



**POTATO VALUE CHAIN ANALYSIS IN AKHALTSIKHE,
AKHALKALAKI, NINOTSMINDA, MARNEULI, BOLNISI,
DMANISI, TSALKA, AND KHULO MUNICIPALITIES**

USAID UNITY THROUGH
DIVERSITY PROGRAM
2023



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1. Introduction

The USAID Unity Through Diversity Program is a five-year initiative led by USAID and implemented by UNA-Georgia. The program aims to integrate ethnic and religious minorities into various aspects of Georgian society, including social, political, and economic spheres. As a subcontractor of UNA-Georgia, PMCG contributes to expanding and strengthening socio-economic connections between the majority and minority communities. The overall objective is to facilitate mutually beneficial business relationships between these groups. One project component involves conducting value chain assessments in target ethnic and religious minority municipalities. These assessments provide recommendations for the Unity Through Diversity Program to increase the integration of ethnic minorities in the value chain and to integrate regional value chains into national or international value chains.

Among the minority municipalities, the potato value chain in Marneuli, Bolnisi, Dmanisi, and Tsalka municipalities of the Kvemo Kartli region; Akhaltsikhe, Akhalkalaki, and Ninotsminda municipalities of Samtskhe-Javakheti region and Khulo municipality of Zemo Adjara was selected as having high development potential in line with the project objectives. The analysis of the potato value chain in these municipalities aims to identify gaps in each stage of production, propose recommendations to meet the market demand for high-quality products and identify business opportunities for religious and ethnic minority municipalities. It also seeks solutions to increase the integration of municipal value chains into national value chains.

The report is structured into several sections to provide a comprehensive analysis of the potato value chain in the selected municipalities:

- Methodology: Provides an overview of the quantitative and qualitative analysis methods used in researching the potato value chain in target municipalities.
- Sector Overview in Georgia: Describes the main findings of desk research on a national and regional level, including key statistics.
- Value Chain Actors: Maps the value chain actors, provides descriptions of their roles, and offers a detailed overview of the value chain process, including primary production, storage and processing, packaging, transportation, and sales. This section also includes a description and summary of external stakeholders.
- SWOT Analysis: Identifies the strengths, weaknesses, opportunities, and threats of the potato value chain in the target municipalities.
- Recommendations: Provides recommendations for the program's value chain development, with a focus on integrating ethnic minorities into the value chain and integrating regional value chains into national or international value chains.

2. Methodology

The potato value chain analysis in the target municipalities utilized quantitative and qualitative research methods. The research involved desk and field research, including interviews with relevant stakeholders. The potato value chain was studied between May and August 2023.

2.1. Desk research

During the analysis, desk research was conducted to provide a sector overview at both national and regional levels. The statistical and qualitative information used in the desk research was sourced from various documents and data sources, including:

- "Samtskhe-Javakheti regional development strategy 2014-2021"
- "Potato production in Akhalkalaki municipality" developed by Care
- "Akhalkalaki municipality development strategy" and "Ninotsminda municipality development strategy" developed by Care, CiDA
- "Development prospects of potato production in the Autonomous Republic of Adjara" developed by PMCG
- "The demand-supply possibilities of locally produced products in Bolnisi municipality and the interests of peripheral consumers" developed for the EU program: "Establishment of an effective platform for business activities in Bolnisi" under the EU initiative - Mayors for economic growth
- "Local economy development plan of Keda, Khulo and Shuakhevi municipalities 2020-2021" developed under the EU initiative - Mayors for economic growth
- Statistical Business Register (number of registered businesses under processing and storage enterprises, suppliers of inputs, machinery, etc.)
- Agriculture Statistics of the National Statistics Office of Georgia (potato production, sown areas, yield by regions, prices)
- External Trade Portal of the National Statistics Office of Georgia (export and import values/volumes by countries)
- National Bank of Georgia (banking entities)

The analysis obtained key insights into the potato sector through this desk research. This was achieved by reviewing national and regional statistics and conducting thorough online research. The findings of this desk research are presented in section 3 of the report.

2.2. Field research

After conducting the desk research, a questionnaire was created to gain further insights into the potato sector's current state, challenges, and opportunities in the target areas. The questionnaire encompassed various aspects of the potato value chain, including current production levels, production plans, the detailed potato production process, sales and distribution practices, sales prices, production costs, disease management, financing, and labor force. Additionally, the questionnaire addressed broader inquiries about the strengths, weaknesses, opportunities, and threats specific to the potato sector in the target municipalities. These general questions aimed to comprehensively understand the potato sector's dynamics and potential

in the designated areas. Furthermore, the questionnaire was designed to be diversity-sensitive and incorporated questions that considered variations and connections among different groups, including the division of labor and roles, practical needs of diverse groups such as religious minorities, women, and youth, as well as access, control, and benefits of resources.

Respondents were selected carefully to ensure a comprehensive representation, considering potato producers' broad geographical range and diverse characteristics. The following table presents an overview of the interviews/consultations conducted with stakeholders in the potato value chain analysis.

Table 1: Number of interviews/consultations conducted with potato value chain stakeholders by municipality

Stakeholder	Number of interviews/consultations conducted
Farmer	24
Supplier of seed	5
Supplier of fertilizer and pesticides	3
Supplier of equipment	2
Storage	2
Processing	2
Laboratory	1
Educational institutions	5
Association	2
International organization	1
Total ¹	47

2.3. Research limitations

The study has encountered certain limitations:

- Incomplete statistical information at the municipality level in Georgia: The availability of comprehensive statistical data specific to each municipality in Georgia is limited (for instance, on production level, land area, producers, etc.), making it challenging to obtain a complete picture of the potato sector at the local level.

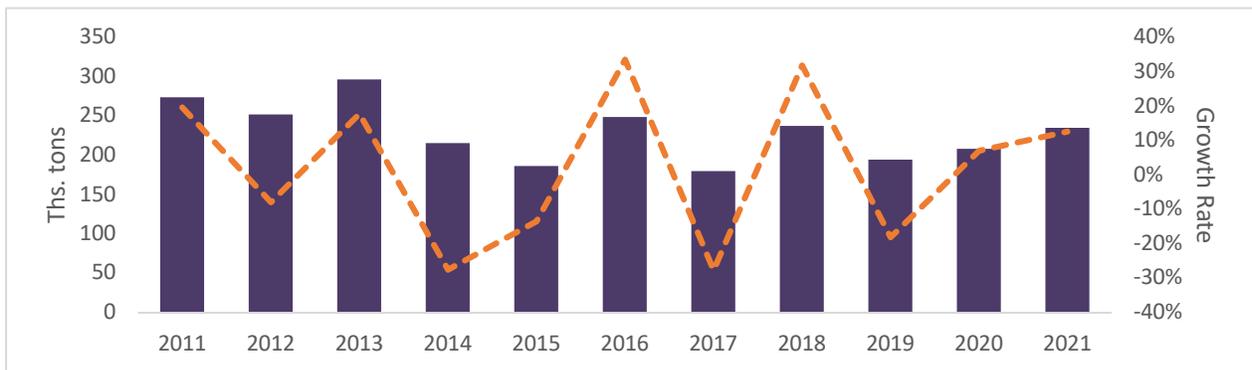
¹ Please note that one respondent can represent different groups of stakeholders. In total, 37 interviews/consultations were conducted with individual respondents.

- Lack of a complete database of farmers by location and agricultural product: The absence of a comprehensive and up-to-date database that includes detailed information on farmers, their sites, and the specific agricultural products they cultivate hinders the ability to gather precise data on the potato producers in Georgia.
- Limited official registration of potato producers: Potato producers in Georgia mainly operate without official registration. Therefore, the official statistics do not fully depict the number of potato producers in Georgia.

3. Sector overview in Georgia

Potato production plays a significant role in Georgia's agricultural industry. According to the National Statistics Office of Georgia, the country produced 234.7 thousand tons of potatoes in 2021, accounting for 25% of the total production of annual crops. During 2019-2021, production is increasing, however, there has been a 14% decrease in production from 2011 to 2021. Between 2011 and 2021, the highest production volume was observed in 2013, reaching 296.6 thousand tons, while the lowest was recorded in 2017, amounting to 180.1 thousand tons. Despite these fluctuations the average growth rate was 3% during the given period.

