International Journal of Social Sciences
Citation: IJSS: **10**(01): 69-74, March 2021
DOI: 10.46852/2249-6637.01.2021.9

Laser Land Levelling: A Way Forwards towards Resource Conservation in Paddy –Wheat Cropping Patterns in Haryana

Dinesh Kumar[1*], Dalip Kumar Bishnoi[2], Mandeep Kumar[3] and Anil Kumar Malik[4]

[1]*Ph.D. Scholar, Department of Agricultural Economics, CCSHAU, Hisar, Haryana, India*
[2]*Assistant Scientist, Department of Agricultural Economics, CCSHAU, Hisar, Haryana, India*
[3]*M.Sc. Scholar, Department of Agricultural Economics, CCSHAU, Hisar, Haryana, India*
[4]*Senior Research Fellow, Department of Extension Education, CCSHAU, Hisar, Haryana, India*

*Corresponding author: thesupremenature@gmail.com **(ORCID ID:** 0000-0002-4883-1159)

Received: 23-10-2020 **Revised:** 11-01-2021 **Accepted:** 28-02-2021

ABSTRACT

Main objective of study was comparative analysis of Laser Land Levelling (LLL) vis-a-vis Conventional Land Levelling (CLL) in terms of resource use efficiency. Regression analysis along with economic concept of marginal value productivity (MVP) and marginal factor cost (MFC) were used to analyse resource use. Six variables were used to regress yield. The results of the study revealed that highest resource use efficiency were obtained in case of seed, while it was observed lowest in case fertilizers under laser land levelling (LLL) in paddy. Whereas, under conventional land levelling (CLL), highest resource use efficiency was found to be in case of labour while least resource use efficiency was obtained in irrigation. Similarly, in case of wheat highest and lowest resource use efficiency under laser land levelling technology were observed in inputs viz: seed and plant protection chemicals, respectively while, under conventional land levelling it was for inputs like labour and seed, respectively. Hence, study highlighted the strength of resource conservation potential of laser land levelling technology. Two variables i.e. irrigation and fertilizer impacted significantly with the adoption of laser land levelling, validated the outcomes of study by difference between MVP and MFC for these two particular inputs were found to be positive and close to zero indicated efficient utilizations of these resources. Hence, it is suggested that adoption of laser land levelling should be promoted on wider scale to tap its resource conservation potential.

Highlights

- Study has evaluated and compared resource use efficiency under laser land levelling and conventional land levelling in paddy-wheat crop rotation.

Keywords: Scale neutral, resource use efficiency, and Marginal value productivity, and Marginal factor cost, Regression analysis

Climate variability is increasing day by day which is threatening mankind. Glaciers are melting at rapid rate due to greenhouse effect and water scarcity will be major problem of in decade to come. Dominant cropping patterns in Haryana are rice- wheat, cotton-wheat and pearl millet-wheat. Also, it was examined that in recent years there is significant shifting of cotton belt into paddy belt. Growing of water thirsty crops had lead to

How to cite this article: Kumar, D., Bishnoi, D.K., Kumar, M. and Malik, A.K. (2021). laser land levelling: A Way Forwards towards resource Conservation in Paddy –Wheat Cropping Patterns in Haryana. *Int. J. Soc. Sci.*, **10**(01): 69-74.

Source of Support: None; **Conflict of Interest:** None

excessive lifting of groundwater causing groundwater table to descend to a seriously threatening level. Thus, keeping in mind this critical problem of water crisis it was imperative to introduce a resource conservation technology and quantify its potential benefits in terms of resource use efficiency.

Laser land levelling is known as water saving technology. It is levelling of field within certain degree of desired slope using laser guided scrapper. Some potential benefits of Laser land levelling are: It is a climate smart and energy efficient resource conservation technology which increases the factor productivity, profitability, decrease cost of cultivation and efficient in input uses (especially of water and fertilizer). It supports diversification because it helps in good water control which is required in vegetables. Also, raised beds are easy to create on levelled field. It increased cultivable area because of reduction in bunds in field. Also, it helps in better weed management. Laser land levelling (LLL) provides employment because owner of laser land levellers hire drivers at peak season (positive labour displacement). This technology is not biased towards large farmers and it is scale neutral technology. Almost each category of farmers has adopted this technology. Some limitations of using LLL are: Stubbles must be burnt or decomposed off before using laser land levelling. Better weed management (especially in cotton) leads to unemployment of labour doing manual weeding (negative labour displacement). Also, it is more economical to use laser land levelling on big size of farm because on small farms rig is continuously adjusted. Irrigated area is pre-requisite for using laser land levelling. So, that rainfed area of state will not get potential benefits of this technology. Thus, study focused on quantification of benefits of LLL in terms of resource use efficiency.

