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Evaluation and Ranking of Citrus Gardens' Risks Using TOPSIS Method (Case Study: East of Mazandaran Province)

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Abstract

Citrus production has a great importance and position in Iran. The growth and sustainability of the agriculture sector is impossible without appropriate and effective risk identification and management. In this study, the main risks of citrus gardens were identified based on the Delphi method through questionnaires completed by 16 experts. Then, using the TOPSIS technique, the risks involved in the horticultural industry of Mazandaran Province were prioritized during 2010-2016 and the most important risk of Mazandaran gardens was selected based on the Shannon unweighted entropy matrix. The results showed that the most important horticultural risks were related to the risks of pests and diseases, price, damage, and production, respectively. In addition, the lowest risks were related to technical, labor and credit risks, respectively. Therefore, the results indicated the significant influence of the risks of pests and diseases, price and loss in horticulture. Among the risks of pests and diseases, mealy bugs, red mites and aphids with 76, 73 and 70 percent, respectively, were of the highest risk and risks arising from financing, purchasing the product and the damage caused by drip irrigation and emitters were of the lowest risk. The risk exposure represented that risk management should be considered in these fields. In this regard, it is essential to make major reforms in risk management areas involved in orchards. Thus, the planners and policymakers must consider this issue.

Keywords:
risk, TOPSIS technique, weighted Shannon Entropy, citrus, Mazandaran

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INTRODUCTION

Due to the increased uncertainty in the agricultural sector and some complications such as natural disasters, pests and diseases, fluctuations in market supply and demand, market price fluctuations of agricultural products, changes in technology, etc., the Agricultural Products Insurance Fund had to insure crops against these factors in order to reduce vulnerabilities and increase the yield of agricultural crops. These uncertainties and risks have led to raise the issue of risk management in the agricultural sector. Risks may have a significantly negative effect on the short-term yield of agricultural products. Therefore, risk management of agricultural products is essential to reduce the variability in the yield of agricultural crops caused by various risks. Risk management involves identifying, assessing, and ranking various risks, and risk ranking is a key part of the process, as each ranking determines the superiority of each risk against other risks and therefore, the decision maker can plan to deal with any risk.

Sources of risk in agriculture encompass production risk, price or market risk, financial risk, institutional risk or risk due to the lack of confidence in government activities in the agricultural sector and human risk. As well, the role and importance of each source of risk is different in each country according to place, time and government policies (Kiyani Rad &Yazdani, 2003). The production risk results from processes that affect the normal development of the product and cause changes in the quality and quantity of product.

Mazandaran Province, as compared to other provinces, has two kinds of weather, and precipitation and temperature are two main elements of the regional climate. In addition, due to geographical location, climatic conditions and soil type, the province has a variety of vegetation such as dense forest, meadow and steppe, and its average precipitation is almost twice as great as the average rainfall of the country (Agriculture Organization of Mazandaran Province, 2014). A part of this province is covered with Caspian temperate climate with annual rainfall of 977 mm due to the little distance of mountains, sea, and humidity. Another part is covered with moderate mountainous climate towards the northern slopes of Alborz Mountains and the distance from the sea, which implies a reduction in annual rainfall and average temperature. The average rainfall of the province is 600 mm. Based on the statistics of 2013 to 2014 growing season, the Mazandaran Province has 63 percent of cultivated area and 47 percent of the weight production, that is, by allocating 112,000 hectares of citrus cultivated area, is in the fourth place, and by producing 1815.23 tons, it has the first rank in country (Agriculture Organization of Mazandaran Province, 2014).

Multi-criteria decision-making (MCDM) models are effective tools to make appropriate decisions. One feature of this method can be pointed to the spectrum ranking of criteria associated with a scoring by experts and interest groups that use a series of techniques, including total weighting or convergence analyses (Higgs, 2006). MCDM can be divided into two broad categories of multi-attribute decision-making (MADM) and multi-objective decision making (MODM), as MADM is one of the most common growing methods during the last decades, which has been widely used in real decision situations. This method is based on finding the best alternative among possible alternatives according to relevant weights, which are evaluated by several quantitative and qualitative indicators. MODM deals with selecting the best alternatives based on a series of more or less incompatible objectives. Several MADM methods have been developed to assess the weights of criteria available in a decision and choose a preferred alternative, including entropy method, least weighted square, analytical hierarchy process (AHP), and TOPSIS (Asgharpur, 2006). MADM methods are divided into two groups: methods that are based on ranking alternatives, which are known as ranking methods, including AHP and TOPSIS and methods that do not necessarily lead to the ranking of alternatives and they are on the basis of rank-priority relationships, which are referred to as outranking methods, including Electre and Prmothee. Among the eight compensatory multi-criteria evaluation methods, TOPSIS has the lowest deficit in the ranking of alternatives. The features of this method, as compared to other ranking methods, include the simultaneous use of objective and subjective criteria, the involvement of both quantitative and qualitative criteria in positioning, determining the priority of alternatives and expressing priorities quantitatively, the consideration of the conflict and agreement between criteria, and the full compliance of results with experimental methods. This method was first introduced by Hwang and Yoon (1981) and was modified over time. It became popular among managers and planners as one of the best and most accurate MADM techniques, and with modern computers, it was made accessible and implementable in many new fields. In Iran, TOPSIS has been used from the early 1990s finitely with functional spectrums in the areas of feasibility, prioritization and performance appraisal. The risk ranking of crops using TOPSIS does not have a long history in economics and agriculture and it is a new topic. More research has been done in other areas, especially in the fields of industrial engineering, management and geography than in agriculture. Thus, some of the most empirical studies conducted both inside and outside the country are analyzed. Recently, several studies have been carried out on the ranking and prioritization of various sectors. There has been no study on the risk ranking of agricultural products, especially oranges, through the TOPSIS ranking technique. The present study deals with it. The following domestic and foreign studies can be noted.

