Opportunities and challenges for sustainable production and processing of *Rosa damascena* in Bulgaria

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ABSTRACT

The production of *Rosa damascena* and rose products is traditional for Bulgaria and is of key importance for the family farms in the rural areas where it is carried out. At the same time, this production faces some technological, economic and environmental challenges. The latter is a prerequisite for the application of the principles of the bioeconomy and the appropriate use of residues. In this regard, the aim of the study is based on research and analysis of the challenges and opportunities in the production and processing of *Rosa damascena*, to reveal the potential for sustainable results. This article discusses (1) trends and problems in the production of *Rosa damascena*; (2) key factors influencing the decision to leave the sub-sector and the possibilities for keeping farmers in it and (3) the potential for increasing the economic efficiency of processing enterprises. The case study and regression analysis are applied. The results of the study show that the main difficulties faced by the producers are determined by the low purchasing price of *Rosa damascena*, the high cost of labor and the lack of workers. In turn, the factors that have a strong effect on the decision to leave or to stay in this type of production are the age of farmers, their education, experience in growing *Rosa damascena* and the size of the cultivated area. Based on the results of the study, it can be recommended to the policies in the field to provide additional support for young farmers to continue to develop this business. Investments are also needed to increase the level of human and social capital. On the other hand, new technologies and models enable processors to further process residuals that are currently being discarded. However, representatives of the processing enterprise identified the need for development of innovative and cheaper solutions for drying waste products.

1. Introduction

The production of oil-bearing roses is traditional in Bulgaria. According to Chalova et al. (2017) commercial cultivation in the country is predominantly based on *Rosa damascena* Mill. f. trigintipetala Dieck. (Kazanlak rose). Although the latter is considered resistant to many diseases and pests, it has very specific requirements in the production process. This determines its limited distribution and cultivation mainly on the territory of Kazanlak, Karlovo, Strelcha, Zelenikovo and Chirpan (Kovacheva et al., 2010). At the same time, the qualities of Bulgarian rose oil are valued worldwide and are a preferred ingredient of many large companies in the cosmetics and perfume industry (Aggarwal and Kaur, 2017; Chalova et al., 2017). In recent years, however, there have been serious challenges for oil rose growers and processors (Capital, 2021; InteliAgro, 2018). There was a significant increase in the purchase price of the raw material in the period 2015–2016. It was caused by the

increased demand for rose oil and its inclusion in a food supplement, popular mainly among customers in Asian markets (Capital, 2020). This has led to a large expansion of the areas of oil-bearing roses in the country. The latter is observed even in areas where such type of production has not been carried out until then. According to InteliAgro (2018), after the contraction of this additional demand, the surplus rose oil was accumulated. The significant change in the price of the respective product has led to a reduction in the use of rose oil by the representatives of the perfume industry - its inclusion only in the established series on the market and exclusion from the new ones (Capital, 2020). In this regard, the Law on the Oil-bearing Rose has been developed, which has been implemented since 2020 and includes the application of various mechanisms to overcome the challenges and stabilize the sub-sector.

The data in the report of InteliAgro (2021), covering an analysis of the production of essential oils in Bulgaria, show that in 2021 there was

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a decline in rose production by 33%, and the resulting rose oil was only 40% of production in 2020. The relative share of uprooted plants is still low at 5%, but the authors emphasize that the share of abandoned areas is large. It is also stated that the profitability of rose growers continues to decline and was negative in 2021. The authors stress that farmers rely mainly on subsidies and state aid. According to them, state aid for the purchase of *R. damascena* did not have the desired effect, creating more harm than good. It is emphasized that the latter has postponed "the necessary adjustment of the areas and, accordingly, the recovery of the market".

Several authors analyze the potential of rose biomass waste in terms of sustainability (Balev et al., 2015; Dimitrova et al., 2019; Dragoev et al., 2021; Slavov et al., 2017; Vasileva et al., 2019). The results indicate that the extracts could be applied as antioxidant supplements and natural color substances stabilizers. However, there is a number of challenges related to technologies, investments and integration of waste management system.

In this regard, the present study aims to reveal the potential for sustainable economic, social and environmental results, based on research and analysis of the challenges and opportunities in the production and processing of *R. damascena*. The article is structured as follows: (1) the production and economic results of a family farm are presented and analyzed; (2) the factors influencing the decision of farmers to leave the sub-sector are analyzed; (3) the possibilities for achieving sustainable results by utilizing processing residues are discussed; (4) conclusions and recommendations for future research are formulated.

