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Determinants of Changes in Fruit Production in Farms in Areas with a Fragmented Agrarian Structure

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Abstract: The main aim of the research was to identify the factors influencing the production of fruit in a region with a fragmented agrarian structure. The novelty of the article is taking into account changes over time. The importance of the research topics stems from the fact that Poland is a significant producer of many species of fruit. Part of this production is carried out on small farms. A panel model with fixed effects (FE) was used to identify the factors. The data for the model came from 18 farms from the Małopolska and Pogórze Region in Poland, which continuously, from 2005–2016, kept accounting under Farm Accountancy Data Network (FADN). The combination of cross-sectional data from 18 farms and a 12-year time series increased the dataset to 216 observations that formed the panel; consequently, the same research period for all farms allowed for the construction of a balanced panel. The research shows that the amount of fruit production in the researched orchard farms was influenced by the value of current assets, the cost of salaries and the age of fruit growers with which experience in running orchards was related.

Keywords: orchards; changes; region; efficiency; panel model

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1. Introduction

Fruit growing in Poland, like other sectors of the economy, changed as a result of the transition from a centrally controlled economy to a market economy, as well as a result of Poland's accession to the European Union. The level of development of fruit production and its spatial and organizational structure are determined by natural conditions and various socio-economic factors. Fruit production depends on the quality of agricultural production space (soil type, water resources, topography), weather conditions (frost, rainfall, hailstorms), proper agrotechnics (including mineral fertilization and chemical plant protection) and socio-economic conditions (agrarian structure, resources and qualifications of the labor force, level of mechanization, supply and prices of means of production, demand for fruit and their prices) [1]. Due to the climatic conditions in Poland, fruit production characterizes with seasonality and large fluctuations in individual years. The range of fruit produced in the country is diverse but limited to temperate species. For many years, Poland has been the largest producer of apples, blackcurrants, raspberries, chokeberries and blueberries in Europe and in the world, as well as a significant producer of strawberries [2]. In this respect, among the European Union countries, Poland is behind Italy, Spain and France and ahead of Greece and Germany. In 2019, Poland's share in the EU-28 fruit harvest was 6.0% [3]. According to data from Statistics Poland, in 2020, the harvest of fruit from trees amounted to 3900.2 tons [3], while the production of berry fruits amounted to 554,200 tons [4]. The highest fruit harvest in Poland is obtained by fruit growers from the Mazowieckie, Lubelskie, Łódzkie, Świętokrzyskie and Małopolskie voivodships.

Fruit production is an important course of farming in the country, and the share of fruit in the value of commercial plant production in 2020 was 25.6% [5]. The increase in

fruit production is favored by adequate land resources, a large group of producers, an increase in fruit consumption and the possibility of exporting to new markets (North Africa, the Middle East, India and China). In addition, the increase in competitiveness in the fruit market forces marketing activities to be carried out by fruit producers and their industry associations together with local government authorities promoting the region and products from a given orchard area. Poland's accession to the EU in 2004 resulted in the necessity to change and adapt the regulations in the fruit sector to the EU market. In the following years, the fruit sector in the country developed dynamically due to the factors resulting from the market situation, strong competitive position and significant cash flows transferred to this market as part of European funds [6]. Proper use of EU funds for the development of production and storage of fruit has contributed to an increase in the competitiveness of Polish fruit and fruit products. In the predictable future, at least a dozen or so years, Poland will probably continue to be the decisive supplier of processed berries, cherries and apple juice concentrate in Europe. The production of fruit in the country is impacted by various conditions in individual years. The literature review shows that the level of fruit production is influenced both by external factors beyond the farmers' control and internal factors inherent in the farm itself. The size of fruit production is mainly influenced by the area of orchards and the yield of trees and shrubs. The level and quality of crops are influenced by natural factors, especially climatic conditions, in which temperature, rainfall and sunlight play an important role, affecting the color of the fruit and its taste. In turn, the economic effects on fruit production in orchard farms are largely influenced by external factors related to the farm environment, such as location, country, culture and market, including prices [7]. Political and economic conditions also play an important role in the fruit market. A manifestation of this type of action was the introduction by Russia of an embargo on fruit and vegetables from the European Union in 2014. The inability to export to this very absorbent market resulted in increased competition of suppliers in the markets of other importing countries. This forced producers to change the direction of exports and the assortment of produced fruit [8]. Due to the importance of this issue, the main aim of the research was to identify economic factors influencing the production of fruit in a region with a fragmented agrarian structure. The literature indicates various factors that determine fruit production. However, there is no empirical research that determines the economic factors of fruit production growth. This study accomplishes the identified research gap. As part of the research, three research questions were formulated:

1. What changes took place in the factors of production of orchard farms after Poland's integration with the EU?
2. What was the value of production and the level of costs in orchard farms in 2005–2016?
3. How did the productivity and profitability of orchard farms change in the analyzed period?

In order to answer the questions posed, the study analyzes the changes in agricultural land and orchards on farms and in labor inputs from 2005–2016. The paper presents the equipment of orchard farms with fixed and current assets, changes in costs and production value. An important element of the analyses is also the assessment of the productivity and profitability of the factors of production.

The hypothesis adopted in the paper states that the production of fruit in orchard farms is influenced to the greatest extent by the intensification of production in the form of the consumption of mineral fertilizers and plant protection products.

The analysis covered farms specialized in fruit production, which continuously, from 2005–2016, kept agricultural accounting for the needs of the Farm Accountancy Data Network (FADN). Due to the limited number of such farms in the FADN database and their reduction in the following years, the research sample covered 18 farms. A panel model was used to identify the factors influencing the volume of fruit production. In the literature, the importance of using panel models is emphasized, among others, by Andreß, Golsch, Schmidt-Catran [9] as well as Griliches and Intriligator [10]. The wide use of panel models for econometric analyses is also presented by Baltagi [11]. The literature review shows that such methods have not been used in the research on fruit production. In the case of

the presented research, the use of the panel method was justified because it allowed for increasing the data set. However, the research period was limited to 12 years because, in the following years, the number of orchard farms keeping accounting for the needs of FADN was even smaller.

The conducted research expands the contemporary literature on the factors determining fruit production in areas with a fragmented agrarian structure. They can also be helpful for economic policy in shaping the supply of fruit on the market. However, difficult access to data from the farm is a significant limitation of this type of research because only some farmers collect data on their farms, and not all of them agree to make it available.

The study contains four sections. The first section is a review of the literature on the factors behind the development of fruit production; then, data sources and research methodology based on the use of panel methods are presented. The next section describes the characteristics of the researched farms, taking into account changes in production factors and economic results from 2005–2016. The fourth section presents the results of the research based on the panel model, indicating which factors in farms had an impact on the changes in the volume of fruit production. The study is finalized with a summary and conclusions.

2. Literature Review

2.1. Results of Research on Factors of Fruit Production Development

The literature review shows that the structure and size of fruit production, as well as its location, are influenced by many different factors. These include, first of all, natural and climatic conditions, soil conditions and economic and social relations, which include the size of the farm, as well as its location in relation to consumption and processing centers and the communication network. The effectiveness of fruit production is also influenced by the availability of the workforce and financial support from local government organizations. Fruit production should be located in such a place where the total production costs, as well as the costs of transporting products to the collection point, are as low as possible [12]. The location of the farm in optimal production conditions contributes to the improvement of production efficacy. An overview of the issues in the field of fruit production analyzed in the literature is presented in Table 1.

Table 1. The issue of fruit production analyzed in the literature.

