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Laser Land Leveler: A Technology for Resource Conservation in India

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Introduction

Declining water table and degrading soil health are the major concerns for the current growth rate and sustainability of Indian Agriculture. Thus, proper emphasis is being given on the management of irrigation water usage for adequate growth of agriculture. Keeping in view, the need for judicious use of our natural resources, concerted efforts are being made to enlighten the farmers for efficient use of irrigation water at farm level (Kaur et al., 2012). Generally, in sugarcane-wheat and rice-wheat, rotation farmers believed that their fields are leveled and needed no further leveling. Rice and wheat are the two principal food crops in India. The total water requirement for rice-wheat system is estimated to vary between 1382 mm to 1838 mm.

Thus to save on water, saving must be effected during rice growing season, the major water user in Rice-Wheat system. Future food security in this region is severely threatened by unsustainable groundwater use and inappropriate water management practices. For the rice-wheat systems developing several water-saving technologies for water-short irrigated environments which besides the development of irrigation schedules and frequency, crop choices and their appropriate cultivars also included the precursor technology known as precision land leveling. In irrigated and rainfed environments, precision land leveling improves uniform application of water, betters the crop stands and helps reduce abiotic stress intensities, enhancing survival of young seedlings and robustness of the crop to withstand stress and stabilize yields through improved nutrient-water interactions.

The enhancement of water use efficiency and farm productivity at field level is one of the best options to readdress the problem of declining water level in the state. Laser Land leveling is one such important technology for using water efficiently as it reduces irrigation

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time and enhances productivity not only of water but also of other non-water farm inputs. It also enhances environmental quality and crop yields. In spite of the known benefits of precision land leveling, Indian farmers are unable to take full advantage of it and have to rely on traditional methods of land leveling which are labor-intensive and crude, and do not achieve a high level of smoothness of land surface. Laser land leveling technique is well known for achieving higher level of accuracy in land leveling. The technology described (laser leveling) offers a great potential for water saving, better environmental quality and higher grain yields.

Conventionally, farmers use plankers drawn by draft animals or by small tractors. Traditional land leveling includes field survey, staking and designing the field, calculation of cuts and fills and then using a scraper and a land plan to even the land. Despite all these labor-intensive efforts, desired accuracy is not achieved. These leveling practices are crude and do not achieve a precise land leveling. Different land leveling techniques require different tools and conditions varying in operating times and accuracy. Laser leveling is a process of smoothening the land surface (± 2 cm) from its average elevation using laser equipped drag buckets to achieve precision in land leveling. Precision land leveling involves altering the fields in such a way as to create a constant slope of 0 to 0.2%. This practice makes use of large horsepower tractors and soil movers that are equipped with global postioning systems (GPS) and/or laser-guided instrumentation so that the soil can be moved either by cutting or filling to create the desired slope/level. (Walker, Timothy et al. 2003).

The use of laser technology in the precision land leveling is of recent origin in India. It does not only minimize the cost of leveling but also ensures the desired degree of precision. It enables efficient utilization of scarce water resources through elimination of unnecessary depression and elevated contours (Naresh *et al.*, 2011). It has been noted that poor farm design and uneven fields are responsible for 30% water losses (Asif *et al.*, 2003). 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 (Jat *et al.*, 2006). The scarcity of canal water supplies coupled with unfit 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

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(Abdullaev *et al.*, 2007). It was estimated that around 25 to 30% of irrigation water could be saved through this technique without having any adverse affect on the crop yield (Bhatt and Sharma, 2009).

Land leveling: Concepts and techniques

Land leveling is done to enhance use efficiency of water and fertilizer nutrients, and to improve the crop stand and yields. However in the initial years crop yields at times are adversely affected, that can be avoided if some of the relevant conditions described below are taken into considerations.

- Level maintenance: With appropriate tillage practices
- Fertilizer needs of cut areas: Cut areas require additional nutrition. Compound fertilizer (N and P) can be applied at around 50 -100 kg/ha
- Subsoil considerations: Make sure that exposed subsoil is not problematic (acidity, salinity, sodicity, higher percolation rate, etc.) while going for heavy cuts
- Efficiency: Identify higher and lower level grades in the field to minimize soil movement
- Operator's skill: Efficient land levelling depends on operator's skill and experience.

Land leveling techniques

1. **Conventional leveling**

Conventionally, farmers use plankers drawn by draft animals or by small tractors shown in Figure 1. However, farmers in Punjab, Haryana and Uttar Pradesh use iron scrappers or leveling boards connected to 4-wheel tractors. Traditional land leveling includes field survey, staking and designing the field, calculation of cuts and fills and then using a scraper and a land plan to even the land. Despite all these labor-intensive efforts, desired accuracy is not achieved. These leveling practices are crude and do not achieve a precise land leveling. Different land leveling techniques require different tools and conditions varying in operating times and accuracy.

Figure 1. Traditional method of land leveling

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2. Bulldozers

Bulldozers are effective in highly undulated fields for initial leveling across larger areas, especially in cases where the terrain is rocky and the soil is hard. However, they should not be seen as presenting the perfect solution to precise leveling. Precise leveling can be achieved using advance methods (such as application of laser technologies, as described below) that complement and refine bulldozer-leveling.