The theoretical foundation of TOPSIS has been provided in some studies, including Asgharpour (2006), Chena and Larbanib (2006), Chu and Lin (2003), Ghatee and Mohades (2009), Simonovic and Vermab (2008), Tsou (2008), Wang et al. (2007), You and Ding (2005). A study was conducted to extend TOPSIS to group decision-makings. The results indicated that TOPSIS was much stronger and more effective than other models (Hsu-Shin Shin et al., 2007).

A study showed no logical relationship between the extent of public green spaces (parks) and urban management performance. Urban management in the indices studied in local and regional parks was more favorable than in the regional and neighborhood parks; however, in some indices, the urban management of the performance of neighborhood and regional parks was appropriate. As one of MADM methods, TOPSIS was used to achieve different economic, social, and environmental criteria (Khakpour et al., 2010).

In Azarshahr, the processing and supplementary industries of agriculture were prioritized by a descriptive-analytic method and a hybrid Delphi and TOPSIS technique. The results indicated that processed dairy product industries should be at the first priority due to the overproduction, rapid perishability of these products, and then, the processing and supplementary industries of orchard products must be prioritized due to their important role in the efficient use of agricultural products (Zaheri et al., 2015). A study on Japanese farmers showed that the biggest production risk was fluctuations in market prices caused by excess supply and lack of market information (Phuson et al., 2003). First, the weight of financial ratios was extracted using fuzzy AHP. Then, banks were ranked through the TOPSIS method. The results showed that the banks were more successful in practice and were ranked higher (Yalkin & Bayrakdaroglu, 2009). In another study, it was found that in Nigerian farmers' view, the main sources of risk were output price and then input price. Other sources of risk included drought, pests and diseases, lack of access to capital and theft, respectively

(Alimi & Wall, 2005). In a study, it was shown that TOPSIS was an effective, appropriate and capable ranking method to assess and rank risks in different areas of agriculture, industry, oil, and services and that this method was less time-consuming and more accurate than other ranking methods (Mohammadi, 2011). In another study, the goals of Tonekabon's woodman herders were ranked using fuzzy logic and simple ranking methods. Then, the herders' lack of interest for cooperation was examined by data collected using a questionnaire and the position of the national destination of forest conservation was determined within two simple and fuzzy ranking methods. Ranchers were asked to prioritize ten goals identified to protect the forests. The findings indicated that ranking by two methods in different groups were almost identical except for a group of ranchers. The main purpose of ranchers was to deal with or avoid the risk of low-income years and the least important goal was forest conservation. This reflected a conflict between personal goals and national destination of forest conservation (Zibaie & Telkani, 2010). The majority of empirical studies carried out in Iran on risk ranking using the TOPSIS method is concerned with optimal investment strategies and financial and ecological plans in geography. In this regard, no study has been conducted on the risk ranking of agricultural products, especially citrus orchard. Therefore, this study attempts to address the importance and ranking of agricultural risks in citrus orchard in Mazandaran Province by the TOPSIS method and learn more about this method and the risks identified by the experts as well as answer these questions:

1. How is the weight of the risks involved in citrus orchards in Mazandaran Province?
2. What are the most influential and important risks involved in Mazandaran citrus orchards?

MATERIALS AND METHODS

This study was a descriptive survey research and an applied one. Therefore, one of the main factors of fluctuations in orange crop yield is the existence of various risks in the citrus gardens and the risks are not the same in all regions where the product is planted. A variety of risks are involved in the citrus gardens and orchardists are mostly ignorant of them. The study

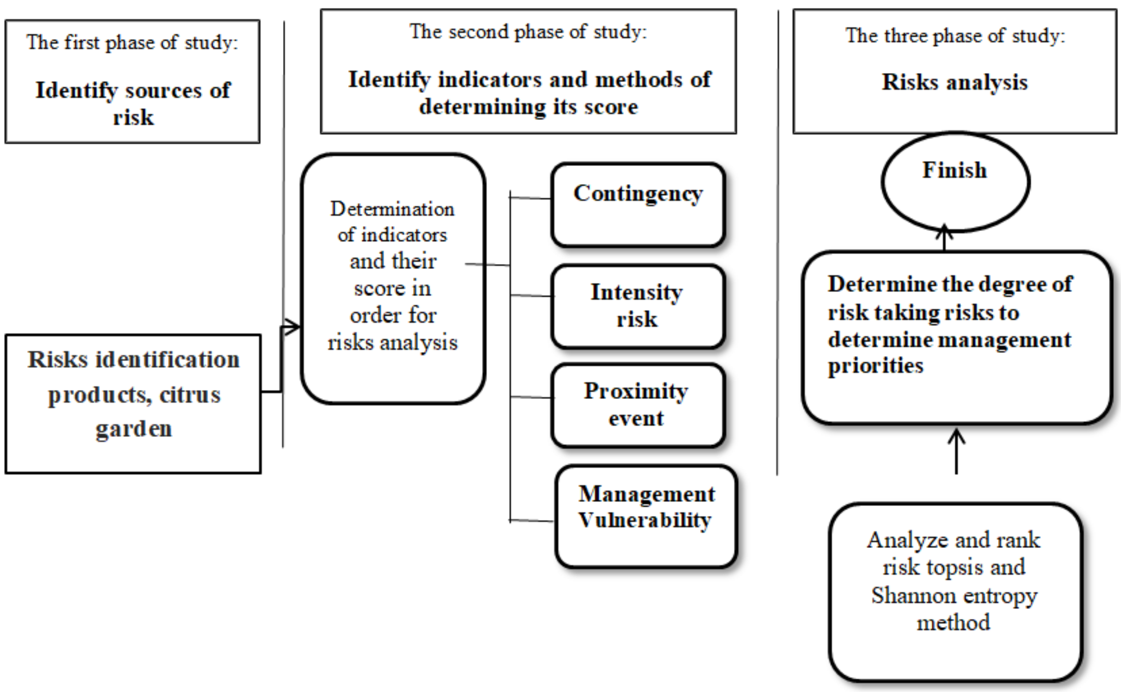

Figure 1. Stages of risk assessment and ranking of citrus groves in Mazandaran Province in 2016

