ANNALS OF THE POLISH ASSOCIATION
OF AGRICULTURAL AND AGRIBUSINESS ECONOMISTS

Received: 21.08.2021
Acceptance: 21.09.2021
Published: 30.09.2021
JEL codes: D24, P14

Annals PAAAE • 2021 • Vol. XXIII • No. (3)

DOI: 10.5604/01.3001.0015.2788

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PROFITABILITY OF RED SWEET PEPPER (*CAPSICUM ANNUUM* L.) PRODUCTION IN FIELD CULTIVATION

Key words: profitability, sweet pepper, field production, economic efficiency, production factors

ABSTRACT. The aim of the study was to assess the profitability of red sweet pepper (*Capsicum annuum* L.) production in relation to incurred labor and capital inputs in selected horticultural farms. The analyzed group consisted of farms producing sweet pepper in traditional cultivation in the districts of Przysucha and Radom. To determine the correlation between income and expenditure, in the analyzed farms a multiple Cobb-Douglas production function was ued. Data were generated using a cost accounting method for estimating the feasibility of production and it was analyzed by using project evaluation methods, like the Pay Back Period (PBP), Benefit Cost Ratio (BCR), Net Present Value (NPV) and Internal Rate of Return (IRR). The results of the estimation of Cobb-Douglas production function parameters show that the dominant positive impact on the gross return value was the cost of seedlings, irrigation costs and overhead costs. The conducted analyzes showed that the NPV for the investment is PLN 240,148, with a B/C ratio of 1.78. On the other hand, the PBP, in this case, amounts to 1.45 crop season and the IRR reached a level of 22% annually.The sensitivity analysis carried out showed that the most important factors affecting the profitability of pepper production in field cultivation are product prices, seed costs, fertilizer costs and human labor costs.

INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is one of the most important and most consumed vegetables in the world due to its pro-health properties [Werner 2021]. Over the past 20 years, the cultivation of red sweet pepper in Poland has been growing steadily. The use of modern machines and technologies increases the share of pepper in the field system. The weather conditions during the growing season (amount of rainfall) are an important factor determining the yield of vegetables grown in the field. What is increasingly important in increasing the area of vegetable crops is the possibility of mechanizing the agrotechnical

process. For years, the process of continuous improvement of both cultivation methods and the development of the breeding process of new varieties intended for cultivation in field conditions can be observed [Anyszka et al. 2012]. This is important since crop yields and economic profits are largely dependent on the production technique [Kaiser, Ernst 2014].

It should be mentioned that the profitability of vegetable production significantly depends on seasonal demand, changes in the price level and characteristics of the production area [Galinato, Miles 2013]. Cost assessments and financial returns on production allow the producers to compare the total cost of production, as well as fluctuations in financial return by production time, project size and the production technique used [Engindeniz, Gül 2009].

Joko Mariyono [2018] in his research on the profitability of small-scale vegetable production, showed that, as in the case of the research results discussed in the paper, this production is profitable. Similar conclusions were also reached by Ibrahim Aliyi and co-authors [2021], who in their research showed that vegetable production is profitable. Assessments of pepper production in the state of Delta in Nigeria were examined by Adaigho Dennis and Tibi Kentus [2018], showing that production is profitable and brings both economic and social benefits to inhabitants by increasing their standard of living. Mubariz Mamedov and co-authors [2019], while investigating the economic efficiency of cultivating sweet pepper hybrids in conditions of the steppe zone, showed that the production of red sweet pepper in underground conditions ensures satisfactory yield and guarantees profitability of production. It should be mentioned that in the literature, the profitability of sweet pepper production in protected cultivation is also discussed to a certain degree, which indicates that it is profitable. However, due to a very large difference in climatic conditions, it is unreasonable to compare the results in quantitative terms. It is worth mentioning, however, that they conducted these studies; among others Sreenivasa Murthy and co-authors [2009], Sanjeev Kumar and co-authors [2018], Haroldo Araújo and co-authors [2018], Elio Jovicich co-authors [2019].

