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Economics of Laser Land Leveling in District Faisalabad

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Abstract: The purpose of precision land leveling is to produce a best-fit uniform and plane soil surface that makes optimum use of soil and water resources for agricultural purpose. Precision land leveling amongst other methods is made with the help of laser technology. This research paper attempts 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 who have got their fields leveled with their traditional methods and with laser technology. Partial budget technique has been employed to determine benefit cost ratio.

Keywords: Precision land leveling, Laser land leveling, Partial Budget

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 Pakistan. The use of both land and water has increased over the years. The paucity 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. In relation to the available land resources, the lack of water has been one of the main limiting factors for agricultural production in Pakistan (Govt. of Pakistan, 1988).

One of the major problems overtime has been the inefficiency of water use. Out of 142 million-acre feet of water from our river sources, only 42 million-acre feet is available for irrigating the crops (Govt. of Pakistan, 1998). Another estimate shows that 30 to 50 percent of water is wasted when land is not properly leveled (Ahmed and Tinnermeire, 1974).

To improve the system and reduce losses, various measures have been undertaken. These include watercourse lining, concrete control structures and precision land leveling.

Land leveling is of great importance for the estimated 16.5 millions irrigated hectares out of the total cultivated area of 20 million hectares (Govt. of Pakistan, 1996). Land leveling is important in terms of saving land, saving water and saving labour. It improves drainage and helps avoid crop damage. It also helps in the efficient use of other farm resources (Ahmad and Tinnermeire, 1974).

Precision land leveling may increase the water application efficiency and consequently the yield of crops. Keeping in view of the soil conditions, sources of water, drainage facility, cost of leveling and farmers' 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 planner 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.

In Pakistan, this practice is being promoted under "On-Farm Water Management", Department of Agriculture, Government of Punjab, to improve yield and conserve irrigation water. However, little is known about the influence of laser land leveling technology over farmers' practice of land leveling in terms of productivity of various crops. 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.

Materials and Methods

The study was based on primary data, which was collected from different villages located around Faisalabad. A list of farmers, who have got their fields leveled with traditional methods and with laser technology was taken from "On-Farm Water Management", Department of Agriculture, Government of the Punjab. A sample of 40 farmers from both the locations were taken at random 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 seven crops grown by the farmers, under both practices i.e. farmers, practice of land leveling and laser land leveling. These crops were wheat, rice, sugarcane, maize, potato, sorghum and ladyfinger.

The data were analyzed by using partial budgeting method described by CIMMYT (1988) and Chaudhry *et al* (1995). For the preparation of partial budget, calculations were made by using following formulas.

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

Where: Y_i = 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 practice. These costs have been calculated as under:

i. Cost of laser land leveling : For land levelling, laser equipment was provided to the farmers by "On-Farm Water Management", Department of Agriculture, Government of Punjab. Costs of laser land levelling was charged on the basis of meter reading of the tractor which took the laser equipment to the farmers' field. One side cost was borne by the farmer and that of the other side by the "On-Farm Water Management" Department of Agriculture.

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

With the consultation of Coordinator "On-Farm Water Management" and other officers, Rs. 150 per hour was decided as average cost of laser land levelling. One acre on an average required three hours for land levelling with laser equipment.

ii. Cost of harvesting and Threshing : Harvesting cost vary widely with respect to different crops. Different crops were harvested at different rates as depicted in the table. Rate of threshing / shelling cost was also different in different crops which is shown as under.

Table 1: Rate of Harvesting, Threshing and Shelling of Different Crops

Crop	Harvesting Rate	Threshing / Shelling Rate
Wheat	1/16th of the Yield	1 / 13th of the Yield
Sugarcane	Rs. 4.25 / 40 Kg	—
Rice	Rs. 4 / 40 Kg	---
Maize	Rs. 3 / 40 Kg	Rs. 6.50 / 40 Kg
Potato	Rs. 6.40 / 40 Kg	---
Sorghum	Rs. 3 / 40 Kg	---
Ladyfinger	Rs.100 / 40 Kg	Rs. 80 / 40 Kg

iii. Labour cost 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 8 hours. The rate of casual labour prevailing in sampled area was taken Rs. 100 / 8 hrs. Labour cost for irrigation was calculated as:

Labour cost for irrigation = Labour cost for one irrigation × No. of irrigation for the crop

Time for one Irrigation: Time taken to irrigate 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 irrigating one acre in one irrigation

$$= \sum t_i / n$$

Where: **t** = Total time spent by the ith farmers in irrigating one acre for one irrigation

n = No. of farmers.