MATERIALS AND METHODS

Primary data has been collected from Karnal district of Haryana purposively on the basis of highest area under paddy-wheat cropping pattern which is most appropriate for the objective of study. Further, two blocks were selected at random and out of each block 20 adopters and 10 non-adopters of the technology were selected at random. Thus, a total of 60 respondents were interviewed using pretested interview schedule. Secondary data were collected from various published and unpublished sources i.e. Agricultural statistical at a glance, Statistical abstract of Haryana. Cobb douglas production function was fitted to quantify impact of LLL. General form of production function used was as follows-

$$Y = ax_1^{b1}.\ x_2^{b2}.\ x_3^{b3}.\ x_4^{b4}.\ x_5^{b5}.\ x_6^{b6}.\ U$$

Where,

Y = gross income (₹/ ha); a = constant; x_1 = Machine hours (hrs/ha); x_2 = Labour (man days/ha); x_3 = Seed (kg/ha); x_4 = Fertilizer (kg/ha); x_5 = Plant protection chemicals (g/ ha); x_6 = Irrigation (hrs/ha); U = Random disturbance term; b_i = (i = 1 to 6) indicate the regression coefficient of factor inputs.

Production elasticities

For testing the significance of production elasticities, t' value was calculated using the formula:

$$t = \frac{b_i}{s.e.\ of\ b_i}$$

b_i = Regression coefficient of input x_i; *S.E.* of b_i = Standard error of b_i.

Returns to scale

Returns to scale is a measure of proportionate change in output as a result of simultaneous proportionate change in inputs. Sum of all the exponents (production elasticities) of production function gives returns to scale.

Decision rules regarding returns to scale are as follows: if,

- RTS < 1: Decreasing return to scale, (Over-utilization of resources)
- RTS = 1: Constant return to scale, (Efficient-utilization of resources)
- RTS > 1: Increasing return to scale, (Under-utilization of resources)

However, Returns to scale are tested by statistical

technique for their significance because arithmetic figure may not depict type of relationship.

Resource use efficiency - Marginal Value productivity (MVP) and marginal factor cost (MFC) were used as tool to estimate resource use efficiency (RUE).

MVP – It is monetary value of additional output produced by using incremental unit of input.

MFC – It is cost incurred in hiring extra unit of unit i.e. market price of input

Ratio of MVP and MFC was calculated and RUE was estimated according to following decision rules- if,

- MVP/MFC > 1 – It indicates underutilization of factor and resource use is far below optimum level.
- MVP/MFC = 1 - It indicates efficient utilization of factor and resource use is equal to optimum level.
- MVP/MFC < 1 - It indicates over utilization of factor and resource use is far above optimum level.

In prescribed cobb douglas production function, MVP of factor input is calculated using formula:

$$MVP \text{ of } X_i = \frac{\overline{Y}}{\overline{X}} \times b_i$$

Where,

$\overline{Y}$ = productivity at geometric mean level; $\overline{X}_i$ = factor use at geometric mean level; b_i = regression coefficients of x_i

Resource use efficiency is considered when cost of hiring additional input (MFC or price) is equated with additional benefits in monetary terms (MVP) i.e.

$$MVP_i = P_i$$

Where, P_i is the price of unit quantity of input X_i.

Difference or deviations of MVP from price is treated as Resource use inefficiency. Greater the magnitude of deviations greater is resource use inefficiency. Also, positive value of deviations shows underutilization and negative values shows overutilization.

T test was used to test significance of deviations and given as follows:

$$t = \frac{MVP_i - P_i}{S.E.\ of\ MVP_i}$$

Where, MVP_i is the marginal value product of i^{th} input and P_i is its acquisition cost or price of input and standard error of MVP is calculated by multiplying Standard error of regression coefficients to ratio of yield and corresponding input at geometric mean level.

RESULTS AND DISCUSSION

Regression analysis and resource use efficiency of paddy in Karnal district under LLL vis-à-vis CLL

Regression analysis and resource use efficiency of paddy under laser land levelling (LLL) and conventional land levelling (CLL) in Karnal district of Haryana were presented in Table 1. The results of analysis are as follows:

Laser Land Levelling (LLL)

The results of the regression analysis under laser land levelling revealed that regression coefficient of fertilizer was found to be positive and significant while in case of seed, machine and labour it were found to be positive but had non-significant impact on paddy yield. Whereas, regression coefficients of plant protection chemicals and irrigation were found to be negative and had non-significant impact on productivity of paddy. Coefficient of determination (R^2) was 0.504 indicating that 50.4 per cent of total variations in dependent variable were explained by independent variables.

