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Determination of Risk Factors in Beekeeping Enterprises Producing Geographically Indicated Kars Honey

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Abstract

Beekeeping, besides yielding honey and various bee products like propolis, beeswax, royal jelly, pollen, and bee venom, also plays an essential role in plant pollination, thereby enhancing plant production. Türkiye, with its rich diversity of plant species, holds a favorable position in beekeeping. Beekeeping activities are widespread across all regions of Türkiye, providing a means of livelihood for numerous families and serving as a connector between continents. Despite these favorable conditions, risk factors within the beekeeping sector pose challenges. This study aims to identify these risk factors within beekeeping enterprises in Kars Province. Data were gathered through face-to-face questionnaires with active beekeeping enterprise owners in Kars Province, affiliated with the Central Union of Beekeepers of Türkiye. The study included 70 enterprises, and factor analysis was used to identify risk factors, categorized into eight titles. Implementing appropriate strategies to mitigate the impact of these risk factors is crucial for the sustainability of the beekeeping sector in Kars Province.

Keywords: Beekeeping sector, enterprise, factor analysis, Kars Province, risk factors

Introduction

Beekeeping thrives in Türkiye due to its prolonged flowering season and diverse flora, positioning the country as a link between continents (Kekeçoğlu et al., 2007; TEPGE, 2022). The variation in flower and plant nectar across Türkiye's regions leads to the production of numerous honey types (Polat et al., 2023). Beekeeping serves as a significant source of income for many Turkish families (Sarıözkan et al., 2009). Despite Türkiye's substantial number of beehives and high honey production volume, the yield per hive and the production and exports of other beekeeping products remain below expectations (Kutlu, 2019).

Table 1 provides detailed data on the beekeeping sector in Kars province and Türkiye within the scope of the research (TURKSTAT, 2024).

According to Table 1, the number of beehives in Türkiye increased by 13.77%, and the amount of honey produced increased by 6.45% from 2018 to 2023. However, despite the rise in the number of beehives and honey production, there has been a 6.43% decline in the average honey yield per hive. This observation suggests that honey production is more influenced by the quantity of beehives rather than the yield per hive. It was observed that the number of beehives in Kars Province increased by 41.27% from 2018 to 2023, with a corresponding 6.45% rise in honey production. However, there was a 7.48% drop in honey yield per hive. Although the number of hives increased from 2020 to 2021 and 2022, there was a notable decrease in honey yield per hive during the same periods. This decrease can be attributed to various factors, including drought induced by global warming and climate change (Anadolu Agency, 2023), along with alterations in regional and operational conditions. However, when analyzing beekeeping data in Kars Province over six years (2018–2023), the honey yield per hive remains relatively stable, except for the years 2021 and 2022.

In addition, Table 1 shows that the percentage of honey produced in Kars Province relative to Türkiye's honey is 1.47% for the year 2023 (Table 1).

The volcanic rocks within the province contribute to the emergence of endemic plant species, setting Kars province apart from other regions with its potential for honey production, stemming from its diverse array of endemic plants. The qualities of honey and other beekeeping products originating from Kars Province differ from those found in other Turkish regions. Notably, the Bee Breeders' Association of Kars Province officially registered Kars honey on August 10, 2018, recognizing its geographical indication, distinctive branding, and unique characteristics compared to other areas. This honey holds significant branding value (Önk & Kılıç, 2014; GIP, 2023); thus, emphasizing the importance of honey and beekeeping products from Kars province within the Turkish beekeeping sector.

Enterprises encounter various risks within their operational domains, with these risk factors often sharing commonalities alongside differences across sectors.

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Table 1.
Data on the Beekeeping Sector in Türkiye and Kars Province Between 2018 and 2022

	Number of Beehives (Number)		Index		Amount of Honey Production (Tonnes)		Index		Honey Yield Per Hive (Kilogram/Number of Hives)		Index	
Years	**Türkiye**	**Kars Prov.**	**Türkiye**	**Kars Prov.**	**Türkiye**	**Kars Prov.**	**Türkiye**	**Kars Prov.**	**Türkiye**	**Kars Prov.**	**Türkiye**	**Kars Prov.**
2018	8 108 424	64 688	100.00	100.00	107 920	1294	100.00	100.00	13.31	20.00	100.00	100.00
2019	8 128 360	90 969	100.25	140.63	109 330	1819	101.31	140.57	13.45	20.00	101.06	100.00
2020	8 179 418	90 768	100.88	140.32	104 077	1815	96.44	140.26	12.72	20.00	95.60	100.00
2021	8 733 394	98 100	107.71	151.65	96 344	1147	89.27	88.64	11.03	11.69	82.88	58.46
2022	8 984 676	71 849	110.81	111.07	118 297	833	109.62	64.37	13.17	11.59	98.92	57.97
2023	9 224 881	91 386	113.77	141.27	114 886	1691	106.45	130.68	12.45	18.50	93.57	92.52

