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Research Article

Analysis of the Autoregressive Equation of the Dependence of Soil Separation in Potato Harvesters on the Length of the Elevator

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Abstract

Modernized potato harvesters are designed to deliver the required level of productivity under specified operating conditions and within different soil environments. However, in present-day field conditions, the effectiveness of these machines does not always meet expectations. In particular, the degree of complete separation of potato tubers from the soil mixture tends to decrease, which in turn leads to an increase in both quantitative losses and mechanical damage to the harvested tubers. These negative outcomes are largely associated with the insufficient efficiency and imperfect operation of the separating components that form a key part of the potato harvester's working system. When the separating elements do not perform optimally, the soil–tuber mixture is not adequately processed, and this results in reduced harvesting quality and lower overall efficiency. The overall performance of a potato harvester is closely linked to the permeability and effectiveness of its separating elements. These components are responsible for allowing soil and smaller particles to pass through while retaining and transporting the potato tubers with minimal damage. If the permeability of these elements is not properly matched to the characteristics of the soil and crop, the machine's performance deteriorates. Therefore, understanding and optimizing the parameters of the separating system is essential for improving the operational efficiency of modern potato harvesters. This study focuses on analyzing how the parameters of the elevator working elements depend on the structural design of the potato harvester. The elevator plays a crucial role in transporting the soil–tuber mixture through the separating system and facilitating the removal of soil from the harvested crop. By examining the relationship between the design features of the harvester and the operational parameters of the elevator working element, the research aims to identify ways to improve separation quality and reduce tuber losses and damage. To investigate these relationships, continuous variations in the mass, volume, and weight of soil entering the separating element were considered. These changing conditions simulate real harvesting scenarios in which the amount and properties of soil entering the machine vary over time. By analyzing how these variables influence the performance of the separating system, the study evaluates the dependence of the separating element length on the operational effectiveness of the potato harvester. The results provide insight into how design and parameter adjustments can enhance separation efficiency, improve permeability, and ultimately increase the overall productivity and reliability of potato harvesting machines under modern agricultural conditions.

Keywords

Separation, Potato Digger, Technical Design, Elevator, Correlation Coefficient, Determination Coefficient, Linear Regression, Autocorrelation, Autoregression, Parameter Estimation

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1. Introduction

In Uzbekistan, the total area allocated to potato cultivation reaches approximately 1.3 million hectares, making it one of the significant agricultural crops in the country's farming structure. The average gross yield obtained from cultivated lands amounts to about 3,110,000 tons, which reflects the important role of potato production in ensuring food security and meeting the domestic market demand. Potatoes are widely grown across different regions due to favorable soil and climatic conditions, as well as their high nutritional and economic value. At present, the majority of the potato harvest is collected using agricultural machinery and various improved harvesting devices. The introduction of mechanized technologies has significantly reduced manual labor, shortened harvesting time, and increased overall efficiency. Nevertheless, with the expansion of cultivated areas and the growing production volume, the demand for modern machinery and advanced harvesting equipment continues to rise steadily. In this context, the development and research of improved types of potato harvesting tools remain highly relevant. Enhancing the design, efficiency, and reliability of harvesting machinery will contribute to reducing crop losses, minimizing tuber damage, lowering energy consumption, and improving overall productivity. Therefore, scientific investigations aimed at optimizing potato harvesting technologies will continue to be a priority direction in the agricultural sector.

2. Research Object

This paper studies the influence of soil mass volume and other quantitative changes on subsequent quantitative changes of each previous quantitative change by continuously measuring the final mass passing through the excavation area. [1, 2] The study established correlations with statistical data of the quantities related to the elevator length in the potato harvester. [3, 4] The studies presented data on the normal distribution of random variables representing correlation and distribution functions. This paper examines issues such as the degree of dependence of each experimental result on the previous result and the degree of correlation [15].

3. Research Results

The following table presents the results corresponding to the mass of excavated cloddy soil along the length of the elevator.

