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WIOLETTA WRÓBLEWSKA

Awareness and perception of contemporary climate change in the opinion of berry producers in Poland

Świadomość i postrzeganie współczesnych zmian klimatu w opinii producentów owoców jagodowych w Polsce

Abstract. Agriculture, including horticulture, is one of the most vulnerable industries due to its high dependence on weather conditions. The topic of the impact of climate change on agriculture is being addressed more and more frequently, but research on berry producers' awareness and perception of climate change is rarely conducted. Meanwhile, adaptation and mitigation measures at the farm level depend largely on the farmer's awareness. Hence, the aim of this work was to identify the opinions of berry fruit producers in Poland and to assess their level of awareness, in terms of climate change and perception of the two-sided impact, i.e. climate change on production and production on climate. The data used in the work came from survey research conducted in 2021–2023 among 140 berry producers from 13 voivodeships of Poland. Only 8.57% of the surveyed berry producers are climate denialists, but as many as 75% of producers believe that berry production does not contribute to climate change. Producers point to rising in air temperature, dry spells, spring frosts, increased frequency of thunderstorms, strong winds and hailstorms as the most dangerous phenomena accompanying climate change. Producers include adaptation changes in their organizational and investment plans, but most see obstacles to implementation.

Keywords: climate change, producers' awareness, berry production, adaptation to climate change, Poland

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INTRODUCTION

Climate change has always taken place, but in the 20th century its pace has become particularly rapid [Kudliński 2006, Kundzewicz and Juda-Rezler 2010]. The effects of climate change are already having an impact on agriculture worldwide and the phenomenon of climate change is now recognized as one of the most serious challenges facing the environment, society and economies. Climate change has and will continue to have a direct or indirect impact on many sectors of the economy, including agriculture and horticulture. Fruit cultivation is the agricultural activity most sensitive and most intensely impacted by global warming and climate change. As a result, fruit trees are negatively affected by unsuitable climate conditions during winter rest, flowering, budding and fruiting periods and large economic losses occur [Oğuz et al. 2023]. Many components of climate change exposure are addressed in research, including precipitation [Lottering et al. 2021], heat [Quiller et al. 2017], frost [Parker et al. 2021], the occurrence of extreme weather events [Rosenzweig et al. 2002], but also the impact of high exposure on reducing yields [Lesk et al. 2022] or deteriorating crop quality [Bisbis et al. 2019]. Weather variability, rising temperature, shifting agroecosystem boundaries and the increasing occurrence of extreme weather events such as droughts are forcing the need for adaptation, given the maintenance of current plans, proper food quality and food security.

Projections for Poland indicate that extreme weather events will occur more frequently and become more intense [Kundzewicz and Kozyra 2011]. It is predicted that precipitation may be violent and heavy, causing floods, an increase in the frequency of heat waves and drought during the growing season. In addition, the intensity of strong winds, an increase in temperature and unfavorable seasonal changes in water resources will adversely affect crop yields, or the processing of agricultural commodities, as well as transport and storage conditions [Kurnik 2019]. For example, changes in the hydrological cycle associated with climate change bring not only onerous, prolonged droughts [Józwiak and Zieliński 2018], but also a change like precipitation: snow becomes less frequent, while the intensity of downpours instead of fine precipitation increases [Szwed et al. 2017]. The cited authors believe that agriculture in Poland may also experience positive changes related to the lengthening of the average growing season and the expansion of the area under certain thermophilic crops, but realistically extreme weather and climatic conditions will result in lower agricultural yields.

In fruit growing, climate change is exacerbating threats such as frost damage and inadequate cooling. Growth rates, premature ripening at higher temperature and increasing pest populations threaten the quality of specialty crops, as well as changes in their nutritional profiles, including sugars, acids and antioxidants [Bisbis et al. 2019, Lennert et al. 2024]. For example, an earlier spring accelerates the development of plants, which may multiply losses when late frosts occur. Such a situation in Poland occurred in 2017 when losses in orchard crops reached about 30% [Pfleiderer et al. 2019]. According to Prandecki [2020], effective solutions to climate problems require the simultaneous application of mitigation and adaptation measures. Their implementation at the farm level depends on several factors, including the type of crop, water availability, soil quality, and, most importantly, the farmer's awareness and knowledge of climate change [Sękowski 2014]. In the face of the increasingly noticeable phenomena accompanying climate change, the awareness of producers is important in this aspect, which will allow them to optimally manage favorable changes and effectively adapt to unfavorable changes [Kundzewicz and Juda-Rezler 2010, Sękowski