Author	Issues	Used Methods
Gunerka L. Jabłońska L. Sobczak W. [12]	Regional differentiation of horticultural crops production in Poland	chain indexes, arithmetic mean, structure analysis,
Filipiak T. Maciejczak M. [6]	Conditions for the development of the fruit sector in Poland	descriptive statistics, heuristic methods,
Pizło W. [13,14]	Socio-economic conditions for the development of orchard farms in the regions of Grójec and Warka	descriptive methods, logit models, cluster analysis, case study,
Filipiak T. [15]	Legal and organizational aspects of the fruit sector in Poland	descriptive methods,
Nosecka B. [16]	Fruit export	structure analysis,
Malchar-Michalska D. [17]	Polish fruit export	single-chain indices, least squares method,
Bieniek-Majka M. [18]	Export determinants of fruits from Poland	descriptive methods,
Olewnicki. D. [19]	Changes in the horticultural economy in Poland in the years 1965–2008 and prospects for its development	descriptive methods, descriptive statistics, regression analysis, time series analysis,

Table 1. *Cont.*

Author	Issues	Used Methods
Makosz E. [20]	Vision of the fruit market in Poland	descriptive methods,
Wróblewska W. Chudzik A. [21]	Price volatility of fruit and means of production and their impact on the economic situation of producers in Poland	descriptive statistics, least squares method, string and single-base indexes,
Jąder K. [22]	Fruit consumption in Poland	descriptive statistics, dynamics indicators,
Pawlak K. [23]	Adaptation of horticulture to the rules and standards in force on the common EU market	descriptive methods, comparative analysis, ratio analyses,
Pizło W. [24]	Fruit market in Poland and selected European Union countries	descriptive methods, comparative analysis
Ziętara W. Sobierajewska J. [25]		descriptive methods, simple and multiple regression, DEA method,
Jabłońska, L. Gunerka, L. Filipiak T. [26]	The economic efficiency of horticultural crops in selected European Union countries	descriptive statistics, chain indexes,
Długokęcka D. [27]	Fruit and vegetable market—Five years of Polish agriculture in the EU—changes and prospects	descriptive methods,
Bieniek-Majka M. [28]	Changes on the fruit market in Poland after accession to the European Union	descriptive methods,
Olewnicki D. [29]	Analysis of the production, economic and financial results of farms engaged in horticulture in Poland.	descriptive methods
Pizło W. [30]		descriptive statistics,
Ryś-Jurek R. Stefko O. [31]		descriptive methods, comparative analysis, descriptive statistics,
Komorowska D. [32,33]		descriptive methods,
Czudec A., Kata R. Miś T., Zając D. [34]	Institutional environment of agriculture (without a detailed analysis of horticulture)	descriptive statistics, chi square dependency test, Pearson's linear correlation coefficient.
Czyżewski B. [35]		DEA method, descriptive statistics.

Source: own elaboration.

The subject of socio-economic conditions for the development of fruit farms in the area of Grójec and Warka was described by Pizło [13,14]. On the other hand, Filipiak [15] analyzed the legal and organizational conditions of the fruit and vegetable sector in the country. The conducted research shows that the changes taking place in agriculture, and especially in horticulture, resulted from the internationalization of the Polish economy and the adoption of solutions of the Common Agricultural Policy. The base of changes in orchard farms in the area of Grójec and Warka, one of the largest fruit producers in Poland, is the implementation of innovations, especially in the field of production technology. Research shows that the development of orchard farms is closely related to their economic strength, infrastructure, past identity and farming tradition.

Poland's accession to the EU and participation in the Common Agricultural Policy (CAP) programs, especially those addressed directly to the sector, has had a huge impact on the development of fruit growing in the country. Additional investments and the use of modern technologies result in increased production efficiency, as well as increased

competitiveness in the external market. The further development of the sector is currently expected in the volume of export due to the growing demand for Polish fruit. This is the result of many promotional and informational activities, which were particularly intensified during the time of the embargo that was imposed on Polish fruit producers by Russia in 2014. The problem of fruit export was the subject of research by Nosecka [16], Malchar-Michalska [17] and Bieniek-Majka [18].

Fruit production in Poland is characterized by the fragmentation of crops [19]. Between the years 2005–2020, the area of orchards increased from 295.6 thousand hectares up to 327.0 thousand hectares, and the fruit harvest increased from 2921.5 thousand tons to 4454.4 thousand tons. The increase in production was associated with a growth of exports by 58.2% and an increase in consumption by 7.2%, according to the balance sheet.

Both external and internal factors have contributed to the development of orchard farms in recent years. The external factors include: organizational and legal conditions of the fruit market (legal regulations in force in the sector, financial support in the field of common market organization, changes in the scope and forms of aid for producer groups), trends in fruit consumption and foreign trade in fruit and their processing products. A particularly important factor was the preferences of recipients in the field of fruit and fruit preserves, including the requirements of commercial networks regarding the concentration of supplies and standardization of fruit and fruit preserves, as well as the expectations of the consumers themselves regarding the quantity and structure of consumed fruit and fruit preserves [36]. On the other hand, the internal conditions of changes in orchard farms lie primarily in their production potential, which consists of land, labor and capital resources. They can also be the result of fruit growers' experience in fruit production.

An important factor in the success of orchard farms is the selection of appropriate varieties of fruit trees and shrubs. Income obtained from 1 hectare of an orchard is determined on the one hand by the sensitivity of selected varieties to frost, various diseases and ground frosts and on the other hand by the regularity of yield, demand and consumer preferences. [20]. Improving the quality of fruits and their distribution system can strengthen the position of fruit growers in the domestic and international markets.

The volume of production and consumption, the level of producers' income, the direction of production and the volume of exports of goods are largely influenced by prices [37]. The volatility of fruit prices and the means of production and their impact on the economic situation of producers in Poland between 2001 and 2012 were analyzed by Wróblewska and Chudzik [21]. The analyses show that the price of fruit is influenced by the seasonality of the supply of raw materials on the market, the dynamics of the size of the harvest, which depends both on the fruit yields in a given year and the cultivation area, labor costs and the cost of the means of production (e.g., fertilizers, plant protection products). Moreover, the prices of all types of fruit are characterized by high volatility in the following years.

The problem of fruit consumption in Poland was undertaken by Jąder in her research [22]. They show that between 2007 and 2014, there was a decrease in the total amount of fresh fruit consumed, but this decrease did not apply to all analyzed groups. A decrease in consumption was noted in the cases of apples and berries, while an increase was recorded in the consumption of southern fruits, e.g., oranges and bananas.

The research also addressed topics related to the adaptation of horticulture to the rules and standards in force in the common market, both in the legislative and practical aspects. The competitiveness of the Polish fruit and vegetable sector within other EU countries was analyzed by Pawlak [23], and the comparison of the fruit market in Poland and selected European Union countries was made by Pizło [24], Ziętara, Sobierajewską [25] and Jabłońska, Gunerka, Filipiak [26]. Moreover, the fruit and vegetable market in Poland after accession to the EU, its changes and development opportunities were also described in the works of Długokęcka [27] and Bieniek-Majka [28].

The analysis of the production, economic and financial results of farms dealing with horticultural crops in Poland was carried out by Olewnicki [29], Ryś-Jurek and Stefko [31]

and Komorowska [32,33]. Research by Pizło [30] shows that between 1999 and 2009, there was a decrease in income in fruit-growing farms in relation to farms engaged in mixed agricultural activity. This could be due to the lower production value and the increase in the total cost of production. According to Komorowska [33], between the years 2013 and 2015, a different situation occurred. During this period, farms specializing in fruit production obtained much higher incomes than all farms. Moreover, the farms were characterized by higher economic efficiency of resource management.

Various organizations in the agricultural environment are also helpful in shaping the production of fruit; they provide farmers with knowledge on the use of new varieties and production technologies, provide the possibility of selling fruit, participate in the transfer of funds from the EU budget for the purchase of new production and storage equipment and/or carry out campaigns promoting increased consumption of fruit on the domestic and foreign markets. The relations of farmers with these organizations may help them make specific decisions regarding changes in management and stimulate transformation processes in the economic structure and methods of operation [14,34,35]

According to the literature review, the problem of fruit production has been the subject of many studies, but most often, they were limited and concerned only selected issues. The lack of such analyses is particularly visible in relation to orchard farms located in the Małopolska and Pogórze region, where large amounts of fruit are produced.. At the same time, this area is characterized by a large fragmentation of farms. Therefore, the production of fruit in this region may contribute to an increase in the efficiency of farming and the rational management of labor resources.

2.2. The Use of Panel Methods in Research

Various methods of data analysis were used in the research on fruit production. The most frequently used methods were descriptive and basic methods of descriptive statistics (Table 1). In a few studies, regression analysis, chain indexes or the DEA method have been used.

