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Amaresh Das
Department of Soil Science, Navsari Agricultural University, Navsari, Gujarat, India

MD Lad
Wheat Research Farm, Navsari Agricultural University, Bardoli, Gujarat, India

AL Chalodia
Department of Agriculture Engineering, NMCA, Navsari Agricultural University, Navsari, Gujarat, India

Correspondence
Amaresh Das
Department of Soil Science, Navsari Agricultural University, Navsari, Gujarat, India

Effect of laser land leveling on nutrient uptake and yield of wheat, water saving and water productivity

Amaresh Das, MD Lad and AL Chalodia

Abstract
A field experiment was conducted during *rabi* seasons of 2013-14 and 2014-15 in Wheat Research Farm, Bardoli of Navsari Agricultural University, Gujarat on a clayey soil with an objective to findout the effect of laser land leveling on yield of wheat crop (var. Lok 1), nutrient uptake, irrigation water saving and water productivity. Four treatments comprising of control i.e. field with traditional level and three leser leveled fields (LLF) with three slopes (%): 0.05, 0.15 and 0.30, were imposed in large plots. Pooled grain yield under 0.15% slope (3475.0 kg ha^{-1}) was 18.3% higher over control and was significantly higher over control and LLFs while significantly the highest straw yield was recorded in field with 0.30 % slope (7906.8 0 kg ha^{-1}), remaining at par with 0.05 and 0.15 % sloppy fields. Significantly the highest total N, P and K uptake in pooled was recorded in field with 0.15 % slope which was at par with 0.30 % slope in case of N and with 0.05 and 0.30 % slopes in case of P and K. The highest (787 m^3 ha^{-1}) irrigation water saving was obtained in field with 0.30 % slope, followed by 0.15 % slope (565 m^3 ha^{-1}or 5.65 ha-cm). Water productivity in field with 0.15% slope (1.121 kg grain m^{-3} water) remaining at par with 0.30% slope, exhibited significantly higher value (>39%) over control. Based on higher additional net income (Rs 9041 ha^{-1}), higher water productivity and saving of 5.65 ha-cm irrigation water over control, LLF with 0.15 % slope was adjudged superior.

Keywords: laser land leveling, wheat yield, nutrient uptake, water saving, water productivity

Introduction
Wheat is the most important food grain and is a staple food for about one third population of the world. It is cultivated over an area of 31.19 million ha with an annual production of 95.91 million tones in India, while the area and the production of this crop in Gujarat state are 1.35 million ha and 3.65 million tones and in South Gujarat the corresponding values are 47.5 thausand hectares and 3.21 Metric tones respectively. Declining irrigation water availability and crop productivity and increasing food demand necessitate quick adoption of modern scientific technologies for efficient water management. Bread wheat as a main source of food grain is highly important for feeding the increasing population of this sub-continent and the world as well. Soil is not uniform across the field under traditionally leveled fields and thus irrigation water applied to wheat crop at uniform rate exhibits wide variability across the field in relation to spatial distribution of water, nutrients and leaching losses which ultimately result in uneven crop growth, poor crop yield and low water productivity. Moreover, traditional land leveling methods are time consuming and expensive too. Precision land leveling involves altering the fields in such a way as to create a constant slope of 0 to 0.2%. Precision land leveling using laser equipped drag scrapper would help to maintain or increase grain yield and water productivity (Ahmed *et al*., 2001) [1] and reduce leaching of nutrients into groundwater. Laser land leveling is a process of smoothing the land surface (± 2 cm) from its average elevation using laser-equipped drag buckets and this technique is well known for achieving higher levels of accuracy in land leveling and offers great potential for water savings and higher grain yields (Jat, 2006) [8]. As was found by Kaur *et al.* (2012) [6], irrigation cost in laser leveled land got reduced by 44 % over the conventional practice and water productivity improved by 39 %. Study has not been done earlier on leser land leveling for boosting wheat yield, nutrient uptake, irrigation water saving and water productivity in South Gujarat. Hence, the present study was planned to find out the increase in yield of wheat crop, nutrient upake, water saving and water productivity in leser leveled field.