2014]. Since agricultural production and climate change have a two-way interaction, studies are being undertaken on farmers' awareness of the impact of production on the environment [Syp and Żukiewicz 2017]. The agricultural sector is not only directly influenced by weather phenomena, including those that are more likely to occur in the future but can significantly contribute to climate change mitigation [Jørgensen and Termansen 2016]. There is also research on climate change and its impact on the environment [Hajto et al. 2021], environmental assessments of agricultural and horticultural production to increase knowledge of the environment left behind by such crops, the search for environmental improvements that can be implemented as sustainable practices [Pérez et al. 2022].

Hence, the purpose of the article was to identify the opinions and assess the level of awareness of berry producers in Poland, in terms of the observed climate change and the impact of berry production on the process, as well as the process on production. Human capital, including the awareness of producers in terms of the reality of climate change represents a kind of potential for adaptation to its changes, support and implementation of sustainable and regenerative agriculture practices. This article is based on the part of the research entitled "Implementation of climate change adaptation strategies on farms with berry production", is intended as an overview of producers' views on the process of climate change. The results of the research topic undertaken can be used to improve the capacity of human and institutional capital for climate change adaptation and mitigation.

The study poses the following research questions:

– Do berry growers perceive climate change phenomena and to what extent?

– What are the observed and potential effects of climate change and its impact on berry production in Poland in the opinion of growers?

– What are the sources of climate change in the opinion of berry growers, including whether fruit production influences these changes and why?

MATERIAL AND METHODS

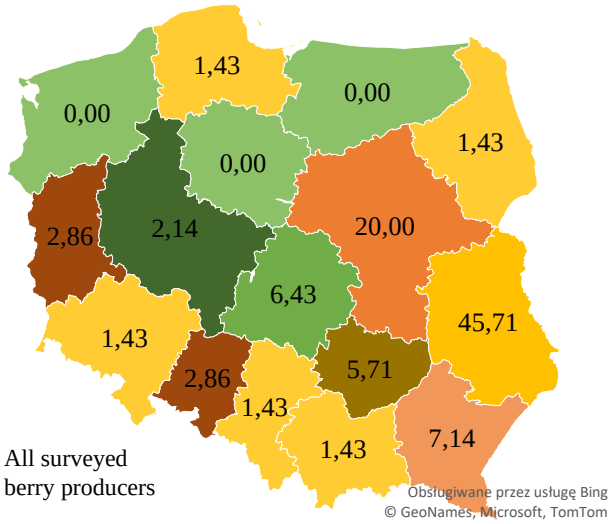
Data for the analyses came from surveys carried out in Poland in 2021–2023 by diagnostic survey, using a questionnaire technique, aimed at three groups of fruit producers – blueberry, strawberry and raspberry. Purposive survey sampling was used, with cultivation of at least one in-ground berry fruit species, i.e. highbush blueberry (*Vaccinium corymbosum* L.), strawberry (*Fragaria ananassa* Duch.) or raspberry (*Rubus idaeus* L.), on the farm as the selection criterion. The survey was conducted primarily using an online survey method (CAWI, or Computer Assisted Web Interview). Producers were reached through various sources, including social media, the Association of Polish Blueberry Growers, as well as other industry platforms (including jagodnik.pl) and groups on Facebook, where a link to the survey was posted with a request to complete it. Difficult access to the operative and reluctance of growers to participate in the survey dictated the use of an additional method of sample selection, i.e. snowball sampling, whereby an initially small group of respondents were surveyed and members of that group recommended other individuals belonging to the general population for further study. A total of 78, 42 and 40 farm owners with blueberry, strawberry and raspberry production, respectively, participated in the survey, of which highbush blueberry producers completed 68 questionnaires from 10 provinces, 36 questionnaires were obtained from strawberry producers from 8 provinces and 36 questionnaires were com-