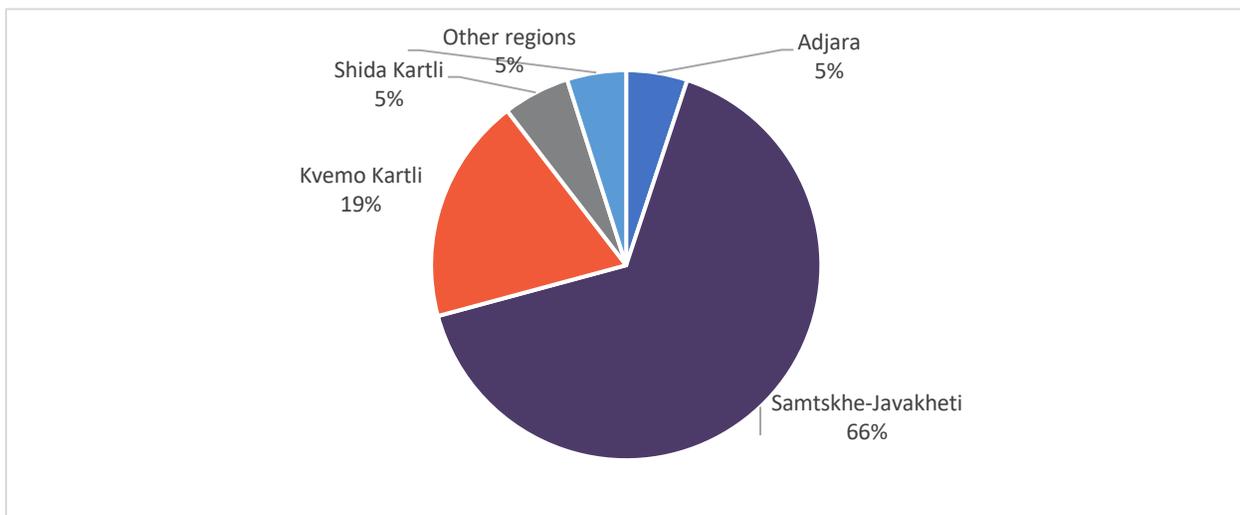
Graph 1: Potato production and its growth rate in Georgia



Source: The National Statistics Office of Georgia

Among regions, Samtskhe-Javakheti stands out as the leading potato producer in Georgia, contributing to approximately 66% of the total production in 2021. Kvemo Kartli and Adjara regions also make significant contributions, accounting for 19% and 5% shares, respectively.

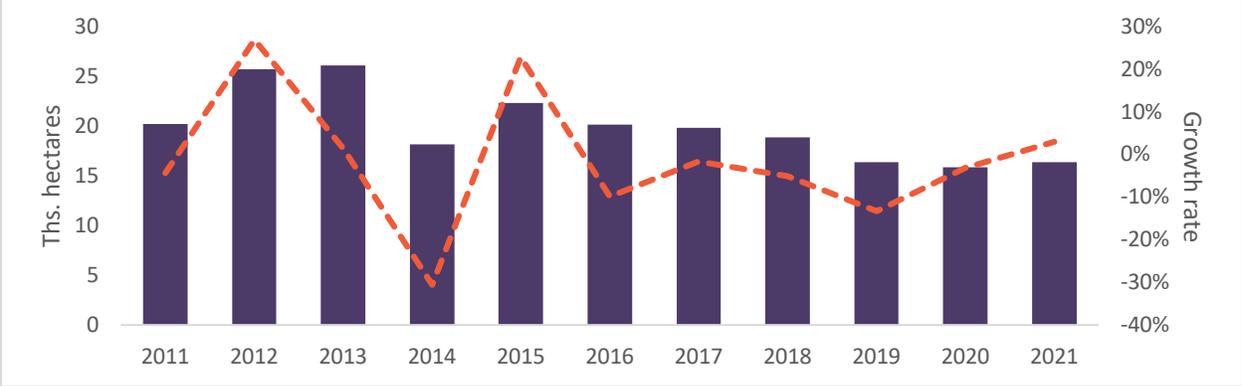
Graph 2: Potato production distribution by regions in 2021



Source: The National Statistics Office of Georgia

In 2021, the total sown area of potatoes in Georgia amounted to 16.4 thousand hectares, which is 19% less compared to the level recorded in 2011. Over the period from 2011 to 2021, the average growth rate of the sown area was -1%, indicating an overall negative trend.

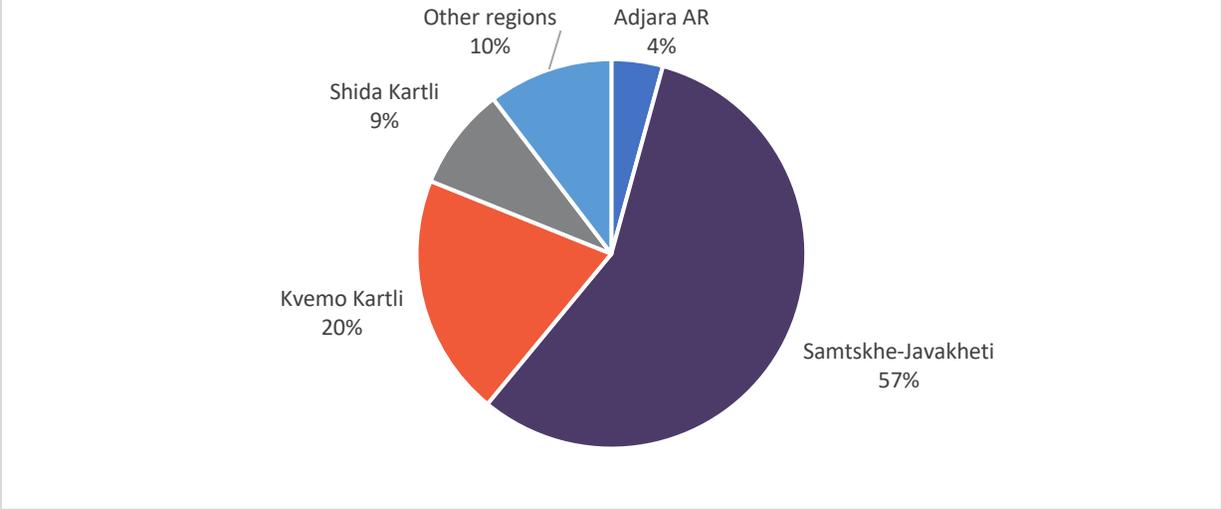
Graph 3: Sown area of potato and its growth rate



Source: The National Statistics Office of Georgia

Most of the land dedicated to potato cultivation in Georgia was concentrated in Samtskhe-Javakheti, comprising 57% of the total sown area. Following that, Kvemo Kartli accounted for 20%, Shida Kartli for 9%, and Adjara for 4%. The remaining 10% was distributed among other regions of Georgia.

Graph 4: Distribution of sown area of potato by regions in 2021

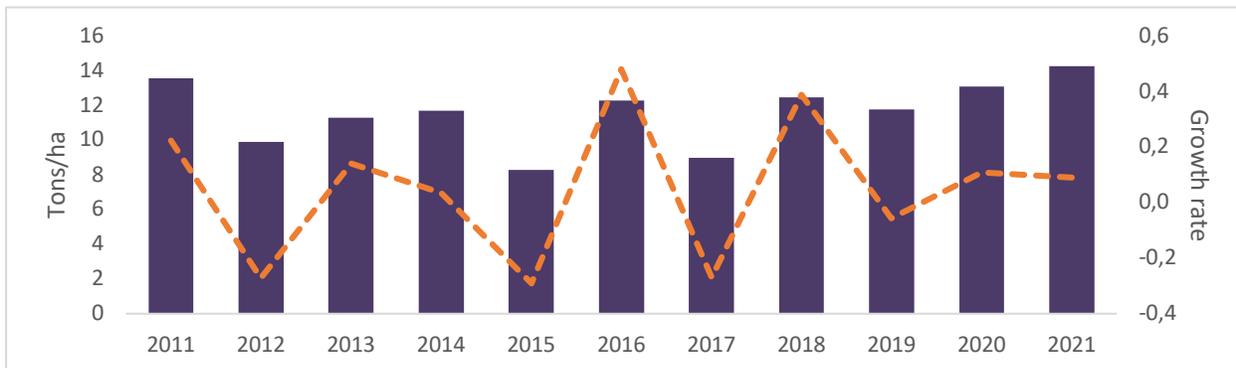


Source: The National Statistics Office of Georgia

In 2021, the average yield of potatoes in Georgia reached 14.3 tons per hectare, representing a 5% increase compared to the level recorded in 2011. However, it is essential to note that Georgia's potato productivity,

as per the FAO²², ranked 112th in the world in 2021. This ranking is notably lower compared to neighboring countries such as Turkey(16th), Armenia(69th), Azerbaijan(80th), and Russia(100th), which have higher potato productivity levels.

