AGRICULTURAL UNIVERSITY – PLOVDIV

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RISK MANAGEMENT IN AGRICULTURE

/ABSTRACT/

dissertation for the award of the educational and scientific degree DOCTOR in the scientific specialty ECONOMICS AND MANAGEMENT (AGRICULTURE) in the professional field 3.8. ECONOMICS

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INTRODUCTION

Farmers encounter various types of risks in practice, with different degrees of manifestation, which need to be effectively managed (Huirne, 2003). By its nature, the concept of risk is associated with multiple adverse outcomes. These can range from common issues, such as reduced yields or income for farmers, to rarer but catastrophic developments leading to farm bankruptcies. Risks in agriculture often extend beyond individual farms, thereby negatively impacting society by causing significant food security and even health-related problems.

The role of farmers is essential, as they must manage various types of risk that often have complex and far-reaching implications, affecting many stakeholders (Wauters et al., 2014). The complexity of agricultural risks can influence decisions and outcomes on scales far beyond the farmer's control. Increasingly, cascading effects are observed in practice, which are difficult to manage but can cause significant damage to farms (Pelka et al., 2015). Another example from the global food crisis of 2007/2008 illustrates the accumulation of three different types of risk simultaneously – production issues due to drought in many regions worldwide, market risk from rising fuel and fertiliser prices, and institutional challenges from export restrictions imposed on agricultural products in many countries (Headey, 2011).

Despite the efforts made, the topic of risk management in agriculture has remained largely underdeveloped. A meta-analysis of 3,283 scientific publications on the subject from 1974 to 2019 shows that two-thirds (66%) of all articles focus solely on traditional production risk (Komarek et al., 2020). Only 18 articles, or about 0.5% of the total, combine all five main types of risk in agriculture: production, market, financial, institutional, and personal risk (Komarek et al., 2020).

Significant gaps are also observed in measuring the impact of different types of risk. The lack of a holistic approach that considers the cumulative effect of all types of agricultural risk is a major shortcoming in the literature on the subject. Recognising this

research gap, the study has the potential to add value by comprehensively analysing the issue through a clear methodology for classifying and quantitatively assessing agricultural risks.

While the main types of risk remain relevant regardless of location, the Bulgarian context has its own specific characteristics. A deeper analysis of these particularities is expected to lead to concrete solutions that can be implemented locally by various stakeholders – farmers, economic agents, and institutional players. Additionally, this dissertation is motivated to explore trends in a specific agricultural sector – fruit growing. This specific sector requires significant capital investment and time for development, which further increases its exposure to risk. Despite this, there are no studies on risk management in the Bulgarian fruit growing sector, even though the latter has the potential to create added value and improve management outcomes through enhanced risk control.

The main aim of the dissertation is to assess the types, impact and frequency of risks in fruit growing and to propose effective risk management methods and strategies tailored to the specific characteristics of fruit farms.

To achieve the main aim, the study addresses a set of specific objectives as follows:

- Analysis of key theories and empirical aspects of risk management in agriculture.
- Development of a methodological framework for objectively examining the types, frequency and impact of risks, as well as their management in the specific case of fruit farms.
- Collection of large volumes of primary data from a representative and diverse sample of fruit growers in Bulgaria.
- Conduct of a critical analysis of the risk management process in fruit growing, identifying sector-specific characteristics and exploring potential improvements.

- A definition of managerial and institutional solutions that could contribute to better risk management and sustainable development of the fruit-growing sector in Bulgaria.

The subject of the study is risk management by fruit farms, which largely determines their ability to achieve sustainable development and economic viability.

The object of the study is fruit farms of various types across the entire country but primarily concentrated in the Upper Thracian Plain.

The time scope of the study covers the period from 2022 to 2024.

The main thesis of the research is that risk management is an underestimated topic for fruit farmers in Bulgaria. Efforts are mainly focused on managing traditional biological risks, while the dynamic external environment creates new and increasingly complex types of risk in agriculture.

Research Methods. The main methodological approach is deductive. The primary theoretical and empirical results from the literature review were applied in the analysis of the specific case – risk management by fruit farmers in Bulgaria. Primary data were collected through a survey among various fruit farmers. The results were analysed using descriptive and comparative methods, but statistical analyses – regression and analysis of variance – were also used to find causal relationships between factors and to compare the results from different groups of farms, respectively.

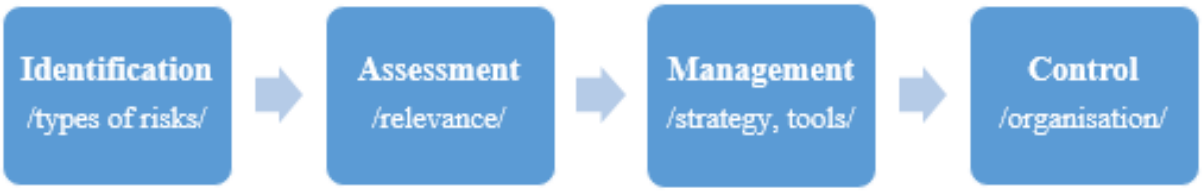
CHAPTER 1: THEORETICAL AND METHODOLOGICAL CONCEPTS FOR RISK MANAGEMENT IN AGRICULTURE

The concept of risk refers to understanding the probability of different negative scenarios that usually arise from external factors (Novickytė, 2019). In this context, risk cannot be avoided by economic agents operating in a market economy. This applies to the agricultural sector as well, as farmers cannot conduct business in isolation from the external environment.

Traditionally, risk management in agriculture has focused on dealing with various biological risks and those related to weather and climate, which are inherently different in nature (Theuvsen, 2013). However, this traditional approach is increasingly unlikely to contribute to effective risk management in the new and ever more dynamic external environment. The argument is that agriculture evolves alongside the entire economy, despite its seemingly more conservative nature. Therefore, it can be argued that the management process in agriculture faces new requirements that increase its complexity.

Effective risk management is a complex, purposeful, and continuous process rather than a separate or one-time event (Wolke, 2007). According to the theoretical framework presented below, risk management requires the systematic addressing of four key phases to achieve optimal results: risk identification, assessment, management, and control (Wolke, 2007). Considering all phases of the process, risk management is a multi-component activity that must not only be carried out sequentially, but also periodically reviewed in the context of changing external and internal environments (Wolke, 2007).

Figure 1 – Main stages of the risk management process



Source: Adapted from Wolke (2007)

Each of the four steps must be carried out in the order presented in the model (Wolke, 2007). The initial phase of the risk management process focuses on identifying the types of risks that may negatively influence the respective economic entity (Wolke, 2007). Overlooking significant risks at this stage of the process can lead to ineffective risk management and unintended exposure to risk.

The types of risk in agriculture are categorised into seven different groups based on their nature: production, human resources, financial, production facilities, market and

price, political, and other risks, as shown below (Näther and Theuvsen, 2012). The model also indicates that each of these risk categories includes several key elements, leading to a total of 26 individual types of risk relevant to agriculture (Näther and Theuvsen, 2012). Based on the presented theoretical model, it can be noted that risks originate from three main sources: the general external environment, the specific agricultural sector, or certain events related to the farm or the farmer's personal circumstances (Näther and Theuvsen, 2012).

Table 1 – Main groups and types of risks in agriculture

Risk groups	Types of risks
Production	Plant and animal diseases, other plant and animal hazards, pests, and extreme weather events
Human resources	Diseases and incidents, death of the owner, divorce, low employee motivation, lack of qualified personnel
Financial	Cash flow problems, difficulty servicing loans, changes in interest rates on loans
Production facilities	Fire, vandalism, broken equipment
Market and prices	Unstable prices of 1) Final products; 2) Production means (materials, raw materials, etc.)
Political	Changes in 1) Agricultural policies; 2) Social policy; 3) Fiscal policy; 4) Building regulations; 5) Animal protection regulations
Other	Theft, natural risks, legal disputes, financial damages

Source: Näther and Theuvsen (2012)

The external environment has multiple dimensions and creates a general context that serves as a source of both opportunities and threats for businesses (Rastogi and Trivedi, 2016). The PESTEL model – an acronym for Political, Economic, Social, Technological,

Environmental and Legal factors – focuses on the analysis of the macro environment. The key external factors that may pose risks to farmers are presented in Table 2.