The panel models have not been used so far in the Polish horticulture literature. According to Dańska-Borsiak [38], this type of method has been used in microeconomic analyses and sectoral and regional studies. The panel model was used, among others, by Franc-Dąbrowska [39] in order to ascertain the determinants shaping sales revenues in agricultural enterprises. To achieve the goal, she built panel models using the generalized least squares method with fixed and variable effects. In turn, Wasilewska and Pietrych [40] used a panel model to analyze the relationship between the aging of the population of the European Union countries and economic growth.

In the foreign literature, such methods can be used in analyses of horticultural production. Muriithi [41] used 5-year double-wave panel data for small vegetable growers in central and eastern Kenya to assess the impact of the commercialization of horticulture on two major poverty indicators: household income and asset ownership. This type of method was also used to determine the factors of development of Dutch farms [42].

Compared to other methods, panel methods have several advantages that are important for achieving the objectives of this study, namely:

- they enable higher efficiency of econometric estimates in relation to estimates based on cross-sectional data or on time series thanks to the use of both inter-unit variability and variability over time [43];
- make it possible to reduce the bias of estimators caused by the unobserved explanatory variables [43];
- by including zero-one-time variables in the model, it is possible to control the measurement error resulting from the observation of a given process in different periods and controlling the trend of the examined process [44];
- dynamic panel model estimation methods allow for model estimation containing endogenous explanatory variables [45];

- based on the estimated parameters of the dynamic model (with its appropriate specification), one can infer Granger causality between the subjects' variables [44].

In the panel model, if all objects are observed throughout the trial period, such data is called a balanced panel, and if, for some objects, the time series is longer or shorter than for others, then the panel is unbalanced [45].

The easiest way to estimate the structural parameters of a panel model is the least square method. When using this estimator, it is necessary to assume the homogeneity of the population (the studied objects are homogeneous) and that the deviations between the actual values of the dependent variable and the theoretical values are only a consequence of the random component [46]. The heterogeneity of the surveyed populations makes these assumptions difficult to meet, so it became necessary to take into account the differences between individual objects in the model in the form of fixed or random effects [40]. Therefore, in the literature on the subject, models with fixed effects (FE) and models with random effects (RE) have been distinguished. The model with FE is used when the occurrence of individual effects is found, and the occurrence of unknown (unobservable), but time-constant differences between objects are assumed.

In the model with random effects, each unit is assigned a certain random variable, the implementation of which is responsible for the individual effect in a given period. The total random error, consisting of the individual effect (random effects) and pure random error, is characterized by a correlation in the same object, while no correlation is assumed for different objects. In this situation, it is necessary to use the Generalized Least Squares Estimator (GLSE).

Due to the possibility of individual effects, panel models should be submitted to statistical tests verifying their validity usage. The purpose of these tests is to identify the most appropriate method estimation of structural parameters of models. In the literature, three verification tests are most used. The first is the Wald test which is applied to test the significance of fixed effects [44]. Based on the Hausman test, a choice is made between the estimator of the fixed effects and the random estimator of individual effects [47]. Random effect testing is performed while using the Breusch–Pagan test [48].

3. Materials and Methods

In order to identify the production and economic changes taking place in fruit farms, an analysis of economic and financial data was carried out on a permanent panel of farms. The research sample included 18 farms that continuously, from 2005 to 2016, had kept agricultural accounting for the needs of the Farm Accountancy Data Network (FADN). The choice of the FADN database was due to the fact that it is the only source of reliable data, especially economic data, concerning farms in the country.

The basic research area covered the Region 800—Małopolska and Pogórze, separated under FADN, which includes four voivodeships: Małopolskie, Podkarpackie, Świętokrzyskie and Śląskie. These voivodeships are distinguished by the greatest agrarian fragmentation in the country, which contributed to the development of fruit production in this area. In the analyzed region, orchards in 2020 covered a total of 63.1 thousand hectares, which accounted for 19.3% of the area of orchards in the country. In 2020, there were collected 683.6 thousand tons of fruit from trees, which accounted for 17.5% of the total harvest in Poland. Similar relations were observed in the field of berry fruit harvest. The harvest of this type of fruit in the Małopolska and Pogórze Region amounted to a total of 64.7 thousand tons and accounted for 11.7% of the total berry harvest in the country [4]. The selection of farms from this region was also due to the fact that no such research had been conducted in this area so far.

The basis for the research was a detailed review of the literature on the factors determining changes in fruit production on farms. In order to present changes in the researched farms, the descriptive method and comparative analysis were used. In assessing the economic and financial situation of the researched farms, the analysis of the productivity of factors of production, management efficiency and profitability was used.

A panel model was used to identify the factors influencing the volume of fruit production due to the nature of the data. In this model, it is assumed that the shaping of the dependent variable is influenced, apart from the independent variables, by certain non-measurable factors, constant in time and specific for a given object, called individual (or group) effects [38].

Contrary to the above arguments, the use of panel models is an appropriate tool for achieving the research aim. The combination of cross-sectional data from 18 farms and a 12-year time series made it possible to increase the data set to 216 observations, which made up the panel. Panel data have both the features of cross-sectional data (describing the group of farms in a single time) and the features of time series (describing a farm in different periods). The differentiation of the random component or the intercept (depending on the assumptions) in relation to objects and/or time allows for taking into account the phenomenon of non-homogeneity of objects or the differentiation of the modeled phenomenon over time. In the constructed panel model, the quantity of fruit production was assumed as the dependent variable, and the selection of explanatory variables was made on the basis of substantive relationships. In order to select the model that was best suited to the empirical data, the heteroscedasticity of the random component was analyzed on the basis of the Wald, Breusch–Pagan and Hausman tests. The coefficient of determination R2, the standard error of the residuals, the sum of squared residuals and the F statistic were used to verify the model.

4. Results and Discussion

4.1. The Characteristics of the Researched Farms

In the researched farms, which had continuously kept accounting for the needs of FADN between 2005 and 2016, the average area of farmlands was 8.88 ha. On the other hand, the average orchard area ranged from 6.53 ha in 2005 to 8.14 ha in 2014 and 2015 (Figure 1). However, along with the increase in the area of farmlands (increased by 16.2%), the area of orchards also increased (by 19.6%). This indicates positive trends, as a larger area of an orchard farm may contribute to the generation of lower operating costs and makes it possible to offer larger batches of homogeneous product on the market. In the Małopolska and Pogórze Region, where there is fragmented agriculture, the phenomenon of land consolidation and exchange is also of great importance, allowing for the adoption of a farm shape conducive to rational management.

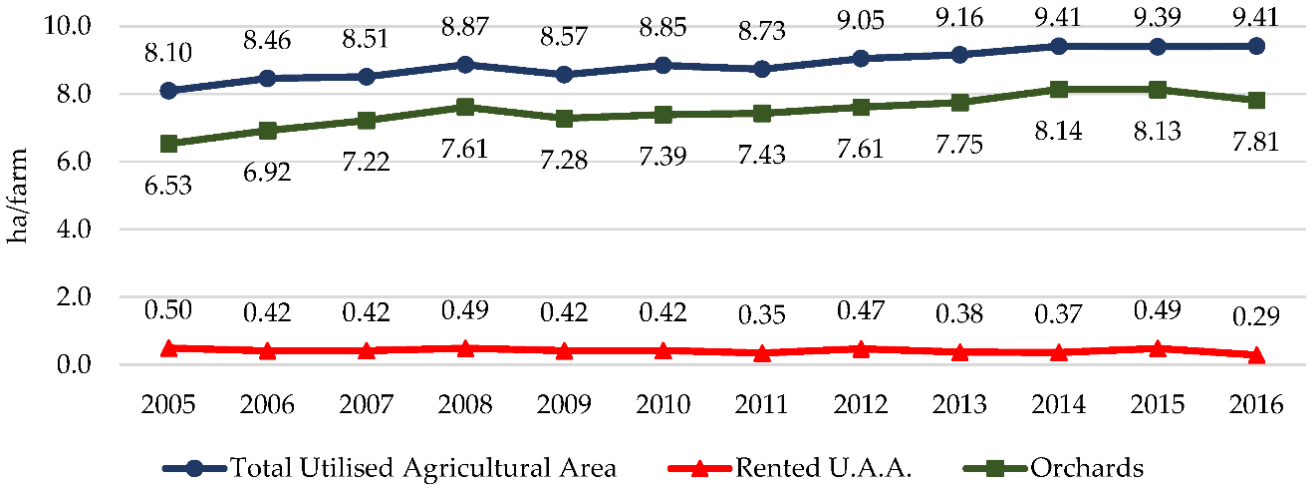


Figure 1. Characteristics of land resources in the researched fruit farms in 2005–2016. Source: own calculations based on FADN data.

