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THE IMPORTANT ROLE OF LASER LAND LEVELING IN THE EFFICIENT AND RATIONAL USE OF AGRICULTURAL CROPLANDS

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ABSTRACT The article highlights the technical aspects, advantages, and limitations of leveling agricultural lands and utilizing irrigation water efficiently under current global climate change conditions. It also describes the operating principles, benefits, and practical application processes of new, modern, and innovative technologies that use laser levelers for land leveling. One of the main factors for achieving high crop yields in irrigated agriculture is the uniform leveling of farmland. In this article, we present modern methods of agricultural land leveling, one of which is leveling crop fields using a laser-guided system. Laser-assisted land leveling ensures uniform distribution of water and nutrients across the field, creating favorable conditions for the growth of all types of crops. As a result, crop productivity increases by an average of 5–10 c/ha.

KEYWORDS: Irrigated lands, land leveling, laser leveler, laser-guided system, modern innovative technologies, major (capital) and current (operational) leveling, climate change, water scarcity, water limits, digital technologies, water-saving technologies.

After Uzbekistan gained independence, significant reforms were initiated to develop the agricultural sector. In this regard, increasing the efficiency of irrigated land use has become one of the most urgent tasks facing the agrarian sector. The land fund of Uzbekistan amounts to 44,892.4 thousand hectares, of which more than 25 million hectares are used for agricultural production.

Although this figure may seem large at first glance, the lands that are intensively exploited in agriculture primarily consist of irrigated areas. Irrigated lands cover 4,331,700 hectares, which accounts for more than 9 percent of the total land fund. Despite this relatively small share, over 95 percent of the country's gross agricultural output is produced on these lands.

The main purpose of leveling agricultural lands is to eliminate irregularities that impede irrigation and mechanized agrotechnical operations, while maintaining the natural slope of the

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field. The evenness of a field ensures efficient water use during irrigation and uniform soil moisture distribution. Since seeds are planted at equal depths, crops develop uniformly, resulting in increased yields.

Traditional land leveling in agriculture is carried out in two ways: general (capital) leveling and current (operational) leveling.

General (capital) leveling aims to transform the natural terrain into a field suitable for agricultural use. This includes leveling operations required for placing irrigation and drainage collector systems, as well as arranging crop fields. Depending on the terrain, the volume of general leveling may range from 300 to 1,000 m³ per hectare.

Current (operational) leveling refers to annual light tillage operations that eliminate minor unevenness in the soil surface. It is sometimes referred to as seasonal leveling. The main purpose of current leveling is to prepare the land for plowing or chiseling after seasonal agricultural activities. During plowing, soil clods must be softened, and small irregularities reduced. Therefore, current leveling is carried out using light equipment—long-base leveling tools and drags (harrows).

However, long- and short-base leveling tools have a drawback: field unevenness is determined by the length of the machine's base, causing the leveling process to remain incomplete. *(Figure 1)*

Figure 1. **Long-base and short-base leveling equipment**

In the context of modern global economic development, one of the most advanced and innovative technological methods for increasing field productivity is the use of laser land-leveling equipment. In irrigated agriculture, the uniformity of the field surface is one of the key factors that ensures the efficient use of land, water, fertilizers, and energy resources, while also contributing to

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higher crop yields and overall economic stability.

Laser-assisted land leveling refers to the process of eliminating high and low spots on a field surface using specially equipped machinery (Figure 2). Although this technology has begun to be introduced into the country's agricultural sector, it is not yet widely adopted. Therefore, there is a growing need for thorough study, field testing, further improvement, broader practical implementation, and incorporation of this technology into educational and training programs.

Figure 2. Laser-assisted land leveling.

The purpose and operating principles of laser-assisted land leveling are generally similar to those of conventional leveling; however, the process differs due to additional preparation requirements. The field must be cleared of plant residues, as accumulated vegetation and soil clods can hinder effective plowing and leveling operations.

