Mitigating impact of risks on economic integration between entities in agrifood supply chain

Khusniddin Pardaev¹, Shavkat Hasanov¹, Shukrullo Muratov², and Fotima Saydullaeva²*

¹Samarkand branch of Tashkent State Agrarian University, Samarkand, Uzbekistan
²“Tashkent Institute of Irrigation and Agricultural Mechanization Engineers” National Research University, Tashkent, Uzbekistan

Abstract. The paper aims to assess and reduce the risks associated with infrastructure, financial, natural and environmental, farm management, and political changes among smallholders in tomato supply chain entities. Uncertainties related to the producer, buyer, infrastructure, finance, natural and environmental, management, and political changes in STSC take into account risk levels' assessment. These threats were assessed using Fuzzy Linguistic Quantifier Order Weighted Aggregation (FLQOWA) model. The obtained results showed the level of risk arising in production, cooperation, infrastructure, and financial issues. At the same time, measures to reduce risk levels were taken in the study. According to the results, applying "written contract" and "insurance" to collaborative relationships to reduce risk levels has been shown to reduce risks to 0.6 coefficients. The results obtained from this investigation will have a positive effect if policymakers use the applications to increase the economic cooperation between the subjects in STSC.

1 Introduction

The agrifood supply chain (ASC) is encompassed inextricably linked blocks of input resource provision, production, packaging and processing, wholesale, and retail trade [1]. This system provides good, safe, and stable food products produced in agriculture, which are necessary for the population's consumption and industry. In agriculture, each product has unique characteristics and problems faced by actors in ASC [2]. These problems arise from various inconsistencies related to climate change, overuse of chemical inputs and infrastructure, and financial, environmental, management, and political changes. As a result, the risks that occur under their influence harm the system's effective operation of delivering the product "from the field to the table" [3]. Such risk factors prevent the implementation of economic relations with partners for agricultural product producers, leading to a decrease in their income.

Recently, the COVID-19 pandemic has threatened human lives worldwide and has been a shock that has negatively affected the agricultural production chain. In particular, it
caused significant food production and supply chain disruptions and destabilized countries' economies [4] [5]. According to the report of the Food and Agriculture Organization of the United Nations, as a result of the impact of the COVID-19 pandemic, there has been a disruption of the structures of demand and supply of products in the agricultural production chain [6]. At the initial stage of the pandemic, the balance of demand and supply of agricultural products was disturbed. In addition, the established substantial order to protect the population from the disease led to the disruption of economic relations between entities in the chain of production of agricultural products [7].

Risk levels in the production system of agricultural products in Uzbekistan are observed in different farming types (farmers, peasants, estates, and agro-firms). There are inconsistencies related to the large scale of production in farmers and agro-firms; otherwise, in smallholders, it occurs in economic partners with subjects [8].

Samarkand region is considered one of the regions that produce the most vegetable products in the republic, and its share in 2020 was 15.6% or 1636.3 thousand tons. Of this, 66.3% of vegetable products are contributed by smallholders. Among vegetable products, tomato is the most cultivated crop, accounting for 31.2% of the total cultivated area. Smallholders' production and sale of tomatoes are somewhat tricky and risky compared to other crops. From an objective point of view, such negatives can be distinguished by their small land and the size of the product, the short period of harvesting, the need for particular vehicles for the product, and the short market life. The product price fluctuates sharply in different periods of the year.

Unfortunately, in Uzbekistan, local producers do not have the full opportunity to maintain the product at the level of technical requirements. As a result, the infrastructure facilities are not fully formed at the stages of delivering the product to consumers [9] [10]. In most cases, processing companies use their monopoly power to force smallholders to sell their products at low prices [11]. In addition, processing enterprises do not have the opportunity to quickly accept the product during the peak season, and they deliberately do not fulfill the terms of the contractual agreements between the entities to reduce prices. The long-term transport and storage of tomatoes in transport seriously damage their quality. Unfortunately, in such cases, smallholders are forced to sell the product at a low price, fearing that the product will become unusable.

The article aims to assess and reduce the risks associated with infrastructure, financial, natural and environmental, farm management, and political changes in the smallholder tomato supply chain (STSC). Based on this, the following questions were answered to determine the causes of risks in STPC and to apply measures aimed at mitigating their level: What risk factors affect the cooperation between entities in the tomato production chain? What measures can be treated to mitigate the effects of the high-risk factors? In search of answers to these questions, we identified STSC risks from the existing literature of review, empirical methods were chosen for analysis, data were collected from subjects in the STSC in Samarkand region based on a questionnaire, and a three-stage-scenario experiment was conducted.

