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TECHNICAL AND ECONOMIC EXAMINATION OF THE MECHANICAL HAZELNUT COLLECTING MACHINE MANUFACTURING

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Abstract: In this study, taking into account the conditions of Türkiye, it will be possible to harvest hazelnuts grown on flat and nearly flat lands, in line with ergonomic principles, with an approach that consider operator comfort and work safety, with a mechanically effective sweeping unit with high work success, which removes the kernel+husk hazelnut from the ground, some performance values of the hazelnut harvesting machine such as collecting efficiency, labor requirement, fieldwork success, product work success, and foreign material separation efficiency, which cleans the mixed hazelnuts in the separation unit at a level that does not affect the performance of the husk peeling machine and stores the cleaned grain+husk hazelnut mixture, were determined and obtained. In light of the data obtained, it is contribution to the economy is discussed. The collecting efficiency of the mechanical hazelnut harvesting machine was 93.26%, the labor requirement was 47.85 h/ha, the fieldwork success was 0.134 ha/h, the product work success was 295.92 kg/h, and the foreign material separation efficiency was 96.85%. Considering the performance values obtained, very successful results have obtained from the field trials performed with the mechanical hazelnut harvesting machine. As a result, the production of the hazelnut harvesting machine and its implementation will make hazelnut production sustainable by significantly reducing production costs, and the import of machinery that is not suitable for the conditions of Türkiye will be no longer needed.

Keywords: Hazelnut harvester, Mechanical harvesting, Hazelnut, Mechanization

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1. Introduction

Türkiye has 74.50% of the world's hazelnut planting areas, with approximately 700 thousand hectares. The amount of production as in-shell hazelnut is about 684 thousand tons, meeting 76% of the world hazelnut production. Hazelnut export is approximately 500 thousand tons, realizing 75% of the world hazelnut export (TÜİK, 2023).

In Türkiye, hazelnut harvesting is still done by hand-picking from the branch or the ground, based on human labor. Afterward, the collected hazelnuts are separated from their husks in the husker. Hand harvesting of hazelnuts in Türkiye requires 306 BIGh/ha. This figure constitutes 71% of the total working time for production and 55% of the production cost (İlkyaz, 1986). This situation significantly increases the hazelnut production cost and causes a labor-based labor requirement during harvest. Reducing the high labor requirement and the price is possible by mechanizing the harvesting process (Beyhan and Yıldız, 1996).

In the paper of the General Secretariat of the Black Sea Exporters' Association on the subject, In Azerbaijan and Georgia, which have meager production costs, hazelnut production is increasing every year due to profitability; international companies that are important hazelnut users have started to realize hazelnut plantations in countries in the southern hemisphere such as Chile, Argentina, and Australia to meet their own needs. These countries have encouraged their farmers to produce hazelnuts. It is reported that efforts to promote it in various ways have started to pose a clear threat to our country in the medium and long term. In addition, in the article, it is stated that the high hazelnut production costs in our country always pose an obstacle to our competitiveness as a handicap, even though the application of state support purchases was abandoned with the new hazelnut strategy and the application was started to create the prices within the free market rules and the basis was prepared for the formation of competitive prices with rival countries is expressed. In particular, it is underlined that the expectation of selling prices above world prices, caused by the high cost of harvesting expenses, is a chronic problem of the sector (KİB, 2023).

In Italy, Spain, and the USA, which produce hazelnuts economically, mechanical harvesting has become widespread as much as planting techniques and land topography allow. For this purpose, machines with

pneumatic (vacuum), pneumatic+mechanical, and mechanically effective total units are used. Working with these machines requires good ground preparation (leveling and compaction) and spread product should be lined with lateral sweepers. The fact that the hazelnuts grown in these countries have a short husk as a variety feature causes the hazelnuts to fall out as grains during the harvest period. For this reason, husk peeling machines are not used. Due to the identifiable geometric shape of the hazelnut kernels, it is possible to clean it with known separation methods effectively. Elements such as stones, soil, etc. that cannot be cleaned are separated in water pools, and the cleaned hazelnuts are dried in dryers.

The fact that Turkish hazelnut varieties have a long husk and tightly wrap the fruit, and do not have an identifiable geometric shape makes the separation systems of these machines ineffective. In addition, the efficiency of the sweeper units decreases due to the differences in planting techniques and the characteristics of the garden floor. Also, the large size of the machines creates a problem depending on the sewing technique (Beyhan, 1992). Although Italian agricultural machinery manufacturers have tried to enter the Turkish market for years, they have not succeeded due to the machines' unsuitability.

This study was carried out by taking into account the conditions of Türkiye our country, which can harvest the hazelnuts grown on flat and nearly flat lands, in line with ergonomic principles, with an approach that consider operator comfort and work safety, with a mechanically effective sweeping unit with high work success, which removes the kernel + husk hazelnut from the ground, It covers the design and prototype manufacturing of the hazelnut harvester, which cleans the mixed hazelnuts in the separation unit without affecting the performance of the husk peeling machine and stores the cleaned grain + husk hazelnut mixture. In addition, some performance values (picking efficiency, labor requirement, fieldwork success, product business success, and foreign material separation efficiency) of the self-propelled hazelnut harvester, whose prototype was manufactured, were determined, and its contribution to the economy was discussed.

