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Article

# Technical Modernization and Land Tillage Technologies in Agriculture

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**Abstract:** Guaranteed provision of the country's population with quality food products and seamless integration of industrial sectors with raw materials are strategic priorities of the agrarian policy. The fundamental reforms being implemented in Uzbekistan's agriculture have raised the efficiency of the sector to a qualitatively new level by enlarging farms, modernizing the material and technical base, and improving the service delivery system. The results achieved in cotton and grain growing, which are considered the locomotive sectors of agriculture, in particular, the country's success in ensuring not only grain independence, but also in forming export potential, are a vivid reflection of systemic changes in the sector. In the context of global climate change, ensuring the stability of the agricultural sector, increasing the competitiveness of the sector, and widely introducing advanced resource-saving technologies into practice are of utmost importance. This study analyzes mechanisms for increasing regional efficiency by integrating innovative approaches, digital technologies, and advanced international practices into agricultural processes.

**Keywords:** Modernization, Final, Soil Particles, Suspension, Two-Tier, Air, Water, Plow.

## Introduction

The development of farming activities in the agricultural sector and the rational use of land resources are a decisive factor in optimizing agrotechnical processes and reducing production costs. Technological improvement of agricultural machinery requires the introduction of innovative approaches to the production cycle. Within the framework of the implementation of the decrees of the President of the Republic of Uzbekistan on the development of the sector and the resolutions of the Cabinet of Ministers [1], [2], [3], the level of provision of agricultural production facilities with a modern machine-tractor fleet has risen to a qualitatively new level. The modernization of energy resources has created a solid foundation for increasing the variety and volume of agricultural products produced, and ultimately, improving the well-being of the population. Managing these complex technical systems based on energy-saving technologies requires high theoretical training and deep practical skills from specialists [4].

## Materials and Methods

The use of highly efficient techniques in the primary tillage processes guarantees the fulfillment of technological requirements. Currently, the following types of plows are widely used in practice:

Mounted plows: "Yeropal 5" (3+1, 4+1), "N100", "Lemken Vari Opal 120-4", "Lemken Opal", "Vari-Diamant 95N 100" and modern models such as "PNO-4-45" [5].

General purpose plows: Traditional equipment such as "LD-100", "OP-4/5-40", "PLN-4-35" and "PLN-5-35".

Two-row plows: "PYa-3-35", "MR-2/3-45", "PNYa-4+1-45" and "PD-4-45" are equipment that allows you to maintain soil fertility and work in accordance with agrotechnical requirements.

**Figure a** **Figure b**

**Figure 1.** Types of plows used in basic soil cultivation processes.

**The importance of primary tillage in increasing soil fertility.**

**Results**

Stable and high yields of agricultural crops directly depend on maintaining the physicochemical properties of the soil in an optimal state. According to scientifically based data, to ensure soil fertility, it is desirable that its composition consists of 25% air, 25% water and 50% solid particles [6]. The most effective way to achieve this physical state is high-quality primary tillage of the soil.

The strategic objectives of the main tillage process are:

Optimization of physical properties: Reducing soil density, improving its water permeability and moisture retention properties.

Creating a favorable environment for plant development: Forming a soft, highly aerated layer for deep root system development.

Agrotechnical efficiency: Uniform mixing of mineral and local fertilizers into the soil layer.

Phytosanitary control: Removal of weed residues and soil fungi and pests [7].

Plowing is the basic method of soil cultivation, which is carried out by loosening the soil layer with or without turning it over. In the conditions of Uzbekistan, the turning method is the most common technological solution. This operation is carried out mainly during the autumn plowing period using sod-cutter and two-tier plows to a depth of 35–40 cm, which provides optimal agrophysical conditions for the development of crops, consistent with long-term experimental evidence that deeper mouldboard ploughing improves subsoil porosity and bulk density relative to shallower tillage [8]. At the same time, the depth and intensity of tillage must be balanced against the risk of soil compaction, since excessive trafficking and repeated shallow passes are known to induce plow-pan formation and reduce water infiltration [9].

In areas prone to wind and water erosion, the method of tillage without turning the soil is used. This involves the use of special plows without turning the soil and flat deep levelers [10].

