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Research Article

# A Device for Laying Film on Potato Ridges

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## Abstract

This article presents the results of field trials and an economic efficiency assessment of a developed film-laying machine designed for potato ridges. The main objective of the study was to evaluate the machine’s operational performance, the quality of the technological process, and its economic advantages compared with the existing manual method. The developed machine was aggregated with tractors of classes 0.9–1.4 and tested under actual production conditions on farms in the Namangan region of Uzbekistan. During the field trials, several key indicators were determined to assess the quality and efficiency of the machine’s operation, including soil density, planting depth, ridge-top width, ridge height, and fuel consumption. The experimental results showed that soil density ranged from 1.14 to 1.16 g/cm$^3$, planting depth was 6.7–7.7 cm, ridge-top width was 26.8–29.0 cm, and ridge height was 17.3–18.2 cm. Fuel consumption during operation ranged from 3.1 to 3.9 kg/ha. These indicators were used to characterize the machine’s performance and its suitability for use in potato cultivation. In addition to the field trials, technical and economic calculations were conducted to determine the practical benefits of introducing the developed machine into agricultural production. The economic assessment focused on labor requirements and operating costs per hectare, which are important factors affecting the efficiency of potato cultivation. The results demonstrated that, compared with the existing manual method, the proposed machine reduced labor requirements by 86.23% and operating costs per hectare by 23.51%. These findings indicate that the developed film-laying machine can improve the mechanization of potato ridge preparation, reduce the labor burden on agricultural workers, and lower production costs. Overall, the study confirms the machine’s potential to improve operational efficiency and support more economical potato production under the tested field conditions.

## Keywords

Potato, Film-laying Machine, Leveling and Compacting Roller, Field Trials, Economic Efficiency, Planting Depth, Ridge Height, Fuel Consumption

## 1. Introduction

Potatoes are an important food product in the daily diet of the population, and the volume and stability of their production play a significant role in ensuring food security. Growing potatoes under plastic film helps preserve soil moisture, reduce weed growth, and obtain an early harvest. However, in small farms and household plots, film is often laid over ridges manually, which requires considerable labor and time and can negatively affect the quality of the operation [1-5].

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Therefore, developing affordable tractor-mounted film-laying machines suitable for small farms and substantiating their effectiveness through practical field trials is an important task. The purpose of this article is to describe the design, field-trial results, and economic efficiency of a film-laying machine equipped with a leveling and compacting roller.

## 2. Machine Design and Operating Principle

Based on theoretical and experimental studies, initial requirements and technical specifications were developed for a film-laying machine designed for potato ridges. On this basis, a prototype machine compatible with tractors of classes 0.9–1.4 was manufactured at BMKB-Agromash LLC. The research results were submitted to BMKB-Agromash JSC for the production of an industrial prototype and the organization of state acceptance tests.

The proposed film-lay [6-10]. ing machine equipped with a leveling and compacting roller (Figure 1) is designed to be aggregated with tractors of classes 0.9–1.4. It consists of a frame (2) equipped with a mounting device (1), a roller for leveling and compacting the ridge surface (3), flat discs for opening furrows for the film (4), film holders (5), film pressers (7), spherical discs for covering the film with soil, and film guides (8).

The machine performs film-laying operations on ridges during potato cultivation on farmland. First, the roller levels and compacts the ridge surface [11-15]. A disc then opens a furrow along the side of the ridge. The film holder guides and holds the film in the opened furrow, after which the film edges are covered with soil using the covering discs. Figure 2 shows the machine aggregated with a tractor.

