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REDUCING ONION LOSSES THROUGH EFFECTIVE REGULATION: A COMPREHENSIVE EVALUATION OF THE ONION SUPPLY CHAIN

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Summary

The article aims to evaluate onion losses within the onion supply chain through surveys and interviews with key stakeholders in order to enhance the effectiveness of state regulation in the reduction of food losses. Findings reveal an 18.8% total loss, with storage contributing the most. Non-compliance with agro-technical norms and climate-induced onion diseases are major causes. Additionally, market instability, poor marketing practices, and inconsistent export relations with Russia contribute to onion losses. This study sheds light on critical factors impacting onion loss, offering insights for enhanced supply chain management.

The article undertook an assessment of aggregated losses within the onion sector by constructing an input-output table for the country's onion industry, coupled with the delineation of onion production flows. The conclusion of the article encapsulated the primary strategies and state regulation directions for mitigating food reduction within this context.

Keywords: *onion loss, supply chain analysis, state regulation, onion production flow.*

General overview of the onion sector

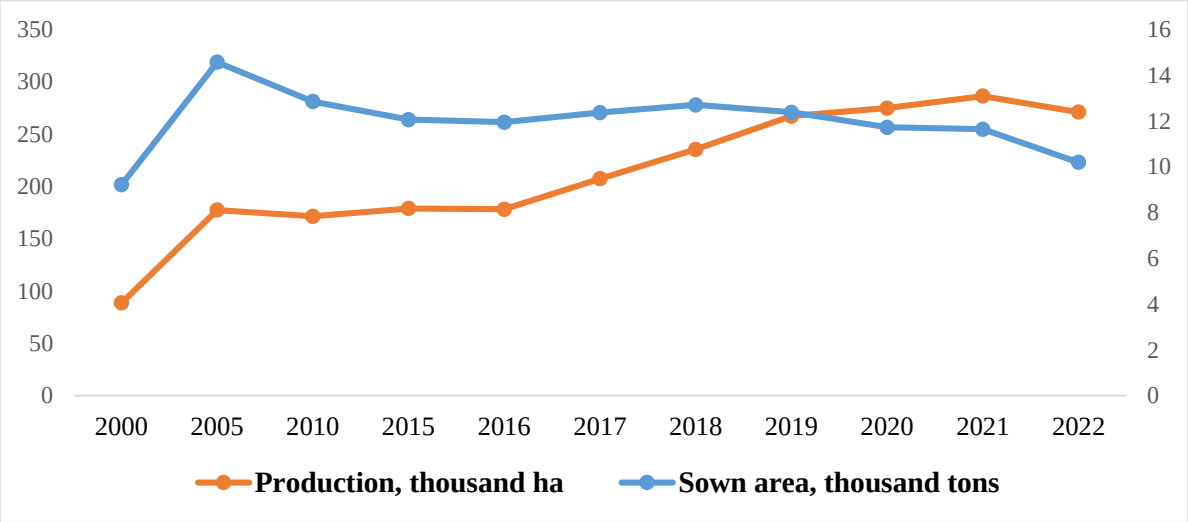
Onion plays an important role in increasing food security and income level for farmers in Azerbaijan. For 2022, onions were planted on 10.2 thousand hectares of land in Azerbaijan. This is 15.6% of the total vegetable crops and 0.5% of the total crops in the country ***(Table 1)***.

Table 1. Share of sown area of onion in the total sown area in Azerbaijan [1]

Crops	Sown area, ha	Share
Cereals and dried pulses	985 686.7	53.0%
Fodder crops	372 745.3	20.1%
Fruits, berries and grapes	237 855.4	12.8%
Potatoes, vegetables, watermelons and melons	126 666.4	6.8%
Industrial crops	125 246.1	6.7%
Onion	10 220.8	0.5%
Total sown area	**1 858 420.7**	**100.0%**

Source: *The State Statistical Committee, https://www.stat.gov.az/source/agriculture/?lang=en*

Graph 1. Sown area and production of onion in Azerbaijan [1]



***Source**: The State Statistical Committee, https://www.stat.gov.az/source/agriculture/?lang=en*

As can be seen from the graph above, although the onion cultivation area is decreasing in Azerbaijan, there is an increase in onion production. This is related to the increase in onion productivity. In fact, between 2000 and 2022, the productivity of onion in Azerbaijan increased more than 2.7 times. This increase in yield is mainly due to improved compliance with agricultural standards by local farmers as well as increase in the usage of fertilizers. It should be mention that, onion productivity in Azerbaijan is above of the world average (18.4 ton/ha).

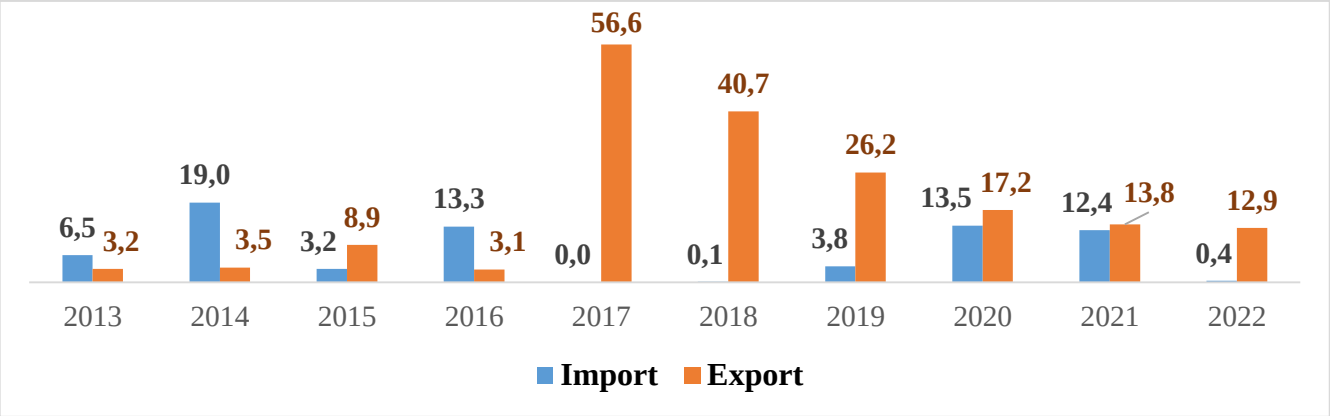
Table 2. Onion sown area, production and productivity per region [1]

	Sown area, ha	Production, ton	Productivity, ton/ha
Aghdam	2 283.0	76 070.0	33.3
Shamkir	1 940.0	53 498.2	27.6
Barda	721.0	32 090.0	44.5
Aghjabadi	535.3	26 392.9	49.3
Beylagan	550.0	22 150.0	40.3
Zagatala	421.0	2 648.1	6.3
Astara	379.3	4 269.5	11.3
Sabirabad	300.0	4 391.4	14.6
Lankaran	295.0	4 536.9	15.4
Gusar	162.0	2 737.8	16.9

***Source**: The State Statistical Committee, https://www.stat.gov.az/source/agriculture/?lang=en*

Azerbaijan is both an importer and exporter of onions. Until 2016, onions were mostly imported, but starting from 2017, onions were mostly exported. Despite this, a noticeable decrease in the volume of onion exports has been observed in recent years.