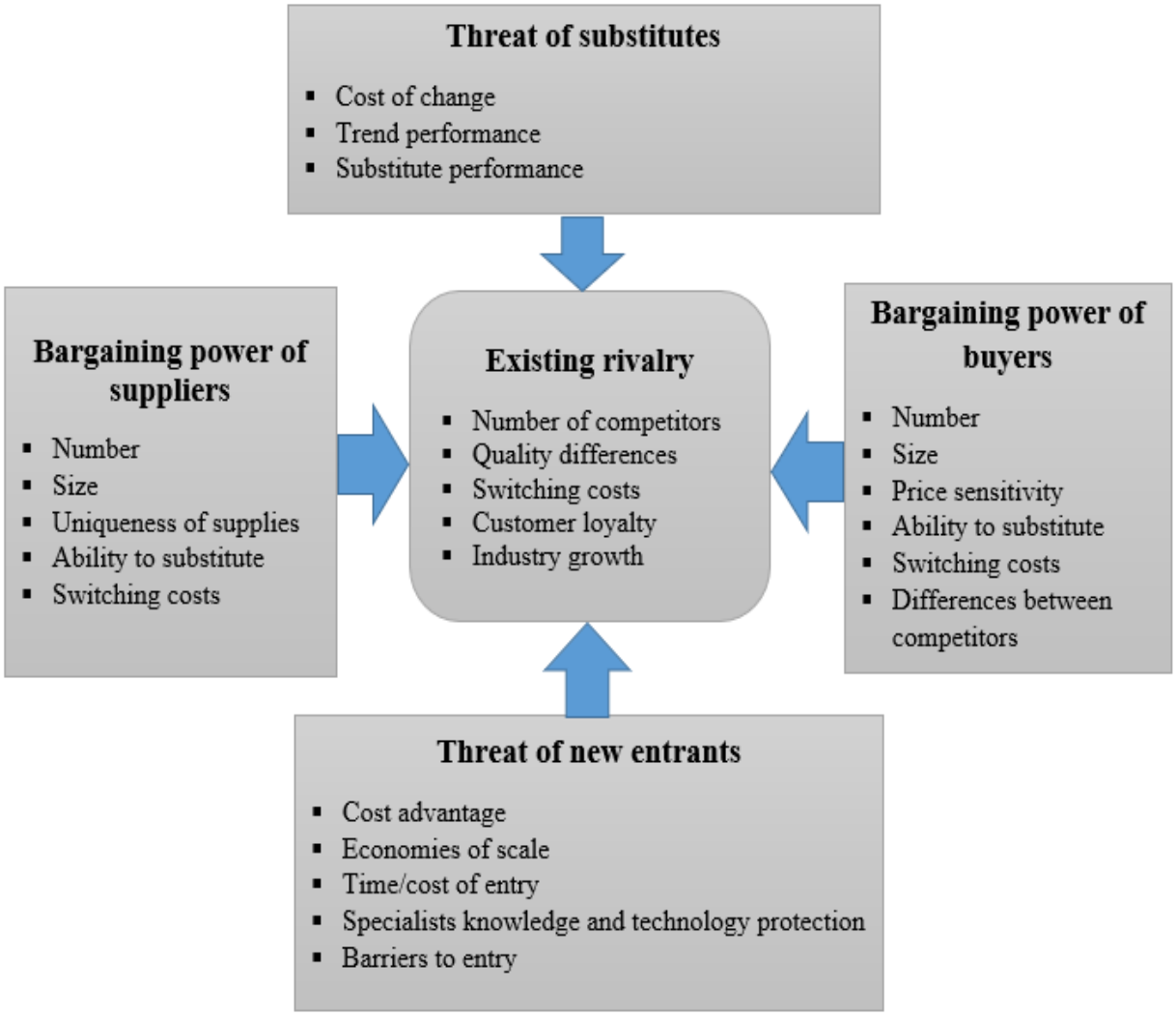
Table 2 – Factors and key elements of the PESTEL model

Factors	Elements
Political	Government policy, corruption, institutional effectiveness, trade regimes, tax policies, grants and subsidies
Economic	GDP level, economic growth, inflation, unemployment, interest rates, exchange rates, disposable income
Social	Population size and growth, age distribution, changes in consumer preferences, workforce trends, cultural specifics
Technological	Technological state, level of innovation, intellectual property, research and development activity
Environmental	Climate change, environmental regulations, environmental preservation, corporate social responsibility
Legal	Regulatory changes, employment legislation, consumer protection laws, anti-trust measures, health and safety laws

Source: Johnson et al. (2017)

The characteristics of the meso environment are determined by the state of a specific economic sector. For agricultural producers, the meso environment focuses on the particularities of the agricultural sector. Porter's Five Forces is a well-known model for assessing the profitability and attractiveness of a given economic sector (Porter, 1979). The theoretical framework combines five distinct groups of factors: the bargaining power of suppliers, the bargaining power of buyers, the threat of new entrants, the threat of substitutes, as well as the intensity of existing rivalry (Isabelle et al., 2020). The combined impact of these five factors determines the relative attractiveness of a sector (Porter, 1979). Porter's Five Forces is a theoretical framework applicable to identifying various sector-specific risks in Bulgarian agriculture.

Figure 2 – Overview of the Porter's Five Forces model



Source: Adapted from Isabelle et al. (2020)

The micro-enterprise level is also a source of specific types of risk for each fruit farm. The presence of personal, production, security-related, and other risks has already been discussed based on the methodology of Näther and Theuvsen (2012).

There are various methodological approaches to risk assessment. The risk assessment matrix is a common model in project management and is also highly applicable in risk management processes (Guo, 2015). Wolke (2007) identifies two key dimensions in risk assessment—loss potential (negative impact) and frequency. The risk matrix model

applies the same dimensions, where the overall significance of a given risk is a function of two factors: negative consequences and likelihood of occurrence (Guo, 2015). The risk matrix model assumes that the corresponding values of these two dimensions are multiplied to obtain a final risk score. Risks with the highest overall scores should be considered the most critical, and vice versa (Guo, 2015). This quantitative assessment is essential for directing focus, efforts, and resources toward the most significant challenges inherent in each agricultural enterprise.

Table 3 – Risk assessment matrix

Likelihood / Impact	Remote (1)	Unlikely (2)	Possible (3)	Likely (4)	Almost certain (5)
Extreme (5)	5	10	15	20	25
Major (4)	4	8	12	16	20
Moderate (3)	3	6	9	12	15
Minor (2)	2	4	6	8	10
Insignificant (1)	1	2	3	4	5

*green – low risk; yellow – moderate risk; red – severe risk

Source: Adapted from Guo (2015)

In the presented case, a five-step rating scale is applied, but in practice, many different quantitative scales are used depending on preferences.

The third phase of the process focuses on the specific management of already identified and assessed various types of risk (Wolke, 2007). In a narrow sense, risk management aims to reduce or eliminate a given risk to limit the negative consequences of its occurrence (Bashev, 2012). This is achieved through individual, collective, or societal activities – a fact that highlights the complexity of the process (Bashev, 2012). The risk management process itself, as well as the decisions associated with it, largely depend on organisational strategies and the respective tools applied in the process (Wolke, 2007).

There are several key risk management strategies. According to Huirne et al. (2000), risk reduction is commonly applied in practice by decreasing its probability and negative

effects. Risk reduction can be achieved through diversification, increased flexibility, access to extensive information that improves the quality of managerial decisions, and the adoption of advanced technologies (Huirne et al., 2000). The risk management process can also focus on its complete elimination (Wolke, 2007). However, this strategy is only applicable in certain scenarios where it is practically feasible and depends on farmers' decisions (Huirne et al., 2000). Other possible strategies emphasise risk transfer, often implemented through insurance, futures contracts, and other financial instruments (Huirne et al., 2000; Wolke, 2007). In this way, the entire potential risk and its negative consequences are assumed by other parties. Finally, farmers may also choose to accept the risk and take no action to manage it, which is also considered a legitimate strategy in many cases (Wolke, 2007).

The final phase of the risk management process emphasises the need for control to ensure future prevention and minimise potential damage from already occurring risks (Wolke, 2007). This is a complex undertaking that includes a set of measures such as planning, monitoring, and access to detailed information to facilitate effective decision-making. It also requires close coordination of activities not only within the agricultural enterprise itself, but also with other related entities, including financial institutions, business partners, authorities/regulators, and others – to achieve an optimal risk management effect (Wolke, 2007).

In practice, risk control cannot guarantee complete protection due to exposure to external negative influences arising from the external environment or the actions of other stakeholders. Several characteristics of agriculture play a significant role in the risk management process.

The first characteristic is related to dependence on weather, climate and certain other natural factors that affect yields and productivity (Kaan, 2000). There is a reliance on numerous circumstances and consequences that emerge at a later stage of development and cannot be effectively controlled (Bencová and Boháčiková, 2021).

The second key characteristic is the interconnection of various risk-determining factors, which can lead to cascading negative effects if a particular risk materialises (Bencová and Boháčiková, 2021). The presence of potential cascading effects makes the risk management process in agriculture even more complex, but also more crucial for agricultural enterprises.

Third, risk management is not merely an isolated activity carried out by farmers. Other agents also play an active role as part of the broader system of social order (Bashev, 2012). According to Lipińska (2016), the process is shared between the government and farmers. The state has intervention mechanisms to support the agricultural sector, including a wide range of subsidies, stabilisation funds, tax relief, access to credit lines and direct financial assistance in the event of highly adverse occurrences (Bashev, 2012; Lipińska, 2016).

Fourth, subjective factors play a significant role in the risk management process in agriculture (Wolke, 2007). The most important subjective factor is related to the risk appetite of individual farmers, as there are individuals with minimal, moderate, and high-risk appetite (Hillson and Murray-Webster, 2007).

Fifth, farm characteristics and the sociodemographic profile of farmers also influence the risk management process (Harizanova-Bartos et al., 2021). According to Kahan (2013), small farms tend to exhibit risk-averse behaviour, while larger farms operate in a more complex manner, resembling business organisations where risk management is considered an important operational activity. In addition to farm size, other studies suggest that the approach to risk management largely depends on the type of production and specific regional differences in the area where the farm is located (Branzova, 2019; Doitchinova, 2019).

