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Water Conservation by Laser Land Leveling in District Mirpurkhas, Sindh, Pakistan

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Abstract:

Pakistan's agriculture sector has remained the main source of livelihood for the rural population as well as ensures food availability to rural and urban people. Due to poor irrigation practices 14 million hectares land has been saline and waterlogged while 11 and 24 million hectares by deforestation and overgrazing, respectively. Among natural resources, land and water are crucial for Sindh's development so there is dire need to conserve them. To cope with water scarcity different strategies are adopted in the world. Leveling of agriculture land is prerequisite for higher yield as unevenness of field results in lower seed germination rate, water loss and lower yield; eventually put financial strain to the farmers. A sample of 60 farmers from district Mirpurkhas was purposively selected for the study within the radios of 10 kilometers. This research study identified that laser leveled wheat yielded 14.7% higher output than non-laser leveled field and laser leveler user farmers obtained 62.5% higher net returns as compared to non-laser users.

Key words: Laser land leveling, economic impact, water saving.

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1. Introduction

Meeting food demand of fast-growing world population is challenging to all stakeholders on supply side which is expected to reach more than 9 billion in 2050. It is estimated that out of 7.3 billion world population 805 million people are suffering from chronic undernourishment and they don't have enough food to eat and majority of them lives in underdeveloped countries. The present food demand and supply gap is widening day by day as food production resources are under pressure and threatened by mismanagement. Studies reveal that 25 % of world land is degraded. Some 1.6 billion hectares of the world's best, most productive lands are currently used to grow crops. Parts of these land areas are being degraded through farming practices that result in water and wind erosion, the loss of organic matter, topsoil compaction, salinity and soil pollution, and nutrient loss (FAO, SOLAW, 2011).

Pakistan's agriculture sector has remained the main source of livelihood for the rural population as well as ensures food availability to rural and urban people. It is a key sector of the economy as it provides raw materials to main industrial units of the country and also plays a major contribution in export earning of the country. The agriculture sector accounts for 21.0 percent of GDP and absorb 43.7 percent of labour force (Pakistan Economic Survey, 2013-14). Pakistan being a developing country also faces such problems with regard to increasing population and underdeveloped agriculture sector. Only 25% of Pakistan's geographical area is suitable for cultivation to feed 180 million populations. Increasing food demand is putting pressure on country's existing natural resources and over-exploitation of land and water resources resulted in their degradation. The problem of land degradation is worsening and causing huge economic losses as well as creating environmental problems for Pakistan including degradation of dry-land ecosystems, loss of soil fertility, flash

floods, loss of biodiversity, reduction in land productivity, soil erosion, water logging, salinity, in addition to other problems associated with rapid population growth - all are putting pressure on natural recourses. The situation is further aggravated by water scarcity, frequent droughts and mismanagement of land resources, contributing to desertification and reduced productivity, consequently increasing rural poverty. Due to poor irrigation practices 14 million hectares land has been saline and waterlogged while 11 and 24 million hectares by deforestation and overgrazing, respectively (Khan M. Azeem. *et al*. ICARDA, 2012).

Sindh is the 2nd largest province of Pakistan, population wise as well as economically. Its contribution to national GDP remained 32% while it shares 24% of population. Sindh's 44 million population livelihood depends on agriculture, service and industrial sectors. Though Agricultural sector contributes 17% in provincial GDP against industry (36%) and service sector (47%), it is the largest employer as it gives employment to 70% rural population besides supporting agro based textile, sugar and edible oil industries. Though Sindh agriculture sector contributes a lot to economy it faces several problems from policy formulation and implementation to natural resources mismanagement and degradation. The total gross command area (GCA) is 5.76 million hectares and it is estimated that about 37.6 percent of the gross command area of Sindh is under water logging and salinity problems which has reduced the production of major crops by 40 to 60 percent (L. Bakshal, L. Masood. 2012). Among natural resources, land and water are crucial for Sindh's development so there is dire need to conserve them. To cope with water scarcity different strategies are adopted in the world.