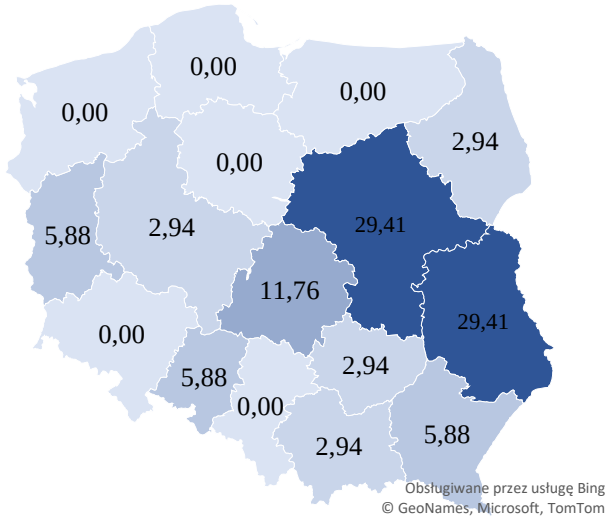
pleted by raspberry producers from 5 provinces, respectively, were qualified for further analysis, after prior verification of the completeness of responses. The structure of the farms by type and space (by province) is shown in Figure 1. and the characteristics of surveyed producers and farms is shown in Table 1. Attitudes to climate change were analyzed in most cases from the perspective of all surveyed berry producers and producers of individual species, which allowed us to capture differences in views and opinions on the topic under study. In the article, in order to avoid repetition – in the case of farms with highbush blueberry, strawberry and raspberry production, the terms blueberry, strawberry, and raspberry, respectively, are used in the tables and graphs.

Table 1. Selected characteristics of the surveyed farms

Specification		Number of holdings			Structure (%)		
		A	B	C	A	B	C
Age	20–29 years	14	11	6	20.59	30.56	16.67
	30–39 years	10	8	13	14.70	22.22	36.11
	40–49 years	14	7	9	20.59	19.44	25.00
	50–59 years	14	8	8	20.59	22.22	22.22
	60 and more years	16	0	0	23.53	0.00	0.00
Education	primary	0	2	0	0.00	5.56	0.00
	vocational	2	4	4	2.94	11.11	11.11
	secondary education	22	12	11	32.35	33.33	30.56
	higher education	44	18	21	64.71	50.00	58.33
Off-farm income	yes	30	10	21	44.12	27.78	58.33
	no	38	26	14	55.88	72.22	41.67
Average UAA area		64.82[1]/8.25[2]	11.78	12.43	–	–	–
Average area under blueberries		19.91[3]/ 8.03[4]	4.45	1.57	–	–	–
Average share of berry crops in the UAA area (%)		30.72[5]/44.00[6]	37.78	12.63	–	–	–

A – blueberry, B – strawberry, C – raspberry
UAA - utilised agricultural area
[1] including two large farms 1500 and 120 ha
[2] excluding two large farms 1500 and 120 ha
[3] including two large plantations 600 and 120 ha
[4] excluding two large plantations 600 and 120 ha
[5] including two large farms 1500 and 120 ha and with berry crops 600 and 120 ha respectively
[6] excluding two large farms 1500 and 120 ha and with berry crops 600 and 120 ha respectively





Blueberry

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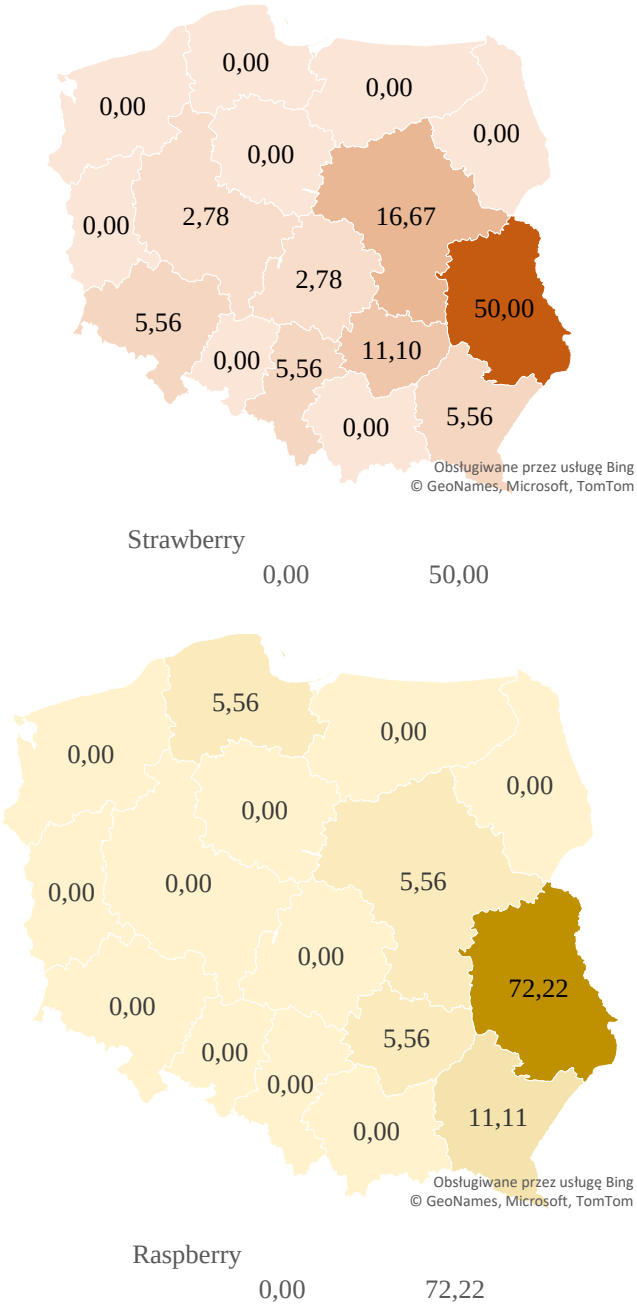