Sixth, the lack of active risk management, which is often observed, is not only related to farmers' personal willingness to take risks, but also to the costs of implementing such a strategy (Vigani and Kathage, 2019). Complex risk management strategies often

lead to negative overall outcomes for farm productivity – a phenomenon explained by excessive costs and the diversion of resources from productive activities to non-productive ones in the field of risk management (Vigani and Kathage, 2019).

Seventh, agriculture often experiences the presence of asymmetric information and opportunism. Regarding asymmetric information, farmers do not possess complete information about economic and market processes due to a lack of understanding, limited access, or the inability to collect and analyse large datasets due to the high costs involved (Bashev, 2012). Farmers also face a high degree of opportunism. Before signing an insurance contract, opportunism manifests as the concealment of information about the range of possible risks. Additionally, insurance coverage is often inadequate, as the market does not provide compensation for certain types of risks – a problem that farmers realise only after a risk has materialised (Bashev, 2012).

The conclusions highlight the significant dynamism and complexity of risk management. Fruit growers face various external, sectoral and organisationally specific forms of risk, which evolve over time. The management of such diverse risks is neither optimal nor straightforward, as it depends on a wide range of factors, including the farmer's personality and farm characteristics, the role of other economic agents involved in the process, and the state as a final authority and partner in many aspects. The conclusions from the discussion contribute to identifying key directions for conducting the ongoing research among fruit growers in Bulgaria.

CHAPTER 2: METHODOLOGY OF THE STUDY, ANALYSIS AND ASSESSMENT OF RISKS IN BULGARIAN FRUIT FARMING

The object of this study is the fruit-growing sector, with a focus on representatives from the Plovdiv region – one of the main centres of fruit production in Bulgaria. Fruit farms face a wide range of risks and threats that impact their operations. Additionally, fruit growing is a segment of agriculture where similar studies have not yet been conducted in Bulgaria. Therefore, the results would have significant practical importance by enabling an

analysis of existing risk types, management practices, and potential solutions for improvement.

Although the study focuses on a specific sub-sector, the general theoretical models and empirical findings in the field of risk management remain valid and applicable in this case. Thus, the insights from the discussed theoretical and empirical literature are also utilised within the specific research context. It can be largely concluded that the study follows a deductive approach, as established theories and models are applied to the specific case of fruit growers in the Plovdiv region (Saunders et al., 2015). Accordingly, the research findings can contribute to expanding theoretical knowledge in risk management by incorporating new data from the studied case.

The study of fruit farms in the Plovdiv region took place during the period from January to October 2024. This ten-month period is dedicated to the actual collection of primary data from sector representatives through a survey, without including the time required for conducting a preliminary pilot study.

According to data from 2010, there are 5,048 fruit farms in the Plovdiv region, accounting for 11.8% of all farms in the country (MZH, 2012). In terms of area, the region has 65,075 decares of fruit plantations, while the total for Bulgaria reaches 445,048 decares (MZH, 2012). Due to their relatively larger area, fruit farms in the Plovdiv region increased their share to 14.6% of all fruit farms in the country. These figures highlight the region's importance as a centre for fruit growing in Bulgaria. This, in turn, supports the chosen focus on the Plovdiv region in the study of risk management practices.

The current sample consists of 86 respondents. This number is based on 105 invitations sent for participation, resulting in a response rate of 81.9%, indicating a high level of motivation to take part in the survey. In terms of agricultural holdings, the size of the current sample represents approximately 1.7% of all fruit farms in the Plovdiv region, assuming that each respondent is responsible for only one farm. The total area of orchards managed by the survey participants reaches 5,933 decares, which accounts for 9.11% of

the total orchard area in the Plovdiv region – a relatively strong achievement that significantly enhances the representativeness of the study.

The sampling design applied in this study is based on the "*snowball sampling*" principle. This approach involves data collection in multiple stages. Initially, the questionnaire is distributed to respondents known to the interviewer who are involved in the fruit-growing sector. Subsequently, these initial participants are asked to voluntarily collaborate by forwarding the questionnaire to other potential respondents who are known to them but unknown to the interviewer and who meet the participation criteria (Saunders et al., 2009). In this way, the snowball sampling method made it possible to increase both the sample size and its diversity to the desired levels (Saunders et al., 2009).

The survey used to collect primary information from fruit growers relies on a specialized online platform – Google Forms. The questionnaire is published on the platform and then sent to potential respondents via an online link that provides access to the survey. Recipients of the questionnaire can choose the most convenient time and device (computer, tablet, phone, etc.) to complete it. Additionally, the first group of directly surveyed participants can share the designated online link with other potential respondents who meet the participation criteria.

The quantitative data collected from the survey has been analysed using various statistical methods, significantly contributing to a high level of precision and objectivity. Descriptive statistical methods help determine the mean values and dispersion (variance) in responses to many of the survey questions. A key role is played by analysis of variance (ANOVA), as the study aims to identify potential differences in performance and assessments between different groups of participants based on socio-demographic characteristics and various orchard farm attributes. In this context, ANOVA is essential for determining the statistical significance of differences in responses related to the study's hypotheses. Statistical analysis also relies on correlation analysis, which helps better observe the behaviour of two or more dependent variables (Senthilnathan, 2019). Additionally, the data is analysed using regression analysis, which is suitable for

identifying causal relationships between multiple independent (explanatory) variables and a dependent variable (Bewick et al., 2003). Regression analysis is particularly useful for examining the combined influence of several potential factors, helping to determine the statistical significance of each explanatory variable and quantify its effect on the dependent variable (Bewick et al., 2003).

According to the main thesis of the current scientific study, risk management at this stage of development is largely an underestimated activity for fruit farmers in Bulgaria. The limited efforts, resources, and strategies for risk management in practice are also suggested by the empirical data of Harizanova-Bartos et al. (2021). In this context, the first hypothesis is formulated as follows:

H_1: For fruit growers, risk management is not a process of primary importance.

Another key thesis suggests that fruit growers primarily prioritise biological risks at the expense of many other types of risks, which have variable but increasing importance over time, as highlighted by the literature review (see Wolke, 2007; Shaper et al., 2012; Bashev, 2012). If the practical focus is limited, it is necessary to analyse whether this is confirmed by the survey data. Therefore, assessing the significance of different types of risks in fruit farming – both in terms of frequency and impact – is crucial.

H_2: Different types of risks are of equal importance to fruit growers.

The literature review also highlights the potential role of individual socio-demographic factors specific to each farmer, which may influence the risk management process (see Weinstein, 1989; Dohmen et al., 2011; Roe, 2013; Rahayu et al., 2021). The following hypothesis encompasses a broad range of socio-demographic factors that explain the individual context of each fruit grower, including gender, age, education level, and years of experience in the industry. The analysis aims to determine whether these individual characteristics have a real effect on decision-making in the field of risk management.

H_3: The individual socio-demographic characteristics of farmers do not affect risk management in fruit farming.

Similarly, the literature also suggests that farm-specific factors may influence how fruit growers manage risk (Harizanova-Bartos et al., 2021). Some key factors discussed in the literature include the type of orchard, its size, topography, and other characteristics. Therefore, a separate hypothesis has been formulated, focusing on analysing farm-specific attributes, as outlined below:

H_4: The specific characteristics of the orchard do not influence risk management.

Beyond risk management, the specific features of a given orchard may also lead to different levels of risk exposure. The current study collects extensive data on farm characteristics, such as size, type and topography, which could, to some extent, impact the risk management process.

H_5: Different types of risks are of equal importance regardless of the characteristics of the orchards.

The final hypothesis analyses the role of the individual making risk management decisions. The literature suggests that owners tend to exhibit greater risk-taking behaviour compared to managers (Xiao et al., 2001). This study examines this claim within the Bulgarian context through the following hypothesis:

H_6: Owners and managers have the same levels of risk tolerance and behaviour in the risk management process.

Gathering sufficient scientific evidence to evaluate these hypotheses significantly contributes to achieving the research objective. The findings will provide valuable insights into risk management practices in fruit farms.

CHAPTER 3: RESEARCH, ANALYSIS AND ASSESSMENT OF RISKS IN BULGARIAN FRUIT FARMING

This section of the abstract presents the results of the survey, which is based on the opinions of 86 fruit growers with different demographic and professional profiles. The sample is diverse from a demographic perspective, which is of utmost importance for

analysing the opinions and practices of various groups of fruit growers. The data from the overall socio-demographic profile demonstrate the potential for achieving objective results based on a diverse sample.

Table 4 – General overview of respondents' demographic characteristics

Gender	Male – 77.9%	Female – 22.1%	-	-	-
Age	20-30 – 23.3%	31-40 – 22.1%	41-50 – 18.6%	51-60 – 24.4%	60+ 11.6%
Education	Basic – 4.7%	Secondary – 24.4%	Secondary vocational – 18.6%	Higher – 52.3%	-
Experience (years)	< 10 – 38.3%	11-20 – 25.6%	21-30 – 18.6%	30+ 17.5%	-
Role	Owner – 66.3%	Renter – 19.8%	Manager – 9.3%	Other – 4.6%	-

Source: Own analysis

The selected types of risks are categorised into six main groups and one additional group, as shown below (Table 5). Each of the six main groups contains several distinct types of risks, making the analysis more comprehensive. Reducing the number of risk types under investigation to 20 helps to focus the study on the topic more effectively.

