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Laser Land Levelling-Background, Working Principle and Advantages in Agriculture

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Abstract

Optimum water requirement for crop production is considered one of the most important factors affecting Agricultural production. Scarcity of water including unevenness of fields leads to inefficient use of irrigation water. Proper land levelling is essential for judicious use of scarce irrigation water due to per capita availability of water diminishing day by day. Thus, it is essential to precision land levelling and proper management of irrigation water usage for adequate growth of agriculture. Land leveling enables efficient utilization of scarce water resources through elimination of unnecessary depression and elevated contours. Traditional methods of land levelling are cumbersome, expensive and time consuming. Precision land levelling is essential for increase the food production through proper water distribution in growing populated country like India.

Introduction

Laser levelling is a process of smoothing the land surface (± 2 cm) from its average elevation using laser-equipped drag buckets. This practice uses large horsepower tractors and soil movers that are equipped with global positioning 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. This technique is well known for achieving higher levels of accuracy in land levelling and offers great potential for water savings and higher grain yields. Traditionally farmers level their fields using animal drawn or tractor-drawn levellers. These levellers are implements consisting of a blade acting as a small bucket for shifting the soil from higher to the low-lying positions. It is seen that even the best levelled fields using traditional land levelling practices are not precisely levelled and this leads to uneven distribution of irrigation water. Laser Land Leveller is regularly used in the USA, Europe, China, Pakistan, Nepal, Bangladesh, Iran and Korea. Laser land leveller is a solution to several problems faced in cultivation. In India, currently more than 5,000 laser levellers are in use in Punjab, Haryana, Western UP, Bihar, Madhya Pradesh, Gujarat, Tamil Nadu, Karnataka and other states.

Components of Laser Leveling System

A laser-controlled land leveling system consists of the following five major components:

- **Drag Scrapper/ bucket:** The drag bucket can be either 3-point linkage mounted on or pulled by a tractor. This system is preferred as it is easier to connect the tractor's hydraulic system to an external hydraulic by the 3-point linkage system.
- **Laser transmitter:** The laser transmitter mounts on a tripod,

which allows the laser beam to sweep above the field.

- **Laser receiver:** The laser receiver is a multi-directional receiver that detects the position of the laser reference plane and transmits this signal to the control box.
- **Control box:** The control box accepts and processes signals from the machine mounted receiver. It displays these signals to indicate the drag buckets position relative to the finished grade.
- **Hydraulic system:** The hydraulic system of the tractor is used to supply oil to raise and lower the leveling bucket.

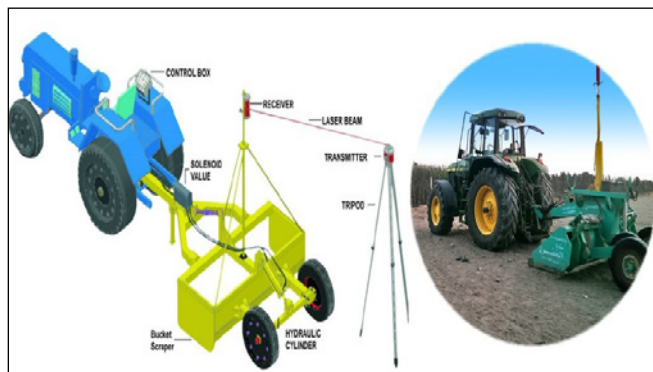


Figure 1: Components of laser leveling system

Working Principle of Laser Land Leveler

Laser land leveler is leveling the field within certain degree of desired slope using a guided laser beam throughout the field. The system includes a laser-transmitting unit that emits a laser beam that travels in a perfectly straight line. Beam received by a laser receiver that senses the light and sends signals to a control box to activate an electro hydraulic valve which raises and lowers the blade of a scrapper & eliminates all undulations tending to hold water. Laser transmitters create a reference plane over the work area by rotating the laser beam 360 degrees. This is all accomplished automatically without the operator touching the hydraulic controls.

There are two types of land leveling:

- To provide a slope for water supply.
- To level the field to its best condition with minimal land disturbance and then vary the water supply.

What is the Procedure for Laser Leveling?

Laser leveling requires soil to be shifted from the high points of the field to the low points in the most cost-effective way. In most situations fields will need to be plowed and a topographic survey undertaken before leveling operation begins.

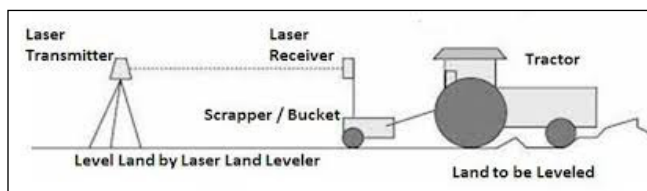


Figure 2. Working Principle of Laser Land Leveler

Step 1: Plowing the Field

The field should be preferably plowed from the center of the field outwards. Plow when the soil is moist, because if it is plowed dry a significant increase in tractor power is required and large clod sizes may result. Cut up or remove surface residues to aid soil flow from the bucket.

Step 2: Conducting a Topographic Survey

Once the field is plowed, a topographic survey should be conducted to record the high and low spots in the field. The mean height of the field can be calculated by taking the sum of all the readings and dividing by the number of readings taken. Then, using a field diagram and the mean height of the field, determine how to effectively move soil from the high to low areas.

Step 3: Leveling the Field

Leveling a field involves the following steps:

- The laser-controlled bucket should be positioned at a point that represents the mean height of the field. The cutting blade should be set slightly above ground level (1-2 cm).
- The tractor should then be driven in a circular direction from the high areas to the lower areas in the field.
- To maximize working efficiency, as soon as the bucket is near filled with soil the operator should turn and drive towards the lower area. Similarly, when the bucket is near empty the tractor should be turned and driven back to the higher areas.
- When the whole field has been covered, the tractor and bucket should then do a final leveling pass in long runs from the high end of the field to the lower end.
- Re-survey to make sure that the desired level of precision has been attained.

The fields should not require further major leveling works for at least 8 years.

Advantages

- A precisely leveled surface leads to uniform soil moisture distribution, resulting in good germination, enhanced input use efficiency and improved crop stand and yield.
- Laser leveling allows for control of water distribution with negligible water losses.
- Laser leveling improves irrigation efficiency and reduces the potential for nutrient loss through better irrigation and runoff control.

- It facilitates uniformity in the placement of seedlings, helping to achieve higher yields.
- Land leveling reduces weed (improved water coverage reduces weeds up to 40%), pest, and disease problems.
- It results in 3 to 4% additional land recovery and improves operational efficiency (reducing operating time by 10% to 15%).
- Leads to reduced consumption of seeds, fertilizers, chemicals and fuel.
- Facilitates movement of agricultural machinery through the fields.
- Assist top soil management.
- Saves labor cost.
- Saves fuel/ electricity used in irrigation.

Conclusion

Laser leveling of agricultural land is a recent resource-conservation technology. It has the potential to change the way food is produced by enhancing resource-use efficiency of critical inputs without any disturbing and harmful effects on the productive resilience of the ecosystem.

The change in our vision of future agriculture in relation

to food and nutritional security, environmental safety and globalization of markets demands improving resource-use efficiency considerably to reach the desired growth levels in food production and agricultural productivity. Laser leveling is evidently one of the ways by which we can address these issues to a great extent.

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