Table 1. The results corresponding to the mass of excavated cloddy soil along the length of the elevator.

N	Q, kg	q, kg/m ^{2}	m, kg	L, m
1	100	30	5	1.6
2	100	30	7.5	0.8
3	100	50	5	1
4	100	50	7.5	0.5
5	100	100	5	0.5
6	100	100	7.5	0.25
7	150	30	5	3.3
8	150	30	7.5	2.5
9	150	30	10	1.6
10	150	50	5	2
11	150	50	7.5	1.5
12	150	50	10	1
13	150	100	5	1
14	150	100	7.5	0.75
15	150	100	10	0.5
16	200	30	5	5
17	200	30	7.5	4.1
18	200	30	10	3.3

N	Q, kg	q, kg/m ^{2}	m, kg	L, m
19	200	50	5	3.3
20	200	50	7.5	3.2
21	200	50	10	2.5
22	200	100	5	2
23	200	100	7.5	1.25
24	200	100	10	1
25	250	30	5	6.6
26	250	30	7.5	5.8
27	250	30	10	5
28	250	50	5	4
29	250	50	7.5	3.5
30	250	50	10	3
31	250	100	5	2
32	250	100	7.5	1.7
33	250	100	10	1.5

The last column of the table shows the elevator length, corresponding to the final mass of the grain at the elevator and the volume. We determine the degree of correlation between these dimensions corresponding to the length and, if so, to what extent. First, we determine the autocorrelation coefficient for the values in the last column of the table according to [5, 6]. Here, we present a correlogram for four lags.

Table 2*. The elevator length, corresponding to the final mass of the grain at the elevator and the volume.*

Lag (order)	$r_{t,t-L}$	Correlogram	
1	0.5872	***	Noticeable
2	0.274	**	Weak
3	0.0937	*	Weak
4	-0.04541	*	Weak

As the table shows, the correlation gradually decreases. Specifically, the results in the table show that the relationship is very weak for the orderings, with a significant correlation for the lagged ordering [7, 8].

Now let's present the second-order autoregressive equation for the last column in this table.

$$L_t = 0.68 + 0.248L_{t-1} + 0.001 \quad (1)$$

The obtained theoretical dependence can be determined using the graph of the practical dependence *(Figure 1)*.

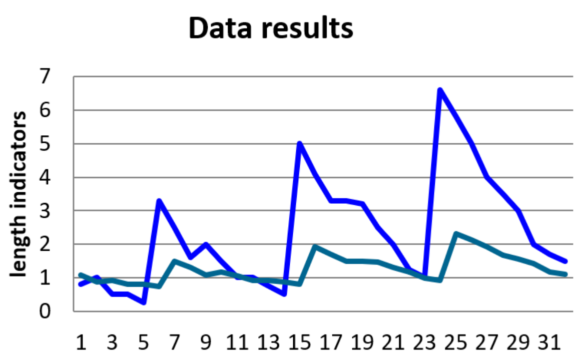

Figure 1*. Results of the second-order autoregressive equation data (1).*

The red line shows the geometric position of the theoretical results, and the blue line shows the geometric position of the practical results [9, 10].

4. Conclusions

The sample standard deviations for the second-order autoregression for the elevator length indicators satisfy the conditions given in [11, 12]. In this series of dynamics, a tendency is observed $r_{t,t}L = 0.587 \to 1$. It is evident from the graph that, in accordance with the results presented in Table 1, the lines overlap several times for sizes greater than 1 m and less than 2 m. Using the model under consideration, it is possible to express the existence of a weak, albeit autocorrelation, relationship between the elevator dimensions and the ratio between the final mass added to the working element and the elevator length using the autoregressive equation [13, 14].