sought to identify the risks by the relevant experts based on the Delphi approach and rank them using the TOPSIS technique in order to identify the main risks of citrus gardens and their impacts on the orange crop yield. In general, the risk assessment, which was carried out from 2010 to 2016, includes three stages. In the first stage, the sources of risks are identified; the second stage is to select criteria and score the risks; and the final stage is to rank and determine the degree of risk-takings using the TOPSIS technique. The data collection method and the study region are also described.

The present model resulted from the study of the theoretical foundations of research through which the risk dimensions and criteria of orange crop in the gardens of Mazandaran Province were derived, and then, the remarkable notes were considered by reviewing and modifying the existing criteria, the model's criteria were selected, and some new criteria were also designed. The selected criteria and dimensions were studied and the most important criteria were selected by experts. These criteria were the orange crop risks of citrus gardens in Mazandaran Province.

Data collection

In this study, the data used for identifying the risks of orange crop were collected in a field study by a self-designed questionnaire completed by the experts and horticulturists of the horticulture sector of Agricultural Jihad Organization of Mazandaran Province In this study, the Delphi approach was used and the population consisted of all knowledgeable experts who had valuable experience in risk management and orange orchards. Hence, 16 experts of the horticulture sector of Agricultural Jihad Organization, the horticulturists and experts of orange orchards were studied. The original questionnaire was designed for the level of expertise. It is noteworthy that orange was chosen due to its strategic position and based on its most production and cultivated area among other citrus products, that is, among the garden products of the region, a product that had the highest area under cultivation and production were selected as the most important horticultural crop. The applied variables have been answered including statistics of identified risks according to the experts' idea with four criteria the probability of occurrence, damage rate,

Table 1
Index of Risk Occurrence Probability

Probability of occurrence	The definition of risk occurrence probability	Score
Scarce	The incident does not happen or happens at most once five years.	P<10%
Impossible	Although the likelihood of an accident is possible, but this incident will not happen in the present or will happen at most once three years.	10%<P<30%
Possible	It happens at least every two years.	30%<P<50%
Probable	Event happens on a regular basis and can be expected to happen once a year on a regular basis.	50%<P<70%
Very probable	Accident happens several times a year.	P>70%

Table 2
Index of risk damage intensity rate

Intensity	The definition of damage intensity rate	Score
Slightly	Crop damage is very small	P<10%
Minimal	Crop damage is small	10%<P<30%
Average	Crop damage is average	30%<P<50%
Hard	Crop damage is hard	50%<P<70%
Very hard	Damage resulted in the loss of whole crop.	P>70%

Table 3
Index of the Closeness of Risk Occurrence

The closeness of occurrence	The definition of closeness of occurrence	Scores based on the Likert scale (1-5)
More than once a year	When the risk occurs during a year.	1
Between in 1-2 years	When the risk occurs every other year.	2
Between in 2-3 years	When the risk occurs every two years in between.	3
Between in 3-4 years	When the risk occurs every three years in between.	4
More than four years.	When the risk occurs every four years or more in between.	5

Table 4
Index of Risk Manageability

Manageability	The definition of manageability	Scores based on the Likert type scale (1-5)
Very easy	The risk is too easy to be managed.	1
Easy	The Risk is easy to be managed.	2
Average	The Risk is relatively hard to be managed	3
Hard	The Risk is hard to be managed.	4
Very hard	The Risk is very hard to be managed.	5

the closeness of occurrence and risk manageability over 2010-2016. The statistical analysis and ranking were performed by MS-Excel software.

Data analysis

Risk identification and analysis

Based on previous studies and using a self-designed questionnaire, the citrus risks were studied and identified. The criteria identified in this study included the probability of risk, risk exposure, closeness of occurrence, and risk manageability. The subjective method was used to determine the probability of occurrence or the frequency of loss, that is, the frequency or probability of risks identified by experienced agriculturalists, experts, and scholars. In addition, the loss severity index refers to the magnitude of loss which was calculated based on the quantity and value of the product. The closeness of occurrence means how long risk occurs, that is, the interval between risks. Risk manageability also refers to the power of managing a risk and response to control it in case of occurrence in the citrus garden. If risk manageability is high, the response management to the risk is simple and its cost is lower. The indicators of probability of occurrence, severity, closeness, and manageability are shown in Tables 1to 4, respectively.