In the next part, STSC risks are classified according to their sources, and the next section presents the methodology outlining the motivation and fuzziness related to evaluating STSC risks and the conduct of materials. Finally, the results and discussion are highlighted in the last section.

1.1 STSC and its risks classification

In Uzbekistan, smallholders are interconnected in a systematic sequence according to the order of integration between subjects in STSC. It is divided into separate blocks according
to the mechanism of participation in the system, and they can be divided into the following sections (Figure 1).

**The supplied block** includes activities to supply raw materials for production (seeds/seedlings, fertilizers, fuel and lubricants, chemicals, machinery, etc.). This block directly affects the quantity and quality of the produced products and reduces the excess costs and risks for smallholders [12]. Raw materials suppliers are divided into buyers and non-buyers of the product. It is profitable for the smallholder to supply raw materials by suppliers who are buyers of the product, i.e., with customers who have formal (by signing a contract) cooperation [12] [13]. In this case, the quality of raw materials is guaranteed, assistance is provided regarding the technology used, and the control mechanism is strengthened. The main participants in the supply block may be:
- smallholders themselves;
- Customers (buyers): processing enterprises; retail outlets; middlemen; exporters;
- “Томорқа хизмати” LLC, and etc;

In STSC, vertical integration is directly linked to the production unit through the supply of resources.

**Fig. 1. STSC in Uzbekistan.** The structure of STSC in smallholders is based on the scientific proposals of Michael Porter, who introduced the "production chain" to science in 1985 [14].

**The production block** includes the production of tomatoes for family consumption and income by smallholders during the summer seasons. According to the Law of the Republic of Uzbekistan on “dehkan” farming, farms produce and sell agricultural products together with family members on owned or leased land. “Tomoka” - households are entities that produce agricultural products for family needs or sell on the market on the plot of land allocated to them. Therefore, they carry out production activities on the land areas separated from them or leased land based on legally defined activities. They supply the resources (seeds, fertilizers, equipment, labor) directly on the farm itself.

Their product sales channels cover the direct or indirect sale of agricultural and household products for consumption or processing. Suppose processing enterprises, outlet stores, bazaars, and various social institutions (canteens and restaurants, hospitals, hotels, kindergartens, etc.) are included in the channels of direct sale of the product. In that case, intermediaries in indirect sales can be included.
In the processing block, the product is prepared and ready to eat - washed, sliced, cut, peeled, trimmed, or otherwise prepared in a way that makes it convenient for consumers. Product storage warehouses (refrigerators) safely store vegetable products grown for the population in the winter and spring seasons and provide them for consumption. Currently, the government is taking several measures to increase the warehouses' number.

Intermediaries, supplier distributors, and exporters are the leading players in the wholesale block. The number of mediators in the tomato production chain is significantly high. In STSC, they buy the product from the smallholder to the primary consumer or buyer (processing companies or retailers). Today, they have become the primary buyers of smallholders. It is positive that they serve to deliver the product to the consumers. However, they buy the product cheaply and sell it at a high price, causing it to rise. Supplier distributors and exporters work officially in the product production chain. It provides a guaranteed market and price for the producer. Unfortunately, there are very few of them today. Especially since the level of risk in delivering tomatoes to consumers is high, they are less involved in the tomato production chain.

In the retail block, supermarkets and minimarkets are considered branches of trade services in providing the population with various consumer goods. In the last 20 years, their number has increased dramatically in the country [14]. Such trade branches of the modern type are more effective and convenient in implementing economic relations between institutions in the chain of food products than farmers’ markets. Bazaars have long been a traditional infrastructure in the food chain, and today they are the prominent institutions that exchange food products between producers and consumers. Today, their number in the republic is 328, but in the following years, it is planned to transform bazaars into outlet shopping complexes in the form of minimarkets, supermarkets, and hypermarkets.

Legal and modern conduct of economic relations between the entities mentioned above, the establishment of parties' agreements, and measures to reduce costs and risks are essential issues in the country.

As in the production chain of various products, risks in STSC also lead to sudden changes in production, service, decision-making of the entities, and ultimately the product's price. The level of risk in agricultural production is higher than in other sectors of the economy. Yusupov argues that the field of agricultural production is described as a complex biotechnological and socio-economic system, and the risk level is high as a result of the production process being closely related to natural factors. Komarek et al. (2020) analyzed the risks that occur in ASC, and they found that the risk factors related to production, marketing, institutional, personal, and financial processes occur more. Considering this, we grouped risks in STSC by sources of formation (Table 1).