2. Prototype Manufacturing and Technical Specifications of Hazelnut Harvesting Machine

In the field of agricultural machinery engineering, the biological factor is essential in terms of engineering applications. Notably, in designs for garden mechanization, factors such as ecology, topography, cultivation techniques, variety characteristics, etc., are the essential elements to be considered. Agricultural Machinery Chair of Berlin Technical University, Faculty of Machinery and Agriculture, Prof. Dr. Eng. Kurt Marks, in the summer of 1958 at I.T.U. At a conference attended by the Faculty of Machinery as a guest, "the knowledge and tools that can be taken into consideration for calculating agricultural machines are very lacking. For this reason, it can be said that the creation of a device becomes a work of personal ability fed by experience and general knowledge rather than calculating, just like in architectural work. In the construction of agricultural machinery, especially in some harvesting machines, the function is so crucial that besides, issues such as strength and drawbar force are not in question. However, the issues of strength and pulling force come into account very quickly." Considering these explanations, designing a hazelnut harvester with adequate agrotechnical functionality requires acquiring research-based primary data and relevant experience in evaluating the obtained data.

Prof. Dr. Mehmet Arif Beyhan, whose majority of his academic studies are on obtaining basic data on hazelnut harvesting mechanization, has designed many experimental purpose hazelnut harvesters based on different principles and tested them in practice. In these trials, he revealed the problems encountered and possible solution methods (Beyhan, 1992; Yıldız, 2000; Keskin, 2004).

Considering the conditions in Türkiye, the self-propelled hazelnut harvester with a mechanically effective sweeping system for the hazelnut harvest, which is grown on flat and nearly flat lands, consists of 4 central units: the collection unit, the separation unit, the unloading unit, the power supply, and the walking system. The collecting unit is a mechanically effective unit consisting of metal chain fingers. Based on a concept design that will sweep the ground and weed bottoms, considering the soil characteristics, the system has been developed according to the results of the experimental studies carried out during the harvest periods, and the manufacturing dimensions have been determined. The separation system consists of a straw walker sieve with longitudinal bars and cutting star wheels placed in the sieve channels. In addition, metal combs have been added to the system to separate grass, leaves, and twigs. Experimental methods have optimized the dimensions subject to manufacturing. The unloading unit uses an endless helix in the unloading team, and the hazelnuts with grain + husk are conveyed to the sack tied to the outlet. 12 HP diesel engine is used in the power supply and travel system. Power transmission systems to the machine (clutch system, safety system, gearboxes, shafts, etc.) are designed using known methods. The walking system is a hydrostatic system. The system consists of variable-flow hydraulic pumps, motors, and a mechanical transmission system.

In the existing hazelnut orchards, the basic dimensions of the machine were determined depending on the factors such as the distance between the rows, the height of the branches, the angle of the components, and the systems in question were placed in the chassis suitable for these dimensions. The moving parts (shafts, axles, gearboxes,

rolling bearing housings, couplings, etc.) that make up the units in question were assembled by machining. The machine is 3200 mm long, 1600 mm high, and 1200 wide, with three wheels. The device is driven by a gasoline engine of 1800 min^{-1}, a cylinder volume of 420 cc, and an engine power of 12 HP.

3. Results on the Performance Values of the Hazelnut Harvesting Machine

After the prototype production of the hazelnut harvester was made, it was subjected to garden trials (Figure 1). Harvest experiments were carried out according to the randomized plots trial design, assuming that the hazelnut yield per decare in Türkiye is 106 kg (FAO, 2020) and at a garden yield of 110 kg/da as milled hazelnuts with 10% moisture (w.b.) content, each parcel containing 30 quarries was carried out in triplicate. The average of the performance values of the machine obtained as a result of the trials is given in Table 1.

Figure 1. General view of the hazelnut harvester during gardening.

Table 1. Performance values of the hazelnut harvester

Working width, (mm)	1200
Working velocity, (m/s)	1.6
Collection efficiency, (%)	93.26
Labor requipment, (h/ha)	47.85
Area business success, (ha/h)	0.134
Product business success (kg/h)	295.92
Foreign material separation efficiency, (%)	96.85
Fuel consumption(L/h)	2.4

In working with the machine, a product loss of 6.74% occurred. Nuts poured into the quarries account for 2.54% of these losses. The remaining 4.20% loss is due to hazelnuts that the machine cannot collect. It was observed that the hazelnuts that could not be collected were found in the soil crevices. The amount of foreign material coming into the sacks, together with the kernels + husk hazelnuts, is 3.15%. Most of the foreign materials are soil. Most of the soil was collected from the grass-free area. Most grass, twigs, leaves, and coarse dust are materials accumulated in previous years. The amount of other material remaining outside the soil will decrease if the harvest is carried out continuously by machine.