Table 5 – Overview of all risks evaluated in the current study

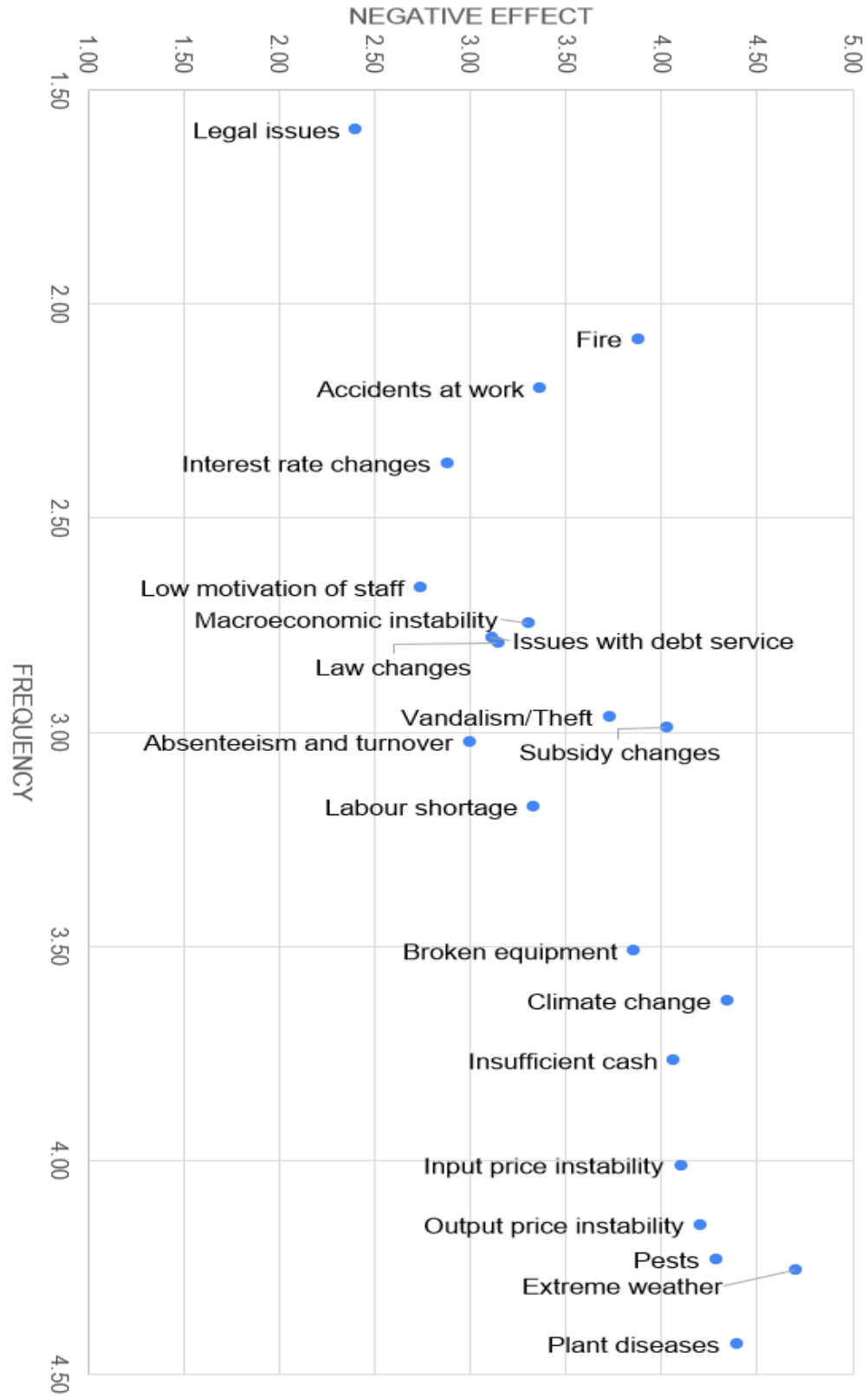
Main groups	Specific risk types
Biological	1. Climate change 2. Extreme weather 3. Plant diseases 4. Pests
Human resource	1. Labour shortage 2. Accidents at work 3. Low motivation of staff 4. Absenteeism and turnover
Financial	1. Interest rate changes 2. Insufficient cash 3. Issues with debt service
Facility protection	1. Fire 2. Vandalism/Theft 3. Broken equipment
Political	1. Subsidy changes 2. Law changes
Market	1. Macroeconomic instability 2. Input price instability 3. Output price instability
Other	1. Legal issues

Source: Own analysis

Risk assessment is the second step in the risk management process. It highlights the significance of each identified type of risk for fruit growers in Bulgaria. The assessment is quantitative, serving as a key factor in achieving objective results. It follows a 5-point Likert scale, in line with the theoretical guidelines set by Guo (2015) (see Table 3). The assessment is based on two dimensions – frequency and negative impact. Thus, the final risk evaluation depends on the multiplied value of these two factors (Guo, 2015).

Risk mapping is based on the arithmetic mean value of each element, derived from a total of 86 responses. As mentioned, the positioning involves two dimensions – frequency and negative impact. The data reveal highly diverse evaluations of risks in fruit farming.

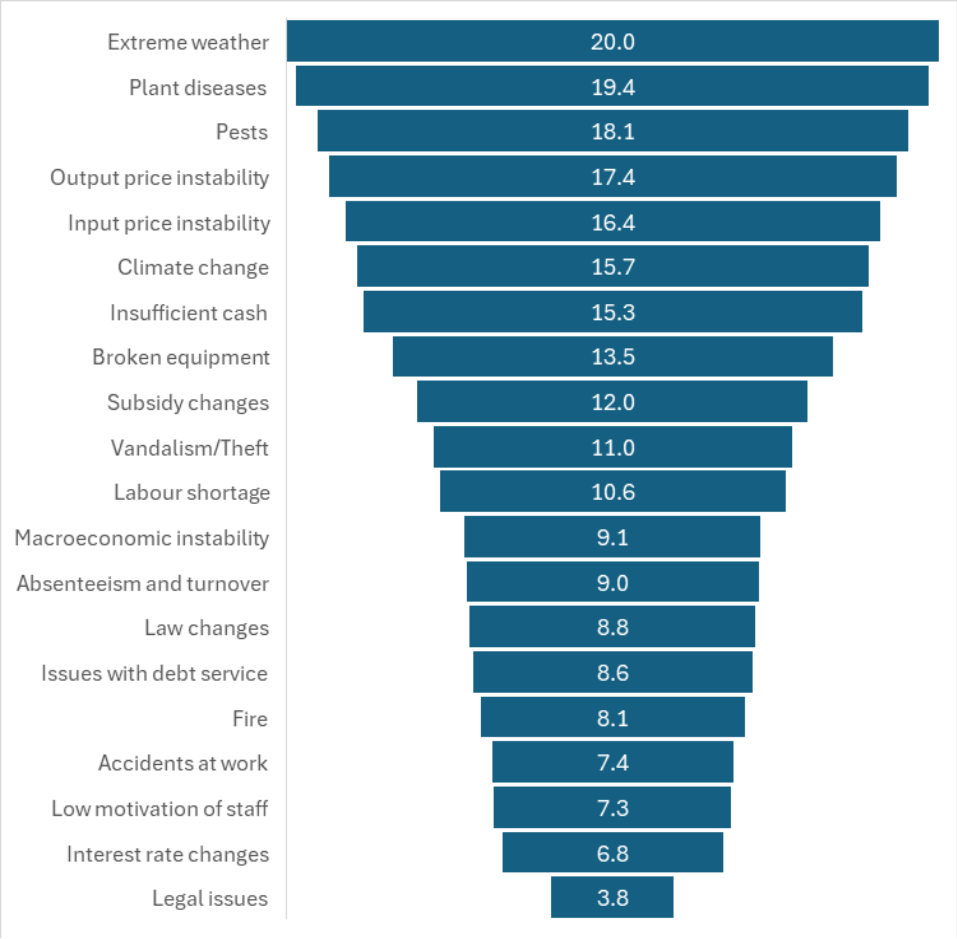
Figure 3 – Risk assessment in fruit growing



Source: Own analysis

As seen, risks tend to have diverse evaluations based on frequency and negative impact. Therefore, it is important to also examine the overall assessment. The overall assessment is based on the quantitative value obtained by multiplying the individual ratings of frequency and negative impact (Guo, 2015). The overall assessment is a quantitative measure that does not distinguish between the two main dimensions in the evaluation process – frequency and negative impact. When creating a ranking to illustrate the risk assessment, the results are presented in descending order, starting from the highest-rated risk and continuing sequentially until the last element with the lowest rating (Figure 4).