A different situation occurred in the case of the leased farmlands. In the researched farms, the area of the leased farmlands ranged from 0.5 ha in 2005 to 0.3 ha in 2016.

Throughout the analyzed period, the share of leased farmlands in their total varied from 6.2% in 2005 to 3.2% in 2016. The small area of leased farmlands and, at the same time, the low share of this area in the total farmlands could result from the fact that in this area are smaller farms than in other regions of Poland. Most of them are family farms, and farmers who have ceased economic activity are rather reluctant to lease their land resources to someone else.

In agricultural holdings, including orchard farms, in addition to land resources and technical means, labor resources are very important because they largely affect farming and production direction and incurred inputs. Work is, next to land and capital, an irreplaceable factor of production in agriculture [49]. In the researched orchard farms in the entire analyzed period, total labor inputs increased by 3.7%, including hired labor inputs (increased by 16.9%), and own labor decreased by 2.0% (Figure 2). The largest decrease in labor inputs was recorded in 2010 and 2015. In 2010, it was probably associated with bad weather conditions and a flood disaster, while in 2015, production collapsed mainly due to the Russian embargo and problems with the sale of fruit. Due to this situation, the fruit growers did not collect some of the fruit, leaving them on trees or shrubs.

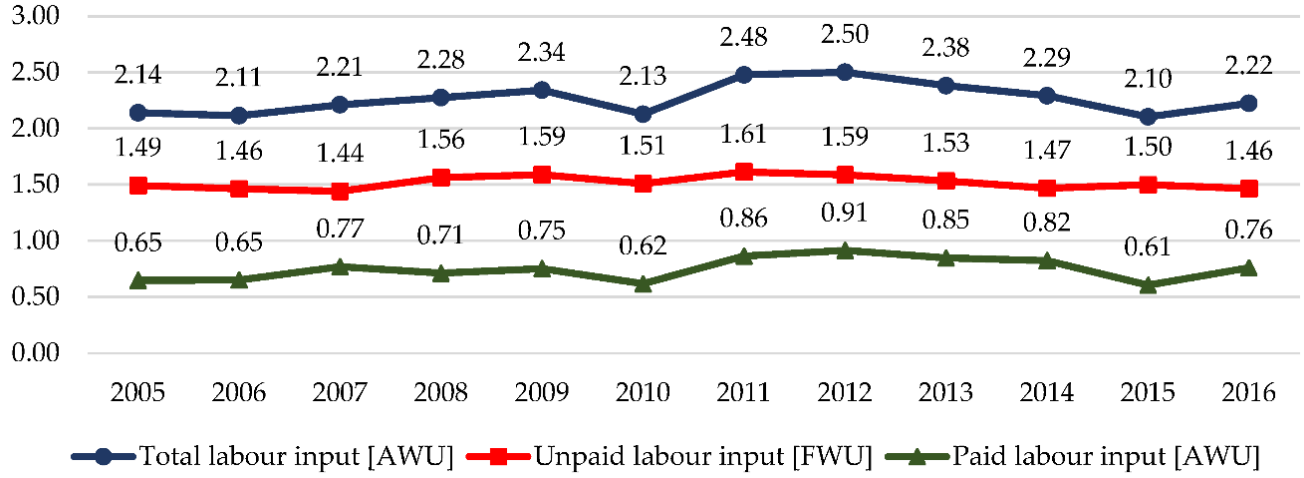


Figure 2. Characteristics of labor inputs in the researched fruit farms in 2005–2016. Source: own calculations based on FADN data.

Apart from land and labor, capital is one of the basic factors of production in agriculture and, thus, in horticulture. It takes the form of fixed and current assets necessary to run a production activity. Tangible property is of fundamental importance in the structure of fixed assets. In all analyzed years, its share clearly dominated total assets and accounted for approximately 80–90% (Table 2). This is because running a fruit production activity requires adequate space and equipment with buildings (e.g., cold stores), technical equipment, machinery, means of transport and other fixed assets.

In the researched farms, the share of machinery, equipment and means of transport in fixed assets decreased from 20.2% in 2005 to 18.9% in 2016. On the other hand, the value of machinery, equipment and means of transport had been increasing annually by 4.2% on average. In 2005, it amounted to 86.04 thousand PLN, and in 2016 135.06 thousand PLN. A different situation occurred in the case of current assets, which share in total assets in the analyzed period ranged from 8.1% in 2014 to 13.2% in 2007, and at the end of 2016, it was 11.5%. In the entire analyzed period, there was an average annual increase in the value of current assets by 4.4%.

Table 2. Equipping the researched farms with fixed assets in 2005–2016 [thous. PLN/farm].

Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2016/2005 [%]
Total fixed assets, including:	425.75	438.22	446.52	522.14	743.69	720.15	736.55	752.13	757.65	770.98	742.46	712.10	167.2
Land	175.51	175.79	188.48	222.02	442.96	423.11	419.76	398.01	393.16	388.54	375.10	368.18	209.8
Buildings	164.19	174.13	169.81	184.16	185.78	193.89	197.96	226.60	228.35	222.93	215.78	208.86	127.2
Machinery	86.04	88.31	88.24	115.95	114.95	103.15	118.83	127.53	136.13	159.51	151.57	135.06	157.0
Total current assets, including:	57.87	66.87	68.04	65.39	66.20	70.81	86.67	86.27	84.27	67.69	80.82	92.81	160.4
Stock of agricultural products	37.64	40.03	45.39	41.46	48.48	46.67	54.35	57.29	57.36	48.23	58.93	62.80	166.8

Source: own calculations based on FADN data.

Since Poland's accession to the European Union, the level of farm equipment with fixed means of production has improved, mainly due to the launch of the instruments of the Common Agricultural Policy. From 2004, Polish fruit growers could use numerous aid programs (including SAPARD, Rural Development Plan 2004–2006, Rural Development Program for 2007–2013 and 2014–2020) and apply for partial reimbursement of costs incurred for the implementation of investments (e.g., construction of specialized fruit storage facilities) and the purchase of machinery. Access to EU funds has significantly accelerated the process of modernizing farms and adapting them to the new economic conditions.

The appropriate number of fixed and current assets, as well as the appropriate relations between them and their effective use, determine the competitiveness of farms and determine their economic situation. Farms with higher labor efficiency and land productivity, simultaneously with lower production costs, more effectively use fixed assets and, when managed more efficiently, develop faster and can compete on the market more easily.

4.2. Changes in the Operating Costs of Orchard Farms

Running an agricultural activity, including fruit production, requires certain costs. Under the Polish FADN, production costs are divided into direct costs (in plant production—seeds and seedlings, fertilizers, plant protection chemicals, and other direct costs of plant production) [50], general economic costs (cost of maintaining buildings and machinery, energy, fuels, services, water, insurance), depreciation and costs of external factors such as salaries of hired employees, rent and interest [51].

From 2005–2016, the researched farms showed an upward trend in total costs from 70.47 thousand PLN up to 112.01 thousand PLN (an increase of 58.9%), but with considerable volatility (Table 3). The highest increase in total costs in relation to the year-on-year was recorded in 2007 and 2009 (by 16.2% and 11.3%, respectively), and the decreases in 2014–2016 (by 2.3%, 0.6% and 3%, respectively). The total costs consisted of direct and indirect costs of farm activity. The value of direct costs ranged from 12.69 thousand PLN in 2005 to 28.36 thousand PLN in 2013. Generally, in the years 2005–2016, there was an upward trend in direct costs with periodic fluctuations. Their average annual increase in the analyzed period amounted to 6.5%.

Plant protection costs dominated in the structure of direct plant production costs. Their share in direct costs was from 31.7% in 2007 to 50.7% in 2009, and in 2016 it was 42.5%. The share of fertilization costs was much lower and ranged from 18.2% in 2010 to 30.6% in 2006, and at the end of the analyzed period, it was 19.4%. Other direct plant production costs changed from 12.7% in 2009 to 28.2% in 2016. The smallest share in direct costs was represented by expenditure on seeds and seedlings. Their percentage varied from 2.9% in 2008 to 15.2% in 2012. This could be due to the fact that in fruit production, new plantings are not planted every year but once in several years.