Source: own study using Bing GeoNames service, Microsft, TomTom

Fig. 1. Structure of the surveyed farms by type and space (%)

The small research frame made it impossible to analyze the correlation of the issues investigated with the characteristics of the producers (demographic characteristics) or the characteristics of the farms themselves. Hence, the primary data collected were subjected to quantitative analyses. Descriptive statistics, structure indices, mean values ($\overline{X}$) and a measure of variability, i.e. standard deviation (SD), were used. To assess the impact of the phenomena accompanying climate change on berry production and to analyze the position of the surveyed berry growers towards the observed and potential effects of climate change and its impact on production in Poland, the mean values obtained were assigned ranks, creating data series in the surveyed groups of respondents. Spearman's rank correlation analysis was used to indicate the degree of co-occurrence between opinion series in the three producer groups studied. This coefficient can be applied to any variable whose values can be ordered [Jóźwiak and Podgórski 2006], and correlation means the strength and direction of the relationship between two variables (or groups under study), i.e. that the variables move similarly, but not necessarily one variable is the cause of the other. In the case of the occurrence of observations with equal values of the ranked variable, these observations were assigned an identical rank, equal to the average of their consecutive numbers (hence they may take incomplete values). The following levels of correlation were used to interpret the results: <0.2 – no linear relationship; 0.2–0.4 – weak relationship; 0.4–0.7 – moderate relationship; 0.7–0.9 – fairly strong relationship; >0.9 – very strong relationship. Statistical significance level α was taken at $p = 0.05$. The figures and tables presented in the paper include the survey questions asked of the surveyed producers.

RESULTS AND DISCUSSION

The results of the study indicate that the majority of the analyzed berry producers perceive climate change and related phenomena in their environment. Of the entire group of producers analyzed, 8.57% of them are climate denialists, including about 11% of blueberry and strawberry producers. All surveyed raspberry growers notice climate change in their area. Among the surveyed producers, the proportion of those who are not convinced of the reality of the climate change phenomenon is slightly higher than in most European countries (about 10%) and Poland (about 7%) [Wójcik and Byrka 2016, Budziszewska et al. 2023].

The problem of perceiving the causes of climate change is complex. However, according to [Kundzewicz and Juda-Rezler 2010], changes in the composition of the Earth's atmosphere and changes in the properties of the Earth's surface are influenced both by natural factors, but increasingly also by human activity. Human-induced climate change is already affecting many weather and climate extremes. Evidence of observed changes in extremes such as heat waves, heavy precipitation, and droughts, among others, and in particular their effects has since been reinforced by the attribution of human influence [Kurowska 2020, IPCC 2021]. The majority, some 61%, of the surveyed berry growers, who are convinced of the reality of the climate change phenomenon, believe that this process and its effects are equally the result of human activity and natural environmental change (Fig. 2). The highest percentage in favour of this statement was found among raspberry producers (72.22%), while the lowest was among blueberry producers (50.00%). According to Budziszewska et al. [2023], such a view is incompatible with scientific knowledge, and in Poland such people are in the majority – 57.20% of respondents – and many people still do not understand that humans are the biggest contributor to climate change. Among