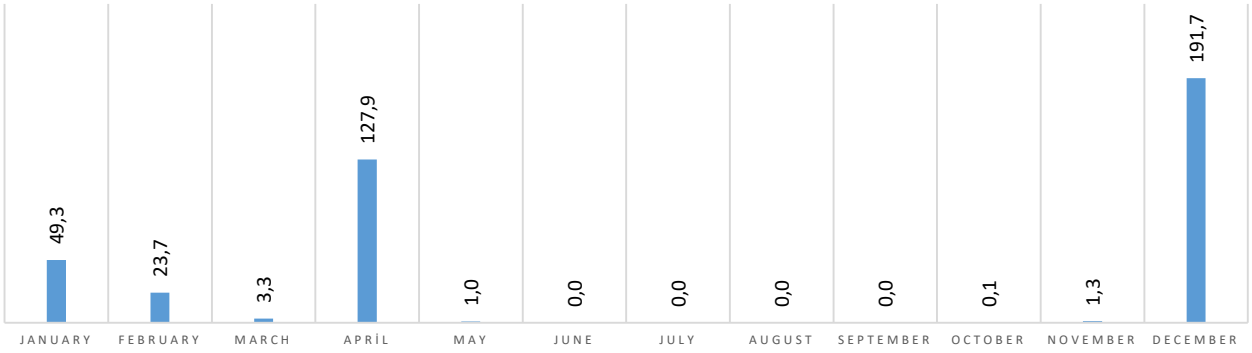
Graph 2. Onion imported to Azerbaijan and exported from Azerbaijan, thousand tons [2]



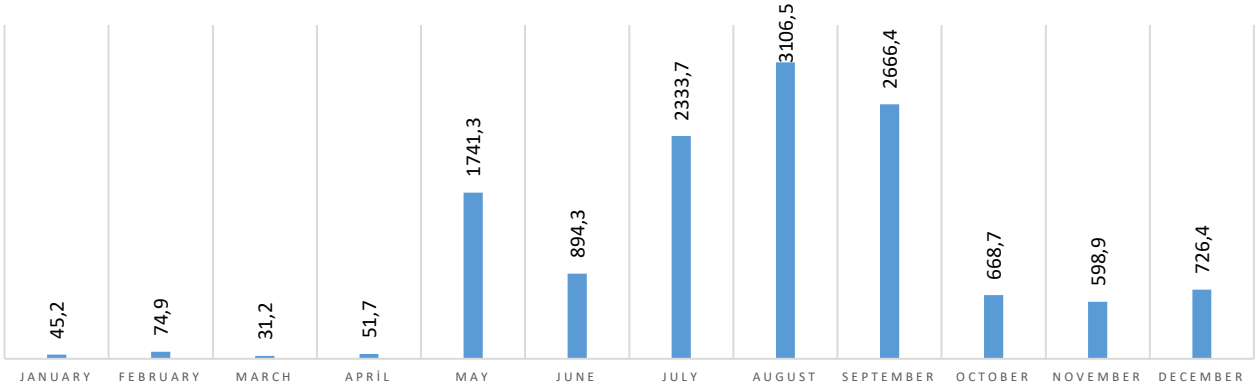
***Source**: International Trade Center, www.trademap.org*

Information on the import and export volume of onion by month is presented in the following graphs.

Graph 3. Onion imported by Azerbaijan per month, tons [3]



Graph 4. Onion exported from Azerbaijan per month, tons [3]



***Source**: The State Statistical Committee, https://www.stat.gov.az/source/trade/?lang=en*

As can be seen from the graphs, Azerbaijan mainly imports onions in winter. Onion export is mainly carried out in the summer months. For 2022 Azerbaijan imported onions mainly from Russian Federation, and exported to Russian Federation and Georgia among others.

As for 2021, the level of self-sufficiency for onion in the country is 100%. Information on resources and utilization of onion is presented below table.

Table 3. Onion balance of Azerbaijan for 2021, ton [1]

RESOURCES	*ton*	*share*
Stocks at the beginning of year	48 984	14.1%
Production	286 375	82.3%
Import	12 432	3.6%
Total of resources	347 791	100.0%
UTILIZATION	*ton*	*share*
For seed	198	0.1%
Personal consumption fund	247 066	71.0%
Export	13 771	4.0%
Losses	29 673	8.5%
Stocks at the end of year	57 083	16.4%
Total of utilization	347 791	100.0%

***Source**: The SSC, https://www.stat.gov.az/source/agriculture/?lang=en*

As can be seen from the table, losses accounted for 8.5% of the total onion use in 2021.

According to the SSC, per capital onion consumption in Azerbaijan for 2021 was 24.2 kg which is 4.4 kg more that of 2007.

The state sells fertilizers and pesticides to farmers at discounted prices. In general, farmers receive subsidies about 250 AZN per hectare of onions. When they become a member of a cooperative, the amount of the subsidy increases by 10%. For 2023, a subsidy of 230 AZN/ha has been determined for the production of vegetables, including onions.

Table 4. Three types of onion grown in Azerbaijan

Types	**Planted**	**Harvested**	**Growing period, month**	**Storage period, month**	**Share in total production**
Autumn onion	Sept - October	April - June	8 - 10	Not stored	23%
Spring onion	Feb - March	Aug - Sept	7 - 8	2 - 8	69%
Intermediate	January	July	7	Not stored	8%

***Source**: Prepared by the author based on discussions with farmers and market participants.*

It should be noted that In Azerbaijan, onions can be grown in the same area twice a year. Usually onion production in the country is mainly carried out in two seasons (spring and autumn) and one intermediate season.

Main part: analysis of onion production costs and losses

Analysis of onion losses have been conducted at five levels: production, post-harvest, transportation, storage and retail. Since onions are predominantly not processed in the country, this stage of the supply chain has not been considered in the article. The analysis of the onion loss involved both primary and secondary data. For the collection of the primary data several surveys were conducted. Surveys of farmers and intermediaries were conducted in Barda, Aghdam (Ergi plain), Aghjabadi and Beylagan regions during main onion seasons. Wholesale and retail traders were interviewed in Baku, since most of the onions produced in the regions are sent to the wholesale and retail markets of Baku. The primary emphasis of the research centers on spring onions, which face increased susceptibility to losses attributable to high storage capacity.

Production and production losses. According to the surveys, farmers devote an average of only 12.5 percent of their farmland to onion cultivation, making them small-scale onion producers. The main reason for this low level of allocation is that farmers consider onion production to be very risky in terms of unstable prices and, of course, climatic factors. Another reason is the size of their warehouses. Although storing produce in other farmers' warehouses is possible, the above risk factors prevail when making decisions to increase production.

Majority of the surveyed farmers indicated that in 2023 they used onion seeds of the Metan Bereket variety. This is a foreign variety (Türkiye, MTN company), and most farmers noted that this variety can be stored for quite a long period of time, and also has a high yield level. In addition, according to farmers, the Metan Bereket variety has a perfectly round shape that meets the tastes of buyers.