According to the performance values obtained, the designed hazelnut harvester can be calculated at 110 kg/da orchard yield, the fieldwork success is 13.4 da/10h, and the product work success is 2.95 t/10h. Since the hazelnut harvest season lasts about 30 days, a machine can collect approximately 90 tons of shelled hazelnuts-kernel during the harvest season. In today's conditions, in the ideal conditions (well-cleaned garden ground and hand-picking from the ground in situations where the entire product is spilled on the floor), the cost of harvesting 1 ton of milled, dried hazelnuts vary between 9-12 thousand ₺ and requires approximately 30 İİG/day. These data reveal the technical, social, and economic necessity of mechanization of hazelnut harvest.

4. Conclusion

Italy is the essential machine manufacturer country for the harvest mechanization of hard-shelled fruits. Turkish major hazelnut producers go to Italy and say that they are examining these machines and they are not suitable for the conditions of our country. In addition, in 1996, the Italian manufacturer brought a pneumatically effective (vacuum) machine to the Ordu region and conducted a demonstration study. However, they were not successful. Despite this, another Italian producer company brought a device to the Çarşamba region in the 2015 harvest season and conducted a demonstration study. According to the information obtained from the manufacturers, this company was not successful either. However, recently, it has been heard that the companies in question are trying to develop hazelnut harvesters suitable for the conditions of Türkiye.

Although it changes yearly, approximately 684 thousand tons of shelled milled hazelnuts are produced in Türkiye. Considering that more than half of the production areas are on flat or near-flat and productive areas, mechanical harvesting of approximately 300 thousand tons of hazelnut seems possible. Considering the fieldwork success of the hazelnut harvester, about 3300 hazelnut harvesters are needed. In addition, hazelnut production areas are constantly expanding in Azerbaijan and Georgia, which produce varieties similar to hazelnut varieties in our country. According to FAO 2020 data, Azerbaijan has 34 thousand tons of milled, dried hazelnuts on approximately 30 thousand hectares.

Otherwise, Georgia produces 30 thousand tons of dried hazelnuts in roughly 16 thousand hectares. If the harvest of half of the hazelnut production amounts of both countries is mechanized, they will need about 350 machines.

According to data, it can be said that there will be a significant demand for machinery both in the domestic and foreign markets. This will add considerable added value to the country's economy.

As a result, if the projected concept design is realized, a new product with high business success, harvest efficiency, and energy use efficiency will emerge. The manufacture of such a hazelnut harvesting machine will make hazelnut production enjoyable by ergonomically improving the working conditions of the producers, will make the hazelnut production sustainable by significantly reducing the production costs, will reduce the use of child labor intensively used in the hazelnut harvest, and will help academics, designers and agricultural machinery manufacturers working on the subject. It will contribute to making new designs that take this concept as a reference. Thus, an important step will be taken to mechanize hazelnut, which is one of the most critical problems in Türkiye with the production of a machine suitable for our garden structure and hazelnut varieties.

Author Contributions

The percentage of the author(s) contributions is presented below. All authors reviewed and approved the final version of the manuscript.

	H.S.	M.A.B.	K.M.U.
C	40	30	30
D	100		
S	100		
DCP	70	30	
DAI	100		
L	40	30	30
W	40	30	30
CR	40	30	30
SR	40	30	30
PM	40	30	30
FA	40	30	30

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because there was no study on animals or humans.

References

Beyhan MA, Yıldız T. 1996. Fındık ve diğer sert kabuklu meyvelerde uygulanan mekanik hasat yöntemleri. OMÜ Ziraat Fakültesi, Fındık ve Diğer Sert Kabuklu Meyveler Sempozyumu, 10-11 Ocak 1996, Samsun, Türkiye, pp: 105.

Beyhan MA. 1992. Design and construction of a hazelnuts harvesting machine with aspirator for our country conditions. PhD Thesis, Ankara Üniversitesi, Institute of Science, Agricultural Machinery, Ankara, Türkiye, pp: 113.

FAO. 2020. Classifications and Standart. URL: www.fao.org/faostat/en/#data/QC (accessed date: February 10, 2023).

İlkyaz H. 1986. Doğu Karadeniz Bölgesinde Çay ve Fındığın Üretim Girdi ve Maliyeti. TOKB, Köy Hizmetleri Araştırma Enstitüsü Müdürlüğü Yayınları, Genel Yayın No: 38, Samsun, Türkiye, pp: 46.

Keskin L. 2004. The effect of some structural and operating parameters on functional properties of the mechanical pick-up unit for hazelnut harvesting machine. MSc Thesis, Ondokuz Mayıs University, Institute of Science, Agricultural Machinery, Samsun, Türkiye, pp: 60.

KİB. 2023. Karadeniz İhracatçı Birlikleri: Aylık Bülten, Türkiye Fındık İhrcatı (accessed date: May 10, 2023).

TÜİK. 2023. Bitkisel Üretim İstatistikleri. URL: https://data.tuik.gov.tr/Kategori (accessed date: February 12, 2023).

Yıldız T. 2000. Desing of a hazelnut harvesting machine with mechanical pick-up unit operated by tractor. PhD Thesis, Ankara Üniversitesi, Institute of Science, Agricultural Machinery, Ankara, Türkiye, pp: 88.