In order to measure the resource use efficiency of paddy in LLL, difference between MVP and MFC was found to be positive for inputs like machine, seed, fertilizer and irrigation indicating underutilization of these inputs suggested more use of these inputs may enhance the productivity of paddy. Whereas, difference between MVP for its unit price (MFC) were observed to be negative for inputs viz: labour and plant protection chemicals said to be overutilization of these inputs advised that decreases the use of these inputs may increase the profitability from paddy under laser land levelling scenario. Highest resource use efficiency was found to be that of seed while least resource use efficiency was found to be of fertilizer because difference between MVP and MFC is most close and most far from Zero (efficiency level) in case of these inputs respectively.

Table 1: Regression analysis and resource use efficiency of paddy under LLL and CLL in Karnal district of Haryana

	Intercept		Machine		Labour		Seed		Fertilizer		PPC		Irrigation	
	LLL	CLL	LLL	CLL	LLL	CLL	LLL	CLL	LLL	CLL	LLL	CLL	LLL	CLL
B	6.60*	13.71*	0.13	-0.04	0.04	0.27***	0.02	-0.01	0.15	0.02	0.01	-0.15***	0.20	-0.45***
SE	2.00	1.84	0.11	0.20	0.05	0.14	0.11	0.05	0.09	0.01	0.07	0.08	0.22	0.24
t	3.30	7.44	1.21	-0.20	0.93	1.98	0.15	-0.25	1.60	0.02	0.07	-1.77	0.90	-1.86
MVP			2.17	-0.70	0.16*	0.87	1.28	-0.93	5.26	0.04*	0.11	-2.85**	2.90	-5.44**
SE			1.80	3.49	0.17	0.44	8.78	3.75	3.29	0.21	1.54	1.61	3.23	2.92
MFC			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DIFF			1.17	-1.70	-0.84	-0.13@	0.28@	-1.93	4.26#	-1.00	-0.89	-3.85	1.90	-6.44#
t			0.65	-0.49	-4.96	-0.29	0.03	-0.51	1.30	-4.68	-0.58	-2.39	0.59	-2.20

*LLL = Laser land levelling, CLL = Conventional land lavelling, PPC = Plant protection chemicals; R^2_{LLL} = 0.504 R^2_{CLL} = 0.770; *Significance at 1% level, **Significance at 5% level, ***significance at 10% level; # Least resource use efficiency @ Highest resource use efficiency; Minus sign in Row of Diff (MVP – MFC) shows overutilization and positive value shows underutilization.*

Conventional land levelling (CLL)

Under conventional land levelling in paddy crop the results regression analysis revealed that regression coefficient of labour was found to be positive and significant while in case of fertilizer it was found to be positive but had non-significant impact on paddy yield. Regression coefficients of plant protection chemicals and irrigation were found to be negative and had significant impact on paddy productivity. However, machine and seed were found to be negative but non-significant effect on paddy yield. Coefficient of determination (R^2) was 0.577 indicating that 57.7 % of total variations in dependent variable were explained by independent variables.

In case of resource use efficiency of paddy under conventional land levelling, difference between MVP and MFC was estimated to be negative for all the inputs indicating over utilization of these inputs. Therefore, it was suggested that decrease the uses of these inputs may help in enhancement of factor profitability of the paddy. Highest resource use efficiency was found to be that of labour while least resource use efficiency was found to be that of irrigation because difference between MVP and MFC is most close and most far from Zero (efficiency level) in case of these inputs respectively.

Regression analysis and resource use efficiency of wheat in Karnal district under LLL vis-à-vis CLL

Regression analysis and resource use efficiency of wheat under laser land levelling (LLL) and conventional land levelling (CLL) in Karnal district of Haryana were presented in Table 2. The results of analysis are as follows:

Laser land levelling (LLL)

In case of laser land levelling it is evident from the table that regression coefficient of the entire explanatory variables viz: machine, labour, seed, fertilizers, plant protection chemicals, and irrigation were found to be positive but had non-significant impact on yield wheat. Coefficient of determination (R^2) was 0.550 indicating that 55% of total variations in dependent variable were explained by independent variables.