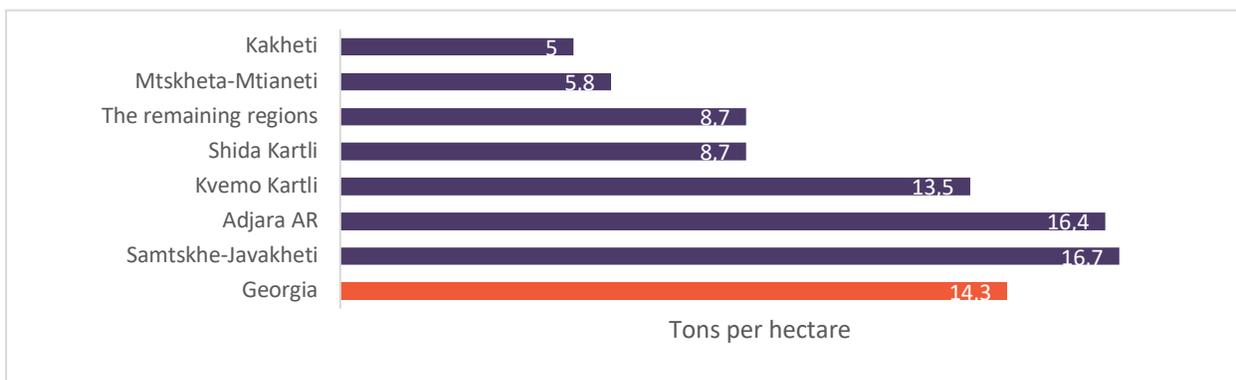
Graph 5: Average yield of potato and its growth rate



Source: The National Statistics Office of Georgia

In 2021, the regions of Samtskhe-Javakheti and Adjara reported the highest average potato yields, with 16.7 and 16.4 tons per hectare, respectively. These figures were notably higher than the national average of 14.3 tons per hectare. It is worth mentioning that in recent years, potato yields have shown an overall upward trend in every region of Georgia.

Graph 6: Average yield of potatoes by regions in 2021



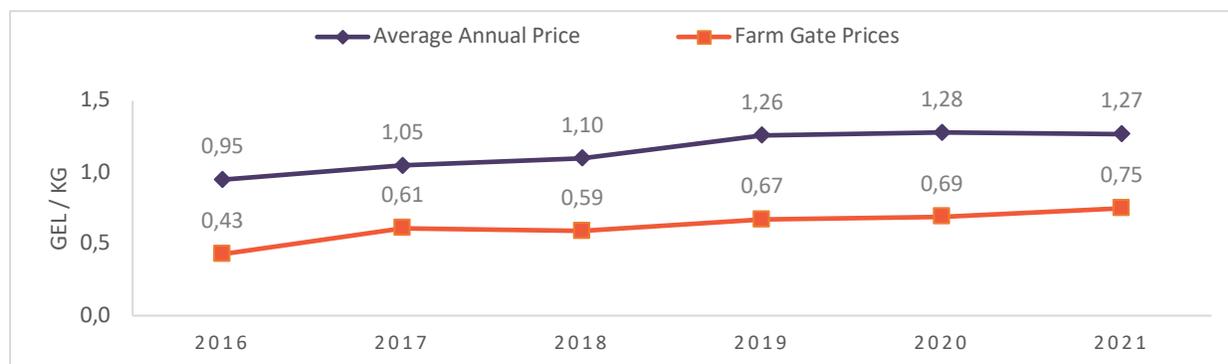
Source: The National Statistics Office of Georgia

In 2021, the average retail price of 1 kg of potatoes in Georgia was 1.27 GEL, while the farm gate price stood at 0.75 GEL. Over the period from 2016 to 2021, the average annual retail price of potatoes in Georgia exhibited a gradual increase of 34%, with a slight decrease observed in 2021. The farm gate prices followed a similar trajectory. However, it is worth noting that there were instances where these two prices moved in opposite directions. In 2018, the retail price of potatoes increased from 1.05 GEL to 1.1 GEL, while the

²² Source: The Food and Agriculture Organization Corporate Statistical Database (FAOSTAT).

farm gate price decreased from 0.61 GEL to 0.59 GEL. A more significant difference occurred in 2021, where the retail price fell by 0.01 GEL, but the farm gate price increased by 0.06 GEL.

Graph 7: Average annual prices and farm gate prices of potato³



Source: The National Statistics Office of Georgia

In 2022, according to the National Statistics Office of Georgia, potato exports totaled 23,650 tons, valued at 5,216 thousand USD. It is worth noting that potato exports in 2022 experienced a significant decrease of 53% compared to the previous year, which recorded the highest levels of potato exports. Over the period from 2011 to 2022, potato export figures displayed notable fluctuations; however, there has been an apparent upward trend in recent years.

On the other hand, Georgia imported 11,169 tons of potatoes in 2022, with a value of 4,108 thousand USD. Import volumes fluctuated relatively less than exports between 2012 and 2022, indicating an overall negative trend. Notably, Georgia achieved a positive trade balance for potatoes in 2017, 2018, 2021, and 2022.

Graph 8: Potato export and import quantities and average import and export prices



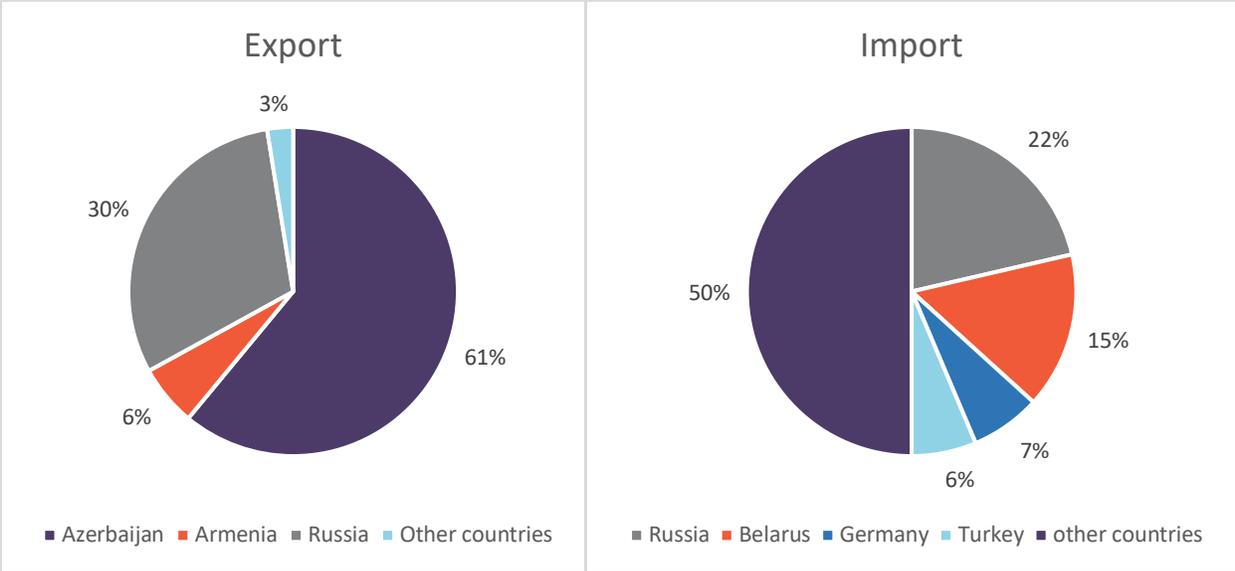
Source: The National Statistics Office of Georgia

³ Farm gate price data is only available starting from 2016 and is not accessible for earlier periods.

Georgia's main potato export trade partners are Azerbaijan, Armenia, and Russia. In 2022, the export of potatoes to Azerbaijan accounted for the largest share, comprising 61% of the total potato exports. Russia followed behind, receiving 30% of the potato exports. However, it is noteworthy that the price of Georgian potatoes in Russia is approximately three times higher than in Azerbaijan.

Georgia's highest share of potato imports came from Russia in 2022, with 3,795 tons imported. The second largest share of imports belonged to Belarus, accounting for 15% of the total. Germany and Turkey were also significant import partners, with shares of 7% and 6%, respectively.