Very few of the farmers noted that they are members of onion producers cooperatives. Generally cooperatives and other forms of farmer unions are not widespread in the country.

Based on the collected data it was calculated that the average productivity of the spring onions in the regions is 988.4 bags per hectare. Considering that the average volume of one bag of onions is about 32 kilograms, then productivity of onion is around 32 tons per ha. However, according to the SSC, this indicator for the country for 2022 is 26.5 ton/ha. The difference could be explained with the size structure of the surveyed farmers. As a matter of fact, large farmers, who use modern approaches such as application of modern irrigation systems and utilization of services of private agronomists drive yields high which is not the case with the small ones.

Farmers in operating in Ergi plain of the Aghdam region do not use the crop rotation system, while farmers from Agjabadi region actively rotate their crop. As a predecessor plant they usually use clover (alfalfa) or cotton. This way farmers try to financially secure themselves through diversification of their production activity, as well as to save up on fertilizer. According to farmers, after alfalfa or cotton there is no need for fertilizer, because the earth already contains the residues of the fertilizers applied during those planting those crops.

A quarter of the farmers who took part in the survey use a modern irrigation system (drip irrigation). This is quite a high figure compared to the country, where only 11% of farmers have access to such systems [4].

As a rule, farmers are not interested in obtaining loans for onion production. The main reasons are high interest rates on loans, lack of collateral and low availability of credit.

Costs associated with onion production can be divided into two parts: costs for materials and costs for services. Materials include seed, fertilizers, pesticides, water, electricity etc. Services include weeding, application of fertilizers and pesticides, irrigation etc.

Table 5. Costs of materials used in the production of onions (for one hectare)

Materials	Amount	Value, AZN
Seed, kg	6.7	85
Manure, tons	11.2	68.5
Nitrogen, kg	263.7	160.7
Phosphorus, kg	41.1	45.2
Potassium, kg	3.4	5.5
Pesticides	-	444.2
Water (electricity)	-	100.8
Total	**-**	**909.9**

Source: *Calculated based on the survey data.*

Farmers use pesticides mainly against lice and weeds. The majority of farmers surveyed use artesian water for irrigation. They collectively dug an artesian well, and each of them pays for the electricity used to extract the water every year. So, they do not pay for water, they pay only for the electricity.

Table 6. Costs of services utilized in the production of onions (for one hectare)

Services	Value, AZN
Application of fertilizers	14.4
Application of pesticides	106.5
Plowing	51.4
Seeding	42.1
Harrowing	33.6
Weeding	640.4
Total	**888.4**

Source: *Calculated based on the survey data.*

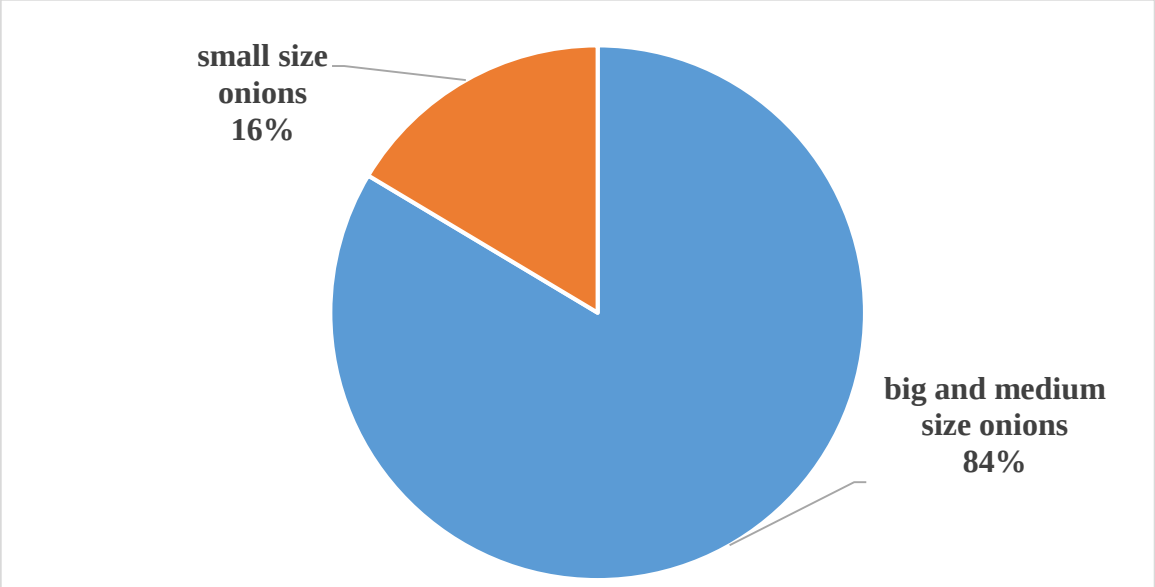
In general, the cost of production of one hectare of onions is 1798.2 manats. This amount only includes production costs and does not include post-harvest costs such as harvesting, cleaning, grading, etc.

Since FAO does not consider losses occurring during the production phase as part of food losses, we will not consider losses at this stage as well [5].

Harvest and post-harvest costs and losses. Farmers do not use machines to harvest onions; the entire process is carried out manually. They spend an average of 13 days collecting onions from their fields. As onions are collected from the ground, they are cleaned, sorted and placed in bags. These bags are then loaded onto trucks for transport to warehouses or for sale to middlemen. All costs associated with harvesting, including cleaning, grading and transportation, are borne by farmers.

The main criterion for sorting is a size of onions. Farmers usually put large and medium size onions in one bag, small size onions are bagged separately. Large and medium size onions are usually stored, whereas small size onions are sold from field. Small onions are commonly used for three purposes: 1) as food (mostly by the poor), 2) as green onion seeds, and 3) as animal feed.

Graph 5. Structure of onion production by onion size



Source: *Calculated based on the survey data.*

As can be seen from the graph, large and medium size onion make up larger share in onion production.

Farmers buy bags of about 32-33 kg each for about 0.29 manat. For every hectare of onions, they buy an average of 988 bags (average yield per hectare according to the survey), which amounts to 287 manats.

Farmers usually use hired labor to harvest their crops. The share of family labor in harvesting is about 5.5%. The structure of hired labor is not gender neutral. Although all survey respondents were men, they made up only 13.6% of hired labor. This means that the majority of hired workers were women. Women are usually engaged in weeding, harvesting (picking up onions from the ground), sorting, cleaning, etc. In contrast, men usually do jobs that require more physical strength, such as digging onions out of the ground, carrying bags to trucks, etc.

Farmers do not pay any money for family labor. It is an implicit cost that farmers do not consider. About 22 hired employee work on one hectare of onions during harvesting and farmer pays on average 1393 manats to these workers.