TOPSIS

Among seven methods of multi-criteria models, the TOPSIS method has the lowest deficit

Table 5
Decision Matrix

Weights		W_1	W_2	....	W_n
	Index	X_1	X_2	....	X_n
Alternativ					
	A_1	X_{11}	X_{12}	....	X_{1n}
	A_2	X_{21}	X_{22}	....	X_{2n}
	.	.	.	.	.
	.	.	.	.	.
	.	.	.	.	.
	A_m	X_{m1}	X_{m2}	....	X_{mn}

in the ranking of alternatives. This widely used method is one of the best MADM models. The sorting technique of preferences due to similarity to ideal solution is one of the most common methods, which was developed by Hwang and Yoon (1981). This technique is based on the notion that every factor should have the minimum distance from the positive (most important) ideal and the maximum distance from the negative (the least important) ideal. It is assumed that the utility of each criterion is steadily increasing or decreasing. In other words, in this method, the distance of one factor from the positive ideal and negative ideal is measured and this is itself a classification and prioritization scale (Azar & Rajabzade, 2008). The method is also easy to use and its calculation is quick enough. For mathematical calculations, all values attributed to the criteria should be quantitative and if these values are qualitative, they should be converted into quantitative values. This technique is based on the theoretical foundations that first the positive (best) ideals and negative (worst) ideals are found for each criterion through a series of techniques and then, the distance of each alternative is calculated from the positive and negative ideals. In this method, m alternatives ($A_1, A_2,..., A_m$) and n variables ($x_1, x_2, ..., x_n$) are evaluated. Therefore, it is sufficient to summarize the information of decision-making process within a decision matrix, so that it encompasses decision alternatives (A_i), decision variables (X_j) and values for each alternative (X_{ij}) and weights (W_j). It is shown in Table 5.

Other steps are as follows:

In the first step this method decision Matrix change to the weighted normalized matrix that re...omes as follows:

$$n_{ij} = \frac{r_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (1)$$

Step 2: Create a weighted normalized matrix given that the vector was input to the algorithm, that is: (given the decision)

weighted normalized matrix=

$$W = w_1, w_2, ..., w_n \} \approx$$

$$\begin{pmatrix} v_{11} & .... & v_{1j} & ..... & v_{1n} \\ .. & & .... & & .... \\ v_{m1} & .... & v_{mj} & ... & v_{mn} \end{pmatrix} V = N_D . W_{m \times n} \quad (2)$$

as N_D is matrix which Indexs scores in that has become comparable and without scale and w... ...ich just main diagon... ...ro.

...l solution: both positive ar...

$$A^+ = (v_1^+, v_2^+, ..., v_j^+, ..., v_n^+) / v_j^+ = \{\max_i v_{ij} / j \in j^+ : \min_i v_{ij} /$$

$$A^- = (v_1^-, v_2^-, ..., v_j^-, ... v_n^-) / v_j^- = \{\min_i v_{ij} / j \in j^+ : \max_i v_{ij} / j \in j^- \} \quad (3)$$

Step 4: Calculate the relative distance of A^+ and A^-. At this stage, the Euclidean distance of each option from the positive ideal solution (di^+) and the Euclidean distance of each option from th... ...) is calculated. T... ...s the formula to ca...

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2}, \quad i = 1, 2, ..., m$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}, \quad i = 1, 2, ..., m \quad (4)$$

...te the relative closeness (cL^+)

$$0 \le C_i^+ = \frac{d_j^-}{d_j^+} \le 1 \quad (5)$$

Step 6: Rank options. The larger the CL, the better the option.

RESULTS AND DISCUSSION

Given the changes in product yield based on various risks during 2010-2016 and according to the obtained indicators, the primary risks were divided into nine categories and sixty secondary risks. The calculations were carried out using the TOPSIS method and four main criteria and the most important risks of orange garden

Table 6
The Summary of the Experts Ideas about Main Risk of the Section of Orange Garden

Index	Probability of occurrence (percent)	Intensity of damage rate (percent)	closeness of occurrence (unit)	Manageability (unit)
Production risk	30	20	3.5	4.41
Pests and diseases risk	62	20	2.05	3.01
Price risk	46	18	2.19	4.32
Loss risk	30	28	3.35	4.52
Technical risk	5	5	3.91	3.08
Labor risk	4	4	4.39	2.29
Credit risk	4	3	4.48	3.72
Information risk	17	9	2.82	3.36
Institutional risk	14	13	2.83	3.71

were identified through risk ranking. Hence, in TOPSIS, the importance of each criterion is determined in the form of a given weight to each criterion using the Shannon entropy method. Since this model is based on experts' knowledge and view, a researcher-made questionnaire was designed and completed by sixteen relevant experts and specialists. Tables 6 and 7 show the results of the questionnaires. Then, the results were entered into TOPSIS software as inputs. Table 8 shows the weights, which were derived based on Shannon entropy with the subjective judgment in the study area. Therefore, in TOPSIS, the numbers assigned to W^*_j of each parameter can be used as the final weight of each parameter in accordance with the characteristic of the study area. As it is observing, the index of probability of occurrence the most scores allocates itself according to their criteria regarding to conditions of the studied area.

1. Risk identification and classification

To apply TOPSIS and analyze the risks of citrus gardens, the identified and classified risks were designed in the form of a questionnaire and the views of experts and horticulturists of the horticulture sector were collected on four main criteria of risks including probability, severity, closeness, and manageability.

Figure 2 shows the results of the risk identification and classification of orange gardens which led to identify sixty secondary risks based on nine primary risks of the horticulture sector.

Figure 2 shows the risk identification and classification of orange gardens risks based on nine primary and sixty secondary risks to 2016

2. Comments of 16 experts and their opinions

Tables 6 and 7 summarize the results of sixteen experts and horticulturist's views on these risks.

3. Risk evaluation and ranking orange gardens

Now, with a decision matrix (Tables 6 and 7) and the weights of the study criteria (Table 8), the entire TOPSIS process can be carried out step by step in order to rank the risks into primary or secondary, which are composed of nine primary risks and sixty secondary risks. The normalized matrices of primary and secondary risks are shown in Tables 9 and 10. The weighted normalized matrix (V) was also obtained by multiplying the normalized matrix by square matrix (Wn*n), in which the main diagonal elements and other elements were zero. The matrix (V) calculated for primary and secondary risks is shown in Tables 11 and 12.