Materials and Methods
A field experiment was conducted on wheat crop (var. Lok 1) during two consecutive rabi seasons of 2013-14 and 2014-15 at Wheat Research farm, Bardoli, Navsari Agricultural University, Gujarat on a clayey soil having available N 111 kg ha^{-1}, available P_2O_5

48 kg ha^{-1}and available K_2O 228 kg ha-1, with an objective to find out the effect of laser land laveling on the yield of wheat crop, nutrient uptake, irrigation water saving and water productivity. The experiment was conducted in four large plots (90 X 25 m) following large plot technique (strip). Four treatments comprising of 1) control (land with traditional leveling) and three treatments with uniform slope (%) of 0.05, 0.15 and 0.30 done by leser land leveler, were imposed in large plot by using "Level Master II Trimble AG Dual graded laser guided land leveler" attached with 65 HP -tractor. Initially the elevation data from three large plots at different points (excepting control plot which was kept as such after traditional leveling) were collected. Irrigation water was allowed to enter from the elevated side of each strip and accordingly based on the maximum and the minimum gage reading, fields were prepared by 'cutting and filling' method of soil so as to have 0.05, 0.15 and 0.30 % uniform slopes in three strips. Initially the slopes were established by manual control and then was settled by laser leveler through auto-adjustment. Recommended dose of fertilizer (N: P: K: 120:25:00) was applied from inorganic fertilizers Urea and DAP in all the strips. 50% N and entire dose of phosphorous was applied as basal and the rest of nitrogen was applied at the time of 1st irrigation. Wheat crop was sown on 12-12-2013 and 02-12-2014 during 2013-14 and 2014-15 respectively maintaining a speacing of 22.5 cm (row to row). Seed rate was maintained 100 kg ha^{-1} althrough. The crop was kept weed free uniformly using pre and post- emergence weedicide followed by two hand-weedings. At maturity crop was harvested on 28-3-2014 and 22-3-2015 during 2013-14 and 2014-15 respectively. Each large plot was partioned into two by a small boundary along the length and then length was sub-divided into four equal compartments by small boundary so as to get eight equal compartments for uniform and easy reach of irrigation water in each compartment from upper elevation along the slope. Noting og ancillary observations and collection of sample- yield data were done from each of eight compartments from all treatments. The crop was irrigated based on critical growth -stage (details as below) through surface method of irrigation putting cut after 75% reach end of each compartment. Application of irrigation water at the field - inlet points was measured from time to time during irrigations to crop and time taken at 75% reach end of each compartment was noted. Data obtained from eight compartments of each treatment was considered as eight repeatations. Irrigation water applied in each compartment was computed separately for each treatment. Ancillary parameters like, plant height, spike length, number of grain / spike, number of effective tillers / plant and 1000 grain – weight were noted from eight compartments of each treatment. Grain and straw yield were recorded based on 2 X 2 m plot- size in eight compartments for each treatment. Total rainfall received during 2013, 2014 and 2015 were 2169.5, 973.0 and 778.5 mm respectively in 91, 46 and 33 rainy days, respectively. However, only 20mm of rain occurred in crop growing season of *Rabi* 2013-14. Initial surface soil samples, grain, straw samples and after harvest surface soil samples from eight compartments of each treatment were collected for analysis purpose. The soils were analyzed for organic carbon, available N, P and K following standard procedure. P and K content in grain and straw samples were determined by digesting the samples with di-acid (nitric acid: perchloric acid (l0:4) mixture) following standard procedure, while N was determined by chromic acid (Trivedi *et al.* 1999) [12]. Plant uptake of N, P and K were computed by multiplying the yield at harvest with the respective nutrient content. Total water applied in each compartment of each treatment was noted. Water productivity was expressed on grain yield (kg ha^{-1}) basis only, dividing grain yield by irrigation water applied (m^3). Data of yield and other parameters obtained from eight compartments of each treatment were subjected to statistical analysis based on CRD.