The beekeeping sector, the focal point of this study, stands out from other animal husbandry sub-sectors due to its reliance on plant presence and susceptibility to climatic influences (Çevrimli & Sakarya, 2018). Consequently, global warming and climate change constitute direct risk factors affecting the beekeeping sector. The escalating number of studies investigating the impacts of global warming and climate change on beekeeping in recent years underscores this reality (Alapala-Demirhan & Şahinler, 2019; Demirpolat et al., 2019; Flores et al., 2019; Fründ et al., 2013; Giannini et al., 2020; Gonzalez et al., 2024; Kutlu et al., 2019; Le Conte & Navajas, 2008; Oskay & Sönmez Oskay, 2023; Rahimi & Jung, 2024; Rai & Ravuiwasa, 2019; Reddy et al., 2012; Varalan & Çevrimli, 2023; Vercelli et al., 2021). Research suggests that global climate change disrupts the developmental cycle of honey bees, significantly impeding their ability to amass energy reserves and manage colonies when faced with temperature stress exceeding their adaptation threshold, ultimately leading to colony starvation (Le Conte & Navajas, 2008; Reddy et al., 2012).

Furthermore, apart from global warming and climate change, other risk factors prevalent in the beekeeping sector include emerging technical risks, the health status of queen bees within colonies, diseases, and risks associated with migratory beekeeping. Additionally, economic, financial, and marketing risk factors pose additional challenges within the beekeeping sector (Çevrimli & Sakarya, 2018; Çukur, 2014; Ellis et al., 2010; Pilati & Prestamburgo, 2016; Seğmenoğlu, 2018; Simeone-Finstrom et al., 2016; Söğüt et al., 2019; Van Engelsdorp et al., 2013; Varalan & Çevrimli, 2023; Wagner et al., 2019).

The aim of this study was to determine the risk factors encountered in beekeeping enterprises producing Kars honey, which is a geographically indicated product in Kars Province, from the production stage to the marketing stage.

Materials and Methods

Material

The coordinates of Kars Province are 40° 27′ 19.8″ north latitude and 43° 0′ 25.2″ east longitude. Kars Province is located in the Eastern Anatolian Region of Türkiye and is bordered by Erzurum Province to the west, Armenia to the east, Ağrı and Iğdır Provinces to the south, and Ardahan Province to the north. Kars Province comprises eight districts, including the central district, and the remaining districts are Akyaka, Arpacay, Digor, Kağızman, Sarıkamış, Selim, and Susuz (Demir, 2014; SERKA, 2023). The reasons for conducting this study in Kars Province are that honey is geographically indicated, has a branding feature, and has unique features compared to other regions.

The primary data for the research comprised information gathered through face-to-face questionnaires administered to owners of operational beekeeping enterprises in Kars province, affiliated with the Central Union of Beekeepers of Türkiye. Secondary data sources included reports and resources from the Apiculture Registration System, Turkish Statistical Institute, Kars Beekeepers Association, Kars Provincial Directorate of Agriculture and Forestry, along with relevant scientific studies on the subject.

Methods

Determination of the Number of Beekeeping Enterprises Included in the Sample

The research sample consisted of beekeeping enterprises registered with the Kars Provincial Directorate of Agriculture and Forestry and the Kars Beekeepers Association. Ethics committee approval was obtained from the Experimental Animal Production and Research Centre at Selçuk University's Faculty of Veterinary Medicine in the Republic of Türkiye (Meeting No: 2022/12, Approval No: 2022/113, Date: October 26, 2022). To determine the number of beekeeping enterprises included in the sample, the minimum number of enterprises was calculated (Fugard & Potts, 2015; Israel, 2009; Scheaffer et al., 2011). In the calculation, the research population was determined to be 610, and the minimum sample number was 61 when the confidence level was 90%. The formulas used in the calculation are presented below:

$$n_0 = \frac{z^2 \times p \times (1-p)}{d^2} = \frac{1.96^2 \times 0.5 \times 0.5}{(0.01)^2} = 67.24$$

$$n = \frac{n_0}{1+\frac{n_0}{N}} = \frac{67}{1+\frac{67}{610}} \approx 61$$

[Table value corresponding to the confidence level ($z = 1.64$); observation rate in the population ($p = .5$) (this rate is taken as 0.5, which gives the highest value when this rate is unknown), acceptable deviation tolerance ($d = 0.01$), N: population size, n: sample size].

In addition to the minimum sample number obtained in the calculation, 9 more enterprises were added to the sample, taking into account the problems that may exist in the data supply. Thus, the number of enterprises included in the research was 70. After the interviews with the Kars Provincial Directorate of Agriculture and Forestry and Kars Beekeepers Association, beekeeping enterprises were selected randomly.

Acquiring the Data
Within the scope of the research, questionnaire forms developed by the research team were used in face-to-face interviews with beekeeping enterprise owners. The data were obtained through the questionnaire forms used. The questionnaire was prepared at this point and consisted of questions aimed at identifying the risk factors faced by beekeeping enterprise owners in Kars Province.