2. Material and methods

2.1. Data collection and research stages

The study was conducted during the period May–December 2021 in the village of Zelenikovo, Plovdiv region, Bulgaria. Data were collected through a survey and in-depth interviews with stakeholder representatives and key experts.

The study goes through several main stages. First, key stakeholders have been identified. Next, the production and economic results of the Georgievi family farm for the period 2016–2021 are presented, summarized and analyzed, as well as the main difficulties facing the farm. Third, a model has been constructed and the influence of the main factors that determine the decision of the farmer to stop or continue the production of *R. damascena* has been determined. Fourth, the potential opportunities for using waste products from processing, which are currently discarded, have been identified and evaluated, based on technology for combined recovery of polyphenols and polysaccharides from waste rose biomass and its energy assessment proposed by Slavov et al. (2017).

2.2. Case study method

The method of descriptive case research was applied within the study (Yin, 2003). The sequence proposed by Soy (1997) in the application of the method has been implemented: (1) research questions have been defined in the following two main directions - applied technology and production results, as well as challenges in carrying out the activity; (2) the data, were collected through in-depth interviews with the representatives of the family farm (6 people in total); (3) a database has been prepared to support the classification, sorting, storage and retrieval of data for analysis; (4) a field study was conducted; (5) the data were evaluated and analyzed, and (6) the results were described.

2.3. Logistic regression

For the purposes of the study, a logistic regression model was constructed to determine the influence of the main factors that would motivate farmers to give up rose production. The data were collected through a survey developed using Microsoft Forms and sent to 35 farmers in the region. Due to difficulties or lack of the necessary devices for filling in the survey by some of the respondents, the latter were personally interviewed on paper. The total number of completed surveys is 32. The Real Statistics Resource Pack for Excel was used (Zaiontz, 2020).

The definition of the variables and the characteristics of the data are presented in tabular form (Table 1). They revealed that the average age of the respondents was 45.88 years with a standard deviation of 12.19. There is equal representation in terms of the gender of the farmers who completed the survey. At the same time, rose growers with secondary education predominate. On average, they have from 6 to 10 years of experience in growing an oil-bearing rose. Due to the specifics of *R. damascena* production, family farms predominate and for them, it is an additional source of income. The smaller farms of the first two categories (less than 0.5 ha and between 0.5 and 1 ha) predominate, which do not grow other crops. The average value of the dichotomous variable concerning the receipt of subsidies is 0.41.

The model is theoretically justified (Eq. 1) and is based on the proposed by other authors independent variables influencing the decision of producers to leave the sector or relevant subsectors (Rayasawath, 2018; Viira et al., 2009; Xuesong et al., 2018).

$$\text{Exit} = \beta1 + \beta2 \text{ Gender} + \beta3 \text{ Age} + \beta4 \text{ Education} + \beta5 \text{ Experience} + \beta6 \text{ Source of income} + \beta7 \text{ Other crops} + \beta8 \text{ Area with Rosa damascena} + \beta8 \text{ Hired Labour} + \beta9 \text{ Subsidies} + ui \qquad (1)$$

Before using the logistic regression model, a correlation analysis was performed to determine the correlation of the variables and possible multicollinearity (Table 2). The results of the analysis revealed that all values of the Pearson correlation are below 0.8 and, on this basis, it can be assumed that there is no multicollinearity (Rayasawath, 2018; Gujarati D, 2004).

Statistics on the model are presented in tabular form. The model has good predictive ability based on the measure using Pseudo-R^2: Cox and Snell $= 0.55$ and Nagelkerke $= 0.74$ (Rayasawath, 2018).

3. Results and discussion

3.1. Production and economic result within the period of market shocks – a case study of a family farm

The family farm operates on the territory of the village of Zelenikovo, Brezovo municipality. The village is located in Sarnena Sredna Gora mountain and has a mountainous and flat terrain. The favorable combination of factors such as climate, soil and geographical location determines its development as one of the centers of the wine-growing and rose-processing industry. Many new rose plantations have been created in recent decades, as the rose oil produced in the area is of extremely high quality (Tsvetkov, 2007).