year	Number of irrigations	Date of irrigation s
Rabi 2013-14	Five (Including showing time irrigation) + rainfall *	13-12-2013, 06-01-2014, 09-02-2014, 25-02-2014 and 10-03-2014
Rabi 2014-15	Six (Including showing time irrigation)	03-12-2014, 25-12-2014, 13-01-2015, 02-02-2015, 25-02-2015 and 12-03-2015

* Rainfall during 22-23/01/2014 = 20.0 mm

Results and Discussion

1. Ancillary parameters

Ancillary parameters of wheat (Var. lok.1) are presented in Table 1. Data on ancillary parameters revealed that the number of grain / spike and number of effective tillers / plant were significant in first year and in pooled. 1000 grain - weight significantly differed during second year as well as in pooled due to varying treatments of slope. Significantly the highest number of grain / spike and more number of effective tillers / plant were obtained under 0.15 % sloppy field, remaining at par with 0.05 and 0.30 % sloppy field. Significantly the highest 1000 grain wt. (41.01 g) was recorded under 0.15 % sloppy field being at par with 0.30 % sloppy field. However, plant height and spike length were non-significant in pooled (Table 1) as to varying treatments. A uniform distribution of moisture and nutrient in uniformly sloppy leveled fields, particularly of 0.15 and 0.30 percent sloppy fields might have led superior crop establishment resulting in more grain per spike, more number of effective tillers / plant and higher 1000-grain weight. as compared to control longer paniclelength, more grain per plant and 1000 grain weight under leser leveling field were also reported by Hoque and Hannan (2014) [2].

2. Wheat yield

Grain and straw yield of wheat are presented in Table 2. The results revealed that the differences in grain yield of wheat (Var. lok -1) during 2013-14 and 2014-15 as well as in pooled was significant as to varying sloppy fields. In both the years, significantly the highest grain yield was recorded under 0.15 % sloppy field. However, the grain yield under 0.15 % sloppy field during 1st year (3343.8 kg ha^{-1}) was at par with 0.30 % sloppy field. In 2nd year, 0.15 % sloppy field recorded 3606.3 kg ha^{-1} grain yield. Pooled data revealed that 0.15 % sloppy field recorded significantly the highest grain yield (3475.0 kg ha^{-1}) over control and other sloppy fields (Table 2). In case of straw yield, significantly the highest yield (7469.9 kg ha^{-1}) was recorded under 0.30 % sloppy field during 1st year, remaining at par with 0.05 and 0.15 % sloppy fields. Straw yield during second year was non-significant as to varying field treatments. Pooled data, however, revealed that (Table 2) significantly the highest straw yield (4906.8 kg ha^{-1}) was registered under 0.30 % sloppy field, remaining at par with 0.05 and 0.15 % sloppy fields. The improvement in both grain and straw yield of wheat under laser land leveling over traditional leveling was mostly due to improved yield attributing characters like number of grain / spike, number of effective tillers / plant and 1000 grain weight under uniformly sloppy fields as a result of uniform availability of moisture,

nutrients and overall better environment for the development of the plants. Sattar *et al.* (2003) [11] and Rajput *et al.* (2004) [10] also reported that the application and distribution efficiencies of applied water were improved significantly under precision land leveling compared to traditional leveling. The results clearly revealed that leser leveled field with 0.15 % uniform slope was superior over others in respect to wheat grain yield and the treatment produced on an average 18.3 % higher grain yield over traditionally leveled field. Jat *et al.* (2003) [8] reported an increased grain yield of wheat from 4.3 t ha^{-1} under traditional leveling to 4.6 t ha^{-1} in precision land leveling. Jat (2006) [8] reported an increase in crop yield by 10-20 %. Hoque and Hannan (2014) [2] obtained the maximum yield (3.41 t ha^{-1}) of wheat in leser leveled field as compared to yield of non-leser leveled field (2.62 t ha^{-1}). Naresh *et. al* (2014) [7] found that grain yield of wheat (4.23 t/ha) under traditionally leveleled field increased to 4.47 t ha^{-1}in leser leveled field.

