Wheat Productivity, Land and Water Use Efficiency by Traditional and Laser Land-leveling Techniques

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Abstract: Present study was conducted to determine the impact of laser land leveling versus traditional land leveling on wheat productivity, land and water-use efficiency during Rabi 2000-2001. The result indicated that Laser land leveling gave significantly higher grain yields (5.56 t ha\(^{-1}\)) than the unleveled land (3.99 t ha\(^{-1}\)) but was at par with traditionally leveled one. However, no significant differences among the treatments were recorded for 1000-grain weight and grains ear\(^{-1}\). The total irrigation duration and applied water depth was reduced by 47 and 15% as compared to unleveled and traditional leveled fields, respectively. The laser-leveled fields exhibited the highest water use efficiency (WUE), which was 98.7 and 29.36% higher than the unleveled and traditionally leveled field, respectively. It was concluded that the use of Laser Land leveling surely increases grain yield and save irrigation water as compared to traditional method of sowing.

Keywords: Wheat productivity, Laser Land leveling, Water use efficiency

Introduction

The use of laser technology in the precision land leveling is of recent origin in Pakistan. It not only minimizes the cost of leveling but also ensures the desired degree of precision. Precision Land leveling has been a significant component of On Farm Water Management since 1977. However, the laser land leveling was introduced in the province in 1992. Land leveling of farmer’s field is an important process in the preparation of land. It enables efficient utilization of scarce water resources through elimination of unnecessary depressions and elevated contours (Anonymous, 1997). It has been noted that poor farm design and uneven fields are responsible for 30% water losses. About 18 million-acre feet (MAF) of water is lost to irrigate uneven fields in Pakistan (Gill, 1998). Salinity patches in the elevated parts and leaching down of soil nutrients from the root zone in lower spots of unleveled fields can attribute towards low crop production
Precision land leveling (PLL) facilitated application efficiency through even distribution of water and increased water-use efficiency that resulted in uniform seed germination, better crop growth and higher crop yield (Nazir, 1994). The scarcity of canal water supplies coupled with unfit under ground water has compelled the farmers to utilize available water resources more wisely and efficiently. Under these circumstances, PLL can help the farmers to utilize the scarce land and water resource more effectively and efficiently towards increased crop production.

Traditional way of precision land leveling includes surveying of the field, staking and designing the field, calculation of cut and fills areas and then use of a scraper and land planer. Despite all these labor-intensive efforts, desired accuracy is not achieved.

By contrast, Laser leveling involves the use of a laser (transmitter), that emits a rapidly rotating beam parallel to the required field plane, which is picked up by a sensor (receiving unit) fitted to a tractor towards scraper unit. The signal received is converted into cut and fill level adjustment and the corresponding changes in scraper level are carried out automatically by a hydraulic control system. The scraper guidance is fully automatic; the elements of operator error are removed allowing consistently accurate land leveling. The laser leveling makes the flow uniform and the advance flow is not much hindered because of less irregularity in the field’s micro-topography. In a word, the laser controlled land leveling facilitates advance phase and consequently more uniformity is achieved.

Laser technology can ensure very accurate and precision land leveling to the extent of ±2 cm (Landon, 1995; Waker, 1989). About 700,000 acres have been leveled in Punjab out of which 50,000 have been leveled with the help of laser technology and its benefits have been widely accepted by the farmers. However, necessary data to support its effects on crop yield and water use are scarce. It was therefore, felt imperative to evaluate the effect of laser and traditional land leveling technologies on wheat productivity, land and water use efficiency under the irrigated conditions of district Toba Tek Singh.