Table 3. Costs of researched farms in 2005–2016 [thous. PLN/farm].

Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2016/2005 [%]
Total inputs	70.47	73.74	85.71	90.37	100.58	102.31	112.05	118.70	118.85	116.16	115.48	112.01	158.9
Total intermediate consumption	30.62	31.52	38.60	40.78	43.77	49.83	52.01	54.05	55.06	52.98	52.61	50.89	166.2
Total specific costs	12.69	12.98	19.74	19.86	19.74	25.21	25.32	27.26	28.36	26.73	21.53	25.32	199.5
Seeds and plants	0.42	0.72	2.09	0.58	1.73	1.00	3.40	4.14	2.70	3.93	1.88	1.15	273.8
Fertilisers	3.06	3.98	4.96	5.96	4.64	4.60	5.57	5.72	5.50	5.73	4.42	4.90	160.1
Crop protection	5.19	5.70	6.26	8.85	10.01	11.26	10.27	10.21	11.72	10.06	10.10	10.76	207.3
Other crop-specific costs	2.56	2.26	5.49	3.60	2.51	5.98	4.65	5.16	5.66	5.17	3.74	7.13	278.5
Total farming overheads	17.93	18.54	18.86	20.92	24.03	24.61	26.70	26.79	26.70	26.25	31.07	25.57	142.6
Total external factors	9.62	11.06	12.98	12.05	14.99	12.87	18.08	21.17	18.98	19.00	17.52	18.80	195.4
Wages paid	7.19	7.66	10.58	10.70	13.65	11.38	16.14	17.41	16.63	17.12	15.66	16.91	235.2
Rent paid	0.93	2.16	1.90	0.87	0.77	0.82	0.77	0.78	0.66	0.69	0.57	0.87	93.5
Depreciation	30.23	31.16	34.13	37.55	41.82	39.61	41.96	43.49	44.81	44.18	45.35	42.32	140.0

Source: own calculations based on FADN data.

There were also analyzed general economic costs in the work, including costs of electricity, fuel, diesel fuel, repairs, maintenance and inspections, services, insurance (e.g., for buildings, property, communication) and other (e.g., charges for water, sewage, telephone) [50]. In the entire analyzed period, these costs increased from PLN 17.93 thousand PLN up to 25.57 thousand PLN, so by 42.6%. The highest level of general economic costs was recorded in 2015 and amounted to 31.07 thousand PLN per farm.

The value of depreciation in 2016 compared to 2005 was higher by 40.0%. It probably resulted from an increase in the value of fixed assets in 2006–2016 as a result of investment activities.

4.3. Changes in the Volume of Production and the Productivity of Land, Labour and Capital

In the examined group of farms, the lowest total production value was recorded in 2005 (99.24 thousand PLN) and the highest in 2012 (160.98 thousand PLN) (Table 4). The fruit of trees and shrubs cultivated in the field accounted for over 92.5% of the total production, except for 2007 when their share was only 87.9%. Their lower share in total production this year could have been influenced by low- and worse-quality fruit crops caused by bad weather conditions during the growing season. The share of livestock production ranged from 3.5% in 2005 to 1.0% in 2016. The exception was in 2012 when the value of livestock production brought losses and amounted to -130 PLN. This was probably due to the fact that these farms specialized in fruit production, and livestock production was carried out as an additional. To some extent, it met the nutritional needs of farmers' families and was a limited source of income.

In the researched group of farms, there were also very low indicators of the share of internal consumption in total production. It ranged from 0.02% in 2008 to 0.1% in 2006, and in 2010–2011 and in 2013, it did not occur at all. This means that these farms carried out production with the use of purchased materials, and the production self-supply was minimal. The index of the value of transfers to the household in relation to the value of realized production in the analyzed period ranged from 0.5% to 0.9%. This could be due to the limited possibilities of direct use of a very narrow range of products produced on these farms.

Table 4. The value of individual production categories in the researched farms in 2005–2016 [thous. PLN/farm].

Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2016/2005 [%]
Total output	99.24	102.16	146.73	119.95	109.87	125.22	144.66	160.98	157.35	124.50	142.92	147.91	149.1
Total output crops and crop production	95.11	98.00	141.35	115.35	106.99	121.94	141.14	160.41	154.89	121.77	138.75	145.06	152.5
Fruit	91.90	95.45	128.98	110.91	102.13	119.26	136.63	154.99	150.50	116.47	135.83	142.31	154.8
Total output livestock and livestock products	3.47	3.50	4.27	3.32	2.10	2.71	2.78	-0.13	2.00	1.74	3.41	1.53	44.1
Total output livestock and livestock products	0.66	0.67	1.11	1.27	0.78	0.57	0.73	0.70	0.46	0.99	0.76	1.32	200.0
Farmhouse consumption	0.75	0.96	1.20	1.00	0.78	1.04	1.10	1.06	1.17	1.01	0.75	0.89	118.7
Farm use	0.08	0.10	0.06	0.02	0.06	-	-	0.03	-	0.06	0.11	0.11	137.5
Sale of fruit	94.41	92.28	121.86	114.45	94.32	120.91	128.25	151.65	149.39	124.39	124.21	137.89	146.1

Source: own calculations based on FADN data.

In order to determine the productivity indicators in the researched farms, the production effects in terms of value were compared to the input of production factors involved in their achievement. The calculation results are presented in Table 5.

Table 5. Productivity of production factors in the researched farms in 2005–2016.

Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2016/2005 [%]
Production per 1 ha of UAA [thous. PLN/ha]	12.26	12.08	17.25	13.53	12.82	14.15	16.57	17.80	17.18	13.23	15.21	15.71	128.1
Production per 1 FWU [thous. PLN/FWU]	46.36	48.33	66.36	52.72	46.92	58.87	58.38	64.35	66.07	54.31	67.91	66.49	143.4
Production per 1000 PLN of the value of fixed assets [PLN]	205.2	202.3	285.2	204.2	135.7	158.3	175.7	192.0	186.9	148.4	173.6	183.8	85.7
Profitability index [%]	140.8	138.5	171.2	132.7	109.2	122.4	129.1	135.6	132.4	107.2	123.8	132.0	93.7

Source: own calculations based on FADN data.

The highest average land productivity, expressed by the total production value per 1 hectare of farmland, was achieved by farms in 2012 at the level of 17.80 thousand PLN/hectare, and the lowest was recorded in 2006 (12.08 thousand PLN/ hectare). In the entire analyzed period, its average annual increase was 2.2%. The obtained results were probably influenced by the income from the sold fruit and the acreage of farms. In the entire analyzed period, the highest average labor productivity was 67.91 thousand PLN per full-time employee achieved by farms in 2015, and the lowest of 46.36 thousand PLN was recorded in 2005. In this group of farms, there was noted an average annual increase in labor productivity amounting to 3.9%. The highest average productivity of capital, expressed by the value of total production per 1000 PLN of engaged fixed assets, was achieved by the researched farms in 2007, while the lowest level of this indicator

was recorded in 2009. The average annual decline in capital productivity from 2006–2016 was 1.7%.

4.4. Changes in the Economic Situation of the Researched Farms

The economic results obtained in the researched fruit farms were determined both by the structure and scale of the conducted production as well as by the price level of the products sold. Their diversity was also influenced by the fact that farms were equipped with basic means of production.

The researched farms in the analyzed period were characterized by significant fluctuations in the value of income (Table 6). Its highest value of 68.31 thousand PLN was recorded in 2007, and the lowest at the level of 14.98 thousand PLN in 2009. In 2016, agricultural income amounted to PLN 57.10 thousand PLN.

Table 6. Profitability of production factors in the researched farms in 2005–2016.

Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2016/2005 [%]
Family Farm Income (FFI)/Family Work Unit (FWU) [thous. PLN]	27.34	43.99	68.31	34.18	14.98	29.87	49.51	49.68	49.00	30.91	41.09	57.10	208.9
Income per 1 ha of Utilized Agricultural Area (UAA) [thous. PLN]	3.38	5.20	8.03	3.85	1.75	3.38	5.67	5.49	5.35	3.28	4.37	6.07	179.6
Income per 1 FWU [thous. PLN]	18.31	30.07	47.40	21.86	9.42	19.79	30.67	31.30	31.96	21.05	27.42	38.99	212.9
Income per PLN 1.000 of the value of fixed assets [PLN]	64.21	100.39	152.99	65.46	20.14	41.48	67.21	66.06	64.68	40.09	55.34	80.19	124.9

Source: own calculations based on FADN data.