To determine the strategic directions for reducing and mitigating risks in STSC, it is necessary to determine the directions of risk, sources of formation, and links of its influence. Such practice means coordinating economic relations between entities in the system, determining risk reduction strategies, and applying efficiency improvement measures.

Different shocks in ASC emerged as a new factor affecting demand and supply in the chain. Under its influence, the risks related to the supply of raw materials, sales, transportation, and management have increased [16].

At the same time, due to the instability of the region's political situation, the risk's impact points related to the amount of production, economic cooperation between the parties, opportunities for product realization, and the reduction of incentives for product production were separately recognized.
Table 1. Sources of risk in STSC and its impact

<table>
<thead>
<tr>
<th>The main directions</th>
<th>Impact points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>Trade, transport</td>
</tr>
<tr>
<td></td>
<td>Production, price, product standard, product quality</td>
</tr>
<tr>
<td></td>
<td>Product quality, productivity</td>
</tr>
<tr>
<td></td>
<td>Product quality, productivity</td>
</tr>
<tr>
<td>Cooperation</td>
<td>Distribution, planning</td>
</tr>
<tr>
<td></td>
<td>Production, harvesting</td>
</tr>
<tr>
<td></td>
<td>Trust of the parties in each other</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Product quality and price</td>
</tr>
<tr>
<td></td>
<td>Product quality and price</td>
</tr>
<tr>
<td></td>
<td>Confidence in place of sale at bazaars</td>
</tr>
<tr>
<td>Financial</td>
<td>Production, product quality, raw materials</td>
</tr>
<tr>
<td></td>
<td>Production, product quality</td>
</tr>
<tr>
<td></td>
<td>Incentives for production, raw materials</td>
</tr>
<tr>
<td></td>
<td>Farmers' decision-making</td>
</tr>
<tr>
<td>Natural and environmental</td>
<td>Productivity, product quality, price</td>
</tr>
<tr>
<td></td>
<td>Production</td>
</tr>
<tr>
<td>Management</td>
<td>Production, harvesting, processing, sale</td>
</tr>
<tr>
<td></td>
<td>Production, product quality, cooperation</td>
</tr>
<tr>
<td></td>
<td>Production, price, cooperation, implementation</td>
</tr>
<tr>
<td></td>
<td>Production, productivity, product quality, cooperation</td>
</tr>
<tr>
<td>Political changes</td>
<td>Production, cooperation, realization</td>
</tr>
<tr>
<td></td>
<td>Production, cooperation, realization, the incentive to production</td>
</tr>
</tbody>
</table>

2 Material and methods

The problem study covered small, medium, and significant organizational entities in vertical integration in STSC. At the initial stage, suppliers of input resources - agro-vet pharmacies, seed, and technical supply farms; suppliers of fuel and lubricants, "Tomorqa xizmati" LLC and customer organizations; the production organizations - households, smallholders, and smallholders producing products by renting land; product processing - product packaging and processing enterprises; wholesale trade - product sellers, supply distributors, and exporters; in retail trade - retail shops, catering establishments, and colonial houses were involved. Data were collected directly from respondents in the Samarkand region in January-March 2021, and a three-staged-experiment was conducted.

In this study, we used non-traditional methods of risk assessment of economic integration relations between entities in STSC based on the data collected based on a questionnaire from the entities listed above. This method was used for the first time to assess the impact of risks in the production chain in Uzbekistan using the Fuzzy Linguistic Quantifier Order Weighted Aggregation (FLQOWA) model.

When assessing the impact of risks, unlike other analysis methods, it takes into account the subjective characteristics of the problem under study, evaluates risks in specific coefficients, is used in the analysis of all life problems in decision-making, and provides opportunities for mutual comparison. Considering the existence of several additional features listed above, this method of analysis was used.

Some modern economic analysis methods were used to determine the impact of risks. These methods include mathematical and multi-criteria decision-making.

Most of the analyzes carried out in this direction mainly included studies in two directions. One is related to the acceptance of opinions based on the knowledge of experts, and the other is based on information from the past. In this study, we used the FLQOWA
model by combining the above two methods. This approach provides a new approach to assessing the impact of various risks on economic cooperation between entities in STSC in Uzbekistan. According to Rohit Sharma et al., this model is adopted to obtain qualitative information on decision-making entities' relationship between various evaluation criteria [6]. Therefore, when performing the analysis, it is appropriate to consider each factor separately, along with the levels of data collected from each respondent [17].