Graph 9: Distributions of potato export and import by countries in 2022

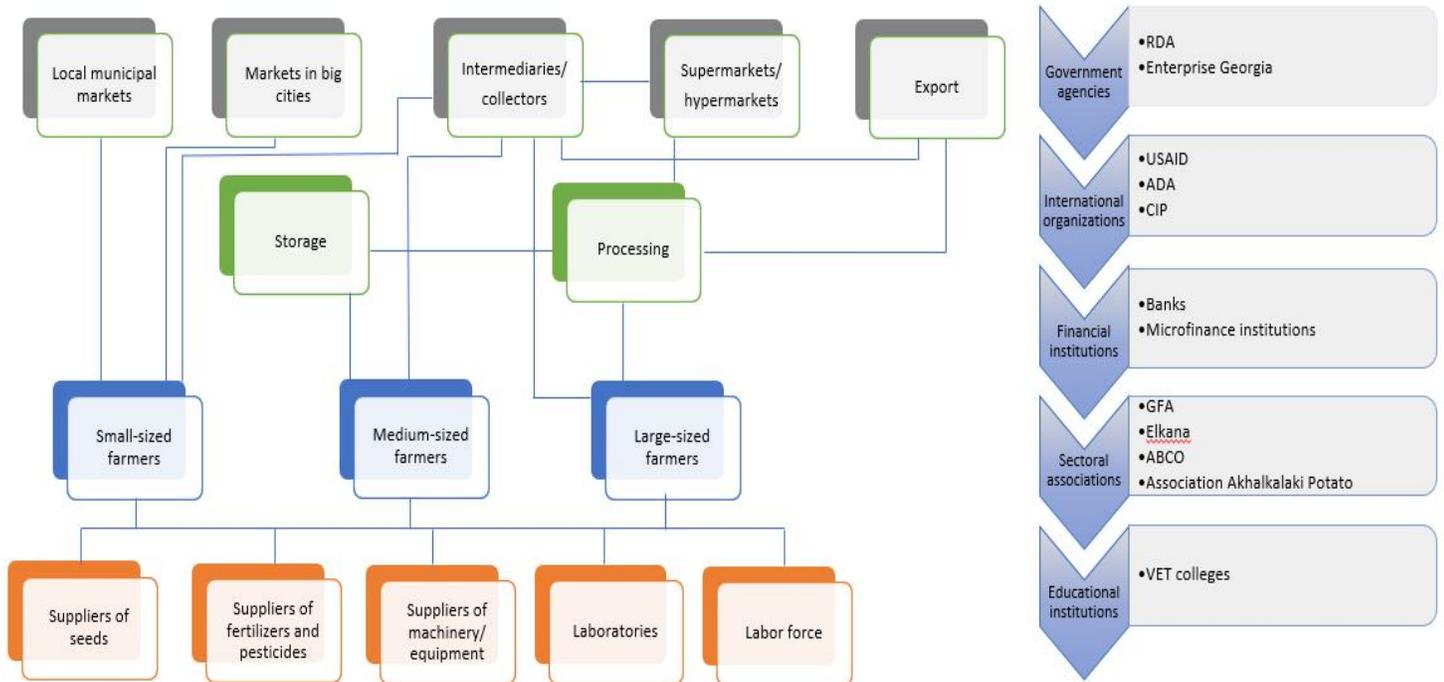


Source: The National Statistics Office of Georgia

4. Value chain actors in target municipalities

The following scheme shows the potato value chain in target municipalities.

Scheme 1: Potato Value Chain in target municipalities



Source: Field research

4.1. Internal actors

In the target municipalities, potato value chain internal actors include input suppliers (suppliers of potato seed, fertilizers, pesticides, machinery and equipment suppliers, laboratories for soil analysis, and labor force), primary production, storage, processing, packaging, transportation, and sales.

4.1.1. Input suppliers

4.1.1.1. Suppliers of potato seed

Potato seed suppliers play a vital role for potato-producing farmers in the target municipalities, as the cost of potato seeds constitutes a significant expense in potato production. According to the farmers, they require 3-3.5 tonnes of potato seeds per hectare for planting purposes. However, some respondents mentioned that high-quality seed material of 2 tons is sufficient in some instances. The price of potato seeds farmers pay varies depending on the potato grade and the supplier.

When purchasing seeds from local farmers, most farmers pay around 1-2 GEL per kilogram of seed. In contrast, when importing seeds directly from abroad or buying seeds from importers with quality assurance

certifications, the average price ranges from 3-5 GEL per kilogram. Through research conducted, according to the respondents, it has been identified that certified local seed producers are currently non-existent in target municipalities and also in Georgia. According to the research in the target municipalities, the primary channels for accessing seeds for farmers producing potatoes are as follows:

- **Buying seeds from other potato and potato seed producer farmers** - Farmers in some target municipalities typically purchase seeds from fellow potato farmers in the same municipalities or from other municipalities. This approach is preferred because farmers trust acquaintances rather than unfamiliar sellers. Buying seeds from known sources reduces the risk of unfair trade practices. It was identified that farmers in Kvemo Kartli municipalities mainly buy seeds from farmers in Samtskhe-Javakheti municipalities.
- **Using part of potato production as seeds** - In the target municipalities, it is common for potato-producing farmers, especially in Samtskhe-Javakheti and Khulo municipalities⁴, to allocate a portion of their potato harvest for future seed use. However, it should be noted that this practice often involves utilizing seed material from multiple generations, such as the 5th, 6th, 7th, and 8th generations. Unfortunately, relying on seed material from such extended generations can gradually decline locally grown potatoes' yield capacity and quality. However, this practice is less common in the municipalities of Kvemo Kartli, mainly in Bolnisi municipality, and as reported by the respondents from this municipality, mainly due to climate conditions in Bolnisi, they cannot produce seeds in the municipality, and, therefore, they mostly purchase seeds in Akhalkalaki or Tsalka.
- **Farmers buy seeds in different stores and markets in target municipalities or throughout Georgia** - In addition to buying seeds from other potato farmers, farmers in the target municipalities commonly purchase potato seeds from various agricultural stores and markets. However, it is worth noting that buying seeds from these sources can pose challenges, as the seed quality may not always meet satisfactory standards. Namely, respondents from nearly all target municipalities have expressed concerns about the reliability of seed quality when purchasing from different stores and markets. This issue arises because farmers often struggle to assess the quality of the seeds they are buying. For example, a respondent from Khulo shared their experience, stating, "Buying seeds is problematic – the sellers may deceive you and sell you already used (last year's) potato seed. It is impossible to check the seed quality."
- **Farmers import seeds directly from abroad** – The share of farmers who import seeds directly from abroad is insignificant. Only a few farmers recorded such practices. Among them, one was an organic potato producer who imported seeds from France several times, also another farmer mentioned he imports seeds from the Netherlands. While farmers are more confident in the quality of imported seeds, access to them is challenging due to their high cost. However, the quality of imported seeds is still not guaranteed in some cases, as the quality of potato seed material deteriorates significantly under poor transportation conditions. There is also a problem with the materials imported from abroad, which is not resistant to the local climate and pest diseases.

Several important actors contribute to the seed supply for potato production in the target municipalities. Some of the key actors include⁵:

⁴ In Kvemo Kartli municipalities, due to the climate, the farmers find it difficult to produce seeds.

⁵ The information given in the report is based on the desk research and conducted interviews, therefore, some actors operating in the municipalities may be omitted.

- **Europlant representative in Georgia** – Europlant, a German company specializing in potato seed production, has its distributor in Georgia. The distributor supplies potato seeds to various stores across the country. The primary seed varieties imported by Europlant in Georgia include Jelly, Otolia, Captiva, and Marlie. The price of imported potato seeds can vary depending on the exchange rate between the Euro and Georgian Lari (GEL), typically ranging from 3-4 GEL. The distributor imports 500-1000 tons of potato seeds annually, providing farmers in the target municipalities access to a significant supply of high-quality seed varieties.

- **Rural Advisory Service in Samtskhe-Javakheti region⁶** - In the Samtskhe-Javakheti region, the Ltd Rural Advisory Service has been operating since 2008 with the goal of supporting agricultural development. The company plays a crucial role in supplying various farm inputs and services to farmers, including high-quality seed materials, fertilizers, plant protection products, veterinarian medicines, and agricultural equipment. Additionally, they provide consultancy services to farmers, offering guidance on farming activities and modern technologies. The company operates an agricultural shop called "A Farmer," which has four branches in Akhaltsikhe, Aspindza, Adigeni, and Akhalkalaki. The company imports potato seeds from Agrico, a reputable seed producer company based in the Netherlands. They offer a selection of up to 20 different seed varieties, including Agria, Picasso, Arizona, and more. These seed varieties have quality assurance certification, ensuring their reliability and performance. As the company's representative mentioned, the price of imported potato seeds increased in recent years in Georgia due to the depreciating GEL against the EURO. On average, the cost of seeds sold by the company is 3.5 GEL.