3. Nutrient content in grain and nutrient uptake by grain

N, P and K content in grain and uptake of N, P and K by grain are presented in Table 3 and 4 respectively. The result (Table 3) revealed that N and K content in wheat grain did not differ significantly in individual year and pooled as to varying slope treatments. P content in grain due to varying slope treatments, though showed non-significant effect in both he years, the effect was significant in pooled. Significantly the highest P content (0.37%) was recorded under 0.30 % sloppy field which, however, remained at par with that under 0.05 and 0.15 % sloppy fields. So far as uptake of N, P, K by grain of wheat is concerned (Table 4), it was noticed that N, P and K uptake by grain in both the individual year as well as in pooled differed significantly due to varying slopes, except P uptake during 2014-15. Pooled data revealed that the highest N (67.55 kg ha^{-1}), P (12.19 kg ha^{-1}) and K (53.28 kg ha^{-1}) uptake were obtained under 0.15 % sloppy field. However, P uptake by grain under 0.15% slope remained at par with 0.05 and 0.30 % sloppy fields.

4. Nutrient content in straw and nutrient uptake by straw

N, P and K content in straw and uptake of N, P and K by straw are presented in Table 5 & 6 respectively. The data revealed that N, P and K content in straw of wheat (Table 5) did not reach to the level of significance in individual year as well as in pooled, except P content in pooled which differed significantly due to varying slopes of field. Pooled data revealed that significantly the highest P content (0.18%) was registered under 0.05 and 0.15 % sloppy fields. In case of uptake of N, P and K by straw (Table 6), it was observed that N, P and K uptake differed significantly during 1st year and in pooled due to varying slopes. Pooled data revealed that the highest N (36.89 kg ha^{-1}) and K uptake (133.95 kg ha^{-1}) by straw was recorded under 0.30% sloppy field remaining at par with those under 0.50 and 0.15 % sloppy field. In case of P uptake, the highest value (13.62 kg ha^{-1}) was observed under 0.15 % sloppy field on pooled basis which, however, remained at par with those under 0.05and 0.30 % sloppy fields.

5. Total uptake (grain + straw)

Total uptake by grain + straw is presented in Table 7. The result revealed that total N and K uptake by wheat differed significantly during first year and in pooled due to various slope- treatments. However, P uptake significantly differed in both individual years as well as in pooled as to varying slope treatments. Pooled data indicated that significantly the highest total N (104.24 kg ha^{-1}), total P (25.81 kg ha^{-1}) uptake were recorded under 0.15 % sloppy field, while the highest total K uptake (182.64 kg ha^{-1}) was registered under 0.30 % slope. However, the value of total N under 0.15 % slope was at par with 0.30 % slope. In case of P uptake, the magnitude under 0.15 % slope was at par with 0.05 and 0.30 % slope. Similarly, total K under 0.30 % sloppy field was at par with 0.05 and 0.15 % sloppy field. Pal *et al.* (2003) found that the uptake of applied nutrients significantly increased under precision land leveling compared to traditional land leveling.