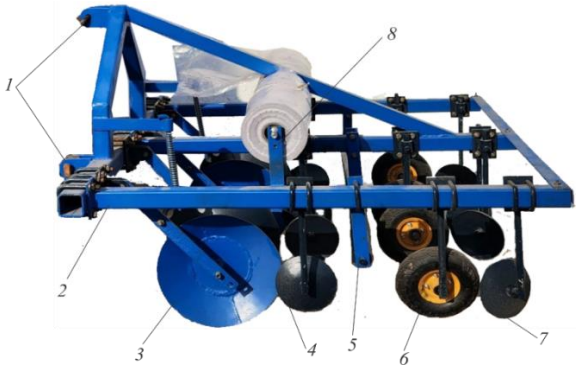


***Figure 1.*** *General view of the film-laying device.*

The main recommended parameters of the leveling and compacting roller are as follows: vertical load of 0.95 kN, total width of 650 mm, width of the conical section of 170 mm, width of the cylindrical section of 300 mm, maximum diameter of the conical section of 500 mm, inclination angle of the conical section of 35°, and spring compression force of 1.0 kN. The technical specifications of the machine are presented in Table 1.

***Figure 2.*** *The machine aggregated with a tractor.*

***Table 1.*** *Technical specifications of the film-laying machine.*

| Parameter | Unit | Value |
|---|---|---|
| Type | – | Mounted |
| Compatible tractor class | – | 0.9–1.4 |
| Operating speed | km/h | 6–8 |
| Field capacity | ha/h | 0.86–1.12 |
| Number of furrow-opening discs | units | 4 |
| Number of film holders | units | 4 |
| Number of film-covering discs | units | 4 |
| Number of compacting rollers | units | 2 |
| Overall dimensions (length × width × height) | mm | 2160 × 1500 × 1200 |

| Parameter | Unit | Value |
|---|---|---|
| Total mass | kg | 660 |

## 3. Field-trial Results

Based on the results of preliminary experiments, the prototype machine was recommended for extensive field trials. The trials were conducted in April 2025 on farms in the Kosonsoy and To‘raqo‘rg‘on districts of the Namangan region. During the trials, the machine was aggregated with an MTZ-80 tractor, and the measured results were compared with the initial technical requirements.

The main parameters of the ridges covered with film were measured during the field trials. The results are presented in Table 2.

***Table 2.*** *Results of field trials.*

| est location | Soil density, g/cm$^3$ | Tuber placement depth, cm | Ridge-top width, cm | Ridge height, cm | Fuel consumption, kg/ha |
|---|---|---|---|---|---|
| Boburxon | 1.18 | 10.5 | 27.5 | 21.3 | 3.1 |
| Usmon Ali | 1.16 | 11.5 | 26.7 | 20.9 | 3.3 |
| Chust Otaxon Dadaxonov | 1.17 | 10.2 | 27.8 | 21.5 | 3.2 |
| Average value | 1.17 | 10.7 | 27.3 | 21.2 | 3.2 |

As shown in Table 2, the average soil density of the ridges covered with film was 1.17 g/cm$^3$, the tuber placement depth was 10.7 cm, the ridge-top width was 27.3 cm, and the ridge height was 21.2 cm. The measured parameters varied only slightly among the farms, indicating stable operating performance. Average fuel consumption was 3.2 kg/ha.

The machine reliably performed the specified technological operations, and no major deficiencies were observed during the field trials. Its agrotechnical and operational performance met the applicable requirements. In addition, the growth dynamics of potatoes planted under the film were monitored. Observations conducted on days 3, 7, 10, and 20 after planting showed normal shoot development under the film, with a substantial increase in leaf mass by day 20.

## 4. Technical and Economic Performance

Economic efficiency was calculated in accordance with the methodology specified in the applicable regulatory document for agricultural machinery testing and economic efficiency assessment, RD Uz 63.03-98. The proposed method was compared with the existing method of laying film manually.

The calculations used a TTZ-812 tractor for the proposed method and a TTZ-80.10 tractor for the existing method. The retail price of the machine was assumed to be 9,000,000 Uzbek soums, and its annual operating time was set at 200 hours.