Studies show that due to unawareness and underdeveloped irrigation water canals network more than 45% water is lost in canals, distributaries and water courses due to water seepage causing water logging and salinity; and 25% is

lost at field level, therefore only less than 35% water is available for crops. This alarming situation has compelled policy makers to sensitize farming community far water conservation. To control seepage and improve water conveyance efficiency canals, distributaries and watercourses are lined while to enhance water application efficiency at field level various projects have been initiated by the government and modern water conservation technologies are being introduced to the farmers. Among them Light Amplification by Stimulated Emission of Radiation (LASER) guided levelers and High efficiency irrigation systems (HEIS) like sprinkle, drip and rain guns are getting popularity among growers.

Leveling of agriculture land is prerequisite for higher yield as unevenness of field results in lower seed germination rate, water loss and lower yield; eventually put financial strain to the farmers. Farmers have been leveling their fields in traditional way by animal and tractor drawn scrapers and blades proved costlier and failed to give desired results. But now empirical evidences have proved that modern water conservation technology of laser land leveling is proved beneficial to minimize operational costs, increase productivity and water conservation.

In Sindh, Laser leveling was introduced in 1990's and afterward many projects were initiated by Sindh government to deliver this modern water conservation technology on subsidized rates of 50% to the farmers as in open market each laser guided leveling equipment costs PKR 6,20,000/=. Currently 1000 laser land levelers are working in Sindh mostly given by the Sindh Government on subsidy having leveling capacity of 400 acres annually. Sindh still needs more laser levelers as out of 7.64 million cultivated acres only 0.5 million acres have been leveled by Laser Levelers. This study aims to evaluate the comparative economic impacts of laser land levelers to the farmers and to compare costs, net returns, water

saving, seed saving, uniform seed germination and increased cropping intensity.

2. Materials & Methods

This study was carried out through primary survey to evaluate comparative economic benefits of laser land leveling to the farmers. For comparison it was necessary to collect data from two different groups of farmers,; one comprising laser land leveler users and other group was those who carry out land leveling operations in traditional way.

Considering scope of the study, time and financial limitations a sample size of 60 farmers from district Mirpurkhas was purposively selected for the study as district Mirpurkhas is one of districts where agricultural lands are degraded due to water mismanagement. Government reforms regarding land and water management are being implemented. Growers of district Mirpurkhas are ahead to embrace water conservation technologies. Therefore, we purposively selected four villages of district Mirpurkhas, with the purpose that two such villages where farmers are adopting water conservation strategies especially laser land leveling and two villages in which farmers are not adopting any water conservation strategy. These all four villages are located in same union Council Mirwah Gorchani within the radios of 10 kilometers. From each village 30 households were randomly selected. Those farmers of villages were particularly chosen who used same input combination and wheat varieties and having same soil profile. The survey was conducted at the end of Rabi Season of 2015 when wheat crop was just harvested. So it was easy for the farmers to recall their memory during data collection as farming sector is not documented and farmers don't have any cost and revenue entries registered. Villages were visited and data was collected through two different questioners which

were initially prepared, tested and modified. Collected data was classified, entered and analyzed on MS Excel software.

3. Results & Discussion

In order to identify and compare indicators like laser leveling technology availability, access and adaptation by different farmer classes, purposively selected farmers groups of laser leveler user & non-laser leveler user farmers were further categorized into small land holders having land holding up to 5 hectares, medium land holders possessing 5 to 10 hectares of land and large land holders having land of more than 10 hectares.

Table 1. Study area sample size

	Small land Holders (up to 5 ha)	Medium Land Holders (5- 10 ha)	Large Land Holders (>10 ha)	Total
Laser Leveler User Farmers	12 (40%)	12 (40%)	6 (20%)	30 (100%)
Non-Laser leveler User Farmers	12 (40%)	12 (40%)	6 (20%)	30 (100%)

As it is indicated in the above Table.1 that 12 land holders from each category of small and medium land holders were selected while 6 growers from large land holders from laser and non laser group were identified and visited for data collection. The total sample size of 60 farmers was comprised of 40 % of small, 40% of medium and 20% of large land holding farmers.

General characteristics of respondents

The socioeconomic indicators of sample growers show that 15% of the farmers were in the age group under 30 years, 48% were in between 31 to 50 years, while 37% grower's age group was above 50 years.