According to farmers, during onion harvest an average of 1.33% of onions are usually left in the field. These onions are usually very small and farmers are not interested in harvesting them because buyers (or middlemen) are not interested in purchasing them. According to farmers, an average of 1.33% of onions are usually left in the field. SSC does not consider onions left in the field to be part of onion production. To account for these losses, we must add them to production. If we apply this percentage to country-level production, we get 3 709 tons of onions. Thus, the total production volume for 2022 will be 278 904 (275 195 + 3 709) tons.

During post-harvest activities (collection, cleaning (root pruning), sorting, bagging and loading these bags onto trucks) losses are quite rare. And the overall level of losses during these events is about 0.15%.

Transportation along the supply chain and transportation losses. The average distance from a farmer's land to his warehouse is 3 km. For transportation, they usually use the services of owners of cargo transport (tractors, Qazel trucks, etc.), and the cost of transporting one ton of onions (31.3 bags) is about 5.3 manats. Farmers pay an average of 167 manats for transporting onions harvested from one hectare.

According to farmers who took part in the survey, there are no losses when transporting onions from the field to the warehouse.

Intermediaries, at the request of wholesalers, purchase onions from farmers, deliver them to wholesalers and receive about 50-150 manats for their services. Costs associated with purchasing and transportation are borne by wholesalers. They do not store onions and their only responsibility is to find healthy onions. It should be noted that in previous years, these intermediaries purchased onions and stored them in their warehouses. But this year, due to the spread of diseases, they prefer not to store the onions, but to immediately sell them, earning a small amount of money for their services.

Intermediaries choose onions using different methods. For example, they cut onion into half and examine the inside, if it is black inside, it means there is some kind of disease. Another common approach is checking the firmness of onions. If they are soft, it means they are going to rot soon. Although middlemen prefer perfectly healthy onions, when it is problematic to find high quality onions they offer lower prices for low quality onions.

According to intermediaries, there are no losses when transporting onions from the field to the wholesaler.

Wholesalers could be divided into two main groups:

- *The first group specializes only in purchasing onions, storing them, and then selling them at a higher price.*
- *The second group, which makes up the majority of wholesalers in the onion sector, are those who, in addition to carrying out the same activities as the first group, are also involved in the production of onions on a large scale (50-150 hectares).*

In both cases, wholesalers deliver onions from their warehouses to different parts of the country, especially to the city of Baku. The average distance between the main onion producers of the country and the main wholesale market (Meyveli Market) is about 350 km. Wholesalers pay about 350-400 manats for transport. A truck is usually rented for this purpose. The main type of transport is Kamaz, which consumes 33-35 liters of diesel per 100 km.

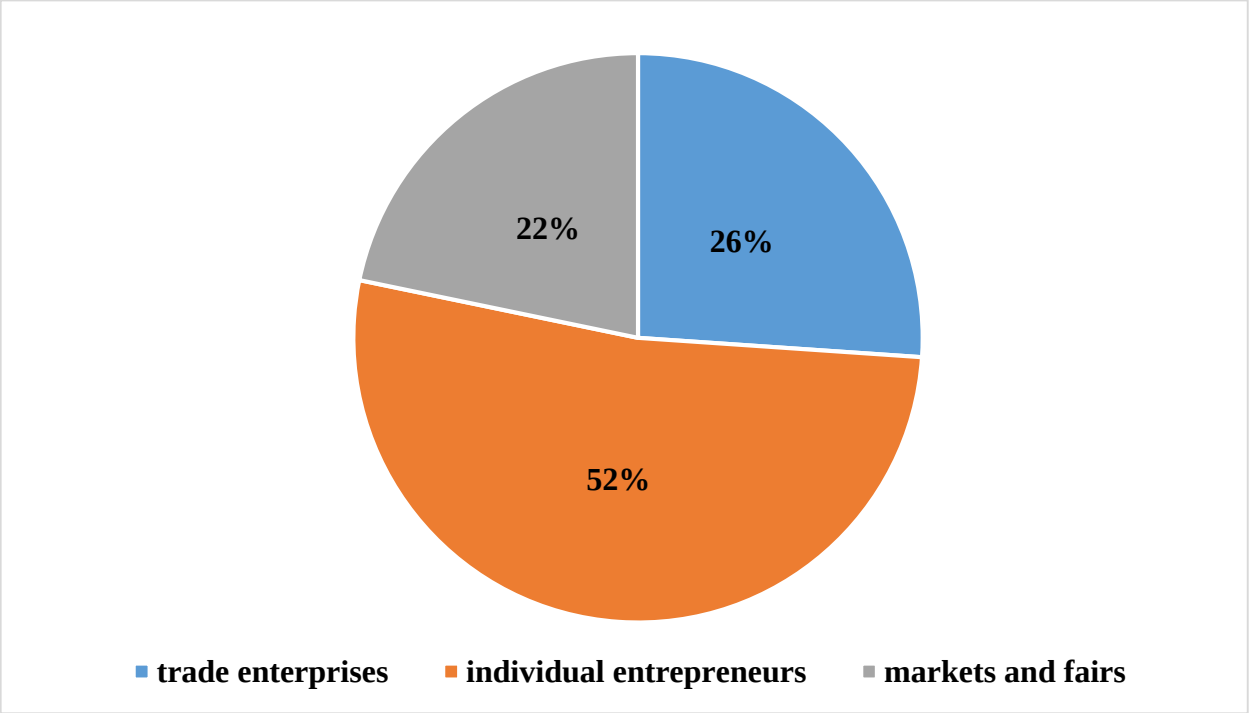
According to wholesalers, there are no losses during transportation. The only loss is due to the onion drying out. In other words, bags of onions lose about 2-3% in weight.

Another item of transportation costs for wholesalers is the fees they pay to middlemen who find farmers to buy onions. For their services they receive about 100-150 manats.

Retail sales in the country are organized in two main directions: supermarket chains and traditional markets (bazaars). According to the information of the State Statistics Committee, 78% of

the country's retail market for 2022 belongs to supermarket chains (trade enterprises and individual entrepreneurs).

Graph 6. Structure of retail trade turnover, by sections of trade [1]



Source: *State Statistical Committee*

In 2010, the share of traditional markets and fairs in the country's retail trade turnover was 41%, however, in 2022, it decreased to 22%.

Since there is no statistical information on the sale of onions by trade sectors in the country, it can be assumed that onion sales share the same pattern as the general retail trade turnover.

The main retail trade center of the country is the city of Baku. According to official information, 23.1% of the country's population lives here in 2023. Therefore survey of the retail actors was conducted in Baku.

The onion transportation process at the retail level includes the steps of procuring onions from the wholesale outlet, loading them into vehicles, transporting them to the retail outlet, and unloading them. In supermarkets, onions are initially collected in a distribution center (depo), and then, after checking the quality of the onions, they are distributed to the market chain. The costs of transporting onions from the wholesale point are borne by the retailers. Medium tonnage trucks (mostly 7-8 tons) are used for transportation. Average transportation distance for Baku city is 10-15 km. Considering that a medium-sized supermarket supplies 180 kg of onions per day, taking into account the driver's salary (on average 600 AZN per month) and other expenses (about 100 AZN per month), we can calculate that the cost of transporting 1 bag of onions (33 kg) to a retail outlet is approximately 0.12 AZN.