The largest decreases in agricultural income occurred in 2008–2009 and amounted to 50.0% and 56.2%, respectively. Income instability could be a consequence of natural, economic and political factors. Such large fluctuations in income contribute to the uncertainty of management, which negatively affects long-term investments in farms. Income uncertainty could also have contributed to the search for alternative sources of obtaining funds and, consequently, to the resignation from farming.

The profitability of land, own labor and the value of fixed assets was strongly diversified and showed an upward trend. In the years 2005–2016, there was an increase in the profitability of land by almost 80.0%, labor by 112.9%, and fixed assets by 25.0%. The highest value of profitability ratios was recorded in 2007, and the lowest in 2009.

Achieving a positive financial result, especially in the long term, is the basis for running a farm, including an orchard. The efficiency of management in a synthetic way reflects the profitability of the activities carried out. The return on property (ROA) and the return on equity (ROE) in the analyzed group of farms were at a similar level and amounted to 6.1% and 6.4% on average, respectively. From 2005–2016, their average annual growth was about 2.0%.

4.5. Panel Model Parameters Estimation

The list of variables that can directly or indirectly explain the changes in the volume of fruit production was developed, taking into account the substantive criterion and the availability of data. In the constructed panel model, the following was assumed as the dependent variable:

Y1—the volume of fruit production in decitons,

At the initial stage, among the explanatory variables, 13 measures of the economic and financial situation of farms were adopted for the model. They result from the production potential of farms, i.e., resources of production factors: land, labor and capital, their

quality and methods of use [52]. The analysis included only those features whose potential relationship with the amount of fruit harvest can be substantively justified. On the one hand, the selection of explanatory variables resulted from the availability of data in the FADN database and, on the other hand, from the analysis of the literature related to fruit production. The analysis included only those features whose potential relationship with the amount of the harvest can be substantively justified. The set of explanatory variables includes:

X1—orchard area [ha],
X2—own labor inputs [FWU],
X3—hired labor input [AWU],
X4—value of non-current assets [PLN],
X5—value of current assets [PLN],
X6—fertilizer costs [PLN],
X7—costs of plant protection products [PLN],
X8—general economic costs [PLN],
X9—salary costs [PLN],
X10—value of additional payments to operating activities [PLN],
X11—net investment value [PLN],
X12—value of machines, devices, means of transport [PLN],
X13—the age of the farmer

Due to the availability of panel data, three types of estimators were considered: panel LSM, fixed effects (FE) and random effects (RE). The choice of the model which best suited the empirical data was based on the heteroscedasticity analysis of the random component. For this purpose, the Wald, Breusch–Pagan and Hausman tests were used. The test results are presented in Table 7.

Table 7. Heteroscedasticity tests for the panel model.

Tests	Explained Variable—Fruit Production [dt]
Wald test H0: No differentiation of individual effects	F(17.184) = 4.707 *p*-value = 0.000
Breusch–Pagan test H0: The individual effect is permanent for all units and can be made replaced with a free word	LM = 10.347 *p*-value = 0.001
Hausman test H0: Both estimators are unbiased and the random effects estimator is more effective	H = 33.208 *p*-value = 0.003
Estimator	FE

Source: own calculations.

In the model, created on the basis of the Wald and Breusch–Pagan tests, the null hypothesis about the lack of differentiation of individual effects in favor of the alternative hypothesis was rejected, thus recognizing the FE estimator as the most appropriate in the case of Wald's test and the RE estimator in the case of the Breusch–Pagan test. The solution to the problem of choosing the best estimator, in this case, was the Hausman test, the result of which indicated that the fixed effects estimator is more effective (compared to the model taking into account random effects). To sum up, the model with the established FE effects was the most effective, thus the one that best described the variability of the production volume in the analyzed farms. It took the form of:

$$yit = xit\beta + \mu i + \varepsilon it,$$

where:

μi—the time-constant individual effect of i-object
εti—pure random error of i-object in the time t.

The estimation of the panel model parameter obtained with the use of appropriate estimators is presented in Table 8.

Table 8. Results of panel model parameters estimation—dependent variable: fruit production [dt].

Variables		Coefficient	Standard Error	t-Student	*p*-Value	Significance
Const		161.244	181.559	0.888	0.3756	
Value of current assets [PLN]	X_5	0.0042523	0.00081091	5.244	4.07×10^{-7}	***
Salary costs [PLN]	X_9	0.0162619	0.00296324	5.488	1.25×10^{-7}	***
Farmer's age [years]	X_{13}	10.0741	3.74770	2.688	0.0078	***
Mean of the dependent variable: 1173.401				Standard deviation of the dependent variable: 8,506,635		
Sum of squares of residuals: 26,775,604				Standard error of residuals: 370.5547		
LSDV R-square: 0.827898				Within R-square: 0.380128		
LSDV F (20, 195): 46.90254				*p*-value for test F: 1.97×10^{-63}		
Log-Likelihood: −1573.085				Crit. inform. Akaik'e: 3188.170		
Schwarz criterion: 3259.051				Hannan Quinn's criterion: 3216.806		
Autocorrelation of residuals: 0.018599				Durbin Watson Statistics: 1.832649		

*** Variable significant at the significance level of 0.01, Source: own calculations.

The least squares method with artificial variables (dummy) responsible for the estimation of the effects of individual farms was used to estimate the parameters of the model. The values of the determination coefficients indicate that the model satisfactorily or highly explains the variability of the dependent variable. The coefficient of determination R2 for LSDV (least square dummy variable) was 0.828. It indicates what part of the explained variable is explained by the explanatory variables. In turn, the intra-group R2 reached the level of 0.380. It indicates what part of the variability of the variable explained within individual farms is explained by the variables used in the model. In this situation, time is of less importance and individual effects of farms are more important. This indicates a different situation of farms included in the panel.

Three explanatory variables turned out to be significant in the presented model; the value of current assets, salary costs and the age of the owner of an orchard farm, which were positively correlated with the volume of fruit production on farms. Current assets are the assets that, in the normal course of operations, are expected to be converted into cash or consumed in the production process within one year. Current assets play a very important role in determining the working capital and the current ratio of a business [53]. Rational and efficient use of the current assets is one of the main conditions for the successful operation of the farm. The research of Ulianchenko et al. [54] shows that among European Union farms, the relationships of the current assets to the total assets have an impact on profitability and financial performance. In practice, the current assets and liabilities improve profitability and performance when linked to the total assets [55]. In the researched farms, the positive impact of the value of current assets on the volume of fruit production was probably related to the maintenance of stocks, which enabled the sale of fruit in a later period. The increase in their value by 1000 PLN contributed to the increase in the production volume by 4.2 decitons. On this basis, it can be concluded that the greater equipment of the farm with current assets causes an increase in the volume of fruit production.

The presented model also showed a positive correlation between production volume and wages and salaries. The increase in wages and salaries by 1000 PLN was related to an increase in production by 16.3 decitons. The allocation of higher amounts for wages probably allowed for a greater harvest of fruit, especially in very fertile years. On the other hand, the shortage of seasonal workers or the lack of funds for remuneration could have resulted in leaving some fruit on trees or shrubs. The importance of salary costs in fruit production was also confirmed by the research of Łakomiak and Zhichkin [56]. Their analysis was based on primary empirical data obtained from the period 2012–2018 from an orchard farm located in the Lower Silesian Voivodship. The farm, with a total area of 33 ha, produces apples and peaches. The research shows that in the structure of the cost of apple production in the orchard in 2018, salary costs dominated, accounting for almost 32%. In recent years, it has become increasingly difficult for farms to obtain the labor they need to produce their crops. This problem does not only concern Poland but also other countries, e.g., United States (U.S.) fruit and vegetable farms depend heavily on labor for the production of the crops they grow and sell. Therefore, labor management strategies have become critical in determining the profitability and long-term sustainability of farms specializing in the production of fruits and vegetables. These strategies are even more significant for smaller farms that face resource constraints that inhibit their use of alternative labor sources (e.g., migrant workers) or their ability to reduce their reliance on labor through mechanization [57].

