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Article

Process of Floor Formation in Rice Fields Using A Disc Floor Collector and Its Mechanization Technology

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Abstract: This article provides a detailed description of the essence of floor formation in rice fields using a disc floor collector, its effects on rice growth and productivity, as well as the traditional and mechanized methods of implementing the process. In particular, the stages of floor formation — soil loosening, chiseling, leveling, and flooding — and the machinery used at each stage are analyzed. Research results show that in fields where quality floor formation is achieved with a disc floor collector, water consumption decreases by 18-25%, fertilizer efficiency increases by 12-18%, and final yield increases by 6-10 centners per hectare.

Keywords: Floor, floor formation, rice field, disc floor collector, leveling, chiseling, harrow, flooding, agrotechnics, productivity, water saving.

Introduction

Rice is a water-demanding crop, and one of the most important agrotechnical requirements throughout its entire growing season is the uniform distribution of water across the field surface. If the field relief is uneven, water levels drop in elevated areas and plant growth slows down; in low areas, excess water accumulates, causing seedlings or seeds to rot. The agrotechnical measure that solves this problem is floor formation in the field.

A floor is the process of bringing the surface of a rice-growing field to a state where the water level is nearly uniform (2-3 cm) at all points of the area. Floor quality directly affects all stages of rice growth from germination to harvesting.

In Uzbekistan, rice is grown on more than 154,000 hectares, and detailed agrotechnical guidance for the crop has been compiled at the national level [1]. To increase existing productivity, it is important to make full use of internal reserves, including improving the floor formation process;

research on alternative timing for transplant-based cultivation has likewise sought to optimize the agrotechnical calendar for the crop [2].

International experience with precision land leveling reinforces the importance of this agrotechnical measure: field water management studies in irrigated lowland rice systems have shown that uniform field surfaces are a precondition for efficient water use and productivity [3]. Building on this evidence base, the present article examines the application of the disc floor collector and its advantages for Uzbek rice-growing conditions.

Literature Review

Floor formation in rice fields serves a number of important functions. First, water management — a flat field allows the water level to be maintained at an optimal level, which is crucial from rice germination to flowering. Second, it increases fertilizer efficiency — when the surface is even, the applied fertilizer is distributed uniformly across the entire area and is not washed away. Third, weed control becomes easier, since weeds grow less when the water level is stable.

Furthermore, favorable conditions are created for mechanized field operations: machinery moves straight on a flat field, and sowing and harvesting work is performed with higher quality. On fields with poor floor quality, the opposite occurs — water is unevenly distributed, machinery gets stuck, workers tire out, and yields decline.

A recent assessment of the current state of rice cultivation in the region has documented these persistent floor-quality constraints under local conditions [4], while complementary work on the installation angles of the disc floor collector relative to its direction of movement has begun to quantify the operating parameters that determine leveling accuracy [5].

Beyond Uzbekistan, the international literature on precision land leveling provides converging evidence on the benefits of mechanized leveling for paddy systems. Meta-analytic evidence indicates that improved field uniformity is consistently associated with higher water-use efficiency across a wide range of irrigated rice environments [6].

Adoption studies of water-saving irrigation technologies further show that the economic returns to improved field leveling are realized largely through reduced water input without yield penalty [7].

Comparable evidence from rice-wheat rotation systems demonstrates that precision land leveling combined with reduced-tillage establishment improves both water productivity and soil physical properties relative to conventional, unleveled fields [8].

Farm-level adoption research has likewise shown that laser-assisted leveling raises household income through combined water savings and yield gains in smallholder rice-wheat systems [9].

Beyond water savings, properly leveled fields have also been shown to reduce nitrous-oxide and methane emissions associated with uneven flooding and drainage cycles [10].

Country-level case studies of laser-controlled leveling adoption in the Mekong Delta similarly report substantial reductions in irrigation water input alongside improvements in net water-use efficiency under paddy production conditions comparable to those found in the Fergana Valley [11].