Thus, the profitability and risk of a venture represent tools that facilitate making decisions with a relatively certain margin of error [Ponciano et al. 2004, Araújo et al. 2018]. One of the activities influencing the level of profit from the conducted production activity is the improvement of farm competitiveness on the market [Būmane 2018]. Unfortunately, in the case of horticultural production, this is not an easy task. It results from the specificity of the market, i.e., a large fragmentation of production, instability of vegetables, high variability in terms of quality, and the sensitivity of production to weather conditions [Gołębiewski, Sobczak 2017]. In addition, farmers can take measures to reduce production costs while obtaining a product of the same quality. However, it should be noted that this action is not always possible. At the same time, it is important to emphasize that for it to be effective, it is necessary to know, in detail, the cost structure of a given production and the efficiency of using the resources available. In addition, the economic assessment of production is helpful in making strategic decisions regarding the

investment process. Considering the above mentioned benefits, the aim of the study was to analyze the financial profitability of the production of sweet pepper grown in the open.

MATERIAL AND METHODS

The studies are a pilot and include farms that produce sweet pepper following traditional cultivation patterns. In the districts of Przysucha and Radom. The research was carried out in 45 farms specializing in the production of sweet pepper in field cultivation. The selection of farms was purposive. During the selection of process, farm technical background, farm size and production specialization were considered. Farms differing in the number of sweet pepper cultivation seasons were selected for the research. In addition, the sample was selected to be diversified in terms of the age of the owner and education. This was to investigate whether these changes affect the way of farming and then whether they translate into the obtained financial results of production. However, there was no correlation in this regard, therefore the data in this cross-section was not analyzed at the next stage. Due to small differences in the structure of outlays in individual farms, results were averaged. 97% of the crop was sold to collection points. The level of costs was determined based on data provided by farms thanks to a questionnaire, taking data from the last four seasons into account. The method of completing the questionnaire form, in which farmers indicated costs incurred and sales revenues, was inspected annually. The level of purchase prices was averaged based on data obtained from farmers and quotations of the authors' own prices. The data was analyzed, interpreted and compiled using Micro Excel, Gretl and SPSS software.

To calculate the profitability of production, a simple profit equation was used, the function of which took the following form:

$$Z_b = P_1 \times Q_1 - T_c \tag{1}$$

where: Z_b – gross return (PLN/kg), P_1 – main product price (PLN), Q_1 – number of main products (kg), T_c – total costs.

To evaluate production efficiency, the Cobb-Douglas [1928] multiple regression function [Gujarati 1995, Aigner et al. 1977] was used, which is commonly used in studies of the impact of the level of inputs on the production volume. The model was specified as:

$$Y = \alpha_0 \times X_1^{\alpha_1} \times X_2^{\alpha_2} \times \ldots \times X_J^{\alpha_J} \times \varepsilon \tag{2}$$

where: Y – production value (PLN/m^2), α – equation's constant, X_1 – explanatory variable, α_1 – estimated coefficients of explanatory variables, ε – random component.

The study used a function composed of 10 variables.

To estimate the parameters of the Cobb-Douglas function using the KMNK method, it was transformed to a linear form. The Cobb-Douglas production function, after linearization, took the following form:

$$lnY = ln\alpha_0 + lnX_1^{\alpha_1} + lnX_2^{\alpha_2} + lnX_3^{\alpha_3} + lnX_4^{\alpha_4} + lnX_5^{5} + lnX_6^{\alpha_6} + lnX_7^{\alpha_7} + lnX_8^{\alpha_8} + lnX_9^{\alpha_9} + lnX_{10}^{\alpha_{10}} + \varepsilon \quad (3)$$

where:

Y – production's value (PLN/ha),

α – logarithm of the equation's constant,

$\alpha_1 \ldots \alpha_6$ – the coefficient of the corresponding variable,

X_1 – general cultivation costs (PLN/ha),

X_2 – seed costs (PLN/ha),

X_3 – mineral fertilizer costs (PLN/ha),

X_4 – organic fertilizer costs (PLN/ha),

X_5 – costs of plant protection products (PLN/ha),

X_6 – depreciation costs of cultivation equipment (PLN/ha),

X_7 – human labor costs (PLN/ha),

X_8 – selling costs (PLN/ha),

X_9 – irrigation costs (PLN/ha),

X_{10} – other direct costs (PLN/ha).