The family has many years of experience in growing *R. damascena*. For them, it is a tradition and an additional source of income. During the period under review, the areas varied between 0.1 and 0.2 ha. Concerning the production technology and the production factors used - disking and deep plowing are carried out mechanized through the use of external services, and cultivation is carried out with their own machinery. All other agro-technical activities, including hoeing, dry and green pruning, fertilization, spraying and harvesting are done manually. The latter is determined by the specifics of the production process, the scale of production and the lack of equipment (a machine for harvesting roses in Bulgaria was presented for the first time in 2018). In the production of oil-bearing roses, the farm does not employ additional labor and relies on the participation of family members who are involved at different stages of the production process. All family members participate during the harvest.

Table 1

Variables definition and summary statistics.

	Variable definition	Mean	Standard Deviation	Minimum	Maximum
D= 1 Exit (Dependent variable)	If a farmer wants to exit D= 1, otherwise D= 0	0.41	0.50	0.00	1.00
Gender	Gender of the respondent, 1 = male, 0 = female	0.50	0.51	0.00	1.00
Age	Age of the respondent, years	45.88	12.19	29.00	78.00
Education	Educational level; 1 = primary education; 2 = higher education; 3 = Bachelor's degree or above	2.28	0.46	2.00	3.00
Experience	1 = under 5 years; 2 = between 6 and 10 years; 3-above 10 years	2.22	0.61	1.00	3.00
Source of income	If agriculture is the main source of income D = 1, otherwise D = 0	0.91	0.30	0.00	1.00
Other crops	If the farmer grows other crops D = 1, otherwise D = 0	0.34	0.48	0.00	1.00
Cultivated area (R. damascena)	1 = under 0.5 ha; 2 =between 0.5 and 1 ha; 3 = over 1 ha;	1.69	0.69	1.00	3.00
Hired labor	If the farmer hires additional labor D = 1, otherwise D = 0	0.66	0.48	0.00	1.00
Subsidies	If farmer receives subsidies D = 1, otherwise D = 0	0.41	0.50	0.00	1.00

Table 2

Statistical test for suitability of the model.

Test Statistic	Value
LL	-9.00023
LL0	-21.6149
Chi-sq	25.22927
df	9
p-value	0.002728
R^2 *(L)*	0.583609
R^2 *(CS)*	0.545435
R^2 *(N)*	0.736079
AIC	38.00046
BIC	52.65782

Note: Significant at 0.05.

Production results of the farm and the dynamics in the purchase price for the period 2016–2021 are presented in Fig. 1. The highest selling price of the family farm was observed in 2016. The latter corresponds to the results of previous studies (InteliAgro, 2018; Capital, 2020). According to these authors, the price created preconditions for a significant expansion of the cultivated areas with oil-bearing rose on the territory of the country, an oversupply of raw material and rose oil, combined with a demand reduction. All this determines the declining trend in the selling price of the farm in the following years of the period and is a prerequisite for the refusal of the family from this type of production. The latter supports the assumptions in the report of InteliAgro (2021) for a continuing outflow of producer of *R. damscena*, despite the development and implementation of regulations for the production and processing of oil roses, as well as strict control over the use of planting material. Regarding the dynamics of yields, the respondents pointed out that it is determined by the influence of natural and climatic factors and, above all, plant frosts. The significant increase in average yields in 2021 is due
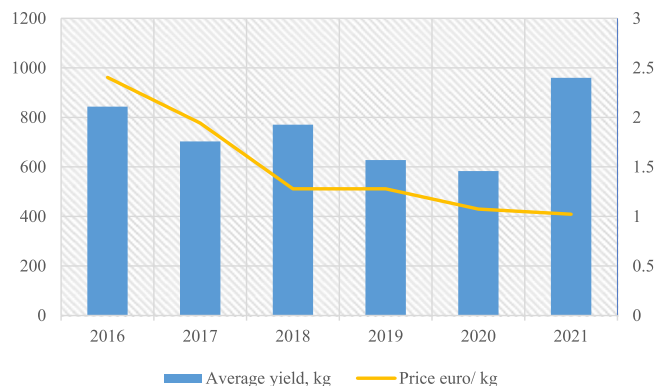
to the decision of family members to focus their efforts mainly on one of the two plots they own.

The achieved economic results in the period 2016–2021 (Table 3) reveal that in three years (2018, 2019, 2020) there are losses. The latter is determined by the valuation of labor costs, which are not often calculated by family farms, and the results would be far more negative when considering opportunity costs and using paid and/ or unpaid leave during the rose picking period. The values of the profit of the farm in 2016 (EUR 769.54) are determined by the higher purchase price of *R. damascena*, lower costs for the purchase or hiring of production factors and high yields. The results show that next are the profit values generated in 2021. This is due to good management decisions and significant growth in average yields.