Figure 4 – Total risk score of all risk types (rating)



Source: Own analysis

The unique ranking clearly demonstrates the dominant role of extreme weather events, with an overall assessment of 20. At the other end of the scale, the role of legal

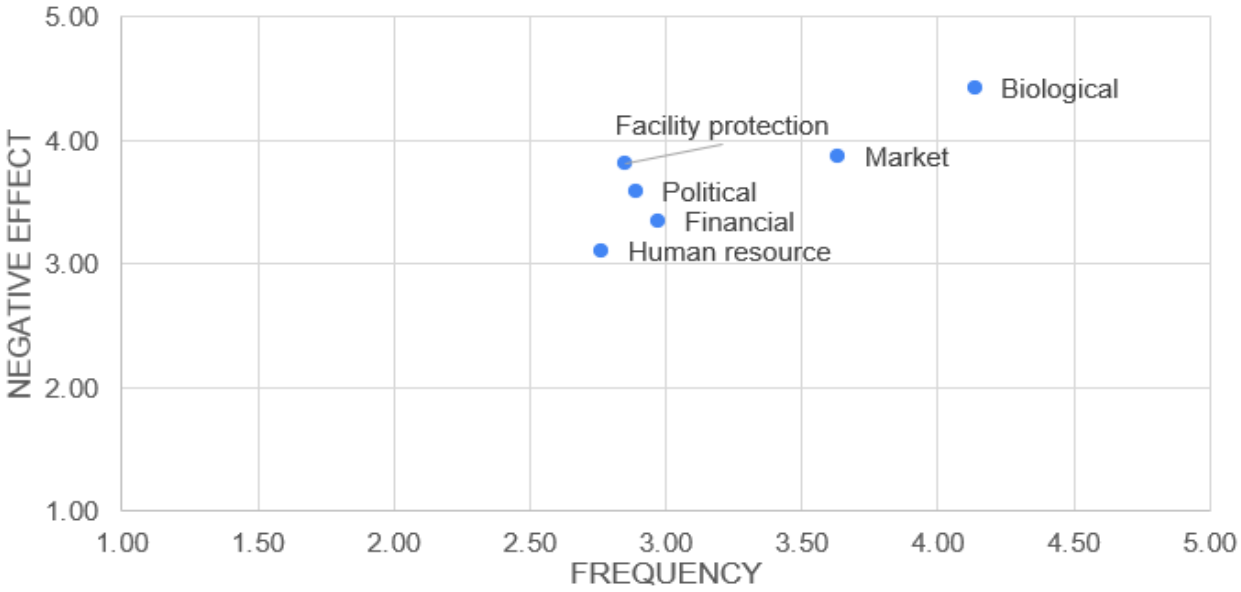
disputes is the weakest, with an assessment of 3.8, which is more than five times lower than the leading risk. Natural and market (macroeconomic) risks are of the greatest importance to fruit growers, and therefore, they should be a priority in decision-making and risk management measures. For the remaining risk types, the assessment gradually decreases.

The risk assessment in fruit farming is also presented by risk groups. After eliminating legal disputes, based on the remaining 19 types of risk, the results for the six main groups are shown below (Figure 5). Natural risks remain the most significant for fruit growers, with an exceptionally high frequency (4.14) and an even higher negative impact of 4.42. Despite advancements in plant protection, natural risks continue to be a leading concern for fruit growers. The importance of this group of risks is further amplified by several increasingly urgent factors, such as climate change and extreme weather events.

Market risks are also clearly highlighted, with slightly lower frequency (3.64) and negative impact (3.86) than natural risks. Thus, market risks should be considered the second most important risk group for fruit growers. Market risks are diverse, including factors related to the macroeconomic environment, as well as the final purchase prices of the products and the costs of materials/raw materials involved in the production process.

The remaining four risk groups are clustered in the middle of the applied assessment scale. Risks are largely related to the protection of long-term assets (LTA), which refers to facility protection, political risks, financial risks, as well as risks related to human resource management exhibit similar frequency, ranging from 2.76 to 2.97. These are identical values, showing relatively equal frequency of occurrence for the above-mentioned four types of risk. The differences are particularly evident in terms of the negative impact when these risk groups materialise. The data show differences, especially when comparing facility protection (3.81) and human resource management (3.10). While all the risk groups in this cluster remain above the average assessment value of three in terms of negative impact, damage to LTA would have relatively higher overall relevance for fruit growers.

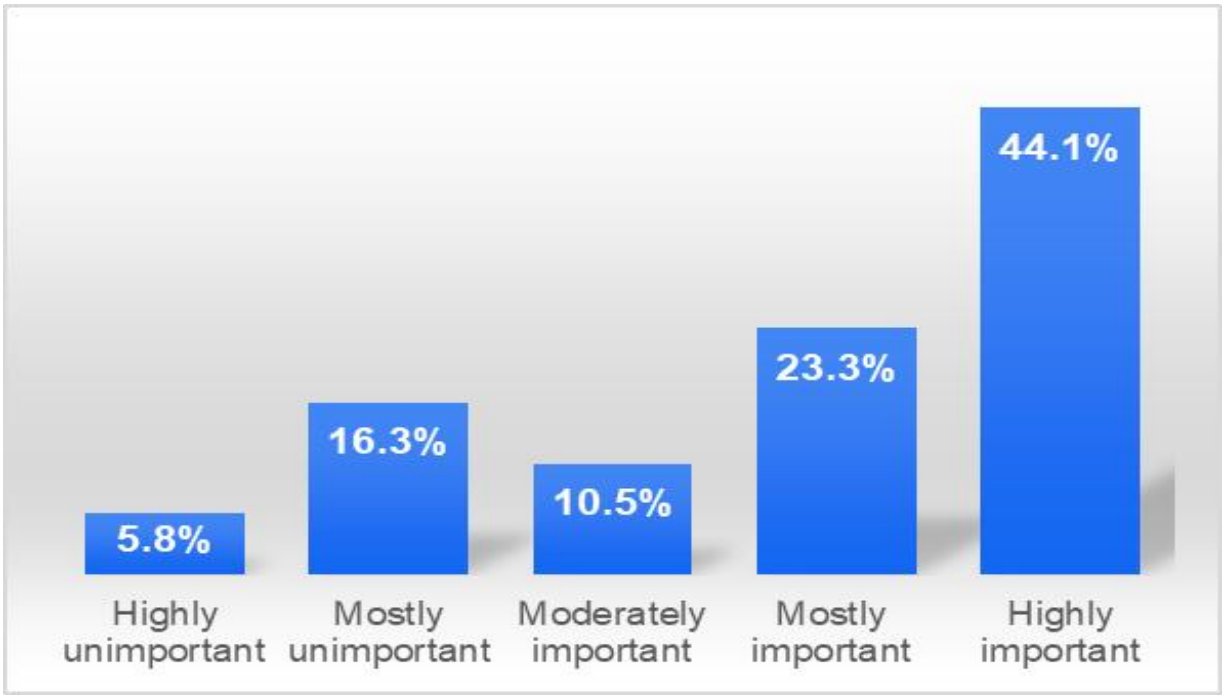
Figure 5 – Risk evaluation of all main groups of risks in fruit growing



Source: Own analysis

Most survey participants, or 67.4% of all respondents, consider the risk management process to be very or extremely important for the sustainable development of the farm.

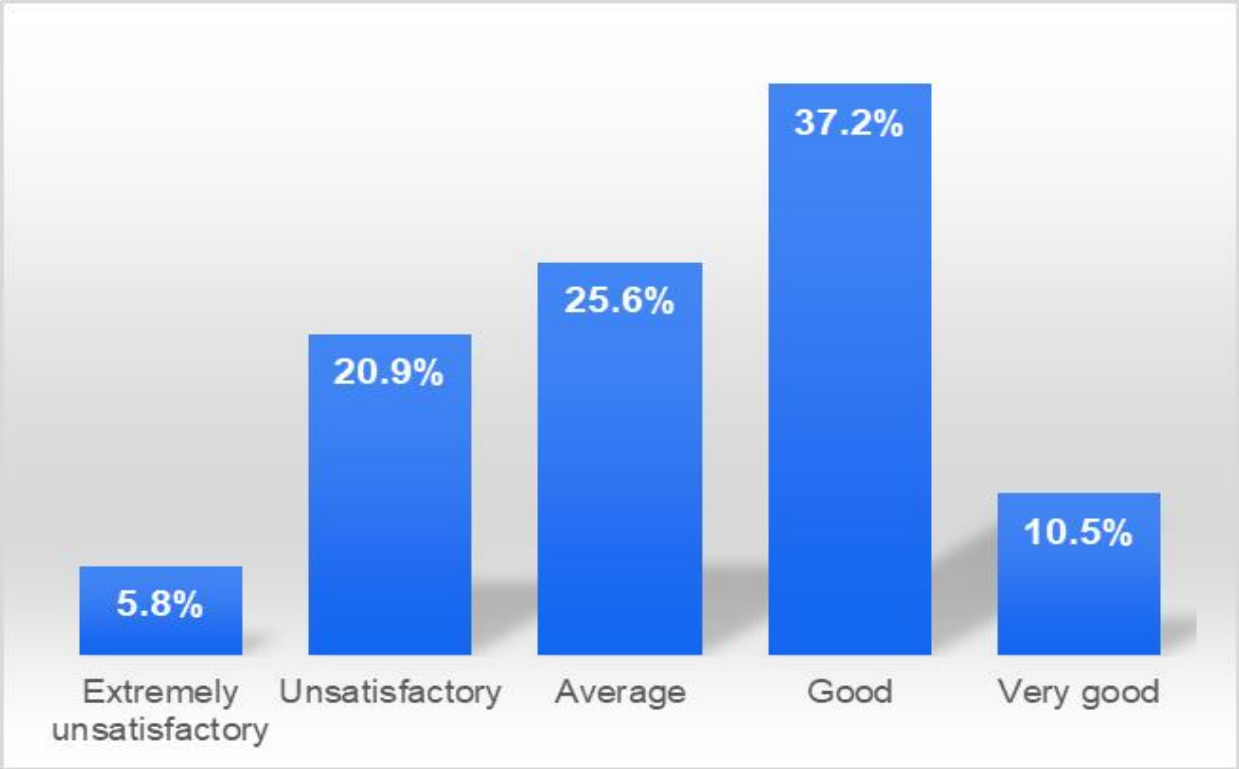
Figure 6 – How important is it to conduct risk management?



