Wheat	20.50
Paddy	28.80

CONCLUSION

The present study showed that benefits were higher for high water demanded crop *i.e.* Paddy so farmer who grow crop of higher water requirement must have laser leveled field. The percent yield increased by 16.80 per cent, 30.00 per cent and 20.50 per cent, 28.80 per cent saves water for the wheat and paddy crops respectively with the precision leveling. Agricultural service providers must be encouraged to purchase the laser land leveler, so that they can provide this latest service to the farmers on rent basis. The farmers who purchase the laser leveler should be given facilitation and training by KVK and Department of Agriculture for the operation and maintenance of laser land leveler. Laser land levelling reduces the use of water for

irrigation and increases crop yields. Irrigation time in laser levelled fields was reduced by 47–69 h/ha/season in rice and by 10–12 h/ha/season in wheat and yields of wheat and rice were 7–9 per cent and 7 per cent higher, respectively, in laser levelled fields as compared to traditionally levelled ones. Reduced duration of irrigation corresponds to decrease in energy use for agriculture and thus lowers greenhouse gas emission from agricultural activities. Therefore, increasing the use of Laser land levelling contributes to climate change mitigation. In addition, less use of water for irrigation also provides scope for the water saved to be used in other sectors of the economy e.g., to satisfy the needs of increasing populations, industrialization and urbanization.

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