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

e. 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

f. Incremental Benefit-Cost Ratio: 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 farmers' practice and laser land levelling with change in their respective costs. It shows the returns from additional costs made on laser land levelling over the farmers' practice of land leveling.

$$IBCR = \frac{\text{Net benefits in Laser land levelling - Net benefits in Farmers' Practice}}{\text{Costs that vary in Laser land levelling - Costs that vary in Farmers, Practice}}$$

Results and Discussion

The results of the study as depicted in Table 2 shows that average yield under farmers' practice of land levelling for the crops of wheat, sugarcane, rice, maize, potato, sorghum and ladyfinger was 1480, 2786,1133, 2600, 10000, 7867 and 480 kg compared with 1563, 33829,1567, 3080,12000, 7867 and 560 kg under laser land levelling respectively. In terms of percentage, yield increased by 5.6, 18.45, 27.70, 15.58, 16.67, 26.25, 14.29 percent for the abovementioned crops respectively with the employing of precision levelling with laser technology. This increase in yield was attributed to improved germination and seedling survival by laser land levelling.

Average yield of wheat as result of laser technology was 3.86 tonnes per hectare in this study while Luzes and Lynce (1990) found in 1988 and 1989 grain yield of 7.1 and 10.2 tonnes per hectare in Portugal. The difference in yields could be attributed to other factors like fertilizer use, weedicide use etc.

El-Yazal and Wissa in Egypt (1990) reported that average yield for the first and ratoon crops of sugarcane were 43686 and 44920 kg per acre for laser levelling of land respectively. While the results of this study showed average yield of sugarcane under laser land levelling was 33829 kg per acre. Climatic and geographic conditions, good quality seed, better management, availability of inputs in time are the factors contributing to higher yield in Egypt

The results in the table 2 reveals that costs varies significantly when farmers employ laser technology for levelling purpose due to upward shift in cost of harvesting (threshing). This increase is due to the fact that harvesting and threshing costs are function of output. Precision levelling resulted in significant increase in yield of the crops and farmers had to pay extra for harvesting and threshing of that increased output. Under farmers' practices costs inclusive of labour charges for irrigation was Rs. 3328, 3461, 729, 1041, 1823, 575, 2411.28 for wheat, sugarcane, maize, rice, potato, sorghum, ladyfinger. On fields levelled with laser technology, total costs that varied were 4106, 4448, 1266, 1594, 2540, 1180, and 3161.25 for the aforementioned crops respectively.

Partial budget for the crops under both practices of land levelling showed that the net benefits in laser land levelling were higher in each crop than farmers' practice of land levelling. Benefits as a result of laser technology were high in sugarcane, ladyfinger, rice and potato crops while benefits for wheat sorghum, maize crops were low. The incremental benefit cost ratio (IBCR) varied from 0.70 to 18.67 for various crops. Generally, speaking, incremental cost ratio was higher for high delta crops than for the crops having low requirement. It was 0.70 for wheat, 4.06 for sugarcane, 1.23 for maize, 5.19 for rice, 18.67 for potato, 0.91 for sorghum and 5 for ladyfinger.