In the conducted survey, it was determined that there is no loss of onions during transportation at the retail level.

Farmer and wholesale level storage and storage losses. Farmers store on average 22% of their produce in their attic-type or conventional warehouses.

The cost of storing onions in a traditional warehouse is quite low (almost insignificant). The only cost is the depreciation of the investment in the construction of such warehouses. Based on the data collected during the survey, it is estimated that storing one bag of onions for the entire period (approx. September - March) in a traditional warehouse costs approximately 0.34 manat, while the cost of storing a bag of onions in a cold storage warehouse is approx. 0.96 manat. But the price of storing onions in cold storages is 2.7 manats per bag (1500 manats for 560 bags of onion for the period). Almost none of the farmers use pesticides during storage. Therefore, the cost of pesticides was not included in the calculation.

Pic. 1. *Typical conventional warehouse for storing onions*

Typically, farmers store onions in their traditional warehouses until December (New Year's Eve). But at temperatures above seasonal levels (above 18º C) or below (below -4º C), storing onions becomes difficult, as the level of losses increases sharply. But when onions are infected with diseases, it becomes even more difficult. To keep onions safe and sound, it is better to store them in the refrigerator (0º-2º C). However, small farmers cannot afford to store their produce in such warehouses. In previous years, farmers stored more onions, but this year due to diseases and high temperature, they prefer to sell their produce immediately rather than store it.

After conversations with agronomists, managers of pesticide stores and representatives of DIAMs (regional branches of the Ministry of Agriculture), it became clear that there is no new disease in the region. All of the challenges associated with disease are related to the effects of climate change. During the harvest period, ten days of incessant rain and the prevailing hot temperatures after that led to the fact that almost all the harvested onions were infected with various kinds of diseases. It is clear that farmers, and therefore everyone else in the supply chain, are struggling with the detrimental effects of climate change.

Since wholesalers are also farmers, losses at the farmer level are accounted for at the wholesale level.

As mentioned above, in 2023 middlemen were not interested in storing onions. They mainly acted as brokers only connecting sellers (farmers) and buyers (wholesalers). Therefore, no storage costs or losses occurred during the season on the intermediate level.

Only a small number of middlemen buy onions from farmers and sell them in traditional markets. Losses arising at this stage are considered at the retail level.

Despite the fact that some diseases were widespread and temperatures were well above seasonal norms, onions were mainly stored in traditional attic-type warehouses. This situation could be explained with two reasons:

1) Cold storages in the country are quite expensive and farmers simply couldn't afford to store their onions in those storages. The high prices might be related with the insufficient cold storage capacity. According to the official information of the Ministry of Economy of the Republic of Azerbaijan, currently there are 168 cold warehouses with a total capacity of 672 thousand tons, of which 503 thousand tons (143 storages) are for storing fruits and vegetables. So, the average capacity of a cold storage for fruits and vegetables is 3.5 tons.

The largest cold storages in terms of capacity are located in Absheron (276 thousand tons), Guba-Khachmaz (101 thousand tons), Gazakh-Tovuz and Ganja-Dashkasan economic regions (97.1 thousand tons). It is clear from this that in other economic regions of the country there are cold storages with a total capacity of only 29,000 tons.

Based on the research conducted by the Center for Agrarian Research in 2019, it was determined that there is a need for 835 thousand tons of storage across the country, so, considering the existing storage capacity, we can determine the need for an additional 287 thousand tons of cold storage. It should be noted that the additional cold store is mainly needed for storing potatoes and onions [6].

2) Due to diseases, respondents (farmers, middlemen and wholesalers) were not sure whether their produce would survive for a certain period, even if it had been stored in cold storage. Most respondents believed that onions are not suitable for long-term storage. Even with short storage periods, significant losses occurred. Therefore, they were interested in selling their products as early as possible. However, as onion exports had been limited, the domestic onion market reached its limit in terms of selling capacity. To better understand the onion market of Azerbaijan onion stocks and usage per month have been calculated based on 2022 data ***(Table 7)***.

Table 7. Stocks and uses of onions in Azerbaijan by month

	Stock	Production	Imports	Exports	Consumption	Losses
January	38,087	-	49	45	18,000	1,000
February	19,036	-	24	75	18,000	1,000
March	-	-	3	31	15,000	500
April	-	19,924	128	52	19,000	1,000
May	-	21,740	1	1,741	19,000	1,000
June	-	20,894	-	894	19,000	1,000
July	-	22,334	-	2,334	19,000	1,000
August	65,045	95,152	-	3,107	23,000	4,000
September	129,530	95,152	-	2,666	24,000	4,000
October	103,861	-	0	669	21,000	4,000
November	77,593	-	1	599	20,671	5,000
December	51,696	-	192	726	20,000	5,362
Total	-	275,195	398	12,939	235,671	28,862

Source: *Prepared by the author based on the official consumption, production, export-import and loss data from SSC.*

The table shows that during the August-September harvesting season (spring onions), about 190 thousand tons of onions are usually produced, and onion reserves reach their maximum level in September (up to 130 thousand tons). The reserve then decreases as it is consumed, lost, and exported. This means that during this period there is a need for at least 100 thousand tons of refrigeration capacity.

As for the onions currently stored in refrigerators, the approximate estimate is about 6000-7000 tons (according to wholesalers). In other words, onions stored in refrigerators account for only 6-7% of all onions stored. This may be one of the main reasons for onion losses in the country.

Meyveli Market is the largest wholesale market in the country and has cold storage facilities with a capacity of 14 thousand tons. According to the manager of the Meyveli Market, onions are currently not stored in refrigerators; they will begin to be stored from January next year. He mentioned that last year (2022) there were up to 1,000 tons of onions in the cold storage of Meyveli Market. Wholesalers probably won't refrigerate onions for fear of disease, he said. Because if the onion rots when stored in the refrigerator, the loss will double (onion loss and cost of refrigeration). He adds that due to such an uncertain situation in the market, in April-March next year there may be an acute shortage of onions and prices will soar.

As a result of the analysis of data collected from wholesalers, it was determined that the amount of loss at the storage level is 12.52% of the total production.

A survey was conducted with Bazarstore, one of the country's largest supermarket chains, to obtain information on onion retailing and losses at this stage. The Bazarstore network includes 90 supermarkets. 55 of these supermarkets are located on the Absheron peninsula (Baku, Khyrdalan and Sumgait cities). Supermarkets located on the peninsula supply onions from "Meyveli", the country's largest wholesale outlet. For this purpose, a permanent representative of Bazarstore operates in "Meyveli". On the basis of the survey conducted with this representative, it was determined that the total amount of onion loss in the Bazarstore network is around 4%.

This loss refers to the onion remaining on the counter (stall) after the onion has been selected by the buyers. At the retail level, almost no onions are stored in the warehouse more than 2 days as onions are purchased on a daily basis. Therefore no loss occures during storing.