Table 2 General characteristics of sample farmers of district Mirpurkhas, 2015

Indicators	Numbers	Percentage
Age Group (Years)		
Up to 30	9	15
31--50	29	48
> 50	22	37
Education (levels)		
Illiterate	6	10
Primary	19	32
Secondary	20	33
Higher Secondary	9	15
Graduation	6	10
Working Experience (Years)		
Up to 10	7	12
11 --20	26	43
31--40	25	42
>40	2	3

As indicated in Table 2, that majority 48% of landowners, tenants and share croppers falling into 31 -40 age group were mature and middle-aged which could be turned into precious human capital through Government and other stakeholder's capacity development programs as their education status was not up to the level, only 10% growers did graduation and 15% reached at intermediate level while majority 33% and 32% got secondary and primary education, respectively. Moreover, among them 10% were illiterate. Though their education level was not satisfactorily, their working experience contributed a lot to get at least enough yields to cover production costs as majority 43% of farmers having 11 to 20 years farming experience while 42% growers had 31 to 40 years field experience.

Status of Ground Water Level

With the excessive use of irrigation water and canal seepage Mirpurkhas is one of the districts where agricultural lands are badly affected and have become water logged and saline. Acute problem of water logging and salinity has not only been affecting crop productivity, income and livelihoods of the area's

population but also deteriorating land environment. To cope this menace in 1984 Government of Pakistan initiated World Bank funded project Left Bank Outfall Drain (LBOD) project to recover 1.27 million acres of waterlogged and salinity affected lands of district Mirpurkhas, Sanghar and Nawabshah districts and later extended to Badin district.

Table 3. Status of ground water level of sample respondents

Water Level Depth (m)	At Present		10 years Back		20 years Back	
	Number	Average Depth (m)	Number	Average Depth (m)	Number	Average Depth (m)
< 2 m	0 (0.00)	0.0	3(5.0)	1.8	49 (81.7)	1.7
2–3 m	56(93.3)	2.9	57(95.0)	2.4	11 (18.3)	2.1
> 3 m	4 (6.7)	3.6	0	0.0	0	0.0
Average Depth (m)		3.0		2.4		1.8

Note: Figures within the parentheses represent percentage to total farmers in the sample

Though LBOD could not achieve desired objectives due to various gaps it has been somehow leaving positive impacts on land environment as ground water table in district Mirpurkhas is getting low from alarming shallow depth of 1.8 meter 20 years back to 3 meters at present as revealed in Table 3. It is also indicated that gradually water table in study area is lowering 0.6 meters in every passing decade.

3.1 Physical Productivity

The average yield of crops in Sindh has been lower due to various factors including traditional field operations. Use of modern tillage operations can help to increase the yield and subsequent profits. This is evident from following data analysis (Table.4) of comparative yield of laser leveler users and non-laser leveler user farmers. An acre of non-laser leveled wheat field yield remained 1336 kilogram of wheat against laser leveled wheat crop; yielded 1532 Kilogram per acre which is 14.7 % higher as compared to laser leveled field. This increased wheat output proved that use of laser leveler can help farmers

to get maximum yield from their farms and bring the yield averages at upper level.

Table 4. Per acre benefits of laser land leveling in wheat cultivation of sample farmers

Particulars	Laser Leveled Farmer's Field	Non-Laser Leveled Farmer's Field	Gain/Loss (%)
Gain in Productivity (Kilogram)	1532	1336	14.7
Gain in Net Returns (Rs)	14101	8680	62.5
Gain in water saving (average application time in minutes)	30.7	35.8	-14.2
Gain in reduced seed rate (Kilogram)	59	65	-8.8
Gain in increased germination ratio (%)	83	69	20.3
Gain in increased cropping intensity (%)	73.8	66.4	11.1

3.2 Costs and Revenues

Besides other aims, one of the main objectives of this study was to evaluate and compare the net returns accrued to the farmers with application of laser land leveling as increased revenue proves an incentive to the farmers and contribute a lot in farmer's motivation to embrace new technologies and increase their farm outputs. The data revealed in Table 4 that there was 62.5% increase in net income of the farmers who applied laser levelers for wheat production as compared to those who leveled their fields in a traditional way. The average net income received from the laser leveled wheat crop was Rs.14101 while non-laser leveled field farmers.