the producers surveyed, one in four advocated the statement that climate change is mainly the result of human activity. According to Budziszewska et al. [2023], the majority of Europeans believe that human influence in shaping climate change is greater than the change resulting from natural processes, and the proportion of people who deny the phenomenon of climate change or believe that it is caused solely by natural causes oscillates around 10%. Among the producers surveyed, the proportion seeing climate change mainly in the environment was over 14% and was highest among strawberry producers (nearly 19%). The research results differ slightly from those conducted by Syp and Żukiewicz [2017] among 125 farmers from the Łęczna district. The study by the cited authors shows that 39% of farmers consider human activity and natural changes in the environment as equivalent causes of climate change, 37% of respondents stated that these changes are only the result of human activity, and 24% of respondents considered natural processes in the environment. The differences in the perception of the causes of climate change among the surveyed berry growers and farmers – according to a study by Syp and Żukiewicz [2017] – may be due to the different production profiles of the two groups, and thus the use of different production technologies. The issue of the perception of the impact of their production on climate change will be discussed later in the paper.

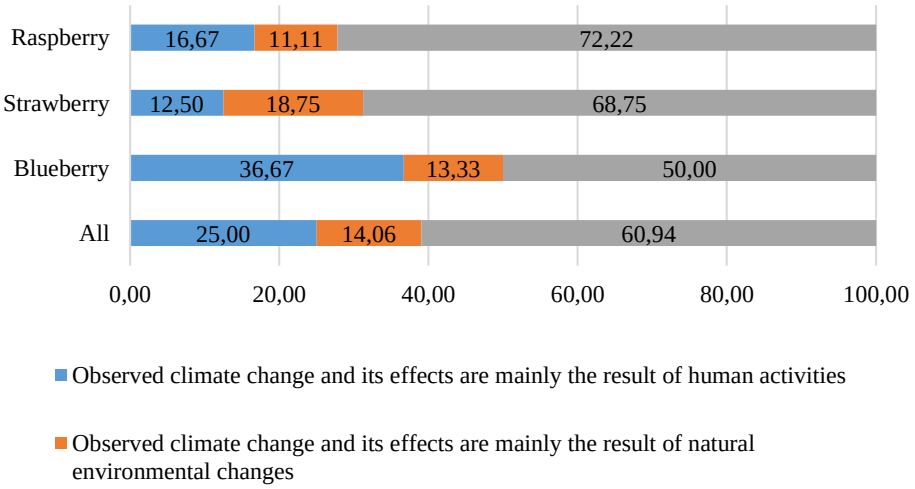

Fig. 2. Determinants of climate change in the opinion of surveyed berry producers in Poland (in percentage of surveyed individual groups)

Surveyed producers perceiving climate change in their environment were also asked to assess the impact of phenomena accompanying these changes on berry production. The owners of all analyzed farm groups assessed the phenomena accompanying climate change as hurting their production activities (Tab. 2). Even theoretically positive changes related to the lengthening of the average growing season, from the point of view of berry fruit producers, whose production is seasonal, were assessed negatively by them. This was

influenced by a realistic assessment of possible weather conditions, e.g. the occurrence of spring frosts, which tended to reduce yields. In the top three most unfavorable phenomena, blueberry producers mentioned longer dry spells, more frequent hurricanes and thunderstorms and heavy rain, strawberry producers mentioned heavy rain, periods of drought and heat waves, and raspberry producers mentioned periods of drought, hurricanes and thunderstorms and heat waves. The assessment of the impact of weather phenomena observed in the process of climate change by the analyzed producers of each species was similar and characterized by a strong relationship, as indicated by the value of Spearman rank correlation coefficients (Tab. 2).

Table 2. Evaluation of phenomena accompanying climate change on berry production in the opinion of surveyed producers (on a scale of –3 to 3, where "negative" values indicate the strength of negative phenomena, 0 – neutral phenomena and "positive" values positive phenomena (–3 – very negative, 0 – neutral, 3 – very positive)