After calculating matrix (V), the positive and negative ideals of each parameter should be obtained. Given the calculations, the values of positive and negative ideals are provided in Tables 13 and 14. So, first criteria should be classified into two general categories of positive

Table 7

The Summary of the Experts Ideas about Section Risk of the Section of Orange Garden

Index	Probability of occurrence (percent)	Intensity of damage rate (percent)	closeness of occurrence (unit)	Manageability (unit)
Flood	3	8	5	4.81
Hail	3	8	5	4.94
Spring rains	54	27	1.44	4.69
Heavy rain	59	28	1.94	4.81
Drought	3	9	4.69	4.88
Drought	13	37	5	4.94
Snow [5]	41	31	3.44	4.94
Glacial	22	20	3.13	4.94
Storm	38	43	3.5	4.94
Sudden heat	42	39	3.75	4.81
Cold snap	1	1	5	4.94
Fire	8	12	4.31	4.25
Teristiza	46	36	1.94	3.88
Gummosis	14	9	1.19	2.94
Navel rot of fruit	100	31	1	1.38
Aphids	100	38	2.13	2.81
Mealybugs	100	36	1	3.13
Red mites	10	11	4.31	3.81
Locust invasion	18	10	4.25	3.06
Branch citrus blast	85	24	2.69	3.5
Fruit flies	98	21	1	1.94
Citrellaphyllocnistis	98	13	1	2.38
Snail	77	19	1.5	4.88
Sun burn	18	9	3.5	2.88
Shortage Nutrients	1	4	4.63	3.5
Heavy textured soils	84	20	1	1.25
Weed	26	6	1.81	3.88
Rodents [6]	90	32	1	1.69
Insects	36	27	1.94	4.88
Drop of product prices	72	20	1.13	4.88
Increase in inputs price	74	24	1.31	4.56
Price fluctuation in market and costs	3	2	4.38	2.94
Not to buy the product	30	29	4.88	4.75
Damage to leaf [7]	25	22	4	4.56
Damage to trunk [8]	34	35	2.88	4.94
Damage to blossom [9]	29	26	2.63	3.81
Damage to fruit	5	2	2.44	3.13
Damage caused by drip irrigation	6	9	4.56	3.06
Damage caused by quality fertilizers	6	9	4.56	3.19
Damage caused by toxins quality	4	5	3	3.81
Quality Plants	4	5	5	2.19
Inappropriate expert advice	4	3	4.31	2.38
Labor shortage	4	5	4.31	2.06
Labor with inadequate skills	5	5	4.56	2.44
Labor working low	1	1	4.31	4
Payment Credits	5	3	4.56	3.94
Cost-benefit credit	4	4	4.56	3.06
Not receive timely loans	8	4	4.5	4.88
Loan administrative problems	39	43	4.19	4.81
Uncertainty and the impact of imports on the domestic orange	14	14	4.5	4.75
Uncertainty and the impact on exports of domestically produced orange	18	12	2.88	3.25
No information of market demand				
No information of market price	23	10	2.5	4.38
Weather false notification	8	6	4.5	3
False notification of insurance	18	9	1.38	2.81
Behavior Inappropriate Employees Insurance Fun	1	1	1.25	2.75
Paper game Insurance Fund	4	6	2	3.5
Poor access to experts insurance fund	14	3	2.19	2.75
Worm-eating germ	88	12	1.81	3.13
Dust	88	13	1.81	4.38
Citrus virus	15	8	1.5	1.94

[5] *Breaking branches and trunks* [6] *Rabbit and mice* [7] *(Caused by cold, locust invasion, ice, miner, etc.)*
[8] *(Caused by cold, locust invasion, ice, miner, etc.)* [9] *(Caused by spring rain, sudden heat, cold snap, terips,etc.)*