- **Potato seed producer farmer in Samtskhe-Javakheti region** – In the Samtskhe-Javakheti region, a potato seed producer farmer in the Akhalkalaki municipality was interviewed during the research. This farmer transitioned from food potato production to seed potato production, considering it more profitable and requiring less land. According to the farmer, food potato production needs more than 3-4 hectares to be profitable, whereas seed potato production can be successful with less area. The farmer currently produces potato seeds on a 0.5-hectare plot. The average yield of seeds produced in the nursery is around 20 tonnes per 0.5 hectares. However, the actual yield can vary annually based on factors such as soil conditions, fertilization, irrigation, weather, and other variables. Regarding seed certification, the potato seeds produced by the farmer are currently not certified. However, the farmer previously obtained certification for the seeds in 2017 and plans to pursue certification in the future⁷. The producer acknowledges that seed certification is a rare practice in Georgia, as farmers generally place little emphasis on labels and certificates. He noted: "Certification is difficult, and you must do it repeatedly yearly. It would be good to do it, but when you have sown on a small plot, it is not easy, and the cost is high. For certification to be worthwhile and profitable, you need to scale. Next year, I am thinking of increasing the production of potato seeds and certification. Certification is also complicated if the seed producer does not allow you to reproduce his potatoes. Seed varieties are protected". The seed producer farmer has established a group of stable customers who directly purchase seeds from them. Many customers contact the farmer in advance to discuss the desired variety and quantity. The farmer mentioned that trust has been established with these customers, and they mainly come from the Samtskhe-Javakheti region, Kvemo Kartli, Racha, Adjara, Tusheti, and other areas. The potato seed varieties the farmer offers include Agria, Jelly, Picasso, and Arnova. The

⁶ <http://www.ras.ge/eng/home>.

⁷ The certification is done by the Agricultural Research Center of the Ministry of Environmental Protection and Agriculture of Georgia.

selection of varieties is adjusted based on market demands. For example, in 2023, Jelly is the most sought-after potato seed variety among farmers in Georgia. The price of 1 kilogram of potato seed ranges between 1.5-2 GEL.

- **Potato seed producer farmer in Kvemo Kartli region** - During the research, an interview was conducted with a potato seed producer farmer in the Tsalka municipality of Kvemo Kartli region. The farmer operates on a 2-4-hectare plot, producing two potato varieties: Arizona and Arnova. The average yield of potato seeds in the nursery is approximately 25-30 tonnes per hectare. However, the actual yield can vary yearly due to factors such as soil conditions, fertilization, irrigation, weather, and other variables. In addition to producing seeds on their farm, the farmer imports potato seeds from Holland. The seeds are primarily distributed to farmers in Tsalka and Bolnisi municipalities.
- **Potato seedling producer cooperative in Kvemo Kartli** – In Marneuli municipality cooperative exists, uniting ten women producing potato seedlings – Tseteli Meskhuri and Tskrialia varieties. Each farmer has a 100-120 square meter greenhouse, and they mainly sell seedlings to the farmers in Tsalka, Akhaltsikhe, and Akhalkalaki. The inputs for seedling production are imported from Peru.

4.1.1.2. Suppliers of fertilizers and pesticides

Based on the conducted research, it has been observed that retail stores offering fertilizers, pesticides, and other agrochemical products are available in all target municipalities. These stores are predominantly located in municipal centers but have representatives in villages farther from the centers. However, it is essential to note that the representatives in villages typically offer a more limited variety of products than the leading stores. An important finding from the research is the lack of suppliers for organic fertilizers and pesticides in the target municipalities, primarily attributed to farmers' limited demand for such products. A farmer from Akhaltsikhe municipality, who had experience producing organic potatoes, mentioned the need to purchase organic products in Tbilisi due to the unavailability of such products in local markets.

While many farmers prefer to buy fertilizers, pesticides, and agro products from local stores in their municipalities, some purchase these items in neighboring municipalities or Tbilisi. For instance, farmers from Khulo municipality buy pesticides in Batumi and Tbilisi. Similarly, some farmers from Ninotsminda municipality mentioned purchasing products in Akhalkalaki municipality for better prices and product options, requiring them to travel to the respective municipality 2-3 times a year, resulting in total savings of approximately 100-150 GEL annually. Additionally, some farmers from Tsalka municipality prefer buying such products in Tbilisi due to the lower prices compared to their local market. The research also revealed that farmers in all target municipalities often utilize homemade fertilizers, such as cattle and chicken manure, for their agricultural practices.

The research findings indicate that farmers in the target municipalities lack knowledge about proper potato care methods. This knowledge gap is evident in their excessive use of herbicides and insufficient use of insecticides, fungicides, and nitrogen fertilizers. As mentioned during the research, farmers often apply herbicides in larger quantities than necessary, using lower doses of insecticides and fungicides than required. Additionally, some farmers use excessive amounts of nitrogen fertilizers.

The lack of knowledge about vegetable diseases, pests, and defense mechanisms challenges farmers in selecting the appropriate products. As a result, approximately half of the substances farmers use do not

achieve their intended purpose. Furthermore, some farmers have reported that the agrochemical stores from which they purchase pesticides sometimes provide them with improper information. This misinformation leads to a lack of productivity in their potato crops. Notably, one farmer from Tsalka mentioned encountering products with expired dates at such shops. Furthermore, farmers mentioned the increasing prices of fertilizers and plant protection products as another challenge. For instance, one respondent said: “Fertilizers and other plant protection products are costly in Georgia, and the prices are increasing. Certain directions are monopolized”. The quality of available products was also a concern raised by some farmers. They expressed dissatisfaction with the low quality of existing fertilizers and pesticides, which may impede their efforts to increase potato productivity.

4.1.1.3. Suppliers of machinery and equipment

Potato production entails various agrotechnical procedures that must be carried out before planting and during harvesting. The machinery and equipment necessary for successful potato production are outlined in the following Table 2.

Table 2: Machinery and equipment for potato production

	Activity	Type of equipment/machinery
1	Plowing	Tractor, plow
2	Cultivating	Cultivator
3	Planting	Potato planter
4	Fertilizing	Compact spreader machine
5	Spraying the chemicals	Mordanting machine
6	Irrigating	Irrigation system
7	Harvesting	Potato lifter/digger, harvester
8	Sorting	Sorting machine

Research indicates that the common issue across all target municipalities is upgraded machinery and equipment requirements. Despite purchasing numerous tractors for farmers in the Akhalkalaki municipality under the ENPARD program, limited access to modern techniques persists. A respondent from Akhalkalaki highlighted the situation, stating, "The majority of farmers lack any equipment, and those who possess some mostly rely on outdated Soviet machinery. While several tractors were procured through the ENPARD project, the quantity remains insufficient”.

The absence of up-to-date machinery and equipment poses a challenge for farmers in the target municipalities, impeding their ability to meet EU standards for potato production. Farmers who lack their machinery and equipment are compelled to rent them from other farmers and other local suppliers of machinery. They have expressed that the cost of production would be significantly lower if they possessed their equipment. For example, one respondent from Bolnisi stated, "I wish to purchase my tractor instead of repeatedly hiring one from others. In doing so, instead of paying 400 GEL for tractor rental to plow the land, my expenses would be only 150 GEL for fuel." Moreover, the farmers from Tsalka mentioned that the decreasing labor force year over year had increased their need for machinery.

Farmers in Khulo municipality have reported utilizing a government-funded program providing free plowing services. However, it has been observed that in Khulo, farmers predominantly rely on manual labor rather than machinery for their potato production. Most farmers lack machinery, with only a few possessing motoblocks.

Furthermore, in the Khulo municipality, the Dioknisi Rural Service Center (DRSC)⁸ operates and offers machinery services to farmers. The center was established with a grant from Caritas Georgia, which facilitated the purchase of machinery. However, according to its representative, the current machinery is outdated and requires renewal. Due to limited capacity, the center can only serve 4-5 villages. According to the center's representative, the demand for their services is high, but they cannot meet all the producers' needs. The existing machinery is depreciated and needs to function more efficiently.

The prices for hiring machinery for various activities in the target municipalities are outlined in the table below.

Table 3: Prices of hiring machinery

	Activity	Frequency	Price (GEL per 1 ha)
1	Plowing	1	220-300
2	Cultivating	1	150-200
3	Planting	1	250-300
4	Fertilizing	1	50-200
5	Spraying the chemicals	3	300

Source: Conducted interviews

4.1.1.4. Laboratories for soil analysis

As recorded by the respondents, in most target municipalities, there is a lack of laboratories dedicated to soil analysis, except Akhalkalaki, Marneuli, and Tsalka municipalities. Notably, Noblex LTD has branches throughout Georgia, including two target municipalities – Akhalkalaki (Agromix) and Marneuli

⁸ <https://www.drsc.ge/>

(Agrosphere)⁹. The company sends soil samples for analysis to YARA Analytical Laboratory in Pocklington, UK. The results obtained from the laboratory are crucial as they come with accompanying recommendations regarding the appropriate usage of mineral fertilizers.