**Materials and Methods**

The study was conducted at district Toba Tek Singh on clay loam soil in the command of watercourse No. 5850/L (Mungi minor) during Rabi 2000-2001. The treatments consisted of Laser land leveling (T₁), Traditional land leveling (T₂) and Control (Unleveled) (T₃), each with four replication. In treatments T₁ and T₂, leveling of experimental field was done as per treatment and information on the topography of each experimental unit was compiled. The net plot size measured was 0.18 hectare (ha) (30’60 m). The border size (10’60 m) was selected according to available water supply and soil type. The main source of irrigation was canal water, which was supplemented with tube well water as and when needed to meet the crop water requirements.
Wheat variety MH 97 was planted on November 25 with Rabi drill. A basal dose of 123-98.0 Kg ha⁻¹ NPK in the form of Urea and SSP were applied. In all, five irrigations excluding Rauni irrigation were given till the maturity of the crop. The crop was kept free of weeds by chemical spray. Observations on the desired parameters were recorded using the standard procedures. The discharge available at outlet was measured every time. The time of irrigation application for each treatment was noted during each irrigation. The applied irrigation depth was calculated from measured discharge applied to known area for recorded time by the following equation

\[ Q = AD \]
\[ Q = \text{Discharge (Cusec, ft}^3\text{-s}^{-1}) \]
\[ T = \text{Time (hr)} \]
\[ A = \text{Area (acres)} \]
\[ D = \text{depth (inches)} \]

The amount of water (ft³) applied to each treatment was determined by multiplying the discharge at field outlet with the time of application. The total amount of water so applied was computed for the entire crop season. The amount of water saved was determined by the difference of water applied to precisely leveled, unleveled and traditionally leveled experimental units.

Water use efficiency was computed as follow:

\[ \text{WUE} = \frac{\text{Yield (Kg)}}{\text{Water applied (m}^3\text{)}} \]

The data collected were analyzed statistically by Flshers’ analysis of variance technique and LSD test was used to compare the treatments means (Steel and Torrie, 1998).

Result and Discussion
Yield and yield components
The laser land leveling significantly affected the yield and yield components (Table 1). The maximum productive tillers were recorded in laser-leveled field against the minimum in the unleveled field. No significant difference was recorded for grains ear⁻¹ and 1000-grain weight. However, laser land leveling resulted in higher 1000-grain weight but less number of grains ear⁻¹. While traditionally leveled field produced the maximum grains ear⁻¹. The less number of grains ear⁻¹ in laser leveled field as compared to traditional leveled field might be due to more productive tillers m⁻² recorded in laser leveled field that increased competition among the plants for nutrition and thereby resulting less number of grains ear⁻¹. Laser land leveling produced maximum grain yield (5.56 t ha⁻¹) against the minimum (3.99 t ha⁻¹) in unleveled field, Table 1. Yield recorded in Laser leveled field did not differ statistically from traditionally leveled field. Significantly higher grain yield over unleveled field might be attributable to better development of yield components like higher productive tillers m⁻² and more 1000-grain weight.
Table 1: Wheat yield and its components as affected by traditional and Laser Land leveling and traditional leveling techniques

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Productive tillers (m⁻²)</th>
<th>Grains ear⁻¹</th>
<th>1000-grain weight gm</th>
<th>Grain yield t ha⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser land leveling</td>
<td>374a</td>
<td>39</td>
<td>42</td>
<td>5a</td>
</tr>
<tr>
<td>Traditional land leveling</td>
<td>300ab</td>
<td>41</td>
<td>39</td>
<td>4a</td>
</tr>
<tr>
<td>Control (Unleveled)</td>
<td>274b</td>
<td>32</td>
<td>39</td>
<td>3b</td>
</tr>
<tr>
<td>LSD</td>
<td>74</td>
<td>NS</td>
<td>NS</td>
<td>0.95</td>
</tr>
</tbody>
</table>

due to more efficient use of inputs and uniform availability of soil moisture in the effective root zone of the crop. The results are quite in line with Burton (1994) who reported that increase in wheat grain yield in laser land leveling was highly significant over traditionally leveled fields. Cheema and Zulfqar (1989) attributed higher grain yield in precision land leveling to more uniform “Wattar” conditions that facilitated timely preparation of land and timely sowing of crop as compared to unleveled fields. The reason for lower grain yield in unleveled field might be uneven distribution of water over the field which drastically reduced the yield and yield components in lower and elevated spots.