The model shows that the farmer's age also influenced the change in the production volume of the researched farms. As the farmer's age increased by one year, fruit production increased by an average of 10.1 decitons. This could be related to the growing experience of fruit growers in the work in orchards, the use of plant protection products and fertilizers and the storage of crops.

The conducted research did not show that the production of fruit in fruit farms might be influenced to the greatest extent by the intensification of production with the use of mineral fertilizers and plant protection products. Hence, the hypothesis formulated in the study was verified negatively.

The influence of the farmer's age on fruit production was also confirmed by studies carried out by Niyaz and Demirbaş [58]. The aim of this study was to identify the factors which affect fresh fruit production and marketing. In this respect, a survey was carried out in Canakkale, and questionnaires prepared in accordance with the aim of the study were filled out through face-to-face interviews with 98 farmers chosen by means of stratified random sampling. The product scope of this study included apples and peaches, which constitute 7% of the total fresh fruit production in Canakkale. Factors affecting fresh fruit production were determined through Binary Logistic Regression Analysis. These studies show that fruit production, apart from the farmer's age, is also influenced by the share of orchards in utilized agriculture areas.

The amount of fruit produced is related to their supply on the market. Ayalew [59] has analyzed the factors influencing fruit market supply in Ethiopia. Ordinary least squares (OLS) regression analysis was employed to identify factors affecting the farm-level marketable supply of fruit. Five variables were found to be significant variables in affecting the farm-level marketable supply of fruit: the quantity of fruit produce, education level of the household head, market information, extension service influenced the marketable supply of fruits (positively) and distance to the market (negatively).

5. Conclusions

The researched farms specializing in fruit production characterize small-scale production because they are located in an area with a fragmented agrarian structure. During particular years, they varied in terms of land, labor and capital productivity as well as achieved economic results. In the entire analyzed period, the income from the family farm showed large fluctuations. They resulted, inter alia, from weather conditions that

determined the amount and quality of the harvest and were also the result of an increase in the prices of means of production and changes in fruit prices on the market.

The level and changes in fruit production are influenced by both external (exogenous) factors, such as natural and climatic conditions, soil, state and EU policy, prices of means of production, trends in consumption of fruit, especially fresh fruit, the location of the farm in relation to centers consumption and processing, as well as internal ones based on the individual farmer and his decisions.

The research shows that among endogenous factors, the value of current assets, the cost of wages and the age of fruit growers had a statistically significant influence on the volume of fruit production in fruit farms in the long term. The value of current assets was related to the storage, which allows for the sale of the fruit at a higher price at a later date. The costs of wages resulted from the possibility of employing workers and harvesting all the fruits. In turn, the positive influence of the farmer's age on the amount of fruit production was related to the growing experience of fruit growers in fruit production.

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References

1. Piwowar, A. Drugi agregat agrobiznesu–rolnictwo. In *Agrobiznes i Biobiznes. Teoria i Praktyka*; Urban, S., Ed.; Wydawnictwo UE we Wrocławiu: Wrocław, Poland, 2014; pp. 36–42.
2. Apetyt na Polskie. Available online: https://apetytnapolskie.com/w-produkcji-ktorych-warzyw-i-owocow-polska-jest-potentatem-na-skale-europejska-i-swiatowa/ (accessed on 9 October 2022).
3. *Rocznik Statystyczny Rolnictwa 2021*; Główny Urząd Statystyczny: Warsaw, Poland, 2021.
4. Bank Danych Lokalnych, Główny Urząd Statystyczny. Available online: https://bdl.stat.gov.pl/bdl/dane/podgrup/tablica (accessed on 8 October 2022).
5. *Rocznik Statystyczny Rzeczypospolitej Polskiej 2021*; Główny Urząd Statystyczny: Warsaw, Poland, 2021.
6. Filipiak, T.; Maciejczak, M. Uwarunkowania rozwoju sektora owoców i warzyw w Polsce w latach 2004–2007. *Rocz. Nauk. Rol.* **2008**, *95*, 97–109.
7. Kierczyńska, S. Wielkość produkcji a poziom cen wybranych gatunków owoców do przetwórstwa. *Rocz. Nauk. Stowarzyszenia Ekon. Rol. I Agrobiz.* **2011**, *13*, 201–205.
8. Bugała, A.; Kraciński, P.; Nosecka, B.; Strojewska, I.; Zaremba, Ł. *Polski i Światowy Rynek Wybranych Owoców, Warzyw i Ich Przetworów*; Nosecka, B., Ed.; Monografie Programu Wieloletniego 2015–2019; IERiGŻ-PIB: Warsaw, Poland, 2017; p. 66.
9. Andreß, H.-J.; Golsch, K.; Schmidt-Catran, A. *Applied Panel Data Analysis for Economic and Social Surveys*; Springer: Berlin/Heidelberg, Germany, 2013.
10. Griliches, Z.; Intriligator, M.D. *Handbook of Econometrics, V2*; Elsevier: North Holland, Spain, 2007.
11. Baltagi, B.H. *Econometric Analysis of Panel Data*, 3rd ed.; John Wiley & Sons Ltd.: Londyn, UK, 2005.
12. Gunerka, L.; Jabłońska, L.; Sobczak, W. Regionalne zróżnicowanie upraw ogrodniczych w Polsce. *Rocz. Nauk. SERiA* **2014**, *16*, 57–63.
13. Pizło, W. *Gospodarowanie w Sadownictwie Grójca i Warki: Region, Klastry, Gospodarstwa Sadownicze*; Wydawnictwo SGGW: Warsaw, Poland, 2011.
14. Pizło, W. *Gospodarowanie w Sadownictwie Grójca i Warki: Społeczno-Ekonomiczne Uwarunkowania Rozwoju Gospodarstw Domowych. Część Druga. Raport z Badań Jakościowych*; Wydawnictwo SGGW: Warsaw, Poland, 2013.
15. Filipiak, T. Uwarunkowania prawno-organizacyjne sektora owoców i warzyw w Polsce. *Rocz. Nauk. SERiA* **2013**, *15*, 63–69.
16. Nosecka, B. Zewnętrzne uwarunkowania wzrostu eksportu owoców, warzyw i ich przetworów z Polski. *Rocz. Nauk. Ekon. Rol. I Rozw. Obsz. Wiej.* **2014**, *101*, 133–144.