3. Laser land leveling

The introduction of laser leveling in the 1970's produced a silent revolution that has raised potential of surface irrigation efficiency to the levels of sprinkler and drip irrigation (Erie and Dedrick 1979). Laser-controlled land levelling equipment grades fields to contour the land for different irrigation practices. With sprinklers, a perfectly level field conserves water by reducing runoff and allowing uniform distribution of water. Furrow irrigation systems need a slight but uniform slope to use water most efficiently. Laser leveling can reduce water use by 20-30% and increase crop yields by 10-20%. The quality of land leveling in zero-slope fields can be estimated through the standard deviation (SD) of soil surface elevation. A field leveled with conventional equipment can attain a standard deviation of 20-30 mm, while using laser leveling the technical limit extends upto 10 mm. The introduction of laser leveling can result in more than 10% increase in application efficiency, while the cost of the leveling operation is two to three times that of a standard tillage operation.

Before starting the laser land leveling process, the field should be ploughed and a topographic survey be carried out. One of the measures to improve irrigation efficiency is zero-grade levelling for crop production. Zero-slope fields can be flushed or drained more quickly. Level fields allow for a more uniform flood depth, using less water and reducing pumping costs. Benefits from precision leveling of land extend for many years, although some minor land smoothing may be required from time to time due to field operations and weather conditions. Laser-controlled precision land leveling helps to:

- Save irrigation water
- Increase cultivable area by 3 to 5% approximately
- Improve crop establishment
- Improve uniformity of crop maturity
- Increase water application efficiency up to 50%

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- Increase crop yields (wheat 15%, sugarcane 42%, rice 61% and cotton 66%)
- Reduce weed problems and improve weed control efficiency.

Components of laser land levelling system

The laser leveler involves the use of laser(transmitter), that emits a rapidly rotating beamparallel to the required field plane, which is pickedup by a sensor (receiving unit) fitted to a tractortowards the scraper unit. The signal received isconverted into cut and fill level adjustment and thecorresponding changes in the scraper level arecarried out automatically by a hydraulic controlsystem. The scraper guidance is fully automatic;the elements of operator error are removed allowingconsistently accurate land leveling. The set-upconsists of two units. The Laser transmitter, whichis mounted on a high platform. It rapidly rotates,sending the laser light in a circle like a lighthouseexcept that the light is a laser, so it remainsin avery narrow beam. The mounting has an automaticleveler built into it, so when it's set to all zeros, thelaser's circle of light is perfectly level.

A laser-controlled land leveling system consistsof the following five majorcomponents:

(i) Drag bucket

(ii) Laser transmitter

(iii) Laser receiver

(iv) Control box

(v) Hydraulic system

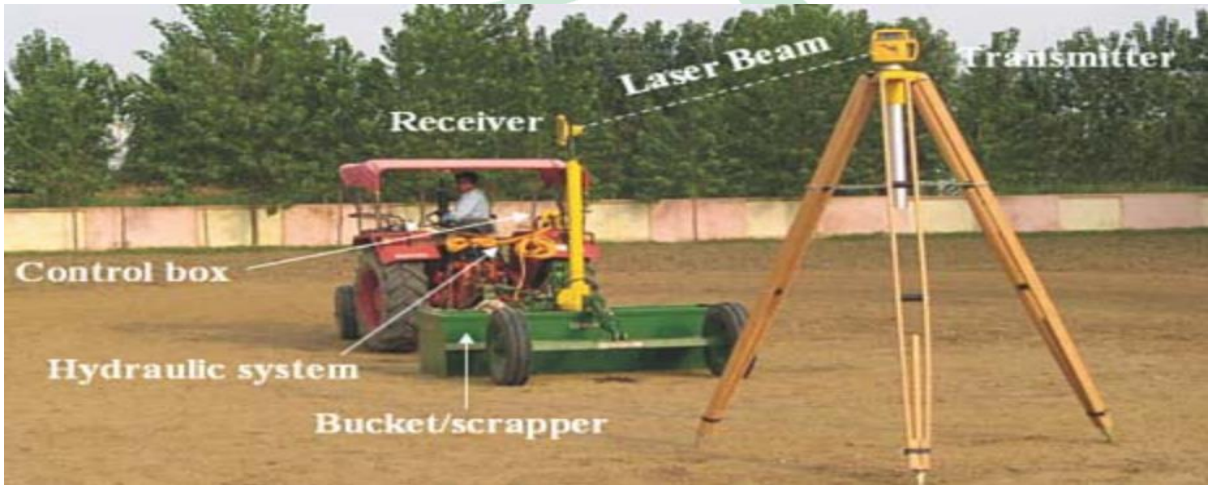

Figure 2. Functioning of laser land leveler

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Steps in laser land levelling

A. Ploughing of field
B. Topographic survey
C. Laser levelling of field

The benefits of laser land leveling

The benefits of laser land leveling over other land leveling methods include the following:

- Precise level and smoother soil surface
- Reduction in time and water required to irrigate the field
- Uniform distribution of water in the field
- Uniform moisture environment for crops
- Good germination and growth of crops
- Less seed rate, fertilizer, chemicals and fuel requirements
- Improved field traffic ability (for subsequent operations)

Limitations of laser leveling

- High cost of the equipment/laser instrument
- Need for skilled operator to set/adjust lasersettings and operate the tractor
- Less efficient in irregular and small sized fields.

Conclusions and recommendations

Laser leveling of agricultural land is aresource-conservation technology initiative in India.The results are quite encouraging. It has thepotential to change the way food is produced byenhancing resource-use efficiency of critical inputswithout any disturbing and harmful effects on theproductive resilience of the ecosystem.Popularisation of this technology amongfarmers in a participatory mode on a comprehensivescale, therefore, needs appropriately focusedattention on priority basis along with requisitesupport from researchers and planners. The changein our vision of future agriculture in relation tofood and nutritional security, environmental safetyand globalisation of markets demands improvingresource-use efficiency considerably to reach thedesired growth levels in food production andagricultural productivity. Laser leveling is evidentlyone of the ways by which we can address theseissues to a great extent.

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