The following profitability ratios were used to assess the economic profitability of pepper production investment: Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (B/C), Payback Period (PBP). Except for PBP, which is an undiscounted measure, all others, BCR, NPV and IRR, are discounted measures of project worthiness [Berry et al. 1979, Gittinger 1982, Murthy et al. 2009]. Parameter estimation was conducted using the financial model. For these studies, the assumed discount rate was 10%. The study assumed forecasting the project for 10 years, on an area of 1 hectare. Depreciation rates appropriate for individual fixed assets were applied. Due to the growing season, one growing season was assumed in each cash flow year. In the investment profitability analysis, the theoretical assumption was adopted that the farm is just starting its production activity, having technical facilities in the year of starting the investment (i.e., machinery park, but it was assumed that the farm did not have an irrigation system), other equipment necessary for production had to be purchased. To assess the economic profitability of investments in the first four years of the cash flow analysis, actual data were used. In subsequent years, the data were appropriately extrapolated. In addition, the study performed a sensitivity analysis using the internal rate of return for a given species to determine whether it

is sensitive to changes in the level of production costs or product price. This analysis provided information about the possible effects of changes in the factors influencing the effectiveness of the project, and thus allows to abstract critical factors.

RESULTS

In Poland, the production of sweet pepper in field cultivation has developed on a large scale in recent years. Sweet pepper in field cultivation is grown in the Lublin region, in Sandomierz and in Radom. According to the estimates of the Central Statistical Office, the share of sweet pepper cultivation area in the total cultivation area of field cultivation vegetables is at a level of approx. 0.7%.

The results of the analyzes showed that the gross return (PLN/kg) of pepper in field cultivation is on average PLN 28,863 per ha. The results of the estimation of the parameters of the logarithmic form of the Cobb-Douglas production function of pepper production under cover are presented in Table 1. They show that the dominant positive impact on the gross return value was exerted by seed costs (the value of the model coefficient 5.142 means that this factor increased by 1%, while maintaining other factors at the same level will increase the production value by 5.142%, general costs of farming (the value of the model coefficient of 2.142, which suggests that an increase in these costs by 1%, will increase the production value by 2.142%) and labor costs (the value of the model coefficient 1.425, which suggests that a 1% increase in labor costs will increase the value of production by 1.425%). The costs of mineral fertilizers also turned out to be significant (the value of the model coefficient of 1.027, which suggests that an increase in these costs by 1%, will increase the production value by 1.027%) and the costs of irrigation (the value

Table 1. Estimation parameters of the Cobb-Douglas type function

Variables	Function's parameter	p-value
X_1	2.142	3.81^{e-07}***
X_2	5.142	4.78^{e-06}***
X_3	1.027	2.21^{e-05}***
X_7	1.425	2.42^{e-07}***
X_9	1.002	2.00^{e-06}***
const	−2.997	2.99^{e-06}***
R^2	0.994	

*** Statistically significant parameters on a level of 1%
Source: own calculations

Table 2. Economic efficiency factors in the production of red sweet pepper in field cultivation

Indicator	Value
Payback Period (PBP) (crop season)	1.45
Net Present Value (NPV) [PLN/ha/10 years]	240,148
Benefit Cost Ratio (B/C)	1.78
Internal Rate of Return (IRR) [%]	22

Source: own calculations

of the model coefficient 1.002, which suggests that an increase in these costs by 1%, will increase the production value by 1.002%). The other variables that were used to build the model turned out to be statistically insignificant. The R^2 coefficient was 0.994, which indicates that approximately 99.4% of the changes in gross profit were explained by the independent variables used in the model.