Specification	$\bar{X}$[1]			SD			Rank		
	A	B	C	A	B	C	A	B	C
Extension of the average growing season	–0.70	–0.78	–1.00	1.60	0.87	1.51	8.0	9.0	8.5
Increase in temperature	–0.53	–0.94	–1.11	1.57	1.09	1.30	9.0	8.0	6.5
Heat waves	–1,20	–2.17	–1.56	1.77	0.85	1.86	6.0	3.0	3.0
Flood	–0.87	–1.44	–0.50	1.33	1.08	1.03	7.0	7.0	10.0
Heavy rain, storms	–1.63	–2.61	–1.22	1.25	0.77	1.15	3.0	1.0	4.5
More frequent hurricanes and storms	–1.70	–2.11	–1.67	1.29	1.12	1.43	2.0	4.0	2.0
More frequent hailstorms	–1.53	–1.83	–1.22	1.56	1.03	1.46	5.0	6.0	4.5
No snow in winter	–1.60	–2.00	–1.11	1.45	1.07	1.12	4.0	5.0	6,5
Longer periods of drought	–1.80	–2.33	–2.11	1.47	1.07	1.51	1.0	2.0	1.0
Increase in sunshine	–0.50	–0.28	–1.00	1.36	1.88	1.31	10.0	10.0	8.5
Spearman rank correlation coefficient p < .01000	A/B rho = 0.866666667			A/C rho = 0.82907566			B/C rho = 0.782907566		

[1] on a scale of –3 to 3, A – blueberry (n = 60), B – strawberry (n = 32), C – raspberry (n = 36)
Source: own study

Producers also presented their position on the observed and potential effects of climate change and its impact on berry production in Poland. Producers, irrespective of the type of berry produced, are mainly concerned about rising temperature and longer periods of drought, which may adversely affect fruit yields. This is, in the opinion of producers, the most important effect of climate change in terms of risks. Producers' concerns are not unfounded. According to IUNG reports [2023a, 2023b], the area of soils at risk of drought in Poland varies dynamically from one reporting period to another. For example, as in the reporting period from 1 May to 30 June 2023, agricultural drought was recorded in fruit bush crops, in 1441 municipalities (i.e. 58.18% of Poland's municipalities), and drought

was recorded in 43.27% of the country's arable land. Agricultural drought was also recorded in strawberry crops, in 1246 municipalities (50.30% of Poland's municipalities) [IUNG 2023a, 2023b]. For many years, the future situation of agricultural production in Poland has assumed that changes in the structure of water balance leading to water deficit will be a factor determining the level of plant and animal production [Mirkowska 2009].

The producers surveyed also identified and assessed the effects of climate change, from the point of view of its impact on their business. In the first place, they indicated the phenomenon of rising temperature and longer periods of drought, which, among other things, affects the quantity and quality of the crop and forces new investments (e.g. irrigation). Here, the average score ranged from 4.50 to 4.35 (Tab. 3). This was followed by the risk of frost during unfavourable periods for plant development and a decrease in yield (mean score of 4.44 to 4.35), an increase in the frequency of extreme weather events, e.g. storms, hailstorms, winds, tornadoes (mean score of 4.44 to 4.16) and the appearance of new invasive species (pests, diseases), which increases the use of plant protection products (mean score of 4.47 to 4.15). The consequence of the above-mentioned phenomena is an increase in production costs and necessary investments on farms. This was also the opinion of farmers in a study by Syp and Żukiewicz [2017]. Here, the vast majority of farmers fear that the consequence of the changes taking place will be an increase in the costs of agricultural production (69%) and a reduction in the standard of living (61%). In the case of the surveyed berry producers, as many as 94.29% see threats to production. Among the main sources of risk, producers cite an increase in production costs. Such concerns are expressed by 71.49%, 77.78% and 66.67% of blueberry, strawberry and raspberry fruit producers respectively. The increase in production costs is due to several factors, including market, legal, agrotechnical and climatic conditions. However, it should be emphasised that, in the opinion of the surveyed producers, it is the climatic conditions, apart from market conditions, that will have the greatest impact on production costs.

Nearly half of the surveyed blueberry and strawberry producers and 30% of the raspberry producers anticipate an increase in outlays and costs in the coming years as a result of the need for changes and investments in terms of adapting to climate change and mitigating the consequences of extreme climate events. The producers surveyed earned income not only from berry production as the share of berry crops in total UAA (utilised agricultural area) represented 30.72/44.00%, 37.78% and 12.63% for blueberry, strawberry and raspberry holdings respectively. However, income from berry production was the only source of income on these farms for 55.88% of blueberry farms, 72.22% of strawberry farms and 41.67% of raspberry farms.