Evaluation of the Data Acquired
The data obtained from face-to-face surveys conducted with beekeeping enterprise owners were transferred to a computer environment using the Statistical Package for the Social Sciences (SPSS) 25 (IBM Corp. Released, 2017) and Microsoft Office 2016 software.

To identify the risk factors encountered by beekeeping enterprises in Kars Province, a questionnaire consisting of 51 items was created in a 5-point Likert format (1: very risky, 2: risky, 3: neither risky nor risk-free, 4: risk-free, 5: no risk). The data were evaluated through the methods of exploratory factor analysis (EFA) and confirmatory factor analysis.

The dataset obtained during the research underwent an explanatory factor analysis utilizing SPSS 25 software. The suitability of the data for factor analysis was assessed by reviewing the correlation matrix. According to Hair et al. (1998), if a significant proportion of coefficients in the correlation matrix are below 0.30, EFA may not be appropriate. Acceptance of the main hypotheses indicates the suitability of variables for factor analysis. Additionally, the Kaiser–Meyer–Olkin (KMO) criterion, derived from correlation and partial correlation coefficients, plays a crucial role in evaluating data suitability for factor analysis. The KMO value, serving as a sample adequacy criterion, ranges from 0 to 1, with values below 0.5 indicating unsuitability for factor analysis (Cerny & Kaiser, 1977). Principal component analysis was utilized in this study to derive the factors. The appropriate number of factors was determined by considering factor selection criteria, specifically selecting those with eigenvalues exceeding one. Furthermore, factor rotation was conducted to elucidate the variables contributing to the formation of each common factor using the "varimax method."

In this study, both SPSS 25 and Analysis of Moment Structures 24 packages were employed to conduct confirmatory factor analysis. The aim of this analytical technique was to validate the structure or theoretical factor structure obtained as a result of EFA, as outlined in Brown's (2015) work.

Descriptive statistics for the variables in the study are the number of units (n) and percentage (%) values. In addition, the assumption of normality, one of the prerequisites of parametric tests, was examined with the Shapiro–Wilk test. The relationships between two continuous variables were evaluated with the Pearson correlation coefficient, and $p < .05$ was considered to indicate statistical significance (Cevahir, 2020).

Results

The risks faced by beekeeping enterprise owners were analyzed via factor analysis.

Initially, a questionnaire comprising 51 items was developed to evaluate the risk factors related to beekeeping (see Appendix 1). However, a total of 24 items (1, 2, 3, 5, 6, 8, 14, 17, 21, 24, 25, 29, 30, 32, 33, 35, 36, 42, 43, 47, 48, 49, 50, and 51) were subsequently excluded from the scale as they did not align with the underlying factor structure. The beekeeping risk factor scale included 27 questions.

The validity and reliability of the beekeeping risk factor scale are presented in Table 2.

When Table 2 was examined, the KMO and Bartlett's test values were examined to determine the suitability of the scale for factor analysis. Based on the significant outcome of Barlett's test ($p <$ .001) and the KMO value of 0.648, surpassing the threshold of 0.50, it was determined that the dataset was appropriate for factor analysis. The beekeeping risk factor scale consisted of eight factors, collectively explaining 73.96% of the total variability. Additionally, the Cronbach's alpha reliability coefficients of both the scale and its dimensions were also high.

The factors were designated based on the items categorized under them. Table 3 displays the factors' names along with their associated question items. The identified risk factors, as listed in Table 3, include various aspects such as "disease surveillance and control," "enterprise and regional risk factors," "economic, organization, and global risks," "financial risk factors," "queen bee and knowledge-related risks," "inadequate care and feeding conditions for bees," "risks associated with migratory beekeeping," and "marketing-related risks." Furthermore, the table presents the distribution of 27 items linked to these factors.

Table 4 illustrates the distribution of responses to the beekeeping risk factor scale questions. The scale comprises 27 items rated on a 5-point Likert scale (1: very risky, 2: risky, 3: neither risky nor risk-free, 4: risk-free, 5: no risk). Upon analysis, it is observed that 88.6% of enterprises perceive exchange rate fluctuations as very risky, while 87.1% view changes in the national economy and 71.4% regard price–quality ratio inadequacy as very risky. Regarding specific risks to beekeeping enterprises, 62.9% of beekeepers indicated no risk associated with neglecting autumn feeding and spraying due to their regular implementation of these practices. Additionally, 55.7% stated no risk of environmental pollution in their region, and 57.9% reported no risk concerning insufficient labor supply for beekeeping operations.