The conducted analyzes showed that the NPV for the ten-year period at a discount rate amounts to PLN 240,148, with the (B/C) ratio of 1.78, which suggests that the project is effective from an economic point of view. The payback period in this case is 1.45 crop season (it should be noted that the purchase of machinery was not considered because it was assumed that the farm is equipped with it). The internal rate of return reached a level of 22% per year, which suggests that the production of pepper in the field is both feasible and profitable. However, it should be noted that this analysis does not consider extraordinary situations such as, for example, a drastic drop in the price of pepper resulting from a large supply of the product or low demand, a decrease in the size and quality of the crop due to unfavorable weather conditions or a reduction in the yield or its quality resulting from the intensification of the occurrence of pests or pathogens.

The performed sensitivity analysis showed that the most important factors influencing the profitability of pepper production in field cultivation are product prices, seed costs, fertilizer costs and human labor costs.

CONCLUSIONS

This study examines the influence of selected factors on the profitability of red pepper production in field cultivation. The results of the Cobb-Douglas production function parameter estimation show that the dominant positive impact on the gross return value was exerted by seed costs, mineral fertilizer costs, labor costs, irrigation costs and general cultivation costs (this is mainly due to the level of fuel prices). The remaining variables

that were used to build the model turned out to be statistically insignificant. The conducted analyzes showed that the NPV for the investment is PLN 240,148, with a B/C ratio of 1.78. On the other hand, the PBP in this case amounts to 1.45 crop season and the IRR reached a level of 22% annually. The performed sensitivity analysis showed that the most important factors influencing the profitability of pepper production in field cultivation are product prices, seed costs, fertilizer costs and human labor costs. Despite many studies on the profitability of vegetable production in the literature, there is much less analysis concerning the cultivation of sweet pepper, especially in European countries. Our results, which lead to the conclusion of profitable pepper production, generally align with the literature.

The results of this study indicate the need for further research on the profitability of red pepper production in field cultivation to formulate recommendations aimed at optimizing pepper production, which will translate into increasing and stabilizing income from cultivation activities. In addition, it should be noted that national statistics do not provide data on the production of pepper, hence this issue should be addressed.

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RENTOWNOŚĆ PRODUKCJI PAPRYKI ROCZNEJ (*CAPSICUM ANNUUM* L.) W UPRAWIE POLOWEJ

Słowa kluczowe: rentowność produkcji, papryka słodka, produkcja polowa, efektywność ekonomiczna, czynniki produkcji

ABSTRAKT

Celem badań była ocena opłacalności produkcji papryki (*Capsicum annuum* L.) w odniesieniu do poniesionych nakładów pracy i kapitału w wybranych gospodarstwach ogrodniczych. Analizowaną grupę stanowiły gospodarstwa zajmujące się produkcją papryki słodkiej w uprawie tradycyjnej na terenie powiatu przysuskiego i radomskiego. W celu określenia współzależności pomiędzy wartością produkcji a poniesionymi nakładami w analizowanych gospodarstwach zastosowano funkcję regresji wielokrotnej Cobba-Douglasa. Dane wygenerowano przy zastosowaniu metody rachunku kosztów i przeanalizowano przy użyciu metod oceny projektu, takich jak: okres zwrotu z inwestycji (PBP), wskaźnik efektywności ekonomicznej (BCR), wartość bieżąca netto (NPV) i wewnętrzna stopa zwrotu (IRR). Wyniki estymacji parametrów funkcji produkcji Cobba-Douglasa wskazują, że dominujący dodatni wpływ na wartość zwrotu brutto miały koszty: nasion, nawozów mineralnych, pracy, nawadniania oraz ogólnouprawowe. Przeprowadzone analizy wykazały, że NPV dla inwestycji przyjmuje wartość 240,148 zł, ze wskaźnikiem B/C 1,78. Natomiast PBP w tym przypadku wynosił 1,45 sezonu zbiorów, a IRR osiągnęło poziom 22% rocznie. Przeprowadzona analiza wrażliwości wykazała, że najistotniejszymi czynnikami wpływającymi na opłacalność produkcji papryki w uprawie gruntowej są ceny produktu oraz koszty nasion, nawozów i pracy ludzkiej.

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