6. Irrigation water applied, irrigation water saving and Water productivity

Total water applied, irrigation water saving and water productivity under different laser leveled treatments in wheat crop are presented in Table 8. Significantly the highest water application was recorded under control in both the individual years as well as in pooled (3664 m^3ha^{-1}), while the lowest water application was recorded under field with 0.30 % slope (2877 m^3ha^{-1}). Quantum of applied water significantly and gradually decreased from traditional land leveling with the increase in slope of field (Table 8). The fact clearly indicated that as compared to control, the highest mean irrigation water saving (787 m^3ha^{-1}) was noted in field with 0.30 % slope, followed by 0.15 % slope (565 m^3ha^{-1} i.e. 5.65 ha-cm). The average water saving under LLF with 0.15 and 0.30 % slope were 15.4 and 21.5 % respectively indicating that irrigation water saving gradually increased with the increase in slope of LLF. Saving in irrigation water under precision land leveling was reported by Jat *et al.* (2003) [7]. Rajput and Patel (2003) [9] observed water saving of 338 to 808 m^3 ha^{-1} in on-farm in vestigations on wheat. Jat (2006) [8] reported irrigation water saving of 5-10 ha-cm in wheat crop on farmers' field of U.P. Pooled data indicated that significantly the highest water productivity (1.121 kg grain/m^3 of water) was recorded under 0.15 % slope, but it remained at par with field having 0.30% slope (1.120 kg grain m^{-3} of water). On an average irrigation water productivity increased > 39 % in 0.15 and 0.30 % uniformly sloppy land developed by leser leveler. The result on water productivity is in good agreement with the report made by Kaur *et al.* (2012) [6]. The improved water productivity was most possibly due to improved application and distribution efficiencies of applied water under precision land leveling compared to traditional leveling as reported earlier by Sattar *et al.* (2003) [11] and Rajput *et al.* (2004) [10]. Laser land leveling when applied under various crops and cropping patterns has resulted in water savings up to 15-30 % (conserveagri.org, 2009). The average irrigation water productivity of wheat was found to increase from 1.02 to 1.22 kg grain m^{-3} water by Jat (2006) [8]. It was recorded (Jat *et al.* 2005) that with similar fertility levels and land configurations, the water productivity of wheat increased from 0.82 to 1.31 kg grain m^{-3}water..

7. Economics of treatments

Expenditure on irrigation and for making sloppy field and combined expenditure are presented in Table 9, while comparative economics of wheat crop (var.Lok-1) under different treatments are presented in Table 10. The data on comparative economics of different treatments revealed that 0.15 % uniformly sloppy land by leser leveler brought the higher (Rs. 12665 ha^{-1}) additional gross income over control and ultimately gave the higher additional net income of Rs. 9041 ha^{-1}over control. Apart from monitory benefit, 0.15 %

sloppy field showed an additional benefit of irrigation water saving of 565 m^3 ha^{-1} or 5.65 ha-cm. Though 0.30 % sloppy field had shown the highest additional water saving (787 m^3 ha^{-1} or 7.87 ha-cm) over control, yet the treatment failed to bring the highest additional yield and monitory benefits over control.

The results clearly indicated that 0.15 % uniformly leser leveled sloppy field boosted the grain yield to the tune of 18.3 % with > 39 % higher irrigation water productivity over over traditionally leveled field and brought the highest additional net income (Rs. 9041ha^{-1}). Moreover, this treatment also registered 565 M^3 ha^{-1} i.e 5.65ha-cm irrigation water saving over traditionally leveled field. Thus, it can be concluded that for growing irrigated wheatin the area of South Gujarat, land preparation with leser land lever maintaining an uniform slope of 0.15 % is highly beneficial in relation to higher crop yield, good quantum of irrigation water saving, higher water productivity and higher additional net income over traditionally leveled fields.

Table 1: Ancillary parameters of wheat (var. Lok-1)

Treatments: LLF with slope (%)	Plant height(cm)			Spike length(cm)			Number of grain/spike			Number of effective tillers/plant			1000 grain weight (g)		
	2013-14	2014-15	pooled	2013-14	2014-15	pooled	2013-14	2014-15	pooled	2013-14	2014-15	pooled	2013-14	2014-15	pooled
Control(traditionally leveled)	69.51	71.50	70.60	8.62	7.00	7.81	28.53	29.75	29.14	4.97	5.04	5.01	37.90	38.78	38.34
0.05	70.75	73.25	72.00	7.95	7.25	7.60	31.28	31.16	31.22	5.69	5.62	5.66	38.54	39.73	39.14
0.15	68.62	72.25	70.43	7.62	7.41	7.52	32.79	31.33	32.06	5.84	5.83	5.84	40.05	41.97	41.01
0.30	69.00	70.83	69.91	7.39	7.12	7.25	30.75	30.95	30.85	5.82	5.75	5.79	39.67	40.57	40.12
Sem±	1.50	0.50	0.77	0.31	0.22	0.33	0.79	0.53	0.48	0.16	0.28	0.16	0.57	0.75	0.46
C.D. (P=0.05)	NS	1.47	NS	NS	NS	NS	2.34	NS	1.38	0.48	NS	0.45	NS	2.22	1.31