In order to examine the resource use efficiency of wheat, difference between MVP and MFC was found to be positive for inputs like machine, seed, fertilizer, plant protection chemicals and irrigation said to be these inputs were underutilized suggested that more units uses of these inputs may enhance the productivity of wheat under laser land levelling. While, in case of labour, the difference between MVP and MFC were

Table 2: Regression analysis and resource use efficiency of wheat under LLL and CLL in Karnal district of Haryana

	Intercept		Machine		Labour		Seed		Fertilizer		PPC		Irrigation	
	LLL	CLL	LLL	CLL	LLL	CLL	LLL	CLL	LLL	CLL	LLL	CLL	LLL	CLL
B	5.32*	7.78*	0.24	0.17	0.12	0.05	0.03	0.44**	0.01	-0.05**	0.17	-0.45*	0.12	0.2***
SE	1.60	2.54	0.15	0.27	0.10	0.13	0.15	0.17	0.11	0.02	0.12	0.12	0.11	0.10
t	3.32	3.07	1.58	0.64	1.17	0.38	0.21	2.64	-0.09	-2.48	1.46	-3.64	1.14	2.03
MVP			2.73	2.13*	0.38***	0.14	1.48	19.10*	-0.19	-1.02	5.62	-13.62*	2.78	3.97***
SE			1.72	3.31	0.33	0.38	7.02	7.23	2.25	0.41	3.85	3.74	2.43	1.95
MFC			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DIFF			1.73	1.13	-0.62	-0.86@	0.48@	18.10#	1.19	-2.02	4.62#	-14.62	1.78	2.97
t			1.00	3.31	-1.87	0.38	0.07	7.23	-0.53	0.41	1.20	3.74	0.73	1.95

*LLL = Laser land levelling, CLL = Conventional land levelling, PPC = Plant protection chemicals; R^2LLL = 0.504 R^2CLL = 0.770; *Significance at 1% level, **Significance at 5% level, ***significance at 10% level; # Least resource use efficiency @ Highest resource use efficiency; Minus sign in Row of Diff (MVP – MFC) shows overutilization and positive value shows underutilization.*

computed to be negative indicating that human labour was over utilized. Therefore, it was advised that reduce the uses of human labour in wheat cultivation and farm machination may help towards increase the profitability from wheat. Highest resource use efficiency was found to be that of seed and lowest resource use efficiency was found to be that of plant protection chemicals because difference between MVP and MFC is most close and most far from Zero (efficiency level) in case of these inputs respectively. .

Conventional land levelling (CLL)

Under conventional land levelling regression coefficients of seed and irrigation were found to be positive and had significant effect on wheat yield. However, regression coefficients for machine and labour were found to be positive but had non-significant impact on wheat yield. Whereas, regression coefficients for fertilizers and plant protection chemicals were found to be negative and had significant effect on productivity. Coefficient of determination (R^2) was 0.770 indicating that 77 per cent of total variations in dependent variable were explained by independent variables.

To examine the resource use efficiency, the difference between MVP and MFC was found to be positive for the inputs viz: machine, seed and irrigation were said to be underutilization of these inputs indicating more units uses of these inputs helps in increased yield of wheat in conventional land levelling scenario. While in case of labour, fertilizer and plant protection chemicals, the difference between marginal value productivity and marginal factor cost were found to be negative was said to be over utilization of these inputs advocated that less use these inputs may help in enhancement of profitability from wheat. Highest resource use efficiency was found to be that of labour and lowest resource use efficiency was found to be that of seed because difference between MVP and MFC is most close and most far from Zero (efficiency level) in case of these inputs respectively.

CONCLUSION

It was concluded from study that it is possible for farmers to efficiently use scarce resources *i.e.* water and fertilizer by adopting and tapping potential benefits of Laser Land Levelling technology on wider scale and minimize rising cost of cultivation. This technology is boon for paddy-wheat cropping pattern where water scarcity pause a serious constraint in crop production. Irrigation efficiency was improved because of uniform slope which reduced application time and also, pulverisation of soil created impervious layer which reduces percolation and infiltration losses. Similarly, fertilizer use efficiency was increased because due to LLL there was uniform application of fertilizer and absence of patchy land unhealthy crop and because of which farmer avoided putting extra dose of fertilizer

to cure patchy crop whose actual reason is not nutrient deficiency but water scarcity or water logging due to undulating surface. Hence, it is suggested that adoption of laser land levelling should be promoted on wider scale to tap its resource conservation potential.

ACKNOWLEDGEMENTS

Authors wish to acknowledge Chaudhary Charan Singh Haryana Agricultural University and all the farmers who participated in the study and made the study successful.

REFERENCES

Ahmad, B., Khokhar, S.B. and Badar, H. 2001. Economics of laser land levelling in district Faisalabad. *Pak. J. Appl. Sci.*, **1**(3): 409-412.

Ali, A., Hussain, I. and Erenstein, O. 2018. Laser-land levelling adoption and its impact on water use, crop yields and household income: Empirical evidence from the rice-wheat system of Pakistan Punjab. *Food Pol.*, **77**: 19-32.