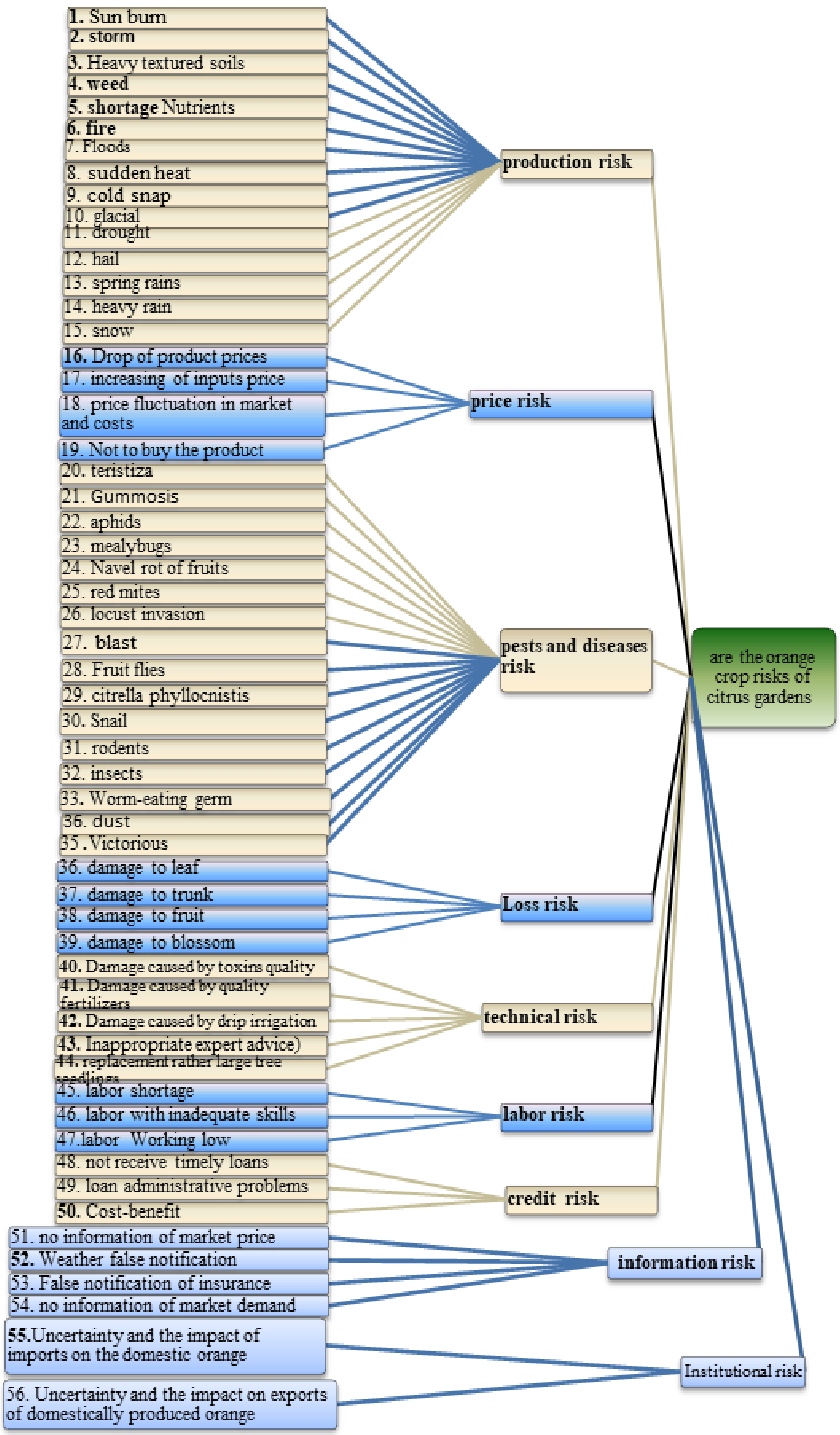

Figure 2: shows the risk identification and classification of orange gardens risks based on nine primary and sixty secondary risks to 2016

side criteria and negative side criteria. Then, for positive side criteria, the positive ideal was the maximum amount of matrix (V) and negative ideal was the minimum amount of matrix (V), and vice versa. This rule applies to negative side criteria. Therefore, based on the previous

Table 8
Major and Secondary Weights of Risk Indices based on the Shannon Entropy

Index/ weight criterion	Probability of occurrence (percent)	Intensity of damage rate (percent)	Closeness of occurrence (unit)	Manageability (unit)
Main risks weight	56	35	5	4
Secondary risks weight	51	32	12	5

Table 9
Normalized Matrix of Main Risks of Orange Garden

Index	Probability of occurrence (percent)	Intensity of damage rate (percent)	Closeness of occurrence (percent)	Manageability (percent)
Production risk	33	42	34	40
Pests and diseases risk	68	42	20	27
Price risk	50	38	21	39
Loss risk	32	59	33	41
Technical risk	5	10	38	28
Labor risk	4	8	43	20
Credit risk	4	6	44	34
Information risk	18	19	27	30
Institutional risk	15	27	28	33

studies and experts' views, "probability", "severity", and "manageability" formed the negative sides and "closeness" formed the positive side. The positive ideal was minimum (V) and the negative ideal was maximum (V). Tables 13 and 14 show the kind of criteria with their positive and negative ideals.

Now, with these values, di+, di-, cli+ of each risk could be calculated and finally various risks could be ranked based on the sequence of CLi+. The calculation results of the distance from positive and negative ideals for each one of risks are shown in Tables 15 and 16. Finally, the relative closeness of each risk to the ideal solution CL was calculated. CL was between 0and 1. The closer the CL is to 1, the closer the parameter is to the ideal solution. The calculation results of CL with the results of distance from positive and negative ideals for each one of risks are shown in Tables 15 and 16.

As it can be observed, among nine primary risks, pest and disease risk (86%) and credit risk (2%) had the highest and lowest risk priorities, respectively. On secondary risks, among sixty secondary risks, mealy bugs (76%), red mites (73%), and aphids (70%) were of the highest risks and damages caused by drip irrigation and emitters (0%) had the lowest risks.

According to the results, pest and disease risk (86%), price risk (62%), and damage risk (55%) were ranked the first to third. Among these sixty secondary risks, mealy bugs (76%) and red mites (73%) had the highest and most dangerous risks and the damage caused by drip irrigation and emitters, financing and purchasing the product with 0% had the lowest risks. It represents that over the last 5 years, damage caused by pests and diseases was severer than damages arising from price and production (natural factors). In terms of management, it was more difficult and complex than other risks of the orange orchards because of the lack of control and surveillance by Agricultural Jihad Organization.

CONCLUSION

Mazandaran Province is one of the most important agricultural provinces in Iran because