* LLF = Laser leveled field

Table 2: grain and straw yield of wheat (var. Lok-1)

Treatments: LLF with slope (%)	Wheat Grain yield (kg ha^{-1})			Wheat Straw yield (kg ha^{-1})		
	2013-14	2014-15	pooled	2013-14	2014-15	pooled
Control(traditionally leveled)	2690.6	3184.4	2937.5	5450.9	7459.4	6455.1
0.05	2968.8	3346.9	3157.8	7153.0	8290.6	7721.8
0.15	3343.8	3606.3	3475.0	7191.5	8112.5	7652.0
0.30	3087.5	3356.3	3221.9	7469.9	8343.8	7906.8
Sem±	138.84	99.15	59.95	406.80	552.76	338.46
C.D. (P=0.05)	288.79	206.24	170.89	1196.64	NS	964.73

* LLF: Laser Leveled Field

Table 3: N, P and K content (%) of grain of wheat crop (var.Lok-1)

Treatments: LLF with slope (%)	N			P			K		
	2013-14	2014-15	pooled	2013-14	2014-15	pooled	2013-14	2014-15	pooled
Control(traditionally leveled)	1.93	1.93	1.93	0.32	0.31	0.31	1.52	1.45	1.49
0.05	1.93	1.93	1.93	0.38	0.32	0.35	1.57	1.48	1.53
0.15	1.97	1.92	1.95	0.38	0.32	0.35	1.61	1.47	1.54
0.30	1.92	1.90	1.91	0.40	0.35	0.37	1.57	1.46	1.51
Sem±	0.02	0.04	0.02	0.02	0.02	0.013	0.03	0.03	0.02
C.D. (P=0.05)	NS	NS	NS	NS	NS	0.038	NS	NS	NS

* LLF: Laser Leveled Field

Table 4: Uptake of N, P and K (kg ha^{-1}) by grain of wheat crop (var.Lok-1)

Treatments: LLF with slope (%)	N			P			K		
	2013-14	2014-15	pooled	2013-14	2014-15	pooled	2013-14	2014-15	pooled
Control(traditionally leveled)	51.88	61.49	56.69	8.59	9.81	9.20	40.99	46.09	43.54
0.05	57.31	64.34	60.83	11.18	10.83	11.00	46.78	49.50	48.14
0.15	65.87	69.23	67.55	12.78	11.59	12.19	53.78	52.83	53.28
0.30	59.24	63.83	61.53	12.37	11.78	12.07	48.48	48.88	48.68
Sem±	1.80	1.67	1.24	0.81	0.56	0.50	1.93	1.25	1.16
C.D. (P=0.05)	5.31	4.91	3.53	2.41	NS	1.42	5.67	3.68	3.31

* LLF: Laser Leveled Field

Table 5: N, P and K content (%) of straw of wheat crop (var.Lok-1)

Treatments: LLF with slope (%)	N			P			K		
	2013-14	2014-15	pooled	2013-14	2014-15	pooled	2013-14	2014-15	pooled
Control(traditionally leveled)	0.45	0.45	0.45	0.16	0.16	0.16	1.64	1.66	1.65
0.05	0.48	0.47	0.47	0.18	0.17	0.18	1.59	1.68	1.63
0.15	0.51	0.46	0.48	0.19	0.17	0.18	1.69	1.71	1.70
0.30	0.48	0.47	0.47	0.16	0.16	0.16	1.68	1.73	1.70
Sem±	0.02	0.02	0.01	0.01	0.01	0.005	0.06	0.04	0.03
C.D. (P=0.05)	NS	NS	NS	NS	NS	0.015	NS	NS	NS