Abbreviations

L_t The Second-order Autoregressive Equation

Author Contributions

Bayboboev Nabijan Gulomovich: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization

Muminov A'zam Latifxonovich: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] N. G. Baiboboev, A. L. Muminov, Statistical analysis of sizes elevator based on observations of the technological process of the mechanism potato harvester. Scientific journal Mechanics and Technology. NamISI. No. 1(10), 2023.

[2] N. G. Baiboboev, A. L. Muminov, Kh. T. Rakhmanov Study of separation soil as a random Markov process. Scientific and technical journal FerPI. 2023. Vol. 27. No. 4. Pp. 93-97.

[3] N. G. Bayboboyev, A. L. Muminov Analysis of Studies of the Distribution of Input Disturbances of Potato Harvesting Machines and Evaluation of Moment Functionals in a Competing Risk Model using an Empirical Bayesian Approach. AMERICAN Journal of Library And Information Science Innovation Volume 3, Issue 2, 2025. p. 8-14.

[4] O. A. Demidova Lecture on econometrics. Higher school of Economics No. 3, Module 4.

[5] Burlakov, G. S. Technology of Products Made of Lightweight Concrete. Moscow, 1986.

[6] Buzhevich, G. A. Lightweight Concretes with Porous Aggregates. Moscow, 1970.

[7] Matyokubov, B. P., & Saidmurodova, S. M. (2022, August). Application of Technology of Vermiculite Lightweight Concretes Based on Low Water Demand Binders. In International Conferences (Vol. 1, No. 15, pp. 103–109).

[8] Matyokubov, B. P., & Saidmurodova, S. M. (2022). Methods for Investigation of Thermophysical Characteristics of Underground External Barrier Structures of Buildings. Research and Education, 1(5), 49–58.

[9] Pulatovich, M. B., & Muzaffarovna, S. S. (2022). Methods for Investigation of Thermophysical Characteristics of Underground External Barrier Structures of Buildings. Volume 1, Issue 5, August 2022, Article No. 202259.

[10] Karimov, G. U. (2021). Energy-Efficient Binder of Low Water Demand with Modified Mineral Additives Based on Locally Available Components. In Euro-Asia Conferences (Vol. 4, No. 1, pp. 106–109).

[11] Karimov, G., & Bakhriyev, N. (2018). Research on the Development of Energy-Efficient Binders for Modern Construction. Problems of Architecture and Construction, 1(2), 61–63.

[12] Yusupov, H. V., Karimov, G. U., Saidmurodova, S. M., & Zayniyevich, I. F. (2024). Modern Problems of Low Water Demand Cements. Miasto, 44, 231–234.

[13] Yusupov, H. V., Karimov, G. U., & Saidmurodova, S. M. Increasing the Efficiency of Vermiculite Concrete Based on Low Water Demand Cement. International Scientific and Practical Conference “Architecture Is the Abode of Time”, Samarkand State Architecture and Construction University, May 23–24, 2024.

[14] Saidmurodova, S. M., & Yusupov, H. V. Technology for the Production of Lightweight Concrete Blocks Based on Multi-Tempered Vermiculite and Low-Grade Cement. International Scientific and Technical Conference “Innovative Technologies in Environmental Protection” May 1–2, 2025.

[15] Sokolov A. V. Distribution of nutrients in the soil and crop yield – Moscow, Publishing House of the Russian Academy of Sciences, 1997 – 328 p.

Biography

Bayboboev Nabijan Gulomovich 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.

Muminov A'zam Latifxonovich is an Uzbek professional known for her dedication to professional development and continuous learning. She has built her experience through education and practical activities, demonstrating responsibility, accuracy, and a strong work ethic.

Research Field

Bayboboev Nabijan Gulomovich: Agricultural mechanization, design of fer-tilizer application systems, potato harvesting technologies, devel-opment of resource-efficient machinery for soil cultivation

Muminov A'zam Latifxonovich: Engineering and Applied Sciences, Agricultural mechanization Construction Engineering and Management, Building Materials and Technologies, Sustainable Construction and Development, Quality Control and Safety in Construction