Table 2. Notations used in the assessment of risks in STSC

<table>
<thead>
<tr>
<th>Notations</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>The index used for organizations where ( p = (1, 2, 3 \ldots, s) );</td>
</tr>
<tr>
<td>Q</td>
<td>The index used for organizational risk factors where ( q = (1, 2, 3 \ldots, t) );</td>
</tr>
<tr>
<td>( a_{pq} )</td>
<td>Input data of 'qth' organizational risk factors of 'pth' organization;</td>
</tr>
<tr>
<td>( b_{pq} )</td>
<td>Normalized input data of 'qth' organizational risk factors of 'pth' organization;</td>
</tr>
<tr>
<td>( a_{q}^{\min} )</td>
<td>Minimization value of 'pth' organization among all 'qth' organizational risk factors ( {a_{1q}, a_{2q}, \ldots, a_{sq}} );</td>
</tr>
<tr>
<td>( a_{q}^{\max} )</td>
<td>Maximation value of 'pth' organization among all 'qth' organizational risk factors ( {a_{1q}, a_{2q}, \ldots, a_{sq}} );</td>
</tr>
<tr>
<td>( w_{q} )</td>
<td>Aggregation weighted vector W of 'qth' organizational risk factors;</td>
</tr>
<tr>
<td>( w^{*}_{q} )</td>
<td>Maximal entropy aggregation weighted vector ( W^{*} );</td>
</tr>
<tr>
<td>OR(_{p})</td>
<td>Organization risk score (p);</td>
</tr>
</tbody>
</table>

In carrying out the analysis, the initially collected data were divided into appropriate groups, separated into vague linguistic quanta, and collected according to their order. In the last step, the respondents' answers were evaluated in a weighted summation order for each alternative. The symbols used in the risk assessment in STSC are presented in Table 2.

The stages and conditions of the analysis were carried out in the following sequence [6]:

1. Set of organizations \( O_{p} = \{O_{1}, O_{2}, O_{3}, \ldots, O_{s}\} \) be a set of \( s \) organisations, where \( p = (1, 2, 3, \ldots, s) \);
2. Risk factors of the organizations (ORFs) [i.e. \( \{ORF_{1}, ORF_{2}, ORF_{3}, \ldots, ORF_{t}\} \)], where \( q = (1, 2, 3, \ldots, t) \);
3. Construct a multiple factor matrix \( A = [a_{pq}] \) based on 'experts' inputs for different risks faced by their organization;
4. Convert the multiple factor matrix \( A = [a_{pq}] \) into a fuzzy multiple factor matrix \( B = [b_{pq}] \) using the fuzzy membership function as shown in Equation (1) and Equation (2).

For the maximization factor,

\[
[b_{pq}] = \frac{a_{pq} - a_{q}^{\min}}{a_{q}^{\max} - a_{q}^{\min}}
\]

where, \( p = 1, 2, 3, \ldots s; q = 1, 2, 3, \ldots t \)

For the minimization factor,

\[
[b_{pq}] = \frac{a_{q}^{\max} - a_{pq}}{a_{q}^{\max} - a_{q}^{\min}}
\]

where, \( p = 1, 2, 3, \ldots s; q = 1, 2, 3, \ldots t \)

\[
a_{q}^{\max} = \max \{a_{1q}, a_{2q}, \ldots, a_{sq}\}
\]
5. Computation of aggregation weighted vector (W):

\[ W_q = Q \left( \frac{q}{t} \right) - Q \left( \frac{q-1}{t} \right), \]  

where, \( q = 1, 2, 3, \ldots, n \)

\[ Q(r) = \left( \frac{r^{a} - 0.5}{r^{b} - 0.5} \right) \text{ if } 0.5 \leq r \leq 1, \ a, \ b \in [0,1], \]  

6. Aggregating the weight vector by the following formula to optimize the order of fuzzy linguistic quantiles and using entropy to constrain the optimization problem. It is advisable to use the following formula to aggregate the weighted vector:

\[ (W) = \frac{1}{t-1} \sum_{q=1}^{t} (t-q)w_q \]  

where, \( q = 1, 2, 3, \ldots, t \)

Logarithmization when using entropy gives maximum use of weighted vector aggregation:

\[ (W) = - \sum_{q=1}^{t} w_q \ln w_q \]  