Table 4: Price of soil analysis according to Noblex LTD

Service Name	Parameters	Price
Broad Spectrum Analysis	P, K, Ca, Mg, S, B, Cu, Fe, Mn, Mo, Zn, Na, CEC, pH, Lime Req.	328.29 GEL
Extra Broad-Spectrum Analysis	P, K, Ca, Mg, S, B, Cu, Fe, Mn, Mo, Zn, pH, CEC, Organic Matter, Sand %, Silt %, Clay %, and soil texture classification	583.59 GEL
Heavy Metal Contamination	Pb, Ni, As, Cd, Cr, Hg, Cu, Zn	583.59 GEL

Source: Noblex LTD

In addition to Noblex LTD, Company Cartlis provides soil analysis services to farmers in Akhalkalaki and Marneuli municipalities. The company operates service centers in these areas and offers soil analysis conducted at the AGQ laboratory in Spain.

Table 5: Price of soil analysis according to Cartlis

Service Name	Parameter	Price
Standard Soil Analysis	N, P, K, Na, Ca, Mg, CaCO ₃ %, EC, PH, Organic Matter, Sand %, Silt %, Clay %, Mechanical analysis, C/N	395 GEL
Complete Soil Analysis	N, P, K, Na, Ca, Mg, S, Fe, Mn, Zn, Cu, B, CaCO ₃ %, EC, PH, Organic Matter, Sand %, Silt %, Clay %, Mechanical analysis, C/N, CEC	599 GEL

Source: Cartlis

Furthermore, the representative of the Ltd. Rural Advisory Center in Akhaltsikhe mentioned that their company possesses the necessary equipment for soil analysis. If farmers approach them, they can conduct soil analyses at a minimal price of 10 GEL. The low cost aims to encourage farmers and emphasize the importance of soil analysis in their agricultural practices. Some farmers from Tsalka municipality also mentioned that there is a laboratory in the municipality.

⁹ <https://lab.agrosphere.ge/niadagis-analizi/#E1%83%A4%E1%83%90%E1%83%A1%E1%83%94%E1%83%91%E1%83%98>

As identified during the research, only a few farmers have mentioned conducting soil analysis, and they typically opt for the Multitest laboratory in Tbilisi. According to them, the price for analysis at Multitest ranges from 200 to 250 GEL. Most farmers in the target areas do not prioritize soil laboratory analysis, perceiving it as an additional business expense. They are unaware that conducting soil analysis can help determine the soil's requirements and potentially increase the productivity of their potato crops.

Regarding Multitest, the laboratory provides comprehensive services for farmers, including field soil analysis, sampling, interpretation of analysis results, and personalized recommendations. The soil analysis conducted by the laboratory currently covers 38 physicochemical parameters. For field analysis, an additional cost of 108 GEL is added. Furthermore, the laboratory offers detailed conclusions and recommendations for an additional fee of 125 GEL.

4.1.1.5. Labor force

In all selected municipalities, there is a consistent demand for labor in the potato sector, particularly during the harvesting season for tasks such as picking and sorting potatoes while machinery is primarily used for plowing, cultivating, planting, fertilizing, and chemical spraying.

Small-scale potato producers usually engage in farming with their family members, while medium and large farmers often hire additional workers. Given the nature of potato production, seasonal labor is required. However, the sector faces challenges in recruiting labor, exacerbated by increasing migration flows. Furthermore, the research revealed that the aging of farmers is a prevalent trend in the target municipalities, with young people showing limited involvement in potato cultivation and agriculture in general.

During the research, instances were mentioned where producers could not hire sufficient labor during the harvesting season, resulting in spoiled portions of the potato crop. One farmer said shifting from potato production to corn was due to labor-related difficulties. To overcome the labor shortage, some farmers bring in workers from other regions, such as Imereti, Adjara, and Kvemo Kartli.

In the Samtskhe-Javakheti region, farmers emphasize that labor cannot be substituted with machinery during the harvesting season due to the rocky nature of the land. The farmers from Tsalka recorded the same problem. According to these farmers, regular harvesters are unsuitable for such terrain and may cause damage to the potatoes. However, it should be noted that some respondents mentioned the existence of harvesters capable of working on rocky land plots. Nevertheless, such specialized harvesters are not available in Georgia.

According to the farmers interviewed, approximately 30-40 workers are required daily for potato picking on 1 hectare, while one worker is needed to sort around 800 kg of potatoes. The daily wages for workers range from 35-70 GEL. Farmers noted that labor costs increase annually, consequently driving up the overall cost of potato production.

Although most activities, including harvesting and sorting, are shared among different groups (women, men, and youth), production is still organized in a gender-specific manner. Men are primarily involved in activities such as plowing, cultivating, planting, fertilizing, chemical spraying, and irrigation. On the other hand, women predominantly participate in picking and sorting potatoes.

4.1.2. Primary production

According to the stakeholders, in the target municipalities of Samtskhe-Javakheti and Kvemo Kartli, most farmers primarily cultivate potatoes on small-scale plots of 1-2 hectares. However, it is essential to note that there is also a significant proportion of medium-sized farmers in these municipalities who cultivate potatoes on 3-10 hectares. Only a tiny fraction of farmers produces potatoes on larger plots exceeding ten hectares. In Khulo municipality, most farmers are small-scale producers cultivating potatoes on less than 1 hectare, with many working on plots ranging from 0.05 to 0.3 hectares.

It is worth mentioning that in recent years, farmers in Khulo municipality have significantly reduced potato production due to various challenges, including limited access to good quality potato seeds and difficulties in marketing and selling their potato harvest. One respondent mentioned: "If farmers in Khulo municipality would plant potatoes on 0.1 hectares of land several years ago, they scaled down and planted 0.03 hectares. This reduction in potato production is accompanied by a shift towards other crops such as berries, which are perceived as more profitable".

Due to data limitation challenges, the research team only collected information on potato production from three target municipalities: Akhalkalaki, Ninotsminda, and Dmanisi. For other municipalities, the numbers provided are based on the information provided by the interviewed respondents.

According to the data, in Ninotsminda municipality, potato production in 2022 amounted to 30,971 tons. The average potato productivity was recorded at 10.94 tonnes per hectare. However, some farmers interviewed in Ninotsminda mentioned achieving higher average productivity ranging from 15 to 30 tons per hectare, influenced by weather conditions and cultivation practices. One farmer said, "In good weather conditions, I can achieve 25 tons per hectare."

Table 6: Potato in Ninotsminda municipality

	Ninotsminda		
	Sown Area (ha)	Production (tons)	Yield (t/ha)
2019	2,603	45,066	17.31
2020	3,151	53,597	17.01
2021	3,163	66,906	21.15
2022	2,830	30,971	10.94

Source: Ninotsminda Municipality City Hall

In Akhalkalaki municipality, the total potato production in 2022 reached 169,120 tons. This output was achieved from a cultivated area spanning 10,775 hectares. Consequently, the average potato yield in the municipality stood at 15.7 tons per hectare. However, it should be noted that during interviews, some

farmers reported higher potato productivity ranging from 17 to 30 tons per hectare. One specific farmer from Akhalkalaki mentioned an exceptional case where he yielded 60 tons of potatoes per hectare in a particular year. This remarkable productivity was attributed to several factors, including careful potato management practices, such as thorough irrigation (with the land being irrigated three times), favorable weather conditions, and the utilization of high-quality potato seeds.

Table 7: Potato in Akhalkalaki municipality

	Akhalkalaki		
	Sown Area (ha)	Production (tons)	Yield (t/ha)
2022	10,775	169,120	15.70

Source: Akhalkalaki Municipality City Hall

The situation in Akhaltsikhe municipality mirrors that of Ninotsminda and Akhalkalaki. Farmers interviewed in Akhaltsikhe mentioned that the average productivity of potatoes depends on the specific year and weather conditions and the care given to the potato crops. According to the respondents, the average productivity ranges between 15 and 30 tons per hectare.

In Dmanisi municipality, the total potato production in 2022 amounted to 12,240 tons, cultivated across an area of 1,020 hectares. This resulted in an average yield of 12 tons of potatoes per hectare. According to the respondents from this municipality, the productivity of potatoes varies between 10 and 25 tons per hectare.