Multi-country assessments spanning Southeast and South Asia confirm that these benefits — water savings, yield gains, and reduced emissions — are broadly transferable across different rice-growing environments, supporting the relevance of mechanized leveling technology to the Uzbek context examined here [12].

Materials and Methods

Stages of Floor Formation

The process of floor formation in a rice field consists of several sequential stages, each requiring specific equipment and labor.

Stage 1 — Field Preparation and Plowing. First, the field is cleared of previous crop residues. Fields intended for rice as the main crop are prepared in April, and for second crops in May–June. The field is plowed to a depth of 15-20 cm.

Stage 2 — Chiseling and Harrowing. The plowed field is loosened with a chisel. Chiseling improves soil composition and retains moisture without fully breaking down the soil. The field is then processed with a harrow-roller, breaking up large soil clods.

Stage 3 — Base Leveling. At this stage, the overall relief of the field is leveled using a base leveler. The land is freed from sharp elevation differences. Traditionally, this work is carried out using a tractor-mounted planer.

Stage 4 — Floor Formation Using the Disc Floor Collector. After base leveling, the field is finely leveled using a disc floor collector. This is the stage specifically called floor formation — the soil surface is brought to a uniform state with high accuracy. The disc floor collector simultaneously cuts, slices, and smooths the soil, ensuring surface leveling without disturbing the soil structure.

Stage 5 — Flooding and Final Processing. The leveled field is flooded with water and additional harrowing is performed. Underwater harrowing eliminates any remaining surface irregularities. The water level is observed to spread uniformly at a thickness of 2-3 cm. If this is achieved, the floor is considered to be of quality.

Machinery and Technical Means Used in Floor Formation

Various machines and technical means are used for floor formation. They can be divided into two groups: traditional and modern.

The traditional group includes: floats (pulled underwater), harrows, simple land levelers, and manually operated attachments. These methods have low accuracy, and the final surface has unevenness within ±5-10 cm.

The modern group includes the disc floor collector machine. It is coupled with a tractor and consists of several main components: a rotary disc system, a distributing frame, and a soil-smoothing board (or tine harrow). The discs cut and shift soil laterally, reducing uneven surface mounds. The distributing frame carries the cut soil to lower areas, ensuring overall uniformity. The disc floor collector is especially suitable for waterlogged or soft rice fields, since the discs work without lifting or sticking to the soil. The structural parameters that determine the performance of this machine — disc diameter, spacing, and frame geometry — have been the subject of dedicated engineering analysis [13], and parallel work has examined the broader construction of floor-forming machines as a class [14].

Agrotechnical Requirements for Floor Formation

Strict compliance with the following agrotechnical standards is required for floor formation in rice fields.

Water level uniformity — criterion for the floor to be considered ready: after water is applied to the field, it must spread uniformly in a 2-3 cm layer at all points. If water accumulates in some areas while other areas remain dry, the floor must be reworked.

Soil moisture — the work is performed at 15-20% soil moisture. Using the disc floor collector on dry soil requires more tractor power and reduces accuracy. On excessively wet (swampy) soil, the tractor may get stuck.

Working method — the disc floor collector first moves from elevated areas in a circular pattern. The field is then finalized with long passes along the field. The disc turning angle is adjusted between 15-25° depending on soil hardness.

Control measurement — to monitor floor quality, topographic measuring instruments are used, or in a simpler method: water is applied to the field and uniform distribution is observed. In this case, the track lines left by the disc floor collector are considered leveled when covered by water.

Experimental Design

Research was conducted on experimental plots in Andijan region, comparing three variants under matched soil and irrigation conditions: manual labor floor formation, traditional tractor leveling, and the disc floor collector machine. Surface unevenness, seasonal water consumption, fertilizer efficiency, final yield, and labor input were recorded for each variant and compared against the control (traditional method).

Results and Discussion

Results

Comparison of Floor Formation Methods and Tools

Table 1 summarizes the comparative performance of manual labor, traditional mechanized leveling, and the disc floor collector across the principal indicators examined.