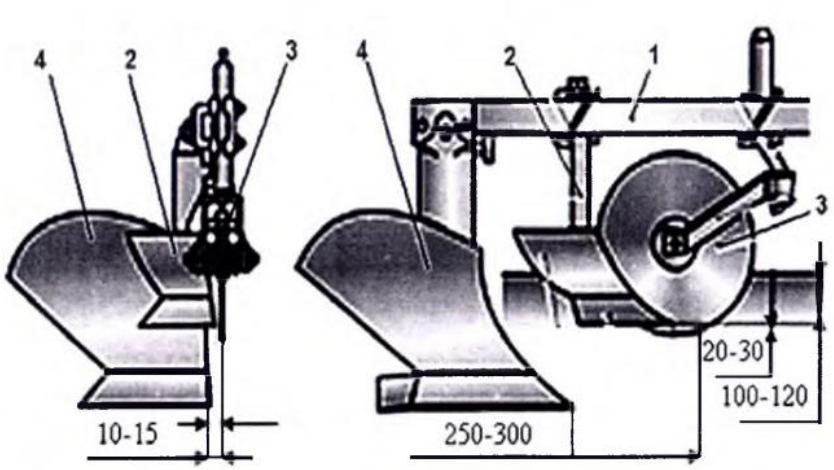


**Figure 2.** The main parts of the plow and their adjustment dimensions.

*1-frame, 2-shear, 3-disc blade, 4-main body.*

I have edited this section in a scientific and technical style, based on certain standards and agrotechnical rules, as follows:

Agrotechnical conditions and quality indicators of the tillage process

**Discussion**

The effectiveness of the main tillage process directly depends on soil moisture. According to scientific data, the optimal moisture content for carrying out agrotechnical measures on gray soils is recommended to be in the range of 16–18% [11]. At this moisture level, the physical and mechanical properties of the soil are optimal; it crumbles well, does not stick to the working bodies, and the specific resistance to cutting is reduced to a minimum value. This, in turn, allows you to reduce fuel and lubricant consumption and increase the productivity of the unit. In cases where soil moisture is below the established norm, it is necessary to carry out irrigation measures and start tillage after the soil reaches a "ripening" state.

**Agrotechnical requirements for plowing**. When controlling the quality of plowing, the following agrotechnical criteria must be observed:

Processing depth: The deviation from the specified depth should not exceed ±2 cm.

Burial depth of plant residues:

For two-tier plows - up to 20 cm;

For general-purpose plows - up to 10 cm.

Soil compaction level: The amount of clods smaller than 50 mm in the plow layer should be at least 75% of the total mass.

Surface roughness: The average height of the grooves (pits) on the plow surface should not exceed 5 cm.

Currently, special attention is paid to the technology of two-layer plowing of the land. In this case, the upper 10-15 cm layer of soil, rich in nutrients, is transferred to the lower part, where moisture is well preserved, so that plants can use nutrients more fully. [12] The lower 15-30 cm layer of soil, which is less nutritious, is completely removed to the field surface. As a result, the emergence of deeply buried weeds is delayed by 40-60 days. This staged approach is conceptually related to multistage plowing methods that combine layer inversion with subsurface loosening to improve profile-wide soil structure [13]. Plowing in this method is carried out using two-layer 3-4-body plows of the PYa-3-35, PD-3-35 PNYa4+1-45, PDO-4-45 models. [14] When these plows are working, the upper body cuts the upper layer, turns it over, and throws it into the furrow formed by the lower body moving ahead. The lower body, in turn, cuts the lower layer of soil, turns it up, lifts it up, and throws it on top of the layer

lying at the bottom of the furrow. As a result, the soil layers are replaced, and weed seeds and plant debris are buried deep into the soil.

## Conclusion

The analysis shows that the use of modern agrotechnical methods in agriculture, in particular, primary soil cultivation using two-tier plows, is a strategic factor in increasing the efficiency of the agricultural sector.

In particular, the use of two-tier plows on highly saline land areas provides the following scientific and practical results, a pattern that is broadly consistent with findings on subsoiling depth and combined tillage practices for managing salt-affected and compacted soils [15]:

Resource saving: By moving the salt content in the top layer of soil into the deeper layer, water consumption during the salt leaching process is saved by up to 25–30%.

Phytomeliorative efficiency: This method of soil cultivation reduces weed germination by 2–2.5 times, which helps reduce the cost of chemical treatment.

Productivity increase: Plowing operations carried out in full compliance with agrotechnical requirements can increase cotton productivity by 2.5–3.3 centners per hectare.

Ultimately, the modernization of agricultural machinery and the implementation of energy-saving technologies not only reduces production costs, but is also a guaranteed mechanism for rational resource management and improving people's well-being.

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