Source: Own analysis

The predominant high ratings for the risk management process clearly highlight the practical significance of the topic analysed in the current study. However, the results also show an unsatisfactory level of satisfaction with risk management in fruit farming.

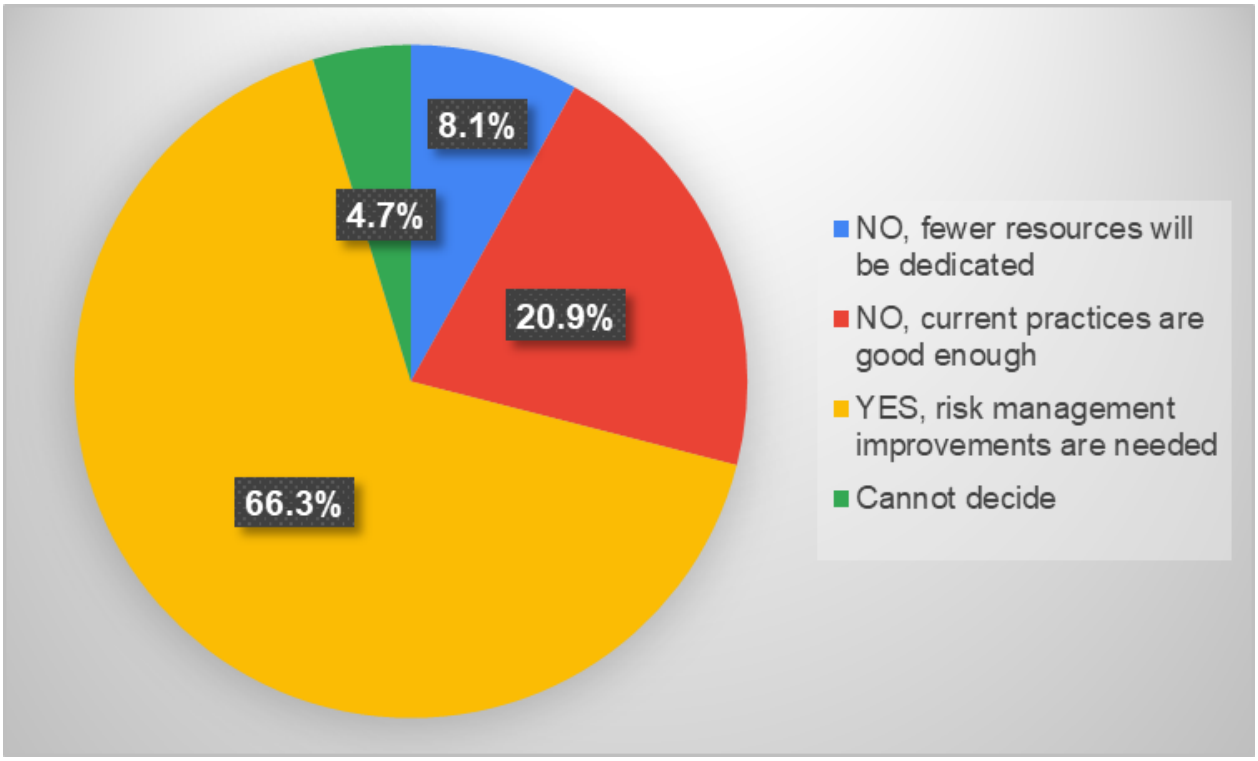
Figure 7 – Satisfaction level with the applied risk management strategies



Source: Own analysis

The need for future improvements in risk management is also evident from the intentions for future development (Fig. 8). Most respondents – 66.3% – express the need for improvement compared to the current level of performance.

Figure 8 – Intentions for future investments to improve risk management process

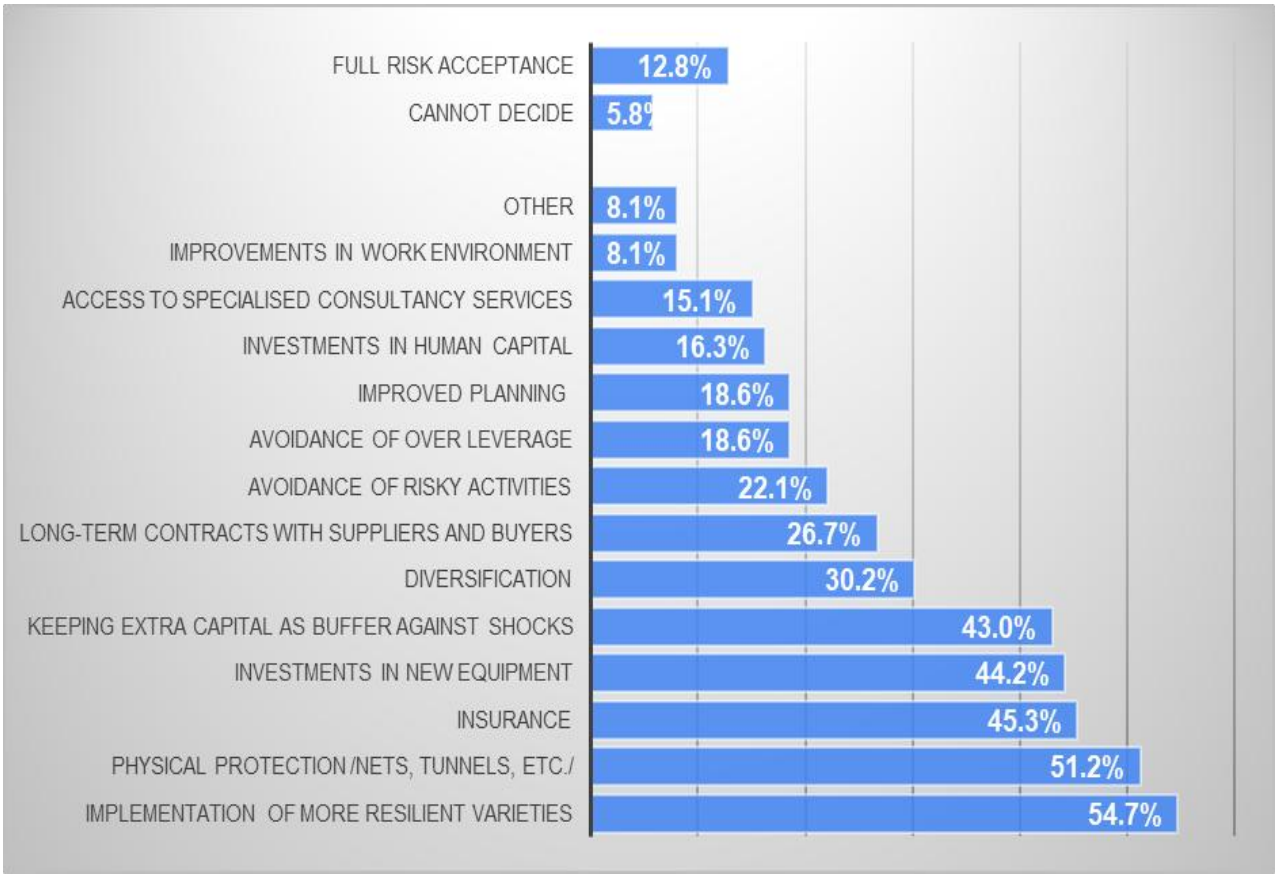


Source: Own analysis

It is assumed in advance that fruit growers apply one or more of several possible main risk management strategies – complete avoidance, reduction, transfer, or acceptance of risk – as theoretically suggested by Wolke (2007). The data from Figure 9 show diverse strategies. While 12.8% of respondents fully accept the risk without additional measures for its management, the remaining participants adopt various strategies, with a leading role played by activities aimed at mitigating existing natural risks and their manifestations. Overall, the survey results are not conclusive. On the one hand, respondents apply a variety of risk management strategies. Another positive fact is the focus on natural types of risks, as the two most popular strategies address issues with pests, diseases, and adverse weather and climate events. In this way, fruit growers take a practical approach by using limited resources to neutralise the most important natural risks. On the other hand, the percentage weight of the analysed strategies remains relatively low, as only two strategies –

introducing resistant varieties and building protective structures – exceed the 50% application threshold among participants.

Figure 9 – Already applied risk management strategies



Source: Own analysis

The study formulates six different hypotheses to better understand the risk management process in fruit growing in Bulgaria. After applying various statistical analyses, it was possible to evaluate the hypotheses, shedding more light on the practices and differences among the participants. The evaluations of the hypotheses, along with brief but important clarifying comments, are presented in Table 6. The conclusions are statistically supported, and the data in the table aim to illustrate the most important findings before proceeding to the discussion of the results.