Discussion

In the results section, it is noted that certain questions were excluded from the research scale due to their inconsistency with the factor structure. This exclusion was attributed to the limited sample size. Specifically, it is suggested that studies with low sample sizes should employ scales with fewer questions for factor analysis (Büyüköztürk, 2002). The scale developed for this study contained a higher number of questions compared to the recommended minimum sample size. Reviewing the literature reveals differing opinions regarding the ideal sample size, with suggestions that common variance values

Table 2.
Validity and Reliability Results of the Beekeeping Risk Factor Scale

Factors	Item Number	Factor Loadings 1	2	3	4	5	6	7	8	Explained Variance %	Cronbach Alpha
Factor 1	4	0.867								8.23	0.756
	9	0.711									
	19	0.800									
Factor 2	7		0.828							7.54	0.708
	34		0.756								
	37		0.568								
Factor 3	10			0.911						11.52	0.840
	11			0.910							
	16			0.609							
	31			0.848							
Factor 4	12				0.812					8.90	0.825
	13				0.814						
	15				0.793						
Factor 5	18					0.747				10.03	0.816
	20					0.783					
	22					0.813					
	23					0.751					
Factor 6	26						0.749			8.70	0.822
	27						0.822				
	28						0.814				
Factor 7	38							0.841		10.55	0.841
	39							0.825			
	40							0.767			
	41							0.738			
Factor 8	44								0.871	8.49	0.808
	45								0.891		
	46								0.621		
Scale										73.96	0.857

Note: KMO = 0.648; Df = 351; $\chi^{2=}$1075.687; $p < .001$.
KMO = Kaiser–Meyer–Olkin test; Df = Degree of freedom.

should be high (>0.6) when the sample size is below 100 (Çolakoğlu & Büyükekşi, 2014). Consequently, several questions were omitted from the scale.

Details regarding the number of items utilized in the beekeeping risk factor scale, the quantity of factors, the proportion of factors explaining total variance, the reliability (Cronbach's alpha) value of the risk scale, and the KMO value were previously presented (see Table 2).

Other studies revealed 24 items on the scale in Ordu (Öztürk, 2013), 25 in Iğdır (Karadaş & Birinci, 2018), 30 in the nomadic beekeeping sector in Türkiye (Aksoy et al., 2022), and 27 in a different study conducted in Iğdır (Kaya & Kılıç Topuz, 2023). Furthermore, eight (Öztürk, 2013), eight (Karadaş & Birinci, 2018), ten (Aksoy et al., 2022), and seven (Kaya & Kılıç Topuz, 2023) risk factors were identified in these studies. When the results of the research were analyzed together with those of other studies, it was found that there was agreement between the number of items in the scales and the number of factors obtained from the factor analysis.

The percentage of factors explaining the total variance was 74.80% in the study of Kaya and Kılıç Topuz (2023), 74.48% in the study of Aksoy et al. (2022), 69% in the study of Karadaş and Birinci (2018), and 64.57% in the study of Öztürk (2013). The results of this study are similar to those of Aksoy et al. (2022) and Kaya and Kılıç Topuz (2023) and greater than those of Karadaş and Birinci (2018) and Öztürk (2013).

When analyzing the Cronbach's alpha and KMO values of previous studies, Öztürk (2013) reported values of 0.66 and 0.62, Aksoy et al. (2022) reported values of 0.53 and 0.57, and Kaya and Kılıç Topuz (2023) reported values of 0.61 and 0.54, respectively. It is noteworthy

Table 3.
Factors and Items Related to the Beekeeping Risk Factor Scale

Factors	Name of Factor	Item Number	Question Items
Factor 1	Disease Surveillance and Control	4	Low income from the beekeeping sector
		9	Failure to keep records in the enterprise
		19	Prevalence of bee diseases and pests
Factor 2	Risk Factors Arising from the Enterprise and Region	7	Inadequate tool-equipment assets of the enterprise
		34	Environmental pollution in your beekeeping area
		37	Too close proximity of apiaries to each other in accommodation during migratory beekeeping
Factor 3	Economic, Organization and Global Risk	10	Changes in the country's economy
		11	Rise in exchange rates
		16	Inadequate organization among producers
		31	Regional climate change caused by global warming
Factor 4	Risk Factors Arising from Finance	12	Inadequate credit facilities
		13	Changes in the interest rates of loans that can be obtained
		15	Increase in indebtedness of enterprises
Factor 5	Risk Factors Arising from Queen Bee and Knowledge	18	The productivity/adaptation level of the bee breed you breed in the region
		20	Insufficient knowledge in the fight against bee diseases and pests
		22	Use of old queen bees in hives
		23	The problem of obtaining quality queens for hives
Factor 6	Inadequate Care-Feeding Conditions of Bees	26	Inadequate care and feeding conditions of bees
		27	Neglect of autumn feeding and spraying
		28	Insufficient technical knowledge on beekeeping
Factor 7	Risk Factors Arising from Migratory Beekeeping	38	Exclusion from village land during migratory beekeeping
		39	Demand for high land prices in the hospitality region
		40	Colony losses during transport of beehives
		41	Inadequate labor supply related to beekeeping
Factor 8	Risk Factors Arising from Marketing	44	Insufficient product marketing opportunities for enterprises or beekeepers
		45	Products can not be sold at the desired time
		46	Inadequate quality/price relationship in products

that this study's reliability value (Cronbach's alpha) and KMO value are higher than those in other studies upon comparison of their findings.