**Water saving**

There was a significant improvement in irrigation performance when the precision Laser land leveling was under taken prior to sowing (Table 2). The maximum water depth (100.3 mm) was required to irrigate unleveled field during each irrigation as against the minimum in the field precisely leveled by laser and followed by traditionally leveled field. On an average, 47 and

Table 2: Total duration, applied water depth and Water-use efficiency as affected by laser and traditional land leveling techniques

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total duration min ha⁻¹</th>
<th>Water depth applied (mm)</th>
<th>Water depth/ Irrigation (mm)</th>
<th>Volume of water applied (m⁻²)</th>
<th>WUE kg m⁻³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser land leveling</td>
<td>1334a</td>
<td>340b</td>
<td>66b</td>
<td>3401b</td>
<td>1.63a</td>
</tr>
<tr>
<td>Traditional land leveling</td>
<td>1539b</td>
<td>392b</td>
<td>76b</td>
<td>3924b</td>
<td>1.26b</td>
</tr>
<tr>
<td>Control (Unleveled)</td>
<td>1967a</td>
<td>501a</td>
<td>100a</td>
<td>5015a</td>
<td>0.82c</td>
</tr>
<tr>
<td>LSD</td>
<td>308</td>
<td>782</td>
<td>15</td>
<td>786</td>
<td>0.23</td>
</tr>
</tbody>
</table>

Total duration
(LL vs TL) 1334.05-1539.2 = -204.95(15%)
(LL vs UL) 1334.05-1967.1 = -633.05(47%)

Water depth per irrigation
(LL vs TL) 68.2-78.5 = -10.3(15%)
(LL vs UL) 68.2-100.3 = -32.2(47%)

Water use Efficiency
(LL vs TL) 1.63-1.26 = 0.37(29.36%)
(LL vs UL) 1.63-0.82 = 0.81(98.7%)
15% as compared to control and traditionally leveled fields reduced the total irrigation duration and water depth in each irrigation event, respectively. Thus, laser leveled field utilized less water per irrigation. The precisely leveled and smooth field showed a positive impact on the total water use resulting in a tangible reduction. At uniform discharge, before and after PLL, there was about 32% saving in water over control and 13% over traditional leveled field. Anonymous (1991) also reported the maximum potential saving of 50% by laser land leveling. Significantly higher amount of water (5015.1 m³) was required for unleveled fields than the Laser leveled field (3401.3 m³), which did not differ significantly from the traditionally leveled field. The results further revealed that 1613.6 m³ i.e. about 47% excess volume of water was required to irrigate unleveled fields as against 15% (519.7 m³) in traditional leveled field. The only reason for excessive water application in control treatments was uneven surface of the unleveled treatment. The greater variation in surface level of unleveled and traditional leveled field resulted not only in wastage of water but also reduced crop yield by about 28 and 11%, respectively.

**Water use efficiency (WUE)**

WUE was significantly affected by different land leveling techniques (Table 2). The highest WUE (1.63 kg m⁻³) was recorded in laser-leveled field against the lowest (0.82 kg/m³) in unleveled field while in traditionally leveled field it was 1.26 kg/m³. Overall, the water- use efficiency was 49% higher in precisely leveled field than control and 22% higher than traditional leveling. This huge difference in water use efficiency was because of reduced grain yield and higher amount of water applied to unlevel and traditional leveled fields. The decrease in water use efficiency in unleveled fields also reflected the sensitivity of the crop to water excess/deficit, a characteristic of undulating surface of unleveled fields. The reason for lower WUE in traditionally leveled and unleveled fields was the inefficient use of the water applied. Similarly, the previous studies (Iqbal, 1997; Kalwij, 1999) have also shown higher water- use efficiency in laser-leveled field.

The result suggests that laser land leveling is more water use efficient more cost effective and give higher crop yield through efficient utilization of scarce land and water resources. Thus, in the light of this study it is imperative to recommend that laser land leveling should be popularized among the farmers as it not only increases water use efficiency and grain yield but also ensures better seed germination, better utilization of water and non water inputs towards increased wheat grain yield.

**References**