According to him, the Bazarstore chain is interested in supplying only quality onions, for this purpose, during the supply of onions, he requires emptying and re-selection of bags. For this reason, the supply price of onion is higher compared to other retailers. He claims, therefore, that the amount of loss in other supermarket chains is higher. He also notes that he prefers medium-sized onions. But onions in bags come in different sizes, which makes it difficult to choose. He recommends using calibration devices to solve this problem.

It should be noted that the Bazarstore network is part of Azersun Holding (the largest food processor in the country). During the interview with the representative of Bazarstore, it was also determined that the amount of onion loss in another supermarket chain (Almarket), which also operates under the Azersun Holding umbrella, is approximately 5.5-6%.

One issue mentioned by the respondent is related to the activities of the Azerbaijan Food Safety Agency (AFSA). According to him, AFSA requires documents related to food safety from him, while, according to the Bazarstore representative, these documents should be requested from the producers of onions.

Another quick survey was conducted with a representative of the Araz market, another large supermarket chain of the country. In this survey is was identified that onion loss is approximately 6.5%. It should be noted that this network includes more than 400 large and small stores.

According to the results of a survey conducted in traditional markets, which are another direction of onion retailing, onion loss is approximately 2.5%. The reason for the relatively low loss of onions in the traditional market is that the onions are packed by the sellers and not by the buyers. In other words, buyers are not given the opportunity to personally select onions, as is usually the case in supermarkets. Therefore, part of the onion loss in these markets occurs at the consumer level.

As a result of the survey and analysis, it was determined that the onion loss at the supermarket level for the current season of 2023 is approximately 5.8%, and as mentioned above, at the level of traditional bazaars it is 2.5%. Consequently, considering the shares of these two retail trade sectors in the overall retail trade turnover, the average onion loss at the retail level is 4.8%.

A part of the onions lost in supermarkets is used in the canteen of the market. The remaining part is thrown into the landfill. In traditional markets, all waste is thrown into the landfill.

Income. Farmers' income comes from the sale of onions. It should be noted that none of the farmers surveyed sell onions directly to consumers. They sell their products to intermediaries, who in turn move them further up the supply chain. The following table provides information on production, sales, prices and income levels of the surveyed farmers.

Based on the collected data it can be calculated that the average income per hectare is 6177 manats, but farmers have onion stocks that they plan to sell when prices rise. To calculate total income, we need to take this into account. On the other hand, some of the stored onions are already lost, so this loss must be considered as well. We really don't know when the prices will be right for them to sell the stored onions or what losses will occur when they continue to store the onions in warehouses. So overall, we can calculate the total income by assuming that they will soon sell the stored onions at the same price they sold them during the season and there will be no more losses. Thus, farmers get 8,003 manats of income per hectare of onions.

Moreover, we calculated the different components of the farmer's costs. Information on the costs of growing onions is presented in the table below.

Table 8. Cost structure for growing onions

Producer costs	AZN
Production (materials and services)	1798
Purchase of bags	287
Harvesting (labor)	1393
Transport (to farmer's warehouse)	167
Total	**3645**

Source: *Calculated based on the survey data.*

Thus, small and medium-sized farmers receive an average profit of 4,358 manats from growing onions in the Agjabadi region.

Based on the survey data it was also identified that one family eats an average of 4 bags of onions per year, which is about 128 kg of onions. Considering that the average family size in the regions of Azerbaijan is 4.5 people, the annual consumption of onions is about 28 kg per person which is close to the figure (23.4 kg for 2022) that can be calculated based on the data of SSC.

In 2023, spring season, due to the climate-driven spread of diseases, intermediaries did not invest in purchasing onions for storage and subsequent sale at high prices, as is usually the case. Instead, they minimized their risks by acting as linking agents between buyers and sellers. Thus, without having any costs, they earned 50-150 manats from each truck of onions (~560 bags) purchased from farmers.

Wholesalers' income is usually generated by price differences. In August-September, wholesalers bought a bag of onions from farmers for an average of 9.5 manats, and sold them for about 12 manats per bag, receiving 2.5 manats in revenue from each bag, based on the difference in the prices. In addition, wholesalers pay the cost of transporting onions from the regions to the main consumption centers (such as Baku, Sumgait, etc.). An average of 350 manats is paid for transporting one truckload of onions. For finding onion sellers (farmers), intermediaries also receive about 150 manats for each truck. In addition, wholesalers pay 30 manats for daily parking of a truck with onions after three days of free parking at the Meyveli Market. Considering that one truck (Kamaz) contains up to 560 bags of onions, the costs, income and profit of the wholesaler can be calculated as follows if the onions are not stored.

As can be seen from the table above, wholesalers earn about 870 manat per truck and an average of 1.6 manat per bag of onions.

On average, retailers supply onions from wholesale outlets on average for 0.37 manats per kg and sell them for 0.59 manat/kg. So, at the retail level, a bag of onions earns about 7.26 (0.22*33) manats.

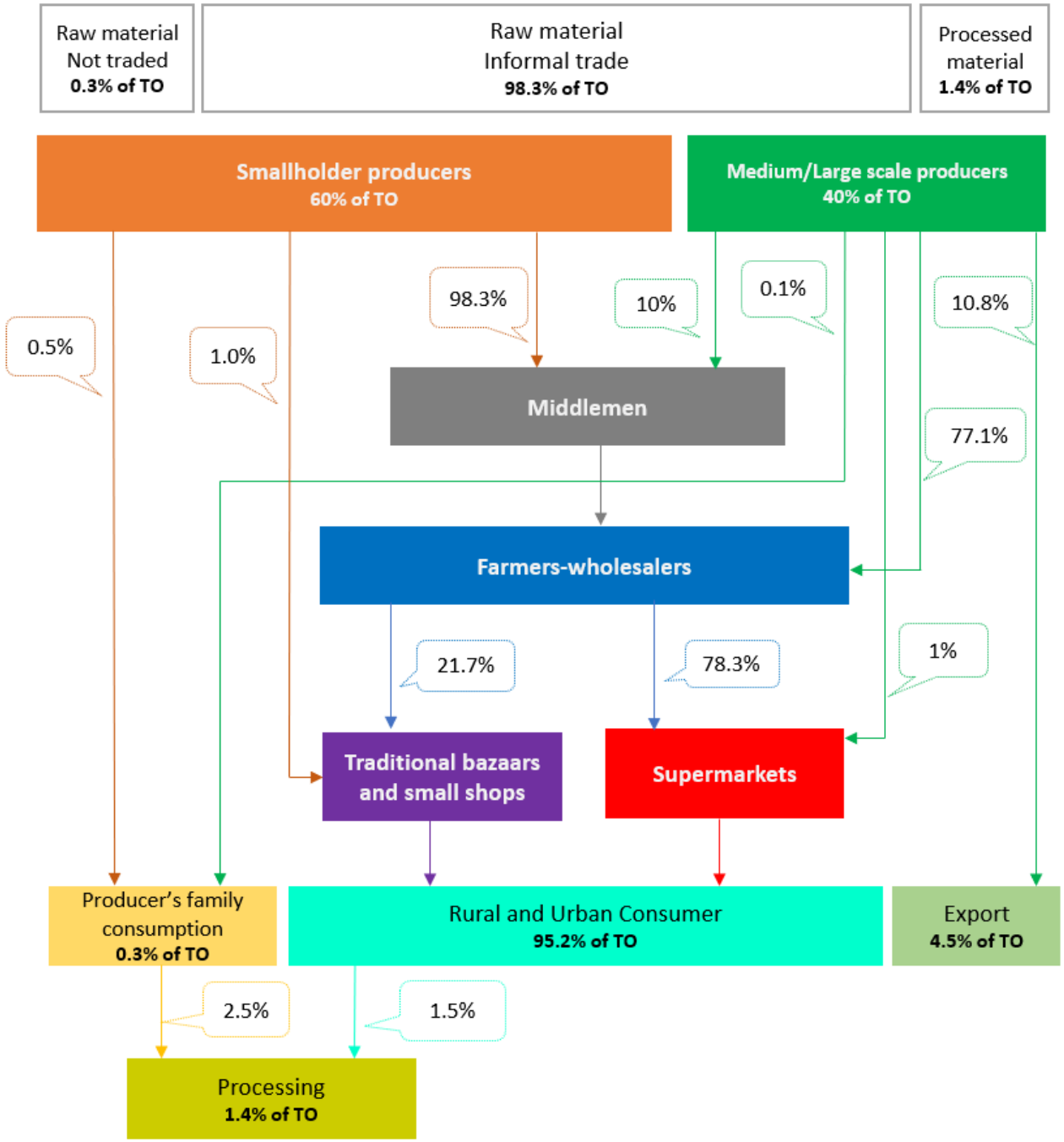
Table 9. Wholesaler's costs, income and profit