When determining the directions of planting and irrigation, the field should be leveled in accordance with these orientations. This ensures more efficient use of irrigation water and enables its optimal management.

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Figure 3. Laser land leveler and its components

Typically, field unevenness is identified using a laser leveler. However, some additional components of the laser leveling system can also be used to rapidly determine surface irregularities. The initial stage involves conducting a topographic survey of the field using the laser leveler. Although the function and measurement accuracy of a laser-based topographic survey do not differ significantly from those performed with a conventional level, the laser system offers greater efficiency by reducing time and labor requirements.

While a conventional leveling instrument can survey the relief of 4–5 hectares in one day, a laser leveler can increase this productivity by 2–3 times. For this process, a laser transmitter, a laser leveler, a laser receiver, and a GPS or GNSS receiver for determining field coordinates are required. The topographic survey of the field can be carried out using a 20 × 20 meter grid method (Figure 3).

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SOIL REDISTRIBUTION CARTOGRAM FOR EACH GRID CELL

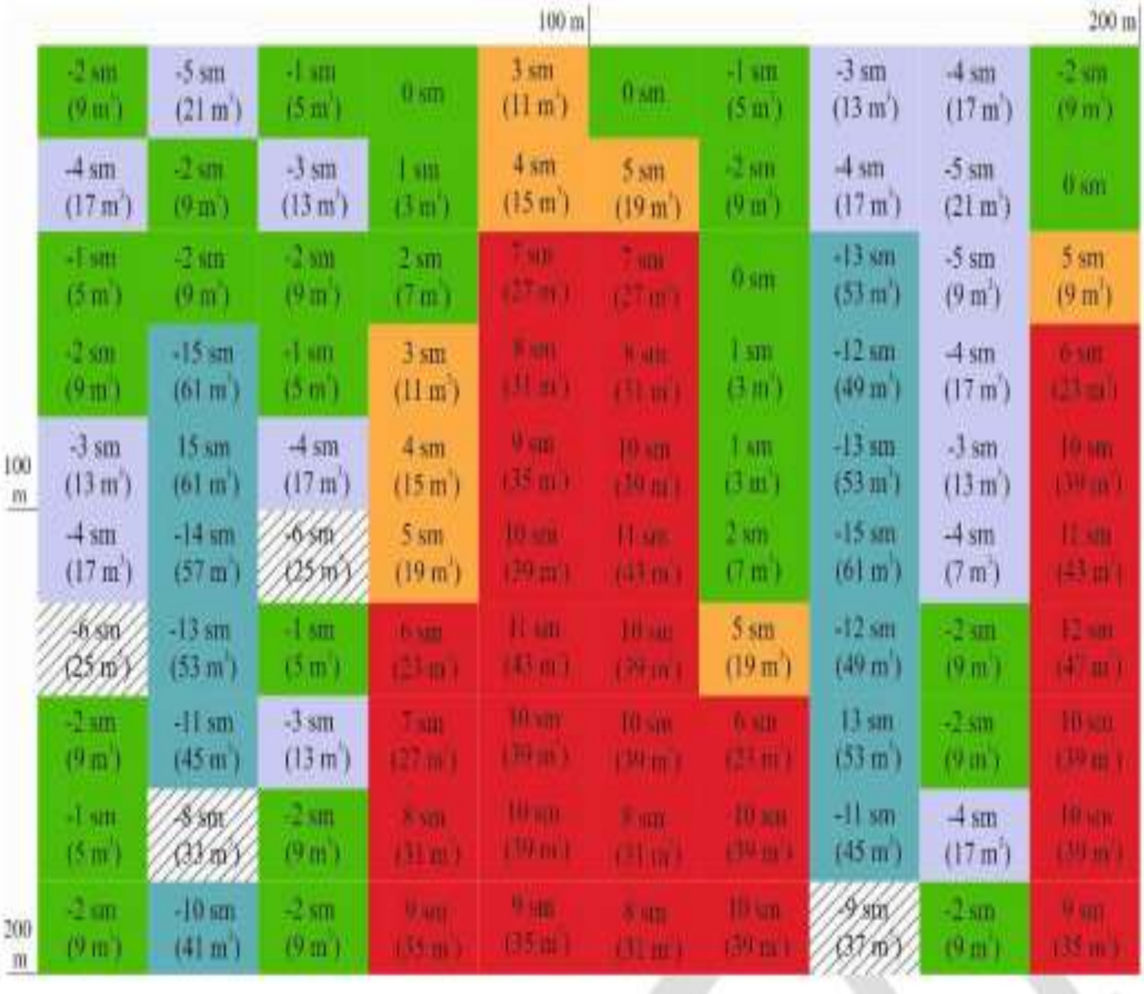
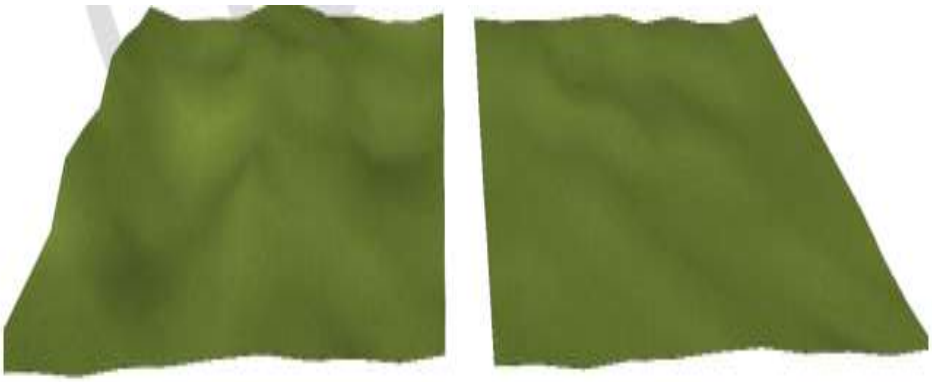