Table 8: Potato in Dmanisi municipality

	Dmanisi		
	Sown Area (ha)	Production (tons)	Yield (t/ha)
2019	1,907	20,435	10.72
2020	969	14,110	14.56
2021	1,277	15,485	12.13
2022	1,020	12,240	12.00

Source: Dmanisi Municipality City Hall

Furthermore, according to a document titled "The demand-supply possibilities of locally produced products in Bolnisi municipality and the interests of peripheral consumers," developed under the EU initiative "Mayors for economic growth," the total production in Bolnisi municipality reached 48,950 tons in 2017. Respondents in Bolnisi and Marneuli municipalities stated that the productivity of potatoes ranges between 10 and 28 tons per hectare. At the same time, farmers from Tsalka mentioned that productivity ranges between 10-30 tons per hectare.

According to Khulo municipality respondents, potatoes' average productivity ranges from 12 to 18 tons per hectare. However, when high-quality care and seeds are utilized, the average productivity can surpass 18 tons per hectare and reach between 30 and 60 tons per hectare.

During the research process, it was identified that in all target municipalities, the cost of producing 1 kilogram of potatoes varies and can be influenced by several factors. These factors include the quality of the seeds used and the cost of chemicals, fertilizers, and other inputs. Additionally, farmers mentioned that the cost of potato production tends to increase year over year.

The most common potato varieties in target municipalities are shown in Table 9 below.

Table 9: Potato varieties in target municipalities

Region	Variety
Samtskhe-Javakheti (Akhaltzikhe, Akhalkalaki, Ninotsminda)	Jelly, Picasso, Agria, Red Meskhuri, Arnova, Arizona, Red Laura
Adjara (Khulo)	Jelly, Picasso, Agria, Madelaini, Marfona, Marabeli, Nevski
Kvemo Kartli (Marneuli, Bolnisi, Dmanisi, Tsalka)	Agria, Sinora, Miranda, Jelly, Arizona, Arnova, Sante, Tskrialia, Red Meskhuri

Source: Conducted interviews with farmers

Farmers in the target municipalities have reported that the quantity of potatoes produced, and the productivity of potatoes can vary significantly from year to year. Various factors influence these variations, including land plots, seed quality, overall care, and weather conditions. Each of these factors is discussed below.

Land plots

One fundamental problem farmers face in the target municipalities is the size of their land plots. Most land plots are small and fragmented, which poses challenges for potato producers. To increase potato productivity, crop rotation¹⁰ is essential, but this becomes difficult with limited space. Farmers mentioned

¹⁰ Potatoes cannot be planted on the same land as the previous year. The optimal timing for crop rotation is 3-4 years.

facing difficulties in purchasing land due to high costs and the reluctance of owners to sell, even if they are not utilizing the land effectively.

Furthermore, some farmers highlighted that the land plots available for sale often lack irrigation opportunities. This is suboptimal for potato production since potatoes require irrigation. An interviewed farmer from Akhaltsikhe stated: "Land is expensive to buy. Those who have land own small plots, and growing potatoes efficiently on a small plot is challenging. Moreover, the land plots available for sale usually lack irrigation possibilities." Moreover, one farmer from Tsalka mentioned, "Many farmers face problems regarding irrigation; such opportunities are scarce in the municipality. Without irrigation, productivity is very low."

In addition, unregistered land poses challenges for some farmers. Despite using the land for generations and being recognized by the community as the rightful owners, they face difficulties officially registering the land. This hampers their ability to utilize the land fully, such as constructing potato processing facilities or using it as collateral for financing.

Renting land is also an expensive option for farmers, with prices ranging from 1000 to 1200 GEL per hectare for a one-year lease in the Samtskhe Javakheti region. Moreover, landowners often prefer shorter rental periods and are reluctant to lease land for extended periods.

Seed quality

The research findings indicate that in the target municipalities, similar to the situation in Georgia, most farmers rely on low-quality potato seeds. These seeds are often susceptible to viruses and diseases, producing low yields. The challenges related to potato seed identified by the interviewed farmers and stakeholders in the target municipalities are as follows: lack of local, high-quality seed producers; low quality of seeds in local markets; high price of the seeds in local markets; lack of farmer knowledge about seed quality.

Overall care

The research findings indicate that most farmers in the target regions lack proper knowledge of high-quality potato cultivation practices. Specifically, they struggle with understanding the appropriate use of fertilizers and pesticides. Additionally, irrigation poses a challenge for many farmers, particularly those who do not have access to irrigation facilities.

Moreover, farmers often overlook the importance of crop rotation, choosing to plant potatoes on the same land plot every year or skipping just one year. This improper crop rotation practice is often attributed to the small size of their land plots. One interviewed farmer highlighted this issue by stating, "We have the wrong crop rotation, which is connected with small-sized land plots. Potatoes should be sown once every 3-4 years for proper rotation. After potatoes, cereals should be sown, followed by something leguminous, such as sunflowers. In Samtskhe-Javakheti, they sow 1-1 because they have no other alternative, one year of potatoes and one year of grain."

Weather conditions

Overall, weather conditions are suitable for potato production in target municipalities. However, changes in weather play a crucial role in determining the productivity of potatoes. For instance, one interviewed farmer from Akhalkalaki mentioned: "Yield depends on the weather, seed quality, fertilizers, and irrigation."

Excessive rain this year has hindered soil warming and potato growth. If drought conditions persist, potato growth will be further affected. Unfavorable climate last year resulted in a low yield".

Despite the strong influence of weather on potato production, it is worth noting that most farmers in the target municipalities do not take advantage of insurance opportunities provided by the Rural Development Agency (RDA). For instance, one farmer from Akhaltsikhe mentioned: "I occasionally have insurance based on my financial situation. There is periodic hail, and if it hasn't occurred in the past five years, I expect it to happen in the sixth year, so I'm considering insuring against it".

4.1.3. Storage

One of the significant challenges farmers face in the potato sector in target municipalities is the lack of organized storage facilities. On average, farmers in the target municipalities experience a 25% loss in potato production due to inadequate storage conditions. However, some stakeholders believe introducing climate-controlled storage facilities is expected to decrease this loss from 25% to 8%. However, it has to be mentioned that storage facilities exist in Bolnisi, Akhalkalaki, and Khulo.

In Bolnisi municipality, the Mziani Mosavali storage facility, under the umbrella of Wellington company, exists exclusively for storing potatoes produced by Mziani Mosavali, which are supplied to Frixx. The facility has a capacity of 3200 tons.

In Akhalkalaki municipality, two storage facilities have been established: one was created by Wellington (Frix) with the capacity to store approximately 800 tonnes (this facility has been established with the support of the ENPARD program), and the second facility was created under USAID potato program with the capacity to store 200 tonnes. Both of these storage facilities have climate control.

The existing storage facility of Wellington in Akhalkalaki can store potatoes for up to 9 months with minimal losses. While the primary purpose of this storage is to supply potatoes to Frixx for chip production, farmers can also store their potato production there. However, there is currently no significant demand from farmers for storage. The price for farmers to keep their production in this facility depends on the quantity of potatoes, but it costs approximately 30 GEL to store 1 ton of potatoes for one month (equivalent to 0.3 GEL per kilogram in 1 month).

Despite the presence of two storage facilities in Akhalkalaki, the yearly potato harvest in the municipality amounts to approximately 200,000 tonnes. In contrast, the existing storage capacity can only accommodate a very small share of the harvest. It has to be mentioned that Wellington plans to open another storage facility in Akhalkalaki with a capacity of 900 tonnes.

Furthermore, in Khulo municipality, the Dioknis Agricultural Service Center has a storage facility with an area of 207 square meters and a capacity of 500 tonnes of potatoes. In the past, when potato production in Khulo was high, farmers used this facility for storing potatoes. The price for storing potatoes for six months was 0.2 GEL per kilogram. However, currently, there is no demand from farmers to keep potatoes in this facility due to low production levels.

Most farmers in target municipalities rely on their cellars for potato storage. However, many of these cellars lack climate control due to the additional cost of establishing and maintaining them¹¹. As a result, appropriate temperature and hygiene conditions are not observed, leading to various diseases and crop

¹¹ For example, a farmer from Akhalkalaki mentioned that they have a warehouse with a capacity of 600 tons. However, it is important to note that this warehouse does not have climate control facilities.

damage. Moreover, the research found that the part of interviewed farmers also did not have cellars. For instance, one farmer from Ninotsminda mentioned: "I want to arrange a cellar to save potatoes, but I do not have finances for that. Here in Ninotsminda, there are harsh winters here, and potatoes will freeze in winter".

Target municipalities' absence of storage facilities compels many farmers to sell their potatoes right after harvest, resulting in unfavorable prices. Some farmers even resort to selling their potatoes below the market price because they lack the means to store them. For example, a respondent from Akhaltsikhe mentioned, "Farmers often sell 1 kilogram of potatoes for 3-7 tetri, and in some cases, they even give away their potatoes for free due to their inability to store them."