* LLF: Laser Leveled Field

Table 6: Uptake of N, P and K (kg ha^{-1}) by straw of wheat crop (var. Lok-1)

Treatments: LLF with slope (%)	N			P			K		
	2013-14	2014-15	pooled	2013-14	2014-15	pooled	2013-14	2014-15	pooled
Control(traditionally leveled)	24.64	33.37	29.00	8.80	11.75	10.28	89.09	123.87	106.48
0.05	34.08	38.38	36.23	13.12	13.65	13.38	112.04	139.28	125.66
0.15	36.29	37.11	36.70	13.46	13.79	13.62	120.26	138.30	129.28
0.30	35.36	38.41	36.89	12.23	13.70	12.96	124.78	143.13	133.95
Sem±	2.01	2.46	1.59	0.80	0.95	0.62	5.59	8.66	5.06
C.D. (P=0.05)	5.91	NS	4.54	2.35	NS	1.76	16.16	NS	14.43

* LLF: Laser Leveled Field

Table 7: Total Uptake (kg ha^{-1}) of N, P and K by Grain + Straw of wheat crop (var.Lok-1)

Treatments: LLF with slope (%)	N			P			K		
	2013-14	2014-15	pooled	2013-14	2014-15	pooled	2013-14	2014-15	pooled
Control(traditionally leveled)	76.52	94.86	85.69	17.39	21.57	19.48	130.08	169.96	150.02
0.05	91.39	102.72	97.06	24.30	24.48	24.39	158.82	188.78	173.80
0.15	102.15	106.33	104.24	26.24	25.38	25.81	173.99	191.13	182.56
0.30	94.60	102.24	98.42	24.60	25.47	25.04	173.25	192.01	182.64
Sem±	3.12	3.11	2.27	1.05	0.93	0.74	6.54	8.72	5.44
C.D. (P=0.05)	9.18	NS	6.46	3.10	2.75	2.10	19.23	NS	15.50

* LLF: Laser Leveled Field

Table 8: Irrigation water applied, Water productivity and Water saving under different treatments treatments by leaser land leveler in wheat crop (var.Lok-1)

Treatments: LLF with slope (%)	Irrigation water applied (m^3ha^{-1})			Irrigation water saving (mean) compared to control (m^3ha^{-1})	Water productivity (kg grain m^{-3} of water)			Percent increace in water productivity (kg grain m^{-3} of water) over control
	2013-14	2014-15	pooled	Mean	2013-14	2014-15	pooled	Mean
Control(traditionally leveled)	3793	3535	3664	-	0.709	0.901	0.802	-
0.05	3571	3297	3434	230	0.831	1.015	0.920	14.71
0.15	3139	3059	3099	565	1.065	1.179	1.121	39.78
0.30	2902	2852	2877	787	1.064	1.176	1.120	39.65
Sem±	48	57	39	-	0.032	0.034	0.023	-
C.D. (P=0.05)	140	168	111	-	0.094	0.099	0.066	-

* LLF : Laser Leveled Field

Table 9: Expenditure on irrigation, making sloppy field and total expenditure

Treatments: LLF with slope (%)	Expenditure on irrigation (Rs.ha^{-1}) (A)	*Expenditure for making sloppy field (Rs.ha^{-1} year^{-1}) (B)	Total expenditure (Rs.ha^{-1}) (A+B)	Remarks
	705/-	Nil	705/-	Cost of cultivation under each treatment excluding expenditure on irrigation and making sloppy field remain the same.
Control(traditionally leveled)	661/-	2800/-	3461/-	
0.05	596/-	3733/-	4329/-	
0.15	Rs.554/-	4667/-	5221/-	

***LLF:** Laser Leveled Field

NB- Hiring charge (including fuel) of Laser leveler per hour = Rs. 700/-.