In a study conducted in Ordu Province (Öztürk, 2013), *disease and* winter loss, a factor referred to as "disease," was similar to the *prevalence of bee diseases and pests,* a factor related to "disease surveillance and control," in this study, and the *increase in input costs* was similar to the *low-income item obtained from the beekeeping sector* in this study. In a study conducted on migratory beekeeping in Türkiye (Aksoy et al., 2022), *disease and* winter loss, which are associated with disease, were similar to the *prevalence of bee diseases and pests* in this study. A study carried out in northern Ethiopia revealed that the income generated from beekeeping was typically inadequate to support households (Yirga & Teferi, 2010). This result was found to be compatible with the low income of the beekeeping sector in the present study. Again, a study conducted in Western Uganda highlighted that diseases and pests pose a significant constraint for beekeeping in the region (Mujuni et al., 2012). This finding is consistent with the prevalence of bee diseases and pests observed in the present study.

The *inadequate tool and equipment assets of the enterprise* in the factor named "risk factors arising from the enterprise and the region" were included in the factor named "policies" as the item for *lack of technical equipment* in Ordu Province (Öztürk, 2013). In another study, it was observed that *a lack of technical equipment* was a factor referred to as "technical knowledge" (Aksoy et al., 2022). The item in this study is compatible with the items in Öztürk (2013) and Aksoy et al. (2022) but differs in terms of factor nomenclature. In a study conducted in Iğdır Province, *the lack of technical equipment* corresponding to this item was included in the factor "enterprise conditions," which is compatible with this study (Karadaş & Birinci, 2018). In this study, the item regarding *environmental* pollution in the beekeeping region was found to align with similar items from other studies. Specifically, in a study conducted in Ordu Province, this item was categorized under the factor "yield" (Öztürk, 2013). Conversely, in a study on migratory beekeeping, the same item was classified under the factor "disease" (Aksoy et al., 2022). However, in a study conducted in Iğdır, the item *on the effect of environmental pollution* was placed under the factor "enterprise conditions," exhibiting compatibility with our study (Karadaş & Birinci, 2018). Additionally, in studies

Table 4.
*Distribution of the Beekeeping Risk Factor Scale Questions**

		Frequency ($n = 70$) n (%)				
Risk Factors	**Question Items**	**1. Very Risky**	**2. Risky**	**3. Neither Risky Nor Risk Free**	**4. Risk-Free**	**5. No Risk**
Disease Surveillance and Control	Low income from the beekeeping sector	18 (25.7)	24 (34.3)	17 (24.3)	5 (7.1)	6 (8.6)
	Failure to keep records in the enterprise	13 (18.6)	23 (32.9)	5 (7.1)	7 (10)	22 (31.4)
	Prevalence of bee diseases and pests	28 (40)	22 (31.4)	9 (12.9)	6 (8.6)	5 (7.1)
Risk Factors Arising from the Enterprise and Region	Inadequate tool-equipment assets of the enterprise	8 (11.4)	20 (28.6)	7 (10)	6 (8.6)	29 (41.4)
	Environmental pollution in your beekeeping area	10 (14.3)	12 (17.1)	7 (10)	2 (2.9)	39 (55.7)
	Too close proximity of apiaries to each other in accommodation during migratory beekeeping	28 (40)	19 (27.1)	5 (7.1)	6 (8.6)	12 (17.1)
Economic, Organization and Global Risk	Changes in the country's economy	61 (87.1)	6 (8.6)	1 (1.4)	0 (0)	2 (2.9)
	Rise in exchange rates	62 (88.6)	4 (5.7)	2 (2.9)	2 (2.9)	0 (0)
	Inadequate organization among producers	46 (65.7)	14 (20)	3 (4.3)	3 (4.3)	4 (5.7)
	Regional climate change caused by global warming	47 (67.1)	16 (22.9)	4 5.7)	1 (1.4)	2 (2.9)
Risk Factors Arising from Finance	Inadequate credit facilities	28 (40)	16 (22.9)	5 (7.1)	3 (4.3)	18 (25.7)
	Changes in the interest rates of loans that can be obtained	29 (41.4)	18 (25.7)	8 (11.4)	2 (2.9)	13 (18.6)
	Increase in indebtedness of enterprises	36 (51.4)	14 (20)	5 (7.1)	4 (5.7)	11 (15.7)
Risk Factors Arising from Queen Bee and Knowledge	The productivity/adaptation level of the bee breed you breed in the region	14 (20)	7 (10)	6 (8.6)	7 (10)	36 (51.4)
	Insufficient knowledge in the fight against bee diseases and pests	26 (37.1)	12 (17.1)	7 (10)	6 (8.6)	19 (27.1)
	Use of old queen bees in hives	20 (28.6)	13 (18.6)	6 (8.6)	11 (15.7)	20 (28.6)
	The problem of obtaining quality queens for hives	21 (30)	11 (15.7)	3 (4.3)	4 (5.7)	31 (44.3)
Inadequate Care-Feeding Conditions of Bees	Inadequate care and feeding conditions of bees	4 (5.7)	16 (22.9)	11 (15.7)	8 (11.4)	31 (44.3)
	Neglect of autumn feeding and spraying	7 (10)	11 (15.7)	5 (7.1)	3 (4.3)	44 (62.9)
	Insufficient technical knowledge on beekeeping	5 (7.1)	13 (18.6)	20 (28.6)	6 (8.6)	26 (37.1)
Risk Factors Arising from Migratory Beekeeping	Exclusion from village land during migratory beekeeping	25 (35.7)	14 (20)	4 (5.7)	4 (5.7)	23 (32.9)
	Demand for high land prices in the hospitality region	22 (31.4)	9 (12.9)	10 (14.3)	5 (7.1)	24 (34.3)
	Colony losses during transport of beehives	5 (7.1)	5 (7.1)	9 (12.9)	15 (21.4)	36 (51.4)
	Inadequate labor supply related to beekeeping	14 (20)	9 (12.9)	6 (8.6)	4 (5.7)	37 (52.9)
Risk Factors Arising from Marketing	Insufficient product marketing opportunities for enterprises or beekeepers	42 (60)	15 (21.4)	5 (7.1)	1 (1.4)	7 (10)
	Products can not be sold at the desired time	42 (60)	15 (21.4)	4 (5.7)	2 (2.9)	7 (10)
	Inadequate quality/price relationship in products	50 (71.4)	8 (11.4)	3 (4.3)	1 (1.4)	8 (11.4)