We use the following formula to calculate the risks of organizations based on the system:

\[ (W) = \frac{1}{t-1} \sum_{q=1}^{t} (t-q)w_q, \quad \sum_{q=1}^{t} w_q, \quad w_q \in [0,1] \]  

Based on the above formulas, we use the FLQOWA model formula as follows:

\[ \sum_{t=1}^{t} (t-q) (W) h^{t-q} = 0 \]

\[ (W) = \frac{1}{t-1} \sum_{q=1}^{t} \left( t-q \right) \frac{h^{t-q}}{\sum_{q=1}^{t} h^{t-q}} \]  

\[ w_q^* = \frac{h^{t-q}}{\sum_{q=1}^{t} h^{t-q}} \]

where, \( q = 1, 2, 3, \ldots, t \)

7. It is appropriate to use the following formula to calculate the levels of risk affecting the relationships between entities in STSC:

\[ TP_p = [w_q^* * b_{pq}] \]  

Inconsistencies in economic relations between entities in STSC prevent mutual integration. Therefore, we evaluated the impact of risks on the economic integration between subjects in STSC separately for each block using the research method that includes
the abovementioned stages. Below, the results of the analysis are presented and interpreted separately.

3 Results and Discussion

Assessment of risk levels of supply organizations in STSC. A total of 7 grouped main factors, which include factors that negatively affect the economic integration cooperation of the supply organizations with smallholders: infrastructure, the capacity of producers, and the level of risk associated with procurement and services, gave an above-average result. That is, due to inconsistencies such as long distances in the delivery of input resources and services by suppliers, deficiencies in the road infrastructure, and insufficient formation of conditions in particular transport and bazaars, the risk level is 0.8. Furthermore, due to small production in smallholders, the lack of access to modern production technology and interruptions in cooperation caused the risk level to be 0.6. The type and quantity of working capital due to the uncertainty of the demand and the lack of an explicit agreement on the purchase of the product the risk level is equal 0.6 (Figure 2). In addition, the risk levels of the financial issues of the supplier organizations are equal to 0.5, which shows that the impact levels of inconsistencies related to the lack of financial support and market price fluctuations in this sector are high.

Assessment of production-related risk levels in STSC. In tomato production, the financial support of smallholders, their economic integration with buyers, and the risk levels associated with production are high. In particular, the level of risk arising in financial matters for farmers is equal to 0.75, from which the risk of lack of supply and financial support during the production period is high. In addition, it was determined that the price of the product in the market changes sharply in different years, which harms their decision-making.

We found that the risk level of cooperation with buyers for farmers was 0.75. 43.6% of this risk level was caused by the lack of a specific agreement on the purchase of products. At the same time, 35.2% was due to the lack of accurate information related to product demand, and another 22.1% was due to other risk factors.

For smallholders, the low production volume, difficulties in using modern technologies, lack of equipment, and supply interruptions caused the risk to increase by 0.5. In addition, deficiencies in the infrastructure were also assessed as increasing the risk level by 39.4% in implementing economic cooperation with entities in STSC.
Fig. 2. Assessment of the level of risk in economic relations between entities in STSC in Samarkand. (The highest risk level is equal to 1 coefficient).

Assessment of risk levels of processing enterprises in STSC. It was found that the activity of other buyers competing for tomato processing enterprises can increase the risk level by 0.9 in their decision to cooperate with farmers. For them, the level of risk associated with financial matters also showed that they could have a significant negative impact on their cooperation. Of course, processing companies can also supply input resources for tomato producers. Financial inadequacies and operating a system of payment of product money in advance in prepayment also mean financial risks for them.

Low production of smallholders, low availability of modern technologies, and other similar factors for processing enterprises have a low level of risk in cooperation with smallholders. Nevertheless, the adverse effects of biological and environmental factors have been shown to increase the risk level by 0.4.

Assessment of risk levels of the wholesaler in STSC. 33.0% indicated a lack of support from various financial institutions, and 43.5% had difficulty using credit opportunities as the cause of the risk. As seen from the figures, we can see that even for wholesale trade organizations, the level of risk has increased due to the influence of other buyers competing in STSC.