The total average costs of wheat crop per acre of both laser and non-laser fields were calculated to compare the cost difference. The data shown in table.3 revealed that the actual cost difference between laser and non-laser leveled wheat crop is only 4.1 % which is not much higher as compared to net income increase of 62.5% as mentioned earlier. The total average expenses incurred by the laser leveled field farmer

were Rs.35018/acre; 4.1% higher than non-laser leveler users who made average cost to Rs. 33626/acre.

3.3 Water Saving and seed saving

Water has become matter of life and death for the farmers as it is the key determinant to well being of growers. The water scarcity is getting worse day by day in Sindh as small land holding farmers who have less influence on water access face clashes among themselves. Water conservation technologies like sprinkler and drip irrigation introduced recently are expensive and needs huge investment so are beyond their access. Among them laser leveler technology is the only technology which is not only affordable but also accessible to large, medium as well as to the small farmers. Water consumption by the crop was calculated by the average time needed to irrigate an acre per turn applied weekly or fortnightly by the farmers. The average time taken by the laser leveled wheat acre was 30.7 minutes per water turn while non-laser leveled field consumed 35.8 minutes to be irrigated which is 14.2% higher than laser leveled wheat acre which farmers use to increase the cropping intensity and improve saline affected lands. So laser land leveling not only has economic benefits but also help to improve overall land environment.

Due to unevenness of fields and flood application in bumpy lands not only results in water loss but also affect weed germination, that is why It is common practice in farmers that they apply higher seed rate than recommended to compensate low germination. With the help of Precision land leveling (PLL) farmers can save water as well as improve seed germination and save seed rate and its cost. In this study seed rate data was also collected from laser and non-laser users and analyzed.

It is evident from the above data presented that average seed rate applied by the farmer in laser leveled field was 59 Kg and 65 Kg in non-laser leveled wheat acre which is 8.8 % less than non-laser leveled field. As market price of seeds is

increasing rapidly so by applying laser leveler farmers can save seed and money.

3.4 Seed Germination Ratio

Seed germination ratio is the difference between seed sown and seed germinated in the field. Higher the germination ration, higher the yield .Among various other factors rough soil receive large amount of irrigation which stands in field for days, block aeration to the seeds which results in low germination, that is shown in the following data analysis of seed germination ratios of laser and non-laser leveled wheat acres. Collected data revealed that there was higher seed germination ratio (83%) in laser leveled field as compared to non-laser leveled fields which remained 69%, which is 20.3% less than laser leveled fields. Lower germination ratio not only waste seed, water and other inputs but also cause reduction in yield.

3.5 Cropping Intensity

Water availability is key determinant to cropping intensity. It was necessary to observe that how farmers use their saved water by applying water conservation technologies. Cropping intensity was calculated by analyzing ratio of cultivated land to their total land holdings.

Analyzed data show that laser leveler users were higher cropping intensity (73.8%) which was 11.1 % higher to the non-laser users, that was 66.4%. Increased cropping intensity turns into higher yields and incomes to the farmers. In this way laser leveler benefits overall well being of farmers as well as agriculture development.

4. Conclusion

By and large the use of laser leveling technology leads to save irrigation water, seed and increase germination ratio resulting higher yields besides increasing cropping intensity. The

particular benefits of laser land leveling can be summarized as under:

- Laser leveled wheat yielded 14.7% higher output than non-laser leveled field.
- Laser leveler user farmers obtained 62.5% higher net returns as compared to non-laser users.
- With the application of laser land levelers farmers saved 14.2% irrigation water.
- The farmers also saved 8.8% of seed and increased 20.3% germination ratio.
- The cropping intensity of laser leveler users is 11.1% higher than non-laser leveler users.

Keeping in view the above research figures it is highly recommended to promote water conservation technologies particularly laser land leveling in order to cope with persisting water shortage and scarcity which is hindering well being and development of agriculture sector.

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