Note: *Summary statistics are given as number (percentage) values.

conducted in Western Uganda and the Manyara region in Tanzania, a lack of equipment was identified as a significant constraint in beekeeping (Mujuni et al., 2012; Namwata et al., 2013). These findings are congruent with our study's item addressing inadequate tool and equipment assets within the enterprise.

The "economic and natural conditions" factor in a study conducted in Ordu Province (Öztürk, 2013) and the "economic structure and natural conditions" factor in a study conducted throughout the migratory beekeeping sector in Türkiye (Aksoy et al., 2022) are similar to the "economic, organization and global risk" factor in this study. The unfavorable climatic conditions in the study conducted in Ordu Province are compatible with the regional climate change caused by global warming in this study, and the changes in the economic situation of the country are compatible with the changes in the economy of the country in this study. However, the item on organization in this study differed in that it was not included in the study conducted in Ordu Province (Öztürk, 2013). This may be because the need for organization in Kars Province is greater than that in other provinces. In a study conducted on migratory beekeeping in Türkiye, the following factors differed from those in this study: increased input costs, losses due to wild animal

attacks, and inability to obtain credit (Aksoy et al., 2022). Another study emphasized that global warming and climate change are important restrictive factors for the beekeeping sector (Wakgari & Yigezu, 2021). Again, in a study conducted in Ethiopia, aridity constitutes the primary constraint for beekeeping in the region (Abebe & Puskur, 2011). These situations are similar to the unfavorable climatic conditions caused by global warming observed in the present study. According to a study conducted in Tanzania, the beekeeper organization model is not yet sufficient, and existing models have not yet been tested (MMA, 2007). These findings are similar to the finding of *insufficient organization among producers* in our study.

Upon examination of the "risk factors arising from finance," it was observed that items categorized under this factor in our study align with similar factors in other research. Specifically, in a study conducted in Ordu Province (Öztürk, 2013), these items were grouped under the "policies" factor, while in studies conducted in Iğdır Province (Karadaş & Birinci, 2018) and specifically on migratory beekeeping in Türkiye (Aksoy et al., 2022), they were associated with factors such as "indebtedness" and "policies," respectively. *Changes in interest rates* reported in the Ordu Province study, *instability in interest rates* in the migratory beekeeping study, and fluctuations *in interest rates* in the Iğdır Province study were found to be analogous to *the* item addressing *changes in loan interest rates* in our study. Furthermore, *the increase in debt* documented by Aksoy et al. (2022) and Karadaş and Birinci (2018) correlates with *the* increased *indebtedness of enterprises* in our study. Additionally, *the item* concerning loan acquisition *status* in the Ordu Province study corresponds to the inadequacy *of credit facilities* in our research. Despite variations in factor names across studies, there is general consistency among the items. Furthermore, in a study investigating barriers to commercialization in the beekeeping sector in Tanzania (Tutuba & Vanhaverbeke, 2018), it was noted that many beekeepers lacked access to funds or financial services for beekeeping investment, which aligns with the inadequate credit facilities item in our study. Similarly, another study in Tanzania highlighted the presence of small-scale beekeeping enterprises (MMA, 2007), further supporting our findings regarding the constraints faced by beekeeping enterprises.