Table 10

Normalized Matrix of Secondary Risks Orange Garden

Index	Probability of occurrence (percent)	Intensity of damage rate (percent)	closeness of occurrence (unit)	Manageability (unit)
Flood	8	5	19	16
Hail	8	5	19	17
Spring rains	15	17	5	16
Heavy rain	16	18	7	16
Drought	8	5	18	16
Snow [10]	4	24	19	17
Glacial	11	20	13	17
Storm	6	13	12	17
Sudden heat	11	27	13	17
Cold snap	12	25	14	16
Fire	1	1	20	17
Teristiza	2	7	16	14
Gummosis	13	23	7	13
Navel rot of fruit	4	6	5	10
Aphids	28	21	4	5
Mealybugs	28	24	8	10
Red mites	28	23	4	11
Locust invasion	3	7	16	13
Branch citrus blast	5	6	16	10
Fruit flies	24	15	10	12
Citrellaphyllocnistis	27	13	4	7
Snail	27	8	4	8
Sun burn	21	12	6	17
Shortage Nutrients	5	6	13	10
Heavy textured soils	1	3	18	12
Weed	23	18	4	8
Rodents [11]	7	4	7	13
Insects	25	20	4	6
Drop of product prices	10	17	7	16
Increasing of inputs price	20	13	4	17
Price fluctuation in market and costs	21	15	5	15
Not to buy the product	1	1	17	10
Damage to leaf [12]	8	18	15	16
Damage to trunk [13]	7	14	15	15
Damage to blossom [14]	10	22	11	17
Damage to fruit	8	17	10	13
Damage caused by drip irrigation	1	1	10	11
Damage caused by quality fertilizers	2	2	18	10
Damage caused by toxins quality	2	6	17	11
Quality Plants	1	3	11	13
Inappropriate expert advice	2	3	20	7
Labor shortage	2	2	16	8
Labor with inadequate skills	2	3	16	7
Labor Working low	2	3	17	8
Payment Credits	1	1	16	13
Cost-benefit credit	2	2	17	13
Not receive timely loans	2	3	17	10
Loan administrative problems	3	3	17	13
Uncertainty and the impact of imports on the domestic orange	10	27	16	16
Uncertainty and the impact on exports of domestically produced orange	4	9	17	16
No information of market demand	5	8	11	11
No information of market price	6	7	10	15
Weather false notification	2	4	17	10
False notification of insurance	5	6	5	10
Behavior Inappropriate Employees Insurance Fun	1	1	5	10
Paper game Insurance Fund	1	4	8	12
Poor access to experts insurance fund	4	2	9	10
Worm-eating germ	24	8	7	11
Dust	24	8	7	15
Citrus psorosis virus	4	5	6	7

[10] Breaking branches and trunks [11] Rabbit and mice [12] (Caused by cold, locust invasion, ice, miner, etc.)
[13] (Caused by cold, locust invasion, ice, miner, etc.) [14] (Caused by spring rain, sudden heat, cold snap, terips,etc.)

Table 11
Weighted Normalized Matrix (V) of Main Risks of Orange Garden

Index	Probability of occurrence (percent)	Intensity of damage rate (percent)	Closeness of occurrence (percent)	Manageability (percent)
Production risk	19	15	2	1
Pests and diseases risk	38	15	1	1
Price risk	28	13	1	1
Loss risk	19	20	2	1
Technical risk	3	3	2	1
Labor risk	2	3	2	1
Credit risk	2	2	2	1
Information risk	10	7	1	1
Institutional risk	8	10	1	1

of its historical record in planting and high potentials in citrus, rice and tea production, so that it has the first rank in the production of citrus, especially orange. On the other hand, since Mazandaran citrus groves have been exposed to various risks for many years, it reveals the need for risk management planning in the province. One of these plans is risk identification, classification, and ranking. Therefore, in this study, the east of Mazandaran Province was investigated because it has possessed the majority of cultivated area in citrus groves during the last ten years. Based on the results of the first phase, the identified and classified risks were prepared using a questionnaire to present orange horticulturists and experts' views. They were under survey based on four criteria including probability of occurrence, the intensity of damage, closeness of occurrence, and risk manageability. Probability of occurrence and intensity of damage were quantitative and closeness of occurrence and risk manageability were qualitative. Therefore, qualitative criteria were converted into quantitative criteria and the results obtained from questionnaires were analyzed for nine risks using the TOPSIS technique. According to calculations and analyses, the identified risks of orange groves could be prioritized based on the scores of each criterion.

The results indicated that out of total nine primary risks, pests and diseases and price were the highest risks. The lowest risks were related to labor and credit risks, respectively. Out of total sixty secondary risks, mealy bugs and red mites were of the highest risk and risks arising from financing and purchasing product were of the lowest risk. Hence, the orchardists' assumption was confirmed that production, price, and pest and disease risks were of higher priorities. Since the mealy bugs had the highest risks among pest and disease risks, the horticulturists should pay special attention to the orange risks. Risk management strategies are required for risks with higher priorities in order to reduce the horticulturists' losses. This issue must also be considered by officials and planners at a macro level. Based on the results of the risk exposure of orange product, it is recommended to reduce the risk of pests and diseases as much as possible through integrated pest management methods in order to reduce the orchardist's risks. However, this risk was not definitely only a function of the risks of pests and diseases and price and other risks in this study. Under similar conditions, other risks should also be examined and considered.

Applying TOPSIS for risk assessment also showed that this method could be used to identify and prioritize the orange risks. Therefore, it is suggested to use this method in a wider range