In addition to the above-mentioned challenges related to the low purchase price of the oil-bearing rose, the respondents pointed out difficulties in providing the necessary external services (including mechanized services), as well as the emergence of new plant pests. Last but not least, the lack of sufficient preliminary information on the price was identified as a significant problem.

3.2. The decision to exit the production of oil-bearing rose - the main factors

The challenges identified in the study are a prerequisite for farmers to leave this type of production. In this regard, a binary logistic regression model was developed and the influence of the main factors on the decision of a producer to stay or give up the cultivation of the traditional *R. damascena* was assessed.

The results of the evaluation of the model show that the estimated coefficient of the independent variable "Age" is negative and statistically

Fig. 1. Average yield of the farm and price of *Rosa damascena* Mill., 2016–2021.

Table 3

Economic results of the family farm activity, 2016–2021.

Indicator	2021[a]	2020	2019	2018	2017	2016
Total revenue, euro	982	626	802	985	1366	2027
Costs for external mechanized services, euro	41	101	101	89	78	78
Estimated labor costs - manual operations (excluding harvesting), euro	202	481	496	429	443	429
Estimated labor costs - harvesting roses, euro	393	501	741	827	679	724
Costs for fertilizers, insecticides and fungicides, euro	50	61	100	32	75	25
Total costs, euro	686	1144	1438	1377	1275	1257
Profit/Loss, euro	296	-518	-636	-392	91	770

Note:
[a] 2021 - reduction of the cultivated area from 0.2 ha to 0.1 ha

significant (Table 4). On this basis, it can be expected that younger farmers are more likely to leave this type of production. The latter is because young farmers grow larger areas with oil-bearing roses. In most cases, they receive subsidies, including support for overcoming the effects of the Covid-19 pandemic, but this support is not enough to cope with the low price of the oil-bearing rose and high labor costs.

The estimated coefficients of the explanatory variables "Education", "Experience", and "Cultivated area" are statistically significant. The relationship between the level of education and the decision to leave the industry is negative. This can be determined by the fact that the pre-release of investments leads to losses and therefore the adoption of other types of management decisions by people with higher education can be taken as temporarily limiting costs, redirecting resources to areas that potentially higher incomes, diversifying production and others. The latter is in line with the findings of Giray and Omerci Kart (2012), who stressed that education and training are important decision-making factors in the sector. It should be emphasized that due to the specifics of the production of oil-bearing rose and its family nature, as well as due to the specifics of the labor force in the agricultural sector (participation of lower-skilled labor and retirees), a significant part of the producers has secondary education.

The positive relationship between the experience and the decision to leave the production of oil-bearing roses is determined by the incentives to enter the industry at the beginning of the study period (high prices of oil-bearing roses) and the investments made. The majority of farmers with little experience have started their businesses since 2016. Some of them have not yet been able to recoup their investments and are therefore less willing to leave this production. The characteristics of the data revealed that more experienced people in the cultivation of oil-bearing roses grow smaller areas and rely mainly on family labor within the production process. This is directly related to the previously mentioned difficulties concerning the mechanization of the processes of harvesting the oil-bearing rose. Several studies indicate similar results, outlining challenges related to the lack of modern technologies in the production of roses (Chalova et.al, 2017; Giray and Omerci Kart, 2012).

Respondents to the survey also pointed out that there are significant challenges with the workforce in the sector (low-skilled and skilled workers), which determines the high cost of labor. The findings are consistent with the study of Singh and Singh (2001) who observed significant problems with the skilled labor in the sectors. In turn, the observed instability of the purchase price of production leads to unstable financial results and, consequently, maintenance of smaller-scale production.

Based on the results of the regression analysis, some recommendations can be made regarding the policies in the field in order to preserve this traditional for Bulgaria production. Providing additional support to young producers would allow them to continue to grow *R. damscena*. Young people, on the other hand, are more inclined to innovate and scale up production (Zagata and Sutherland, 2015). With the potential stabilization of oil-bearing rose prices, they could enhance their business

and purchase harvesting equipment, which will increase production efficiency and make them less dependent on labor.

It is also necessary to provide incentives for producers to cooperate, as the family nature of this production predetermines their large number and fragmentation of areas. An earlier study found that higher levels of social capital lead to improved outcomes in rural areas (Shishkova, 2020). Investing in farmers' qualifications would also contribute to sustainability in its three main dimensions. With the acquired knowledge, farmers can make better management decisions to achieve sustainable economic and social results. Knowledge will also allow them to apply the principles of the bioeconomy.