Aryal, J.P., Bhatia, M., Jat, M.L. and Sidhu, H.S. 2014. Impacts of laser land levelling in rice-wheat rotations of the North-western Indo-Gangetic Plains of India. In *World Congress of Environmental and Resource Economists*, June 28 - July 2, 2014. Istanbul, Turkey.

Aryal, J.P., Rahut, D.B., Jat, M.L., Maharjan, S. and Erenstein, O. 2018. Factors determining the adoption of laser land levelling in the irrigated rice-wheat system in Haryana, India. *J. Crop Improvement*, **32**(4): 477-492.

Chia, Raymond. 2013. Laser Land Levelling, Reporter 63: *The Global Magzine of Leica Geosystems*, Switzerland.

Conservation agriculture, "Conservation Agriculture: Resource productivity and efficiency", IV World Congress on Conservation Agriculture, New Delhi, PACA, Ist Floor, NASC Complex, DPS Marg, Pusa, New Delhi - 110012 INDIA, 2009. Available: www.conserveagri.org, 2009.

Gill, G.J. 2014. *An assessment of the impact of laser-assisted precision land levelling technology as a component of climate-smart agriculture in the state of Haryana, India*. New Delhi: CIMMYT-CCAFS, International Maize and Wheat Improvement Center (CIMMYT).

Jat, M.L., Gathala, M.K., Ladha, J.K., Saharawat, Y.S., Jat, A.S., Vipin Kumar, Sharma, S.K., Kumar, V. and Gupta, R. 2009. Evaluation of precision land levelling and double zero-till systems in the rice–wheat rotation: Water use, productivity, profitability and soil physical properties. *Soil and Tillage Res.*, **105**(1): 112-121.

Jat, M.L., Chandna, P., Gupta, R., Sharma, S.K. and Gill, M.A. 2006. Laser land levelling: A precursor technology for resource conservation. *Rice-Wheat Consortium Technical Bulletin Series*, **7**: 48.

Jat, M.L., Gupta, R., Saharawat, Y.S. and Khosla, R. 2011. Layering precision land levelling and furrow irrigated raised bed planting: Productivity and input use efficiency of irrigated bread wheat in Indo-Gangetic Plains. *Am. J. Plant Sci.*, **2**(04): 578.

Kahlown, M.A., Raoof, A. and Hanif, M. 2000. *Rice yield as affected by plant densities*. Mona Experimental Project Bhalwal, Report No. 238.

Kaur, B., Singh, S., Garg, B.R., Singh, J.M. and Singh, J. 2012. Enhancing water productivity through on-farm resource conservation technology in Punjab agriculture. *Agric. Eco. Res. Rev.*, **25**: 79-85.

Lybbert, T.J., Magnan, N., Spielman, D.J., Bhargava, A.K. and Gulati, K. 2018. Targeting technology to increase smallholder profits and conserve resources: experimental provision of laser land-levelling services to Indian farmers. *Eco. Dev. Cul. Change*, **66**(2): 265-306.

Naresh, R.K., Gupta, R.K., Kumar, A., Prakesh, S., Tomar, S.S., Singh, A., Rathi, R.C., Misra, A.K. and Singh, M. 2011. Impact of laser land leveller for enhancing water productivity in Western Uttar Pradesh. *Int. J. Agric. Engg.*, **4**(2): 133-147.

Naresh, R.K., Singh, S.P., Misra, A.K., Tomar, S.S., Kumar, P., Kumar, V. and Kumar, S. 2014b. Evaluation of the laser levelled land levelling technology on crop yield and water use productivity in Western Uttar Pradesh. *Af. J. Agric. Res.*, **9**(4): 473-478.

Rickman, J.F. 2002. Manual for laser land levelling, Rice-Wheat Consortium Technical Bulletin Series 5. New Delhi-110 012, India: *Rice-Wheat Consortium for the Indo-Gangetic Plains*, 24.

Sapkal, S., Kamble, B.H., Kumar, P., Kar, A. and Jha, G.K. 2019. Impact of laser land levelling in rice-wheat systems of the North-Eastern indo-gangetic plains of India. *J. Pharmacognosy and Phytochemistry*, **8**(1): 764-769.

Singh, A., Bishnoi, D.K., Kumar, N. and Kumar, R. 2020. Resource use Efficiency in Wheat under different Techniques in Haryana. *Indian J. Eco. Dev.*, **16**(SS): 260-266.

Singh, T. 2013. *An Economic Evaluation of Laser Land Levelling Technology In Punjab*. M.Sc. thesis submitted to PAU, Ludhiana, Punjab.