17. Malchar-Michalska, D. Polski eksport owoców i warzyw. Studium przypadku uznanych organizacji i wstępnie uznanych grup producentów owoców i warzyw (rynek pierwotny) z województwa dolnośląskiego. *Ekon. Międzynarodowa* **2014**, *6*, 91–107.
18. Bieniek-Majka, M. Determinanty eksportu owoców i warzyw z Polski w latach 2004–2014. *Rocz. Nauk. SERiA* **2015**, *17*, 32–38.
19. Olewnicki, D. *Przemiany w Gospodarce Ogrodniczej w Polsce w Latach 1965–2008 Oraz Perspektywy Jej Rozwoju, Praca Doktorska*; SGGW w Warszawie: Warsaw, Poland, 2011.
20. Makosz, E. Wizja rynku owocowego w Polsce. In *XLIV Zjazd Sadowników*; Wydawnictwo Instytut Sadownictwa i Kwiaciarstwa w Skierniewicach: Skierniewice, Poland, 2005.
21. Wróblewska, W.; Chudzik, A. Zmienność cen owoców i środków produkcji a sytuacja ekonomiczna producentów w Polsce. *Zesz. Nauk. Ekon. I Organ. Gospod. Żywnościowej* **2015**, *109*, 123–132. [CrossRef]
22. Jąder, K. Konsumpcja owoców w Polsce w różnych typach gospodarstw domowych. *Rocz. Nauk. SERiA* **2016**, *18*, 117–123.
23. Pawlak, K. Wybrane aspekty konkurencyjności polskiego sektora owocowo-warzywnego na tle krajów Unii Europejskiej. *Wieś I Rol.* **2005**, *128*, 35–43.
24. Pizło, W. *Rynek Owoców w Polsce i Wybranych Krajach Unii Europejskiej–Ujęcie Teoretyczne i Empiryczne*; Wydawnictwo SGGW: Warsaw, Poland, 2001.
25. Ziętara, W.; Sobierajewska, J. *Gospodarstwa Ogrodnicze w Polsce i w Wybranych Krajach Unii Europejskiej, Konkurencyjność Polskiej Gospodarki Żywnościowej w Warunkach Globalizacji i Integracji Europejskiej*; Wydawnictwo IERiGŻ-PIB: Warsaw, Poland, 2012; p. 58.
26. Jabłońska, L.; Gunerka, L.; Filipiak, T. Efektywność ekonomiczna gospodarstw ogrodniczych w wybranych krajach Unii Europejskiej. *Rocz. Nauk. SERiA* **2017**, *19*, 77–82.
27. Długokęcka, D. *Rynek Owoców i Warzyw–5 Lat Polskiego Rolnictwa w UE–Zmiany i Perspektywy*; FAPA: Warsaw, Poalnd, 2009.
28. Bieniek-Majka, M. Zmiany na rynku owoców i warzyw w Polsce po akcesji do Unii Europejskiej. *Studia I Pr. Wydziału Nauk. Ekon. I Zarządzania* **2015**, *41*, 109–119. [CrossRef]
29. Olewnicki, D. Przemiany wybranych czynników ekonomicznych gospodarki sadowniczej i warzywniczej w gospodarce żywnościowej w latach 1980–2008. *Zesz. Nauk. Inst. Sadow. I Kwiaciarstwa W Skiern.* **2010**, *18*, 167–180.
30. Pizło, W. Economic situation of the polish fruit growers in the period 1999–2009. *Acta Oeconomia* **2011**, *10*, 123–134.
31. Ryś-Jurek, R.; Stefko, O. Wyniki produkcyjne i ekonomiczne gospodarstw ogrodniczych według ich wielkości ekonomicznej w Polsce i w UE-27 w 2009 roku na podstawie danych FADN. *Wieś I Rol.* **2012**, *156*, 113–129.
32. Komorowska, D. Efektywność gospodarowania zasobami w gospodarstwach sadowniczych. *Zesz. Nauk. Probl. Rol. Swiat.* **2017**, *17*, 187–194. [CrossRef]
33. Komorowska, D. Wyniki produkcyjne i ekonomiczne gospodarstw ogrodniczych. *Zesz. Nauk. Probl. Rol. Swiat.* **2018**, *18*, 111–120. [CrossRef]
34. Czudec, A.; Kata, R.; Miś, T.; Zając, D. *Rola Lokalnych Instytucji w Przekształceniach Rolnictwa o Rozdrobnionej Strukturze Gospodarstw*; Wydawnictwo Uniwersytetu Rzeszowskiego: Rzeszów, Poland, 2008.
35. Czyżewski, B. *Rola Instytucji w Modernizacji Gospodarstw. Program Wieloletni 2005–2009*; Wydawnictwo IERiGŻ-PIB: Warsaw, Poland, 2008; p. 103.
36. Filipiak, T. *Zmiany na Rynku Warzyw i w Gospodarstwach Warzywniczych w Polsce po Integracji z Unią Europejską*; Wydawnictwo SGGW: Warsaw, Poland, 2014.
37. Tomek, W.G.; Robinson, K.L. *Kreowanie Cen Artykułów Rolnych*; Wydawnictwo PWN: Warsaw, Poland, 2001.
38. Dańska-Borsiak, B. Zastosowania panelowych modeli dynamicznych w badaniach mikroekonomicznych i makroekonomicznych. *Przegląd Stat.* **2009**, *56*, 25–41.
39. Franc-Dąbrowska, J. Praktyczne zastosowanie wybranych modeli panelowych do oceny sytuacji finansowej przedsiębiorstw rolniczych. *Zesz. Nauk. SGGW W Warszawie Ekon. I Organ. Gospod. Żywnościowej* **2009**, *76*, 31–40.
40. Wasilewska, E.; Pietrych, Ł. Starzenie się społeczeństwa a wzrost gospodarczy w krajach Unii Europejskiej. *Probl. Rol. Swiat.* **2018**, *18*, 481–492. [CrossRef]
41. Muriithi, B.W. Does Commercialization of smallholder horticulture Reduce Rural Poverty? Evidence based on Household Panel Data from Kenya. In Proceedings of the 4th International Conference of the African Association of Agricultural Economists, Hammamet, Tunisia, 22–25 September 2013.
42. Lansink, A.G.J.M.O.; Verstegen, J.A.A.M.; Van Den Hengel, J.J. Investment decision making in Dutch greenhouse horticulture. *NJAS-Wagening. J. Life Sci.* **2001**, *49*, 357–368. [CrossRef]
43. Hsiao, C. Panel data analysis—Advantages and challenges. *TEST* **2007**, *16*, 1–22. [CrossRef]
44. Goczek, Ł. Metody ekonometryczne w modelach wzrostu gospodarczego. *Gospod. Nar.* **2012**, *254*, 49–71. [CrossRef]
45. Dańska-Borsiak, B. *Dynamiczne Modele Panelowe w Badaniach Ekonomicznych*; Wydawnictwo Uniwersytetu Łódzkiego: Łódź, Poland, 2011.
46. Geise, A. Przestrzenno-czasowe modelowanie zmienności produkcji w sektorach mikro-, małych, średnich i dużych przedsiębiorstw w Polsce. *Przegląd Stat.* **2013**, *60*, 269–282.
47. Hausman, J. Specification tests in econometrics. *Econometrica* **1978**, *46*, 1251–1271. [CrossRef]
48. Breusch, T.S.; Pagan, A.R. The Lagrange multiplier test and its applications to model specification in econometrics. *Rev. Econ. Stud.* **1980**, *47*, 239–253. [CrossRef]
49. Ziętara, W. *Organizacja Gospodarstw Rolniczych*; Wydawnictwo PWRiL: Warsaw, Poland, 1984.

50. Skarżyńska, A.; Jabłoński, K. Koszty jednostkowe i dochody wybranych produktów w 2011 roku–wyniki badań w systemie agrokoszty. *Zagadnienia Ekon. Rolnej* **2013**, *2*, 24–143.
51. Grzybowska, E. *FADN i Polski FADN (Sieć Danych Rachunkowych Gospodarstw Rolnych i System Zbierania i Wykorzystywania Danych Rachunkowych z Gospodarstw Rolnych)*; Wydawnictwo IERiGŻ-PIB: Warsaw, Poland, 2017.
52. Stańko, S. Zewnętrzne uwarunkowania rozwoju rolnictwa. *Rocz. Nauk. Rol.* **2008**, *94*, 65–79.
53. Current Assets: What It Means and How to Calculate It, with Examples. Available online: https://www.investopedia.com/terms/c/currentassets.asp (accessed on 9 October 2022).
54. Ulianchenko, Y.O.; Vasylishyn, S.I.; Yefanov, V.A.; Skolotii, I.V. Policy improvement of formation and efficient use of the current assets of the agricultural enterprises. *Financ. Credit. Act. Probl. Theory Pract.* **2018**, *4*, 259–267. [CrossRef]
55. Ugli, A.B.U.; Tohirovich, Q.N.; Khatamovna, R.S.; Nigoraxon, M. Current Assets and Their Role in Company Activity. *J. Mark. Emerg. Econ.* **2021**, *1*, 25–30.
56. Łakomiak, A.; Zhichkin, K.A. Economic Aspects of Fruit Production: A Case Study in Poland. *BIO Web Conf.* **2020**, *17*, 00236. [CrossRef]
57. Justin, L.C. Labor Use and Labor Challenges Faced by Small Fruit and Vegetable Farms: The Case of Tennessee. Haslam Scholars Projects. 2020. Available online: https://trace.tennessee.edu/utk_haslamschol/10 (accessed on 9 October 2022).
58. Niyaz, Ö.C.; Demirbaş, N. Identifying The Factors Affecting Fresh Fruit Production And Marketting In Canakkale/Turkey. *J. Tekirdag Agric. Fac.* **2015**, *12*, 78–85.
59. Ayalew, Y. Factors Affecting Fruit Supply in the Market: The Case of Habru Woerda, North Wollo, Ethiopia Regional State, Ethiopia. *J. Mark. Consum. Res.* **2015**, *7*, 35–44.