Assessment of risk levels of the retailer in STSC. Retail trade organizations are one of the main blocks that serve to deliver agricultural products to the table of the population. It was found that the main risk in economic cooperation with farmers in financial relations. If we look at the analysis data, we see that the risk associated with financial issues equals 0.7. It is shown that the level of risk in financial relations is caused by the lack of advance payments and input resources, as well as the sharp changes in the price of agricultural products in the market. At the same time, it was found that the level of risk in the economic relationship of this type of entity with farmers is somewhat higher. 46.5% of the increase in risk was caused by the lack of specific equipment, 32.2% by supply interruptions, and 21.3% by the lack of modern production technologies for smallholders.

In STSC, the level of risk in economic relations between subjects showed that the part related to financial issues is high. At the same time, there are high levels of risk arising from production, supply, infrastructure, and financial issues in cooperation between supplier organizations and smallholders. In conclusion, it should be mentioned that it is
appropriate to consider ways to eliminate high-risk factors related to buyers, financial issues, infrastructure, and production when smallholders implement economic cooperation with entities in STSC.

**Risk mitigation in STSC.** The tomato production chain by smallholders covers all value-added activities from the initial stages of production to consumption. Since this supply chain is essential for producing constant, cheap, high-quality, and sufficient consumer products, it is crucial to ensure that the cooperation between the entities in this system works smoothly and efficiently during the transitional economy. However, due to several inconsistencies and high risks in the system, it is challenging to keep it running smoothly.

To determine strategic directions for reducing and eliminating risks in STSC, it is necessary to determine the directions of risk, sources of formation, and links of its influence. Such practice means coordination of economic relations between entities in the system, determination of risk reduction strategy, and application of efficiency improvement measures.

Based on this practice, as measures to reduce the risks affecting cooperation, with the participation of representatives of "Provision companies," "Smallholder," "Processing companies," "Wholesalers," and "Retailers" in the main blocks of STSC a three-staged-scenario experiment was conducted. In the first stage of the experiment, "collaboration without guarantee" (current condition); in the second stage, "Written contracts," and in the third stage, "Insurance" was introduced. The results obtained at each stage were separated and analyzed using the FLQOWA model. The results of the analysis are presented in parts A, B, C, D, and E of Figure 3.
Fig. 3 Evaluation of the impact of assurance factors on mitigating risk among subjects in STSC. Sources of occurrence of risk levels: a) Production; b) Cooperation; c) Infrastructure; d) Financial; e) Natural and environment; f) Management; g) Political changes.
The results of the analysis showed that the guarantee factors have a positive effect on cooperation between entities and reduce the impact of risks. For example, when a "written contract" is introduced, the level of risk decreases in supply organizations on average by 0.2-0.4; 0.3 in smallholders; 0.1-0.6 in product processing enterprises; 0.1-0.2 in wholesale trade organizations; and up to 0.1-0.2 in retail organizations. Furthermore, when "Insurance" is introduced, the level of risk decreases in supply organizations on average by 0.1-0.3; 0.1-0.3 in smallholders; 0.1-0.4 in product processing enterprises; 0.1-0.2 in wholesale trade organizations; and retail trade organizations by 0.1-0.4.

4 Conclusion

The results of the analysis carried out in this article will help to implement the tasks of doubling the income of smallholders set in the new development strategy of Uzbekistan for 2022-2026. The study determined the risk levels of various inconsistencies in establishing cooperation between farmers and households in ASC with economic partner subjects and ways to reduce it. The problem was studied on subjects participating in five blocks in STSC in the Samarkand region. In this study, we found the following answer to the question, "what risk factors affect the cooperation between subjects in the tomato production chain?".

The model results demonstrated that in cooperation between subjects and smallholders, the production-related risk levels in product manufacturers and supply organizations are 0.6 and 0.5 coefficients, respectively; 0.5-0.9 coefficient in the cooperation of suppliers, manufacturers, processing enterprises, and wholesale trade enterprises; 0.8 coefficient of the level of risk of supply organizations with infrastructure; and it was proved that the level of risk related to financial issues in all blocks is higher than the average by 0.6-0.8. Therefore, it was concluded that higher than average levels of risk lead to disruption of cooperation between entities.

For the question "What measures can be treated to mitigate the effects of the high-risk factors?" we found the following answer. First, the level of risk related to relations between subjects, financial issues, infrastructure, and production is above average. Second, the high level of risk harms the economic relations between smallholders and partners in ASC. Third, applying "written contract" and "insurance" to collaborative relationships to reduce risk levels has been shown to reduce risks.

The results obtained from this investigation will have a positive effect if policymakers use the applications to increase the economic cooperation between the subjects in STSC.

References