Table 6 – Detailed assessment of the hypotheses from the study

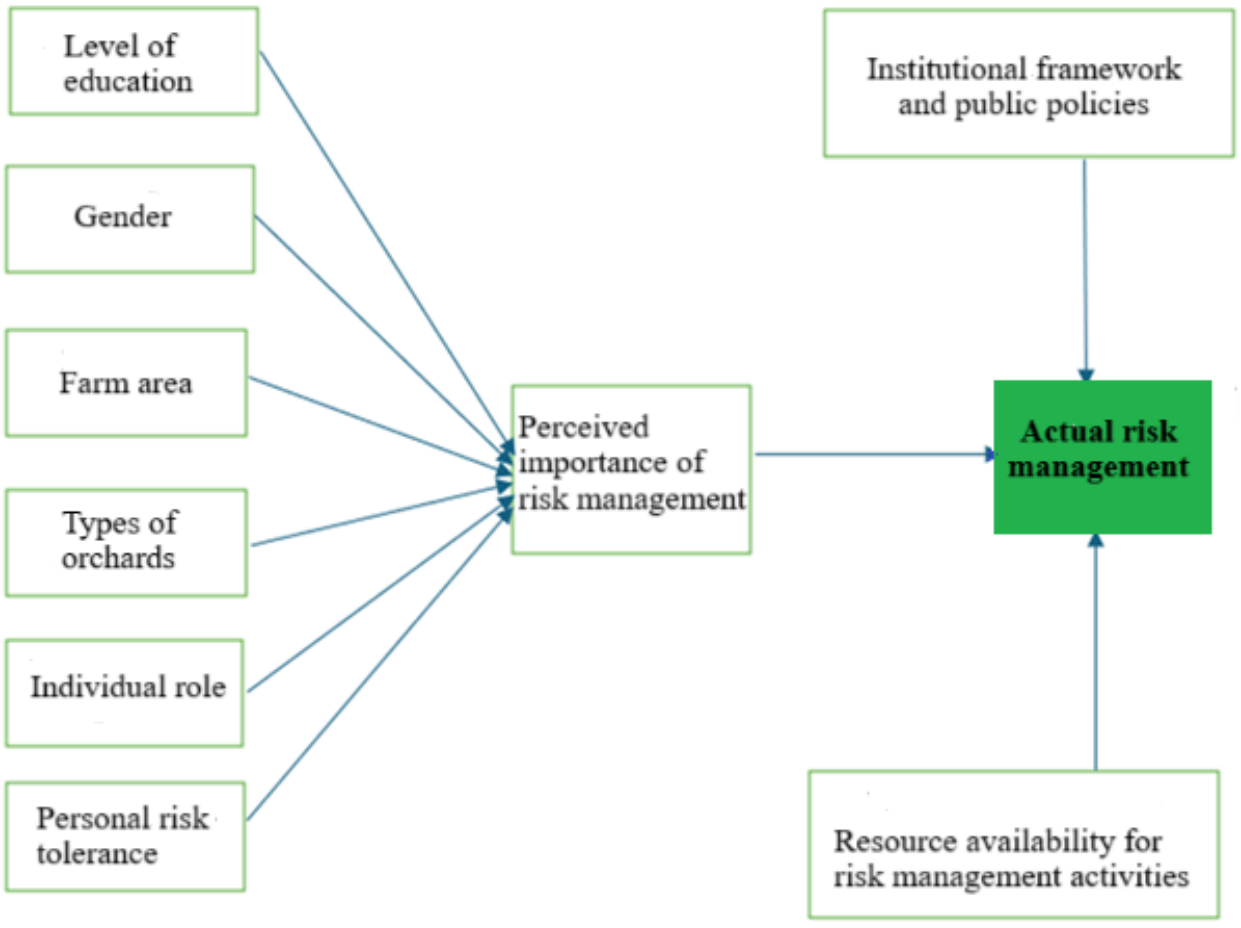
Hypothesis	Assessment	Comment
H_1: For fruit growers, risk management is not a process of primary importance.	**Rejected**	The management of risk is important for all groups of fruit growers, except for those with the lowest level of education.
H_2: Different types of risks are of equal importance to fruit growers.	**Rejected**	All types of risks are important for fruit growers, but natural risks, and to a certain extent market risks, stand out due to their significance.
H_3: The individual socio-demographic characteristics of farmers do not affect risk management in fruit farming.	**Partially rejected**	The level of education plays a significant positive role in risk management. Female fruit growers are more sensitive to risk compared to male fruit growers.
H_4: The specific characteristics of the orchard do not influence risk management.	**Partially rejected**	The size and type of the farm have a significant impact on risk management, while the types of plantations and topography remain less important.
H_5: Different types of risks are of equal importance regardless of the characteristics of the orchards.	**Rejected**	Risk and its management play a significantly more important role for the group of active farms.
H_6: Owners and managers have the same levels of risk tolerance and behaviour in the risk management process.	**Partially rejected**	Managers tolerate risk less than owners, but there are no significant differences between the two groups regarding its management.

Source: Own analysis

The conclusions are that all null hypotheses have been fully or partially rejected based on the collected evidence. The personal characteristics of fruit growers, their role, as well as the characteristics of the fruit farms themselves, are factors that significantly influence the risk management process and perceptions of the importance of different types of risks. Despite the observed differences in evaluations among different demographic groups, the risk management process remains important in general.

The following model is based only on the statistically significant factors in the current study. The proposed theoretical framework systematises all the evidence to show the significant determinants in risk management, as well as some possible directions for future improvements in the field.

Figure 10 – Risk management model of fruit growing in Bulgaria



Source: Own analysis

The model reflects specific sectoral characteristics of fruit growing that have not been studied before. Additionally, access to new empirical data explains the prioritisation of certain determinants with proven statistical significance in the current model and the rejection of others. The proposed theoretical framework shows that risk management in fruit growing depends on how important the process is perceived by fruit growers. Even though it is considered important, risk management requires resources to be as comprehensive and effective as possible, which is why resource limitations are treated as a separate factor. Another key factor in the model, which is independent of the individual farmers, is related to the role of the state: the quality of institutions, policies in the agricultural sector, the creation of collective protective mechanisms to mitigate different types of risks and many other aspects.

The model also shows that the perceived importance of risk management as a determinant of actual risk management in practice depends on several factors:

1. Educational level has a positive role.
2. The presence of female gender correlates with increased importance of the process.
3. The size of the farm is positively correlated with the perceived importance of the process.
4. All types of orchards, except for unmanaged ones, encourage more responsible risk management by the farmers.
5. The role of manager, as opposed to owner, increases the importance of risk management.
6. The individual risk profile influences perceptions of risk.

The complex combination of these six factors largely determines how important risk management is perceived and, subsequently, how it is actually managed in practice. Based on this rich array of factors, various strategies for improving the risk management process can be developed.

CHAPTER 4: PRODUCTION AND INSTITUTIONAL SOLUTIONS FOR SUSTAINABLE DEVELOPMENT OF FRUIT FARMING

The recommendations for improvements are divided into three groups, addressing the general external environment, the fruit-growing sector, and individual farms. In this way, the three different levels, which were analysed in the literature review as potential sources of risk for fruit growers, are addressed.

Risk management is a complex process, where the role of the government and public institutions can be crucial in shaping the external environment (Bashev, 2012). First, the quality of governance in Bulgaria needs to be improved in terms of combating corruption and enhancing the effectiveness of public institutions (Transparency International, 2023). This progress should be deepened with effective structural reforms, improvements in the judicial system, the implementation of new technologies, and optimisations in the operation of public administration. In addition, it would be beneficial to create stronger collaboration between the public and private sectors, including joint efforts to develop policies that encourage innovation in the agricultural sector and effective risk management methods. This could also involve the creation of new subsidies or grants aimed at stimulating the modernisation of fruit-growing farms and the implementation of more effective technologies for managing risks.

The second general recommendation is related to the need to optimise regulations in Bulgaria. According to the World Bank (2020), the business environment in Bulgaria requires optimisation of the tax system, improvement of the company registration process, as well as greater accessibility to credit.

The third general recommendation is related to the need for Bulgaria to actively participate in global efforts against climate change. At this stage, Bulgaria is an active member of COP29 and acknowledges the need for carbon neutrality to combat climate change (Kotseva, 2024).

A specific recommendation for improvement, which requires significant public support, is the need to improve the irrigation system in Bulgaria. The increased frequency of extreme heatwaves and prolonged droughts are a major climate risk for Bulgarian fruit farming, according to the literature analysis and results from the survey among fruit farmers (Marinova and Bočeva, 2023; World Bank, 2021). In Bulgaria, irrigable land exceeds 7.4 million hectares, but according to data from 2023, the state-owned company "*Irrigation Systems*" EAD, which mainly deals with this activity, has serviced only around 300,000 hectares, or 4% of the total area (Agri, 2024). Water losses in the irrigation system are significant due to the outdated infrastructure, as only 10-15% of the water resource reaches the end users because of substantial losses along the pipeline (Agri, 2024).