The calculations showed that the machine achieved an effective operating capacity of 0.98 ha/h and a shift capacity of 0.74 ha per shift. Its annual field coverage was estimated at 141.12 ha. The total cost of processing one hectare using the manual method was 399,719.56 soums, whereas the corresponding cost using the proposed machine was 305,730.22 soums. Total labor requirements were 22.30 and 3.07 person-hours per hectare, respectively.

The annual economic benefit was determined using the following formula: Ey = (Xm – Xya) × Wxya = (399 719,56 – 305 730,22) × 141,12 = 13 263 774,33 soums. Where: Xm and Xya – is the total cost per hectare using the proposed method;, Wxya – is the annual field coverage of the machine, ha.

***Table 3.*** *Comparison of the main performance indicators of the existing and proposed methods.*

| Parameter | Manual method (existing) | Film-laying machine |
|---|---|---|
| Total cost per hectare, soums | 399,719.56 | 305,730.22 |

| Parameter | Manual method (existing) | Film-laying machine |
|---|---|---|
| Total labor requirements, person-hours/ha | 22.30 | 3.07 |
| Annual economic benefit, soums | – | 13,263,774.33 |

The calculations indicate that the proposed method reduces labor requirements by 86.23% and operating costs per hectare by 23.51%. These results suggest that the machine could be a cost-effective solution for small farms, subject to confirmation of its payback period under actual operating conditions.

## 5. Conclusions

The film-laying machine equipped with a leveling and compacting roller reliably performed the specified technological operations during the field trials. No major deficiencies were observed, and the measured agrotechnical parameters met the applicable requirements.

Compared with manual film laying, the proposed machine reduced labor requirements by 86.23% and operating costs per hectare by 23.51%. The estimated annual economic benefit amounted to 13,263,774.33 soums.

*Scientific and practical recommendations:*

1) Complete the production of the industrial prototype and conduct state acceptance tests.
2) Introduce the machine more widely in small farms and household plots in combination with film-based potato cultivation technology.
3) Continue research aimed at improving the design, optimizing technological and geometric parameters, and enhancing operational quality.

The implementation of these solutions will support the introduction of innovative technologies in small-scale agricultural production, increase potato yields, and contribute to strengthening food security.

## Abbreviations

$R_0$ Central Point
$R$ Rotational Radius
$R_n$ Bending Radius
$\delta$ Lateral Angle

## Author Contributions

**Bayboboev Nabijon G‘ulomovic:** Conceptualization, Data curation, Formal Analysis, Funding acquisition, Methodology, Resources, Software, Validation, Writing – original draft, Writing – review & editing

**Komilov Ne’matilla Muxammadjonovich:** Conceptualization, Supervision, Visualization, Writing – review & editing

**Ergashev Muxriddinxon Fazliddinxon o‘g‘li:** Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Resources, Software, Validation, Writing – original draft, Writing – review & editing

## Conflicts of Interest

The authors declare no conflicts of interest.

## References

[1] RD Uz 63.03-98. Testing of Agricultural Machinery. Methodology for Calculating the Economic Efficiency of Tested Agricultural Machinery. Tashkent, 1998.

[2] Research results obtained by the authors: field-trial reports for the film-laying machine, 2025.

[3] Nuriddinov, A. D. Substantiation of the Parameters of a Plough Device for Simultaneous Soil Tillage. Doctor of Technical Sciences (DSc) dissertation. Tashkent, 2020, p. 107.

[4] Mukimova, D. K. Substantiation of the Parameters of Disc Rollers of a Combined Machine Used for Sequential Tillage of Ploughed Land. Abstract of the dissertation for the Doctor of Philosophy (PhD) degree, pp. 12–13.

[5] Komilov, N. M., Akbarov, Sh. B., and Ergashev, M. F. Theoretical Foundations for Developing the Design and Parameters of a Soil-Leveling and Compacting Roller. Research article.

[6] Pervushin, V. F., Salimzyanov, M. Z., Casimov, N. G., Shmykov, S. N., Costin, A. V. Justification of the parameters and operating modes of a rotary cultivator for potato crops. Journal of Agriculture and Horticulture Research, 2026, 9(2), 1–11.