Crop production is highly dependent on weather and climate conditions, but often also has an impact on climate change. A small percentage of the surveyed producers, only 17.65% (Fig. 3), believe that berry production contributes to climate change. This opinion was expressed by blueberry and strawberry producers, while none by raspberry producers. Among the mentioned factors/activities, influencing climate change, the blueberry producers indicated mainly the significant water consumption in production, the use of chillers and thus CO_2 emissions, and exhaust emissions from machinery and equipment used in the production and post-production process (storage, transport). The raspberry growers indicating the reality of the impact of their production on the climate mentioned mainly the use of organic fertilization, significant water consumption, the use of refrigeration units, agrotechnical treatments accompanied by CO_2 emissions and evaporation of water from the soil (Tab. 4).

Table 3. Position of surveyed berry growers towards observed and potential effects of climate change and its impact on production (on a scale of 1 to 5, where 1 – strongly disagree, 5 – strongly agree)

Climate change is causing	$\bar{X}$			SD			Rank		
	A	B	C	A	B	C	A	B	C
Increase in investment/ costs	4.26	4.31	4.22	1.08	1.19	1.21	3	4	6
An increase in production risk and, for example, the need to take out insurance	4.06	3.94	3.75	1.14	0.95	1.44	7.0	7.0	8.0
The occurrence of frost at unfavorable periods for plant development and a drop in yields	4.35	4.35	4.44	1.01	1.43	1.13	1.5	3.0	4.5
Lack of snow in winter, water shortages, which among other things reduces soil fertility	4.12	4.44	4.45	1.19	1.01	0.71	6.0	2.0	3.0
Increased temperature and longer periods of drought, which among other things affect the quantity and quality of the crop and necessitate new investments (e.g. irrigation)	4.35	4.50	4.50	0.98	0.85	1.00	1.5	1.0	1.0
An increase in the frequency of extreme weather events – thunderstorms, hailstorms, winds, tornadoes – which affect lower crop yields	4.24	4.16	4.44	1.12	0.78	1.05	4.0	6.0	4.5
The extension of the growing season, which can increase yields	3.00	2.63	3.78	1.17	1.39	1.12	8.0	8.0	7.0
The appearance of new invasive species (pests, diseases), which increases the use of plant protection products	4.15	4.30	4.47	1.17	0.76	1.10	5.0	5.0	2.0
Spearman rank correlation coefficient p < .01000	A/B rho = 0.718575757			A/C rho = 0.536144578			B/C rho = 0.754504545		

A – blueberry, B – strawberry, C – raspberry

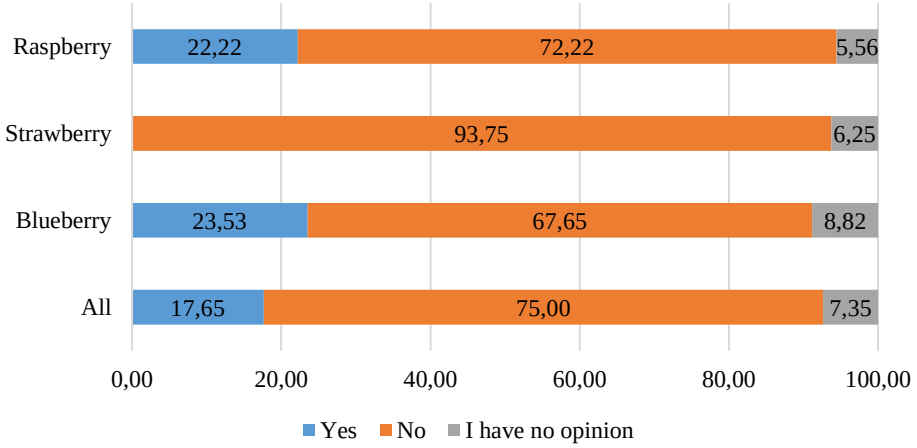

Fig. 3. Do you think that blueberry (n = 68)/strawberry (n = 32)/raspberry (n = 36) production contributes to climate change? (in % of each group of farms surveyed)

However, the majority of berry growers surveyed, 75%, think that berry production does not contribute to climate change. Producers of the different species mentioned several factors which, in their opinion, prove this. First of all, producers emphasized that berry production, compared to meat production, has a much smaller carbon footprint. In addition, the most frequently mentioned factors influencing climate protection, in all farm groups, were a significant proportion of manual work, mainly in harvesting or sorting the fruit, a limited number of agrotechnical procedures, (perennial crops) and the rational use of plant protection products. The opinions of producers of individual berry species, in terms of the lack of impact of these productions on climate change, are presented in Table 4.