In this investigation, the aspect referred to as "risk factors stemming from the queen and her knowledge" was identified as distinct from findings in other research. The said factor and its associated elements were not observed in other studies regarding their congruence (Aksoy et al., 2022; Karadaş & Birinci, 2018; Öztürk, 2013). This discrepancy might stem from the nature of queries posed to the proprietors of beekeeping enterprises or the unique risk factors encountered by beekeeping enterprise proprietors in the Kars region in comparison to their counterparts in other regions. An analysis of bee colony mortality in the USA during 2007–2008 revealed that inferior-quality queens were among the top five mortality causes (Van Engelsdorp et al., 2008). Moreover, research by Van Engelsdorp et al. (2013) in the eastern USA determined that issues related to queen failure and the failure to successfully replace queens amplified the risk of colony loss by 3.1 times (Van Engelsdorp et al., 2013). The factor "inadequate care-feeding conditions of bees" was analyzed; although the *nutrient deficiency* item in the study conducted in Ordu Province was similar to the *inadequate care and feeding conditions of bees* item in this study, the *nutrient deficiency* item in Ordu Province was included in the factor "enterprise conditions." Again, in a study conducted in Ordu Province, although the item *for lack of technical knowledge* was compatible with the item for *insufficient technical knowledge on beekeeping* in this study, it differed from that in a study conducted in Ordu Province because this item was included under the factor "technical knowledge and debt" (Öztürk, 2013). In a study conducted on migratory beekeeping in Türkiye, although *nutrient deficiency in the hive* was compatible with *inadequate care and feeding conditions for bees* in this study, it differed from that in the present study because *nutrient deficiency in the hive* was included in the factor "climatic conditions" (Aksoy et al., 2022). A study of beekeepers in northern Ethiopia revealed that a lack of beekeeping knowledge and skills is a problem affecting honey production (Yirga & Teferi, 2010). Again, in a study conducted in Western Uganda, lack of knowledge and skills was found to be a constraint for beekeeping in the region (Mujuni et al., 2012). The results of studies conducted in northern Ethiopia and western Uganda are consistent with the *insufficient technical knowledge on beekeeping*. Additionally, a study in Ethiopia reported inadequate bee feed as a constraint for beekeeping (Abebe & Puskur, 2011). This finding is consistent with the *inadequate care and feeding conditions of bees*.

Compared with other studies, the "labor force" factor in the study conducted in Ordu Province and the "labor force" factor in the study conducted on migratory beekeeping (Aksoy et al., 2022; Öztürk, 2013) were found to be associated with inadequate labor supply related to beekeeping and "risk factors arising from migratory beekeeping." Again, in a study conducted in Iğdır, this item was included under the factor "provision of external services" as *the external labor shortage* item and under the factor "social and human capital" as *the family labor shortage* item (Karadaş & Birinci, 2018). In general, although the item of *inadequate labor supply related to beekeeping* is compatible with other studies, the factor nomenclature of the item has differed. Other subitems of this factor were not found in other studies. This may be due to the presence of beekeeping enterprise owners in the province or the lack of question items similar to those used in other studies. A study conducted in Western Uganda concluded that a labor shortage is a constraint for the beekeeping sector (Mujuni et al., 2012). This result is consistent with *the inadequate labor supply related to beekeeping* in the present study. In another study, attention was given to the loss of colonies during the transport of beehives (Hristov et al., 2020). This finding is in line with the *colony losses that occurred during the transport of beehives* in the present study.

In the study, the aspect identified as "risk factors arising from marketing," also known as factor 8, showed compatibility with the "insufficient marketing opportunities" item under the "enterprise conditions" factor found in the research conducted in Ordu Province, albeit with a difference in the naming of factors (Öztürk, 2013). Furthermore, the factor labeled "marketing" in the research on migratory beekeeping enterprises in Türkiye aligned with this study. Nevertheless, the specific items associated with this factor varied. This variation may be attributed to the items related to marketing being more narrowly defined in this study, whereas in the other research, they were categorized more broadly under marketing problems (Aksoy et al., 2022). In the research carried out in Iğdır, the issue of *insufficient marketing opportunities* was found to be in agreement with the lack of *marketing opportunities for enterprises*

or beekeepers as observed in this study. However, in the Iğdır study, this issue was classified under the "enterprise conditions" factor, marking a difference (Karadaş & Birinci, 2018). A study in Northern Ethiopia identified marketing problems as a significant issue for the beekeeping sector, which was consistent with the findings of this study (Yirga & Teferi, 2010). In research examining factors influencing the success of beekeeping programs in developing countries, over 80% of participants recommended measures to ensure market stability and highlighted the need to address issues such as market unpredictability and inefficiencies within the honey value chain (Nat Schouten & John Lloyd, 2019). The outcomes from Nat Schouten and John Lloyd (2019) resonated with those of this study.

Within a broad framework, the identification of shared risk factors across this study and those discussed in the article's discussion section is notable. These risk factors delineate the general hazards prevalent in the beekeeping sector. In both this research and others, common risk factors such as diseases, climatic conditions, economic and financial conditions, marketing conditions, technical knowledge, and operating conditions were identified.