Figure 4.

Based on the data transmitted from the laser transmitter to the laser receiver mounted on the measuring rod, the operator determines the measurement points in the field according to the audible signals of the receiver. Conducting a topographic survey of the field using a laser leveler is not a complex process. Depending on the model, the diameter of the laser beam transmitted by the laser emitter ranges from 300 to 600 meters. Without repositioning a laser transmitter with a 300-meter transmission diameter, it is possible to perform a topographic survey of a 4-hectare field located 200 meters away from the center.



(Figure 4).

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a) **Figure 4.** b)

a) Three-dimensional view of the land surface before leveling **b)** Three-dimensional model of the land surface after initial leveling operations

The application of laser-assisted land-leveling technology increases the number of agricultural operations performed on wheat fields during the first year. However, in subsequent years, the number of operations decreases due to the elimination of moling and other long-base leveling practices. Since the field is leveled using a laser system, mechanization costs (long-base leveling, reduced need for additional field boundaries) are significantly reduced.

Experimental results from farms show that starting from the second year, not only do mechanization costs decrease by 16 percent, but labor costs decrease by 21 percent, irrigation time is reduced by 22 percent due to more uniform water distribution, irrigation expenses drop by 23 percent, and total water consumption decreases by 26 percent.

Overall, the use of laser land leveling reduces total wheat production costs by 9 percent in the second year. At the same time, crop yield increases by 6.0 centners per hectare, enabling the profitability level to rise from 15 percent to 22 percent in the first year and up to 37 percent in the second and subsequent years. Because fields leveled with a laser system allow for uniform distribution of water and nutrients, favorable growth conditions are created for all types of crops, resulting in an average yield increase of 5–10 c/ha.

The implementation of this new technology ensures high economic efficiency. Reduced costs and increased yields create opportunities for significantly higher profits.

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