*****As the longevity of developed sloppy land is three years, the total expenditure on making sloppy land by laser leveler per ha was divided by three and placed above. Time taken for making 1 ha field with 0.05, 0.15 and 0.30 % slope were 12, 16 and 20 hour respectively. Working hour day^{-1} was 8 hours.

Table 10: Comparative economics of wheat crop (var.Lok-1) under different treatments

Treatments: LLF with slope (%)	Yield (kg ha^{-1})		Gross income (Rs ha^{-1})	Additional gross income over control (Rs ha^{-1})	Additional expenditure over control (Rs ha^{-1})	Additional net income over control (Rs ha^{-1})	Additional water saving as compared control (m^3ha^{-1})
	Grain	Straw					
Control(traditionally leveled)	2937.50	6455.10	69078/-	-	-	-	-
0.05	3157.80	7721.80	75511/-	6433/-	2756/-	3707/-	230
0.15	3475.00	7652.00	81743/-	12665/-	3624/-	9041/-	565
0.30	3221.90	7906.80	77089/-	8020/-	4516/-	3504/-	787

*** LLF:** Laser Leveled Field

Selling price: Wheat grain: Rs.20 kg^{-1}, wheat straw: Rs. 1.60 kg^{-1}

References

1. Ahmed B, Khokhar SB, Badar H. Economics of laser land levelling in district Faisalabad. Pakistan Journal of Appied Sciences. 2001; 1(3):409-412.
2. Hoque MA, Hannan MA. Performance Evaluation of Laser Guided Leveler. Int. J Agril. Res. Innov. & Tech. 2014; 4(2):82-86
3. Jat ML, Chandna P, Gupta RK, Sharma SK, Gill MA. Laser land levelling: A precursor technology for resource conservation, Rice-Wheat Consortium Technical Bulletin Series 7, Rice-Wheat Consortium for the Indo-Gangetic Plains, New Delhi. 2006; 48.
4. Jat ML, Pal SS, Subba Rao AVM, Sharma SK. Improving resource use efficiency in wheat through laser land leveling in an *ustochrept* of Indo-Gangetic plain. In: National Seminar on Developments in Soil Science, 68th Annual Convention of the Indian Society of Soil Science, CSAUAT, Kanpur (UP), 2003.
5. Jat ML, Sharma SK, Gupta Raj K, Sirohi K, Chandana P. Laser land leveling: the precursor technology for resource conservation in irrigated ecosystem of India. In: Conservation Agriculture-status and prospects (Eds., Abrol, I.P., Gupta, Raj K. and Malik, R.K.), CASA, New Delhi. 2005, 145-154.
6. Kaur B, Singh S, Garg BR, Singh JM, Singh J. Enhancing Water Productivity through onfarm Resource Conservation Technology in Punjab Agriculture. Agric. Econ. Res. Rev. 2012; 25(1):79-85.
7. Naresh RK, Singh SP, Misra AK, Tomar SS, Pardeep Kumar, Vineet Kumar, *et al*. Evaluation of the laser leveled land leveling technology on crop yield and water use productivity in Western Uttar Pradesh. African Journal of Agricultural Research. 2014; 9(4):473-478
8. Pal SS, Jat ML, Subba Rao AVM. Laser land leveling for improving water productivity in rice-wheat system. PDCSR Newsletter, 2003.
9. Rajput TBS, Patel N. Laser land leveler se khet samatal karayiye, pani bachayiye aur paidavar badhayiye. Folder (Hindi). Water Technology Centre, Indian Agricultural research Institute, Pusa New Delhi, 2003.
10. Rajput TBS, Patel N, Agrawal G. Laser levelling- A tool to increase irrigation efficiency at field level. J Agril. Eng. 2004; 41(1):20-25.
11. Sattar A, Khan FH, Tahir AR. Impact of precision land leveling on water saving and drainage requirement. J AMA. 2003; 34:39-41.
12. Trivedi BS, Patel GG, Desai RM, Padhiyar GM. Comparision of Kjeldahl's and Chromic Acid Method of nitrogen determination. GAU Res. J. 1999; 25(1):9-14.