At the farm level, there are many opportunities to implement mitigating (e.g. pro-environmental farm profile) and adaptive actions and measures so that the damage and negative impacts of change are minimized, while the positive impacts are fully exploited. The adaptive potential of farms varies and depends on many resources, including human, financial, organizational, infrastructural and knowledge. Hence, each farm is characterized by a specific adaptation potential. These activities at farm level in many cases are not yet taking place for various reasons such as lack of: investment resources, adaptation policy initiatives, adaptation capacity and access to knowledge. On the farms surveyed, the larger farms' adaptation measures already made were recorded and mainly concerned berry crops under shelter. It is encouraging that most producers include adaptation changes in their organizational and investment intentions. However, a significant percentage, i.e. 61.76, 44.44 and 50.00% of the surveyed producers of blueberries, strawberries and raspberries respectively, see obstacles to the introduction of various forms of adaptation of berry production to climate change. These difficulties are primarily perceived by producers as the lack of sufficient monitoring and early warning systems for risks (30.95, 31.25 and 44.44% of blueberry, strawberry and raspberry producers respectively), lack of investment support for farms (33.33, 37.50, 33.3%) and lack of training and technological advice taking into account aspects of adapting production to increased climate risks.

Table 4. Categories of impacts in berry production contributing to climate change and limiting climate change impacts, according to surveyed growers (in %)

Categories of impacts	Berry production		
	A	B	C
Negative impact on the climate[1]			
A significant water consumption in production	62.50	–	37.50
Application of organic fertilizer (including manure) and nitrous oxide emissions (NO_2)	–	–	50.00
Use of chillers – emission of gases such as CO_2	37.50	–	37.50
Agro-technical treatments including exhaust emissions CO_2	25.00	–	25.00
Use of plant protection products, pesticides	12.5	–	–
Use of packaging	12.5	–	–
Protective effect on the climate[2]			
A significant proportion of manual work	65.22	31.25	61.54
Perennial cultivation – low number of agro-technical operations, hence low emissions of CO_2	60.87	31.25	23.08
Small carbon footprint compared to, for example, meat production	56.52	31.25	26.92
Reducing agro-technical measures, e.g. plowing intensity	52.17	56.25	38.46
No or limited use of organic fertilizer and nitrous oxide emissions (NO_2)	34.78	–	–
Absence or rational use of plant protection products	34.78	71.87	61.54
Rational fertilisation, precise application of fertilisers	34.78	71.87	61.54

[1] A – blueberry (n = 16); B – strawberry (n = 0) - strawberry producers did not declare any negative impact of this production on climate change; C – raspberry (n=8),
[2] A – blueberry (n = 46), B – strawberry (n = 30), C – raspberry (n = 26)

CONCLUSION

The results of the research carried out allow the research questions posed in the study to be answered and indicate. The majority of the analysed berry producers perceive climate change and related phenomena in their environment. Only 8.57% of them are climate denialists. Some 61% of the producers surveyed are convinced of the reality of the climate change phenomenon, believing that this process and its effects are due equally to human activity and natural environmental changes. Among the most adverse phenomena accompanying climate change, producers cited droughts, more frequent hurricanes, storms and heavy rain, heat waves. The producers surveyed also identified and assessed the effects of climate change,

from the point of view of its impact on their operations. Among the most dangerous phenomena, they indicated an increase in temperature and longer periods of drought, the occurrence of frosts at unfavorable times for plant development, an increase in the frequency of extreme weather phenomena – storms, hailstorms, winds, tornadoes and the appearance of new invasive species. The consequence of the aforementioned phenomena is an increase in production costs and necessary investments on farms. The producers surveyed were aware that berry production has the potential to both negatively impact and protect the climate. As many as 75% of producers think that berry production does not contribute to climate change, which is mainly due to the high proportion of manual work, mainly in harvesting or sorting the fruit, the limited number of agrotechnical operations (perennial crops) and the rational use of plant protection products. Producers take adaptation changes into account in their organizational and investment plans, but most also see obstacles to the introduction of various forms of adaptation of berry production to climate change. These difficulties are mainly attributed by producers to the lack of sufficient monitoring and early-warning systems for risks, the lack of investment support for farms, and the lack of training and technological advice on how to adapt production to increased climate risks.

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