Fig: Incremental Benefit Cost Ratio of Laser Land Levelling for Various Crops

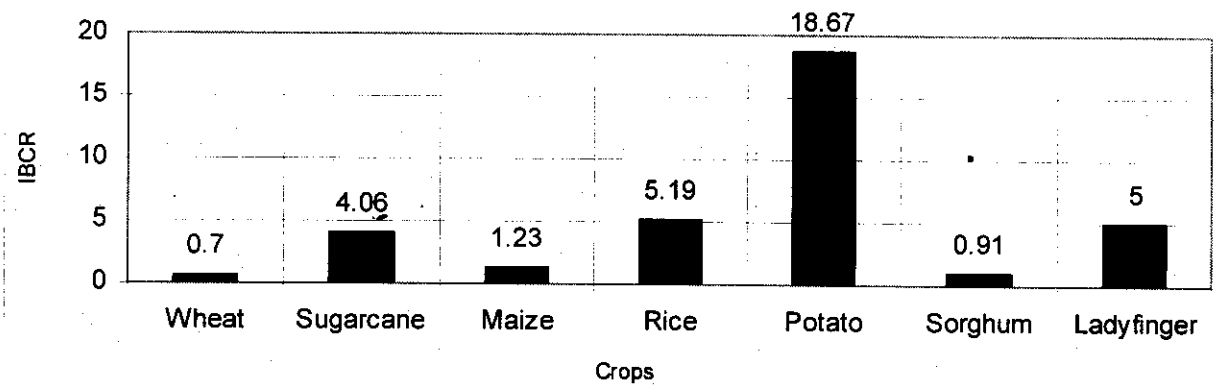

Table 2: Partial Budget for Various Crops

	Wheat		Sugarcane		Maize		Rice		Potato		Sorghum		Ladyfinger	
	FP	LL	FP	LL	FP	LL	FP	LL	FP	LL	FP	LL	FP	LL
Average Yield (Kg/Ac)	1480	1563	27586	33829	2600	3080	1133	1567	10000	12000	7867	10667	480	560
Gross Field Benefits	12257	13579	22069	27063	6500	7700	8951	12379	70000	84000	3245	4400	27000	31500
Cost of Laser Land Leveling (Rs/Ac)	-	450	-	450	-	450	-	450	-	450	-	450	-	450
Cost of Harvesting (Rs/Ac)	1717	1917	2931	3594	195	231	566	783	1600	1920	492	667	1200	1400
Cost of Threshing / Shelling (Rs/Ac)	1443	1612	-	-	422	500	-	-	-	-	-	-	960	1120
Cost of Casual Hired Labour for Irrigation (Rs/AC)	168	127	530	404	112	85	475	361	223	170	84	64	251.28	191.25
Total Costs That Vary (Rs/Ac)	3328	4106	3461	4448	729	1266	1041	1594	1823	2540	575	1180	2411.28	3161.25
Net Benefits (Rs /Ac)	8929	9473	18607	22615	5771	6433	7911	10784	68657	82036	2670	3220	24588.7	28338.7
Incremental Benefit Cost Ratio (IBCR)	0.70		4.06		1.23		5.19		18.67		0.91		5	

FP: Farmers' Practice LL: Laser land leveling

Precision leveling leads to saving of significant amount of water as water is evenly spread over the entire land surface. The results of the study revealed that 24.5, 24.5, 31.66, 26.50, 33.00, 31.00, 17.00 percent water was saved in case of wheat, sugarcane, rice, maize, potato, sorghum and ladyfinger respectively due to laser land leveling (Table 3). This is real advantage of laser leveling over farmers' practice of land leveling. As rice is leading crop in the rice based cropping area and grown on larger areas and almost one third water saving due to laser leveling may lead to positive impact on the overall deteriorating water situation of the country.

Table 3: Extent of Water Saving (%)

Crop	Water Saving (%)	Crop	Water Saving (%)
Wheat	24.50	Sugarcane	24.50
Rice	31.66	Maize	26.50
Potato	33.00	Sorghum	31.00
Ladyfinger	17.00		

Recommendations

From the results of this study, certain recommendations are given below.

a) The number of laser equipments of laser equipment possessed by "Ono-Farm Water Management", Department of Agriculture is too limited to provide services to the farmers of the whole province of Punjab. Government should supply adequate number of laser equipment to the department so that farmers can be benefitted from this technology.

b) The present study showed that benefits were higher for high delta crops so " On-Farm Water Management", Department of Agriculture, must ensure the availability of laser equipment to the farmers who would grow crops of higher water requirements.

c) Private businessmen and agricultural service providers must be encourage to purchase the laser equipment so that they can provide this latest service to the farmers on rent basis.

d) Government and private enterprises and

corporations should conduct research for the manufacturing of the laser equipment in the country. The company, which manufactures laser equipment, should be given subsidy. The farmers who purchase the laser equipment should be given facilitation and training for the operation and maintenance of laser technology.

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