fact sheet

Laser land leveling – a precursor technology for resource conservation

Traditional methods of leveling land are cumbersome, time consuming, and expensive, so more and more farmers are turning to modern methods to level the land.

What is laser land leveling?

Laser leveling 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 leveling and offers great potential for water savings and higher grain yields.

What are the benefits of laser land leveling?

- 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

What are the limitations of laser leveling?

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

How does a laser level work?

A laser transmitter transmits a laser beam, which is intercepted by the laser receiver mounted on the leveling bucket. The control panel mounted on the tractor interprets the signal from the receiver and opens or closes the hydraulic control valve, which will raise or lower the bucket. Loose soils are picked up by the bucket and released lower in the field.

4-wheel tractor - A 4-wheel tractor is required to drag the leveling bucket. The size of the tractor can vary from 30-500 hp depending on the time restraints and field sizes, though a 4 wheel drive with power shift transmission is preferable.

Drag bucket - The leveling bucket can be either 3-point linkage mounted or pulled by the tractor's drawbar. Pull type systems are preferred as it is easier to connect the tractor's hydraulic system to an external hydraulic ram.

Laser transmitter - The laser transmitter mounts on a tripod which allows the laser beam to sweep above the tractor unobstructed. With the plane of light above the field, several tractors can work from one transmitter.

Laser receiver - The laser receiver detects the position of the laser reference plane and transmits these signals to the control box. The receiver mounts on a mast attached to the drag bucket.

Control panel - The control box accepts and processes signals from the machine-mounted receiver. It then indicates the drag bucket's position relative to the finished grade.

Hydraulic control system - The hydraulic system supplies oil to raise and lower the leveling bucket. A pressure relief valve is needed in the system to return the excess oil to the tractor reservoir. If this relief valve is not large enough or it malfunctions, damage can be caused to the tractor's hydraulic pump.

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 commences.

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.

What are the different types of laser levelers?
Manual leveling lasers - Set-up of a laser leveling instrument requires the operator to manually level the unit by using the units' screws and bubble vials. These lasers can achieve a maximum accuracy of 1 cm at 100m.
Semi self-leveling lasers - These lasers adjust themselves automatically within a range, and can achieve accuracy of at least 1 cm at 100 m. They are equipped with either a circular bubble with a bull's eye or electronic lights that turn green when you reach the self-leveling range.
Fully self-leveling lasers - These lasers automatically find and maintain level within a specified range. They are the easiest to use and can achieve accuracy of up to 2.5 mm at 100 m.
Split-beam lasers - These lasers emit simultaneous horizontal and vertical beams to establish both level and plumb reference lines.

References:
Rickman, J.F., 2002. *Manual for laser land leveling*. Rice-Wheat Consortium Technical Bulletin Series 5. New Delhi: Rice-Wheat Consortium for the Indo-Gangetic Plains.
Jat, M.L., Parvesh Chandna, Raj Gupta, S.K. Sharma and M.A. Gill. 2006. *Laser Land Leveling: A Precursor Technology for Resource Conservation.* Rice-Wheat Consortium Technical Bulletin Series 7. New Delhi: Rice-Wheat Consortium for the Indo-Gangetic Plains.

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