Similar to this research, studies have been conducted to identify risk factors in beekeeping enterprises across various regions. However, no research focusing on identifying risk factors for enterprises producing honey in Kars was found in the literature review. This absence underscores the significance of the current study. The support from the Ministry of Agriculture and Forestry, along with the Kars Provincial Directorate of Agriculture and Forestry, and the candid responses from enterprise owners in the province, lend strength to this study. Due to the sample of enterprises selected for factor analysis not meeting the required quantity relative to the number of questions on the scale, some questions were omitted from the scale. This limitation is acknowledged as a drawback of the study and should be considered in future research similar to this investigation.

Conclusion and Recommendations

The risk factors elucidated in this study pose a threat to the sustainability of beekeeping in the province. Thus, implementing appropriate strategies is crucial for ensuring the sector's sustainability.

Disease surveillance and control have been pinpointed as significant risk factors in beekeeping, with colonies being susceptible to various diseases that lead to losses. Incorrect practices stemming from misinformation not only fail to benefit enterprises but also introduce additional costs by exacerbating risk factors. To mitigate this, beekeepers could be offered both theoretical and practical training on disease management, thereby reducing losses for producers.

The transmission of diseases can be curtailed by either limiting the movement of hives in migratory beekeeping or by increasing the spacing between hives, thereby facilitating controlled and manageable beekeeping practices. Furthermore, should migratory beekeeping be pursued, it is advisable to ensure that it occurs within a restricted regional area.

Regarding colony management, an expected decrease in honey yield per hive occurs when a colony is in the process of replacing its queen. By applying appropriate strategies at this juncture, the adverse effects of the risk factors associated with queen bees and knowledge, as identified in the study, can be minimized.

In Kars Province, various factors create "marketing risk" in the province. Enterprise owners in the province are more hesitant about the production of byproducts such as pollen other than honey in beekeeping. The economic income of beekeeping enterprise owners can be increased by enabling them to produce not only honey but also other byproducts. In addition, to facilitate product marketing, producers need to brand their products and conduct advertisements for this purpose.

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Appendix 1. Beekeeping Risk Factor Scale

Please tick each of the following risk factors that you face in the beekeeping sector from production to marketing stage between 1 and 5 as appropriate for you.	1: Very Risky	2: Risky	3: Neither Risky nor Risk Free	4: Risk-Free	5-No Risk
Socio-Economic Factors					
1. High average age of beekeepers					
2. Low experience period of beekeepers					
3. Beekeeping as an additional job					
4. Low income from the beekeeping sector					
5. Continuation of traditional beekeeping					
6. The state of the infrastructure in your beekeeping region (transport, etc.)					
7. Inadequate tool and equipment assets of the enterprise					
8. Use of nonstandard equipment					
9. Failure to keep records in the enterprise					
10. Changes in the country's economy					
11. Rise in exchange rates					
12. Inadequate credit facilities					
13. Changes in the interest rates of loans that can be obtained					
14. Changes in input prices					
15. Increase in indebtedness of enterprises					
16. Inadequate organization among producers					
17. Inadequacy of co-operatives/unions in supporting producers					
Technical Factors					
18. The productivity/adaptation level of the bee breed you breed in the region					
19. Prevalence of bee diseases and pests					
20. Insufficient knowledge in the fight against bee diseases and pests					
21. Challenges in accessing expert personnel to diagnose and treat bee diseases and pests					
22. Use of old queen bees in hives					
23. The problem of obtaining quality queens for hives					
24. Losses incurred during winterization					
25. Technical errors made by the producer in winterization					
26. Inadequate care and feeding conditions of bees					
27. Neglect of autumn feeding and spraying					
28. Insufficient technical knowledge on beekeeping					
Environmental and Climatic Factors					
29. Insufficient nectar flow in nature for bees					
30. Vegetation condition for beekeeping in your region					
31. Regional climate change caused by global warming					
32. Extreme cold weather					
33. Drought					
34. Environmental pollution in your beekeeping area					
35. Untimely unannounced use of pesticides and agrochemicals by farmers					
Factors Related to Migratory Beekeeping					
36. Widespread migratory beekeeping is prevalent in your area.					
37. Too close proximity of apiaries to each other in accommodation during migratory beekeeping					
38. Exclusion from village land during migratory beekeeping					
39. Demand for high land prices in the hospitality region					

Please tick each of the following risk factors that you face in the beekeeping sector from production to marketing stage between 1 and 5 as appropriate for you.	1: Very Risky	2: Risky	3: Neither Risky nor Risk Free	4: Risk-Free	5-No Risk
40. Colony losses during transport of beehives					
41. Inadequate labor supply related to beekeeping					
42. Hive theft in stationary-migratory beekeeping in your region					
Factors Related to Marketing					
43. Residue problem in honey					
44. Insufficient product marketing opportunities for enterprises or beekeepers					
45. Productscan not be sold at the desired time					
46. Inadequate quality/price relationship in products					
47. Unfair competition in the honey market					
48. Wholesalers/firms setting low prices in honey purchase					
49. Cooperatives and/or provincial unions are not effective in honey marketing					
50. Insufficient promotion and advertising of Kars honey					
51. Insufficient level of branding in Kars honey					