Another major risk related to extreme weather events and climate change is hailstorms. Fruit farmers continue to be exposed to the risk of hailstorms, which in some cases can destroy the entire harvest (Nikolov, 2024). The existing hail protection system relies on rockets and aviation. In Bulgaria, there are plans to build 25 new rocket launch sites – a step in the right direction to increase the area protected from hail (Ministry of Agriculture, 2024). Another innovative method with successful applications in Hungary, France and Spain is the construction of generators that launch silver iodide into the atmosphere (Agri, 2018; MZH, 2024). Silver iodide generators are the cheapest way to combat hailstorms and can operate from one to three hours depending on the duration of the adverse weather process (Dimitrova, 2024).

The second group of recommendations is focused on the fruit farming sector. There are several improvements that can enhance sector performance and, consequently, the resilience of fruit farms to various types of risks. It is strongly recommended to improve the cooperation between representatives of the fruit farming sector and research and development institutions. According to Gould's (2012) open innovation model, an organisation should not exist in isolation from its surrounding environment. Active exchange of knowledge, ideas, and technologies with experts, scientific organisations, business partners and other stakeholders is essential for improving organisational

competencies and innovation potential – key factors for better market decisions and increased competitiveness (Gould, 2012).

The exchange of information between fruit farmers and various types of scientific organisations also improves the overall level of education among fruit farmers. In this regard, conducting various educational initiatives would help achieve a better understanding of the problems and effective practices for fruit farmers in the risk management process. In addition to the existing curriculum, universities and research centres could offer specialised courses, continuing education options, internships, and act as a connecting platform to enhance the exchange of experience and knowledge between sector representatives, scientific bodies and various business organisations.

At the sector level, several structural changes would have a positive effect on better management of the market and financial risks. Currently, most fruit farms operate autonomously, with a very low level of cooperation, despite the lack of precise information on the topic. According to the MZH (2023), successful cooperation and market entry would lead to a reduction in the cost of the final product. A high level of cooperation results in economies of scale, which are associated with lower fixed costs, as well as increased market power, helping stabilise purchase prices and profit margins (Rodríguez-Villalobos and García-Martínez, 2018).

The above-mentioned regulations and opportunities for the establishment of farmers' markets also contribute to strengthening vertical integration in fruit farming. Vertical integration is desirable because it would increase the control of fruit farmers over the entire supply chain – from the orchard, through storage of the produce, logistics/transport, and delivery to the end customers. Vertical integration and increased presence along the supply chain have numerous positive effects, such as improved ability to identify problems and proactively manage them (Partyká and Paiva, 2024).

Risk management should be a rational process. In this regard, fruit farmers should adhere to the core principle derived from Wolke’s (2007) model, where risk management is

presented as a process consisting of four consecutive steps (Fig. 1). Farmers would increase their efficiency if they followed the steps – identification, assessment, management and control – and made decisions based on the specifics of their farms, available resources, and various contextual factors. It is also recommended that farmers define a specific budget, which is feasible depending on the resource availability of the farm, as well as a wide range of indicators aimed at improving real-time monitoring and control over the processes. The risk management process should be viewed as a systematic activity.

Without going into specifics, the conclusions of the research suggest the need for improving the education of fruit farmers, as this is a key demographic factor for understanding the importance of risk management and making effective decisions in the field.

Individual fruit farmers, especially those responsible for large farms, should be proactive in managing market risks. The use of forward contracts is defined in Bulgarian legislation and can be applied to eliminate the negative effects arising from fluctuations in market prices of the final product.

The methodological limitations of the current study open space for important future research on the topic. Firstly, the study is limited to respondents from the Plovdiv region – a leading area in the field of fruit farming in Bulgaria. In this regard, it is important to include representatives from other traditional fruit-growing areas such as Kyustendil, Silistra, and other regions in the Upper Thracian Plain. An expanded scope for future research would contribute not only to access to more representative data, but also to a comparative assessment and more specific recommendations for each region.

Secondly, changes are also possible regarding the strategy for accessing primary data. The use of interviews would be an effective strategy for understanding the individual context of each fruit farmer (Saunders et al., 2009).

Thirdly, future research on the topic could apply other theoretical models and scientific approaches, such as the analysis of risks with cascading effects, which cannot be isolated

and affect various areas of management. Another direction could be focusing on extreme and extremely rare risks, such as "*black swan*" events, which are not anticipated by fruit farmers but would have catastrophic effects on farms if they materialise (Taleb, 2007). Risk management could also be analysed through the lens of stakeholder theory, where a more systematic analysis of the role, interests, and influence of various stakeholders – individuals and organisations – in the management of fruit farms and the associated types of risks would be needed (Freeman, 1984).

Finally, the dynamics of the environment make it necessary for research on risk management to be a periodic process. Regular studies would provide specific data on the performance of monitored fruit farms, allowing for an accurate assessment of their ability to manage risk, as well as areas for potential improvement.

CONCLUSION

The results of the dissertation cover various aspects of risk management in fruit growing. The main objective was achieved, as the study successfully identified and assessed the most important types of risk in fruit farming based on a large sample of participants with different profiles. The results indicate that the Bulgarian case is not an exception to the general trend, as fruit farms can be affected by various types of risk described in theory and empirical discussions. It can be concluded that all analysed risk groups are relevant for Bulgarian fruit growers, but the role of natural and market threats remains the most significant now. Therefore, it is important to focus on better management of these two risk groups while not underestimating other potential threats that may be significant for a given farm.

Risk management itself also depends on various factors, including the personal characteristics of farm owners, the specific features of orchards, and other considerations. Therefore, it is difficult to provide a clear assessment of the effectiveness of the risk management measures implemented in fruit farming, despite the recognised need for improvement in this area. Overall, it can be summarised that the current risk management

measures are insufficient and that improvements are possible. This results in significant losses for farmers, as well as an increased level of uncertainty – key obstacles to sustainable development. The specific characteristics of each farm and its exposure to specific types of risk should be considered as part of the management process.

The dissertation successfully identified useful solutions for improving the future process, which involves various stakeholders, addresses current weaknesses in the performance of different agents, and is based on solid empirical evidence from both primary and secondary data. The developed risk management model can serve as a roadmap for future research in the field and for the practical application of strategies. The data supporting the proposed theoretical framework also reinforces the notion that the risk management process is largely individual and depends on the specific context of a given farm and the role of the fruit grower, as previously mentioned.

The results of the empirical study also confirmed the initial main thesis of the research – risk management is an underestimated topic for fruit growers in Bulgaria. Current practices are primarily focused on managing traditional natural and biological risks, while the dynamic external environment is generating new and increasingly complex types of risk that cannot be ignored by fruit farmers. In this regard, improvements in risk management can contribute to enhancing the quality of management and the economic sustainability of fruit farms. Specific recommendations, supported by empirical data, are presented to facilitate future improvements at both the individual and sectoral levels.

Overall, risk management should consider opportunities for deeper collaboration among stakeholders. The role of universities is also significant in improving knowledge transfer to fruit growers. The introduction of forward contracts could substantially reduce market risk for farms by ensuring stable purchase prices. The state plays a crucial role in managing natural risks, particularly in hail protection and the development of efficient irrigation systems, which would be essential for better management of escalating climate risks. Access to various financial incentives, as well as a stable political and macroeconomic environment, also depends on government actions. Regarding the farms

themselves, their primary responsibility lies in systematically implementing the risk management process and improving their level of education in this area. At a structural level, introducing better horizontal and vertical integration in the fruit-growing sector would be a step toward enhancing the competitiveness of farms.

CONTRIBUTIONS

The dissertation has several key contributions, which are outlined in a separate chapter. Based on the results and conclusions achieved, four main contributions have been identified.

First, the study successfully highlighted the topic of risk management in agriculture, which is of growing importance in an unstable external environment and has been largely underestimated as an area of interest in academic research. The findings of the dissertation have generated new knowledge that helps bridge the gap between the need for better risk management in practice and the scientific contribution to improving the process. In this way, the research has benefited many stakeholders who are directly or indirectly affected by agricultural risk – farmers, suppliers and consumers of the final product, financial and insurance institutions, government bodies, academic institutions, and others.

Second, the dissertation successfully analysed the specific field of fruit growing—a sector of agriculture that has been largely unexplored in previous research in Bulgaria. By focusing on fruit farming, the study was able to thoroughly examine the sector's unique characteristics, the significance of different risk categories, existing risk management practices, and the intentions of fruit growers, which shape future trends and highlight the need for improvements. The extensive empirical data not only provided essential context but also enhanced the understanding of sector-specific trends. In this regard, the findings contributed to identifying key characteristics that would be crucial for implementing more effective management solutions to address the challenges in the industry.

Third, the proposed theoretical model encapsulates the most important conclusions regarding risk management in fruit growing. The framework is based on research data and

represents the first scientific attempt to map the key factors influencing risk management in the fruit-growing sector in Bulgaria. In this regard, the model can serve as a foundation for future studies on the topic, farm profile analysis, and more targeted risk management practices.

The final major contribution relates to the proposed improvements for future actions. These are empirically grounded recommendations that address the identified critical issues in risk management, offering a set of possible effective solutions. The recommendations also involve various stakeholders, including the role of the public sector. Each proposed solution is presented with specific details, enhancing the validity and practical value of the information in the context of Bulgarian fruit growers. In this regard, the dissertation successfully focuses on crucial aspects of potential improvements, based on scientific evidence and feasible solutions. These solutions consider both individual fruit farms and external factors such as the institutional environment, public policies, scientific and technological progress, and partnerships with organisations.

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