	manats
purchase	5320
transportation	350
payment to middlemen	150
parking (one day)	30
total cost per truck	**5850**
income per truck	**6720**
profit per truck	**870**
total cost per bag of onions	**10.4**
income per bag of onions	**12.0**
profit per bag of onions	**1.6**

Source: *Calculated based on the survey data.*

Production flow map. Onion production flow information is presented in the graph below. Different participants in the chain are represented by different colors. The percentages in the middle show the shares at the corresponding stage, and the outer percentages show the shares in the total output (TO).

Pic. 2. Production flow map of spring onions



Source: *Prepared by the author based on the SSC, SCC and the survey data.*

The movement of production in physical volume is presented in the table below. Flows are represented as input-output relationships.

Table 10. Input-output table for onion sector in Azerbaijan (2022)

	Small-size producers	M/L scale producers	Middlemen	Farmers-wholesalers	Supermarkets	Traditional bazaars	Family Consumption	R/U Consumer	Export	**Total**
Small-size producers	0	0	162,310	0	0	1,651	826	0	0	**164,787**
M/L scale producers	0	0	11,008	84,650	1,101	0	110	0	12,109	**108,977**
Middlemen	0	0	0	173,318	0	0	0	0	0	**173,318**
Farmers-wholesalers	0	0	0	0	201,989	55,979	0	0	0	**257,968**
Supermarkets	128,698	85,329	0	0	0	0	0	203,090	0	**203,090**
Traditional bazaars	36,088	23,648	0	0	0	0	0	57,630	0	**57,630**
Family Consumption	0	0	0	0	0	0	0	0	0	
R/U Consumer	0	0	0	0	0	0	0	0	0	
Total	**164,787**	**108,977**	**173,318**	**257,968**	**203,090**	**57,630**	**936**	**260,720**	**12,109**	
Share in TO	**60.2%**	**39.8%**	**63.3%**	**94.2%**	**74.2%**	**21.1%**	**0.3%**	**95.2%**	**4.4%**	

Source: *Calculated based on SSC and the survey data.*

The table rows represent supply of onions. They show how much onion each member of the supply chain receives. The sum of the row represents the total supply per actor. For example, small onion producers supply a total of 164.8 thousand tons of onions. The columns of the table reflect demand. The sum of the columns represents the total demand per actor. For example, middlemen require 173.3 thousand tons of onions, which is 63.3% of the total output (TO).

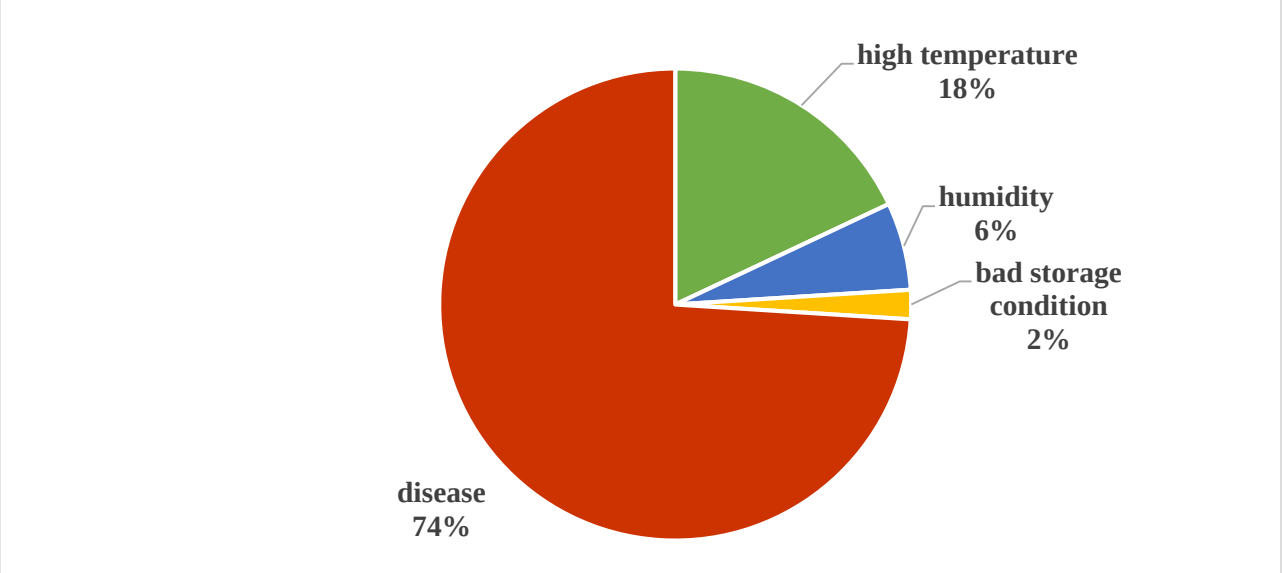
Reasons for the loss of onions. According to farmers, middlemen and wholesalers, the main reason for onion loss in the region is the spread of diseases. As we indicated above, this is not a new type of disease as the majority of farmers indicate, but a mix of several known diseases that proliferated under the impact of adverse climatic events, such as excess rain and heat. This conclusion was reached after having interviews with local agronomists and pesticide sellers. Moreover, it was officially confirmed by DAIMs that the existence of a new disease does not reflect the reality, loss issues are related with climatic changes, as well as improper observance of agrotechnical rules.