Interviews revealed that farmers are still waiting for the purchase price of the oil-bearing rose to rise. It was emphasized that the subsidies have a positive impact on the financial result of the activity, but they are extremely insufficient. Respondents also stressed that if the trend of low prices of *R. damascena* continues, they will be forced to give up. The latter is confirmed by the results of Rusanov et al. (2011) from previous period with a similar market situation, according to which farmers have replaced the production of oil-bearing roses with alternative agricultural products that are more profitable and competitive.

3.3. Potential for increasing the economic efficiency of processing enterprises

Previous research has shown that the potential of biomass from the production of *R. damascena* for alternative profitable use according to the principles of bioeconomy is not sufficient (Giray, and Omerci Kart, 2012; Gul et. al, 2015). In this regard, the study focuses on processors and the possibility of fuller utilization of the residues they generate, and on this basis a possible increase in the purchase price of *R. damacsena*. The results of a previous research (Slavov et al., 2017) revealed that these residues can be processed into polyphenols and polysaccharides. Our study shows that the price of the final products obtained by this technology exceeds that of the use of the respective residues as fertilizers.

In-depth interviews were conducted with representatives of processing companies to determine their attitudes towards the use of residues from the production process. The interviews revealed that in the 1990s, investments were made in technologies for further processing of *R. damascena* waste products, but at the same time the respondents pointed out that reaching dry biomass is a too expensive process and the costs associated with it significantly exceed potential revenues. The above mentioned determines the need to seek innovative solutions for waste products drying, which will make their use attractive and lead to the possible reduction of the negative effects on the environment.

4. Conclusions

Serious challenges are expected in the cultivation and processing of *R. damascena* in the coming years. The results of the study show that

Table 4
Influence of the factors on farmers' decision to exit the *R. damascena* production.

	Coefficients	SE	Wald	P-value	Exp (b)	Lower 95%	Upper 95%
Intercept	19.58	9.85	3.95	0.05	3.2E+ 08		
Personal factors							
Gender	-2.04	1.47	1.93	0.16	0.13	0.007283	2.31
Age	-0.21[a]	0.09	5.15	0.02	0.81	0.671028	0.97
Education	-3.79[a]	1.74	4.73	0.03	0.02	0.000743	0.69
Experience	3.44[a]	1.74	3.91	0.05	31.27	1.032839	946.90
Agricultural production factors							
Source of income	-2.51	3.58	0.49	0.48	0.08	7.33E-05	89.67
Other crops	0.62	1.86	0.11	0.74	1.86	0.048545	71.35
Cultivated area (*R. damascena*)	-4.03[a]	1.97	4.20	0.04	0.02	0.000375	0.84
Hired Labor	-2.25	2.45	0.84	0.36	0.11	0.00086	12.95
Subsidies	4.18	2.68	2.43	0.12	65.07	0.342131	12375.34

Note:a Significant at 0.05.

during the period under review there were market failures that led to a decrease in income and profits of producers and processors in the country. The continuing downward trend in prices is expected to lead to a significant simultaneous outflow of farmers engaged in this type of production. The latter is complemented by the structure of agricultural production in the country, related to the cultivation of less labor-intensive crops, for which economies of scale can be achieved and innovations can be implemented. Government policy and some financial resources under the Common Agricultural Policy could be directed to support the traditional and important for Bulgaria production of *R. damascena*. Cooperation, vertical and horizontal integration are also opportunities to overcome emerging problems in the sector.

Opportunities for sustainable production by applying the principles of the bioeconomy at this stage are identified mainly for processors. However, the study reveals the need for further research and development of new technologies to reduce the cost of obtaining dry biomass from *R. damascena*. At the same time, the economic evaluation of the chosen technology shows that the processing of dry biomass into polysaccharides and polyphenols has the potential to improve productivity and generate additional profits.

CRediT authorship contribution statement

Mariyana Shishkova: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, **Boryana Ivanova:** Conceptualization, Supervision, **Rositsa Beluhova – Uzunova:** Writing – original draft preparation of some parts of the Introduction and Discussion**,** Reviewing and Editing, **Adelina Harizanova**: Writing – reviewing & editing.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Mariyana Shishkova, Boriyana Ivanova, Rositsa Beluhova-Uzunova reports financial support was provided by Republic of Bulgaria Ministry of Education and Science.

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