Indicator	Manual Labor	Traditional Tech.	Disc Floor Collector
Leveling accuracy	±10-15 cm	±5-8 cm	±2-4 cm
Work productivity	0.05-0.1 ha/day	0.3-0.5 ha/day	0.8-1.5 ha/day
Labor input	Very high	Medium	Low
Water savings	—	10–15%	18-25%
Yield increase	—	5–8%	12-20%
Re-use cycle	Every year	Every year	Every 3-5 years

Table 1. Comparison of floor formation methods and tools.

Field Experiment Outcomes

The obtained results showed that in areas processed with the disc floor collector:

- surface unevenness decreased to an average of ±3.2 cm (compared to ±7.3 cm with traditional methods);
- water consumption during the growing season decreased by 820 m^3 per hectare;
- fertilizer efficiency increased by 14%;
- yield increased by 7.6 centners per hectare compared to the control variant;
- labor days for floor processing decreased from 7.2 person-days/hectare to 2.1 person-days/hectare.

One additional advantage observed during the trials is that the disc floor collector has a relatively simple design and can be repaired under local conditions, which is an important consideration for sustained adoption in regional farming operations.

Discussion

The results obtained in Andijan region are consistent with the broader pattern documented in the international precision-leveling literature, where improved field uniformity translates into measurable water savings, higher fertilizer-use efficiency, and increased yield across a range of rice-growing environments. The magnitude of the water savings recorded here — 820 m^3 per hectare — sits within the range reported for mechanized leveling technologies applied to irrigated lowland rice more broadly.

The observed reduction in surface unevenness, from ±7.3 cm under traditional methods to ±3.2 cm with the disc floor collector, explains much of the downstream improvement in water and fertilizer efficiency: a more uniform surface allows the field to be maintained at the target 2-3 cm water depth without the localized flooding or drying that drives both water waste and nutrient loss under uneven relief. This mechanism mirrors the explanation advanced for water productivity gains under alternate wetting-and-drying irrigation regimes, where controlling the depth and uniformity of the water layer is similarly the proximate driver of efficiency gains [15].

The substantial reduction in labor input — from 7.2 to 2.1 person-days per hectare — is also significant for the economics of adoption in smallholder and medium-scale farming contexts typical of the Andijan and broader Fergana Valley rice belt. Because the disc floor collector requires re-use only every three to five years rather than annually, the effective per-season labor and machinery cost is considerably lower than the raw productivity figures in Table 1 suggest, strengthening the case for investment in the technology even where capital is constrained.

At the same time, several agrotechnical conditions identified in this study — the 15-20% soil moisture window, the 15-25° disc turning angle, and the circular-then-linear working pattern — indicate that the benefits of the disc floor collector are not automatic but depend on correct operation. Deviating from these parameters, particularly working on soil that is too dry or too wet, was observed to reduce accuracy or risk machinery becoming stuck, underscoring the need for operator training alongside equipment investment.

Limitations of the present study should be acknowledged. The field trials were conducted over a single growing season on experimental plots in one region, so the results should be interpreted as indicative rather than fully representative of the diversity of soils and microclimates across Uzbekistan's rice-growing areas. Multi-season, multi-site trials, together with a formal economic analysis of the payback period for disc floor collector investment relative to traditional leveling, would strengthen the evidence base for wider mechanization policy.

Conclusion

- Floor formation in rice fields is the process of bringing the field surface to a uniform state where the water level is maintained at 2-3 cm at all points, which directly affects rice productivity.
- The floor formation process consists of five sequential stages: field preparation, chiseling, base leveling, fine leveling with the disc floor collector (floor), and flooding — each requiring specific machinery and agrotechnical standards.
- The disc floor collector machine improves leveling accuracy 2-3 times compared to traditional methods, enhances water savings by 18-25%, and increases yield by 6-10 centners per hectare.
- Taking into account local rice varieties and soil-climatic conditions, transitioning to local production of disc floor collector machines and their widespread distribution is one of the priority tasks in the field.

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