Table 12
Weighted Normalized Matrix (V) of Secondary Risks of Orange Garden

Index	Probability of occurrence (percent)	Intensity of damage rate (percent)	closeness of occurrence (unit)	Manageability (unit)
Flood	1	2	2	1
Hail	1	2	2	1
Spring rains	7	5	1	1
Heavy rain	8	6	1	1
Drought	1	2	2	1
Snow [15]	2	7	2	1
Glacial	6	6	2	1
Storm	3	5	1	1
Sudden heat	6	9	2	1
Cold snap	6	8	2	1
Fire	1	1	2	1
Teristiza	2	2	2	1
Gummosis	7	7	1	1
Navel rot of fruit	2	2	1	1
Aphids	14	7	1	1
Mealybugs	14	8	1	1
Red mites	14	7	1	1
locust invasion	2	2	2	1
Branch citrus blast	3	2	2	1
Fruit flies	12	5	1	1
Citrellaphyllocnistis	14	4	1	1
Snail	14	3	1	1
Sun burn	11	4	1	2
Shortage Nutrients	3	2	2	1
Heavy textured soils	1	1	2	1
Weed	12	4	1	1
Rodents [16]	4	1	1	1
Insects	13	6	1	1
Drop of product prices	5	5	1	2
Increasing of inputs price	10	4	1	2
Price fluctuation in market and costs	11	5	1	2
Not to buy the product	1	1	2	1
Damage to leaf [17]	4	6	2	2
Damage to trunk [18]	4	4	2	2
Damage to blossom [19]	5	7	1	2
Damage to fruit	4	5	1	2
Damage caused by drip irrigation	1	1	1	1
Damage caused by quality fertilizers	1	1	2	1
Damage caused by toxins quality	1	2	2	1
Quality Plants	1	1	1	1
Inappropriate expert advice	1	1	2	1
Labor shortage	1	1	2	1
Labor with inadequate skills	1	1	2	1
Labor Working low	2	1	2	1
Payment Credits	1	1	2	2
Cost-benefit credit	2	1	2	2
Not receive timely loans	1	1	2	1
Loan administrative problems	2	1	2	2
Uncertainty and the impact of imports on the domestic orange	6	9	2	2
Uncertainty and the impact on exports of domestically produced orange	2	3	2	2
No information of market demand	3	3	1	1
No information of market price	3	2	1	1
Weather false notification	1	1	2	1
False notification of insurance	3	2	1	1
Behavior Inappropriate Employees Insurance Fun	1	1	1	1
Paper game Insurance Fund	1	2	1	1
Poor access to experts insurance fund	2	1	1	1
Worm-eating germ	13	2	1	1
Dust	13	3	1	2
Citrus psorosis virus	2	2	1	1

[10] *Breaking branches and trunks* [11] *Rabbit and mice* [12] *(Caused by cold, locust invasion, ice, miner, etc.)*
[13] *(Caused by cold, locust invasion, ice, miner, etc.)* [14] *(Caused by spring rain, sudden heat, cold snap, terips,etc.)*

Table 13
Positive and Negative Ideals Main Risks

Index	Probability of occurrence (percent)	Intensity of damage rate (percent)	Closeness of occurrence (percent)	Manageability (percent)
Kind index	Negative	Negative	Positive	negative
Positive ideals	38	20	1	1
Negative ideals	2	2	2	1

Table 14
Positive and Negative Ideals Secondary Risks

Index	Probability of occurrence (percent)	Intensity of damage rate (percent)	Closeness of occurrence (percent)	Manageability (percent)
Kind index	negative	negative	Positive	negative
Positive ideals	14	9	1	1
Negative ideals	1	1	2	1

Table 15
The Distance from Positive and Negative Ideals and the Prioritization of Main Risks of Orange Garden in Mazandaran Province (Percent)

Ranking	Risk	d+	d-	CL
1	Pests and diseases risk	6	38	86
2	Price risk	17	28	62
3	Loss risk	19	24	55
4	Production risk	24	20	45
5	Institutional risk	40	10	20
6	Information risk	42	9	18
7	Technical risk	51	2	4
8	Labor risk	53	2	3
9	Credit risk	53	1	2

of different products in the country.

With due attention to, besides the simultaneous use from both subjective and objective criteria and indexes, to the appropriate speed and simple task method, and full conformity with experiential methods have preference rather than other ranking methods, it is suggested that other researchers conduct more comprehensive research on the risk assessment procedure of products by taking into account other parameters because the inclusion of other risk factors can affect the final result.

According to a very strong compensatory multi-attribute technique and the prioritization of alternatives through assimilate to the ideal solution in the TOPSIS method, it is recommended to agricultural policy-makers to apply this method for prioritizing and developing their future plans, to evaluate different alternatives qualitatively or quantitatively, and to make more real forecasts towards the better and more efficient management of this important sector of the economy by studying different risks.

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Table 16
The Distance from Positive and Negative Ideals and the Prioritization of Main Risks of Orange Garden in Mazandaran Province (Percent)

Ranking	Risk	d+	d-	CL
1	Mealybugs	6	20	76
2	Red mites	7	20	73
3	Aphids	8	19	70
4	Insects	10	17	64
5	Citrellaphyllocnistis	10	16	60
6	Fruit flies	11	16	59
7	Snail	12	15	54
8	Uncertainty and the impact of imports on the domestic orange	13	14	52
9	Sudden heat , weed, price fluctuation in market, dust	13	13	51
10	Worm-eating germ, Sun burn, Cold snap	14	14	50
11	Increasing of inputs price and Heavy rain	14	13	48
12	Gummosis	15	15	46
13	Spring rains	15	12	44
14	Glacial	15	12	44
15	Damage to blossom	16	11	42
16	Damage to leaf	17	9	36
17	Drop of product prices and Snow	18	10	35
18	Damage to fruit	19	8	31
19	Damage to trunk	20	8	28
20	Storm	21	6	24
21	Uncertainty and the impact on exports of domestically produced orange	22	5	18
22	No information of market price	22	4	16
23	Branch citrus blast and no information of market demand	23	4	15
24	Shortage Nutrients and locust invasion	24	3	13
25	Rodents	24	4	13
26	Teristiza	24	3	12
27	False notification of insurance	25	3	11
28	Damage caused by toxins quality, Drought, Flood and Hail	25	2	9
29	Navel rot of fruit, Citrus psorosis virus and Weather false notification	24	2	8
30	Loan administrative problems	25	2	7
31	Inappropriate expert advice	26	2	7
32	Behavior Inappropriate Employees Insurance Fun	28	2	6
33	Labor Working low	25	1	4
34	Poor access to experts insurance fund, Damage caused by quality fertilizers, not receive timely loans, Cost-benefit credit, labor with inadequate skills, Quality Plants and Heavy textured soils	26	1	4
35	Paper game Insurance Fund	27	1	2
36	Fire	27	1	2
37	Labor shortage	27	1	2
38	Payment Credits, Not to buy the product and Damage caused by drip irrigation	27	0	0

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