[7] Bayboboev, A. N., Kodirov, S. T., Akbarov, Sh. B., Goipov, U. G., Khamzaev, A. A. Calculation of the technological process of soil separation using a loosening drum.

[8] Akhmetov, Adilbek Agabekovich. Development of a combined machine with rotary working elements for pre-sowing tillage of saline soils.

[9] Bayboboev, N. G., Mukhamedov, J. M., Akbarov, Sh. B. Optimization of the parameters of the support-copying device of a potato harvester. Bulletin of Ryazan State Agrotechnological University named after P. A. Kostychev, 2015, 4(28), 45–48.

[10] Umirov, A. T. Mechanization of Vegetable and Potato Production. 2023, 30 p.

[11] Shoumarova, M., Abdillayev, T. Agricultural Machinery. Tashkent: Sharq, 2014, 300 p.

[12] Bayboboev, N. G., Khamzaev, A. A. Harvesting Jerusalem artichoke using potato diggers. Scientific Knowledge of Modernity, 2017, No. 3, 24–27.

[13] Akmalkhonovich, K. A., Dzhorayevich, A. Z., Rafiqjon o‘g‘li, X. X. Calculation of operating modes of cardan transmissions of an experimental digger for harvesting Jerusalem artichoke. British Journal of Global Ecology and Sustainable Development, 2023, 16, 121–126.

[14] Turdaliev, Vohidjon Mahsudovich. Scientific and Technical Solutions for the Development of a Combined Machine for Soil Tillage and Vegetable Crop Sowing. Tashkent, 2018.

[15] Kidirov, Adham Rustamovich. Justification of the Parameters of a Passive Rotary Tiller for Surface Soil Tillage. Dissertation. Na mangan, 2023.

## Biography

**Bayboboev Nabijon G‘ulomovich** is a highly respected Doctor of Technical Sciences and a professor, renowned for his extensive contributions to the field. He has conducted extensive research in the field of agricultural machinery, particularly in fertilizer application and potato cultivation technologies. Currently, he works as a professor at the Department of Agricultural Mechanization at the Namangan State Technical University He is also the chairman of the specialized academic council for doctoral dissertations in technical sciences. Bayboboev is the author of more than 100 scientific publications, including monographs, articles, and teaching manuals. He holds several patents for inventions that have been practically implemented in Uzbekistan’s agricultural sector.

**Komilov Ne’matilla Muxammadjonovich** is a respected PhD-qualified associate professor at the Namangan State Technical University, with specialized expertise in agricultural mechanization—particularly in soil tillage and fertilizer application technologies. His impactful work in both theoretical and applied research supports ongoing innovations in Uzbekistan’s mechanized agriculture sector.

**Ergashev Muxriddinxon Fazliddinxon o‘g‘li** is a researcher specializing in agricultural engineering and agricultural machinery. His research interests include the design, development, and optimization of agricultural machines and working implements for soil tillage and crop cultivation. His scientific activities focus particularly on mechanization technologies for potato and other row crops, rotary tillage implements, soil-engaging working elements, and the theoretical and experimental investigation of their operating parameters.

## Research Field

**Bayboboev Nabijon G‘ulomovich:** Agricultural Mechanization, Design of Fertilizer Application Systems, Potato Harvesting Technologies, Development of Resource-efficient Machinery for Soil Cultivation

**Komilov Ne’matilla Muxammadjonovich:** Soil Tillage Mechanization, Fertilizer Distribution Systems, Theoretical and Experimental Studies of Rotary and Disk-based Working Tools, Kinematics of Granular Fertilizer Flow

**Ergashev Muxriddinxon Fazliddinxon o‘g‘li**: Mechanization of Harvesting Processes, Baler-collector Design, Humate-treated Forage Harvesting Technologies, Optimization of Machine Parameters for Crop Handling