Moreover, farmers and other interviewed participants noted that “there is an overproduction of onions this year. In addition, there are some problems with the export of onions. This is why prices in the domestic market are low compared to last year”. Let’s check it with the official data. According to the SSC, 251.6 thousand tons of onions were produced in the country in January-August of this year, which is 12.4% more than the same period of 2022. On the other hand, the ban on the export of some food products, including onions, imposed by the decision of the Cabinet of Ministers at the beginning of this year is currently in force. On the basis of a joint discussion between the Ministry of Agriculture and the Ministry of Economy, the export of onion was allowed with a quota of one thousand tons for each exporter during a month. By the way, the main purpose of this decision is to stabilize the price of onion in the domestic market and prevent its increase in price. This is due to the sharp increase in the price of onions in the world.

But it should also be noted that on average only 5% of onions are exported from Azerbaijan annually. Nevertheless, this year, 21,000 tons of onions were exported from the country, which is 2.5 times more than that of last year. The main export countries were Georgia (8,403 tons), Ukraine (6,758 tons) and Russia (5,505 tons). Therefore, the problem of overproduction does not seem so serious.

The following pie chart shows the most frequently cited reasons for onion loss in the survey.

Graph 7. The most popular answers to the question about the reasons for the onion loss



Source: *Prepared based on the survey data.*

As can be seen from the diagram, the main reason for onion losses is the spread of diseases (as three quarters of farmers noted this).

Information about overall losses has been generalized in the table below.

Table 11. Estimated onion losses per supply chain stages

Supply chain stage	Share in the total production	Physical volume, tons
production-harvest	1.33%	3,651
post-harvest	0.15%	414
transportation	0.00%	-
storage	12.52%	34,452
retail	4.80%	13,209
Total loss	**18.80%**	**51,726**

Source: *Calculated based on the survey data.*

Most farmers noted that they dump onions unfit for sale and/or consumption. Other ways of loss utilization are to feed animals (which is not so popular because, according to farmers, animals don't like to eat onions) and allow poor people to come and pick onions from the field.

Conclusions and recommendations

In conclusion, the assessment of the onion supply chain in Azerbaijan revealed a significant total loss of 18.8%, with storage contributing the highest share at more than two-thirds. Non-compliance with agro-technical norms, climate-induced onion diseases, market volatility, and poor marketing practices emerged as primary causes of losses.

Reducing food losses in the onion supply chain involves implementing regulatory strategies at various stages of production, storage, transportation, and distribution. Here are several approaches to decrease food losses in the onion supply chain:

- *Improved Harvesting Techniques*. Farmers should be trained in proper harvesting techniques to minimize damage to onions during the harvesting process. Moreover, appropriate tools and equipment to reduce mechanical damage to onions should be used.
- *Post-Harvest Handling*. Training on post-harvest handling practices to reduce bruising, cuts, and other forms of damage during sorting and packing should be provided. Farmers should implement proper sorting and grading processes to ensure only high-quality onions enter the supply chain.
- *Proper Storage Facilities*. Improved storage facilities, such as cold storage or controlled atmosphere storage, should be invested in to extend the shelf life of onions. Storage conditions, such as temperature and humidity, should be regularly monitored and controlled to prevent spoilage
- *Transportation*. Appropriate transportation methods should be employed to minimize physical damage during transit. For example, cushioning and ventilation in transportation containers can help prevent bruising and rot. Ensure that transportation times are minimized to mitigate the risk of spoilage.
- *Infrastructure Improvement*. Proper handling facilities should be implemented at transportation hubs to prevent damage during loading and unloading.
- *Market Access and Information*. Market access for farmers should be improved to reduce the time between harvest and sale. Farmers should be provided with market information to enable them to make informed decisions about when and where their produce should be sold.
- *Collaboration and Coordination*. Collaboration and coordination among stakeholders in the supply chain, including farmers, distributors, retailers, and government agencies, should be fostered to streamline processes and reduce losses.
- *Education and Training*. Stakeholders should be educated about the importance of reducing food losses and be trained in best practices for handling and storing onions.
- *Technology Adoption*. The utilization of technology, including sensors and data analytics, is to be explored for monitoring and managing the condition of onions throughout the supply chain. Traceability systems are to be implemented to swiftly identify and remove batches of onions at risk of spoilage.

By implementing a combination of these strategies, it is possible to decrease food losses in the onion supply chain and improve the overall efficiency and sustainability of the system.

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Effektiv tənzimləmə yolu ilə soğan itkisinin azaldılması: soğan təchizat zəncirinin kompleks qiymətləndirilməsi

Xülasə

Məqalə qida itkilərinin azaldılmasında dövlət tənzimləməsinin effektivliyini artırmaq üçün əsas maraqlı tərəflərlə sorğular və müsahibələr vasitəsilə soğan tədarük zəncirində soğan itkilərini qiymətləndirmək məqsədi daşıyır. Təhlil nəticəsində ümumi soğan itkisinin 18,8% olduğu müəyyən edilmişdir. Ən çox itki saxlama mərhələsində müşahidə edilir. İtkinin əsas səbəbləri isə aqrotexniki normalara əməl olunmama və iqlimdən qaynaqlanan soğan xəstəlikləridir. Bundan əlavə, bazarın qeyri-sabitliyi, zəif marketinq təcrübəsi və qeyri-sabit ixrac münasibətləri də soğan itkisinə səbəb olur. Araşdırma soğan itkisinə səbəb olan kritik amilləri və təchizat zəncirinin təkmilləşdirilməsi istiqamətlərini müəyyən etməyə imkan vermişdir.

Məqalədə soğan sektorunun məcmu itkiləri soğan istehsalı axınlarının təsviri və sektor üçün giriş-çıxış cədvəlinin qurulması vasitəsilə qiymətləndirilmişdir. Məqalənin nəticəsi soğan itkilərinin azaldılması üzrə əsas strategiyaları və dövlət tənzimləməsi istiqamətlərini əhatə edir.

Açar sözlər: *soğan itkisi, tədarük zəncirinin təhlili, dövlət tənzimləməsi, soğan istehsalı axını.*

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Сокращение потерь лука через эффективное регулирование: комплексная оценка цепочки поставок лука

Резюме

Целью статьи является оценка потерь лука в цепочке поставок лука посредством опросов и интервью с ключевыми заинтересованными сторонами для повышения эффективности государственного регулирования в снижении продовольственных потерь. Результаты показывают, что общие потери составляют 18,8%, причем наибольший вклад вносят хранилища. Основными причинами являются несоблюдение агротехнических норм и заболевания лука. Кроме того, нестабильность рынка, плохая маркетинговая практика и непоследовательные экспортные отношения способствуют потерям лука. Это исследование проливает свет на критические факторы, влияющие на потери лука, и предлагает идеи для улучшения управления цепочками поставок.

В статье оценены совокупные потери в луковом секторе путем построения таблицы «затраты-выпуск» для луковой отрасли страны в сочетании с разграничением потоков производства лука. В заключении статьи изложены основные стратегии и направления государственного регулирования по смягчению последствий сокращения потерь продовольствия.

Ключевые слова: *потери лука, анализ цепочки поставок, государственное регулирование, поток производства лука.*