Consequently, a significant number of farmers from Samtskhe-Javakheti and Kvemo Kartli municipalities emphasized the substantial support that storage facilities would provide. However, the farmers' usage of storage facilities will significantly depend on the storage price. One farmer from Bolnisi municipality highlighted the potential benefits, stating, "Having a storage or processing enterprise where we save product would be advantageous. However, the price has to be acceptable for us".

While the Rural Development Agency has a program for financing storage and processing enterprises, the respondents mentioned that the co-financing required from the applicant side is still high, making it difficult for farmers to take that risk. The development of storage facilities would enable farmers to store their unsold potatoes and sell them during off-season periods when prices are higher. Additionally, these warehouses should incorporate renewable energy solutions to reduce costs.

4.1.4. Processing

Overall, in addition to the shortage of storage facilities, the processing sector is also underdeveloped in the target areas. None of the interviewed potato farmers process their potatoes, although some have expressed interest in starting potato chip processing ventures. Also, some farmers mentioned that starch and alcohol can be produced from potatoes. However, they face challenges in terms of financing and a lack of information about local and international market demand, which makes it risky for them to initiate such ventures.

Some respondents from Kvemo Kartli and Samtskhe-Javakheti municipalities highlighted that 65% of potato production consists of edible potatoes suitable for the market, while the remaining 35% comprises non-edible potatoes (rotten, green, etc.). Therefore, establishing a processing enterprise to utilize this 35% of potatoes and create value-added products is necessary. One mentioned, "Currently, tons of rotten and green potatoes are discarded. Non-edible potatoes were sometimes sold for 3-7 tetri per kilogram. Sometimes farmers give away such potatoes as gifts, asking others to take them but clean out their storage." The respondent from Samtskhe-Javakheti also recounted a recent case where someone attempted to open a potato chip processing enterprise in the region. However, after evaluating the market, local varieties, supply, and prices, they decided to import potatoes from Turkey instead.

However, it is worth noting that from 2017 to 2021, Freko, a chips producer company, operated in Akhaltsikhe municipality but ceased functioning due to a lack of input, precisely an insufficient quantity of potatoes purchased from farmers. Currently, the company is part of the Wellington union and plans to resume operations. Wellington (Frix), with its storage facilities, operates in Akhalkalaki and Bolnisi municipalities. In Akhalkalaki, the company solely operates a storage facility without any processing activities, while in Bolnisi, they have their own potato production and storage facility. Their processing plant is located near Lilo in Tbilisi.

Wellington processes approximately 4,500-5,000 tons of potatoes per year to produce chips. The company annually produces an average of 700-750 tons of chips and holds a 30% market share in Georgia, with its main competitor being Lays. Besides Georgia, Wellington also sells its products in Azerbaijan, Armenia, Lithuania, Hong Kong, and Canada (albeit in small quantities limited to certain specialized stores in Hong Kong and Canada).

The company follows a business model where 70%-80% of the potatoes needed for chip production are grown by the company in Bolnisi municipality. The remaining 20% is purchased from farmers. The company cultivates potatoes on 50 hectares in Bolnisi, using seed varieties like Sinora from Holland and Miranda from Germany. They also conduct trials with new potato varieties in Georgia. The potato productivity of the company ranges from 36-40 tons per hectare for the second and third use of seed, while it amounts to 60 tons per hectare for the first use. In total, the company harvests around 2,500-3,000 tons of potatoes annually.

Regarding the purchase of 20% of the total potato production, Wellington cooperates with farmers in Bolnisi and Akhalkalaki municipalities. The price offered to farmers ranges from 0.55 to 0.65 GEL per kilogram, depending on the quality. Some farmers from Akhalkalaki municipality mentioned that Wellington requires specific varieties of potatoes, such as Agria, which hinders them from collaborating with the company.

Wellington plans to expand its production and has started constructing a new processing factory in Tbilisi. The company intends to adopt the same business model along with the new processing facility. They plan to allocate a portion of their potato cultivation area in Akhalkalaki municipality to produce 70%-80% of the potatoes required for chip production, while the remaining 20% will be purchased from local farmers. The company representative predicts that as their chip production increases, the share of potatoes sourced from farmers will also rise, and in 5-7 years, the distribution between own production and purchased potatoes will be 50%-50%. However, the company foresees challenges in achieving this goal, as it requires developing a culture among farmers to adhere to contractual details. In recent years, some farmers violated contract terms and exported their production to Russia with the reopening of the Russian market.

Nevertheless, the company acknowledges the importance of collaborating with farmers who possess the necessary resources (e.g., equipment, irrigation systems, knowledge) to grow potatoes. Wellington aims to establish long-term relationships with such farmers.

4.1.5. Packaging, transportation, and sales

In the target regions, farmers commonly use sacks and wooden crates for storing and transporting potatoes. For transportation, most farmers rely on local municipality transportation, while some use their own vehicles or hire cars. However, a significant number of interviewed farmers reported not needing transportation as they sell their potatoes directly at the farm gate.

The most significant challenge for farmers is the unpredictable and fluctuating price of potatoes, heavily influenced by the prices of imported potatoes. A farmer from Tsalka expressed, "The price of potatoes in Georgia is highly volatile and subject to frequent fluctuations. This volatility is primarily driven by the importation of potatoes into the country. Importing potatoes presents significant challenges for local potato producers in Georgia. Moreover, the rising cost of production exacerbates the situation, making it even more difficult for local farmers to compete with imported potatoes."

For instance, farmers from Khulo municipality mentioned that in 2022, the average price for potatoes ranged from 0.6-0.7 GEL per kilo, but during December-January, it even reached 1.2 GEL. On the other hand, farmers from Samtskhe-Javakheti municipalities recounted cases where they could not sell potatoes at all. Sometimes, they sold potatoes to collectors at a meager price, such as 0.03-0.07 GEL per kilo. One farmer shared an example: "My brother was not able to sell potatoes, so he decreased the price and sold 1 kilo for 0.4 GEL, while the cost to produce 1 kilo of potatoes was 0.7 GEL". On average, during autumn, the price for 1 kilo of potato is around 0.9-1 GEL, increasing to 1.1 GEL during December-January.

The main sale channels of interviewed farmers in target municipalities are the following:

- Farm gate – selling potatoes to collectors

Based on the research findings, it was observed that most farmers in the target municipalities of Samtskhe-Javakheti and Kvemo Kartli sell their products at the farm gate through intermediaries, commonly known as collectors. A similar sales channel exists in Khulo municipality, although it is less common there.

These collectors are often individuals from major cities like Tbilisi, Kutaisi, and Batumi, with whom the farmers have established relationships over several years. Collectors purchase the potatoes and then sell them in bigger cities throughout Georgia or export them. However, the price collectors pay to potato-producing farmers varies yearly and is unstable. According to the respondents, collectors, on average, make a profit of 0.1-0.15 GEL per kilo of potatoes. However, there are cases where their profit can be as high as 0.5 GEL per kilo.

- Farm gate – selling potatoes to consumers

Some farmers mentioned selling potatoes directly to consumers at an average price of 1 GEL per kilo. However, in the case of spoiled potatoes, some farmers said to sell them to other farmers for use as animal feed or compost, and in such instances, the price ranges between 0.1-0.15 GEL per kilo.

- Markets – selling to consumers and resellers

Sometimes, when local sales are not feasible, farmers take the initiative to bring their potato products to key markets, especially in Tbilisi, Kutaisi, Batumi, and Rustavi. However, this selling approach becomes less profitable for farmers due to transportation expenses and food and lodging costs during their stay in the cities. In these cases, the price of potatoes can vary, ranging between 0.5-1.2 GEL per kilo, depending on market conditions and local demand. Farmers also participate in selling potatoes in their municipalities' markets.

- Wellington – selling potatoes to Wellington by farmers from Akhalkalaki and Bolnisi

Some farmers from Akhalkalaki and Bolnisi municipalities cooperate with Wellington, selling their potato production to them. The price in this arrangement typically ranges between 0.55-0.65 GEL per kilo, depending on the quality of the potatoes.

4.2. External actors

This section includes the analysis of value chain financing and value chain technical assistance (skills development).

4.2.1. Government agencies

Two government agencies, the Rural Development Agency (RDA) and Enterprise Georgia, play integral roles in the potato value chain.

Rural Development Agency (RDA)

The Rural Development Agency (RDA) is a non-profit entity operating under the Ministry of Environment and Agriculture of Georgia. Its primary objective is to promote agricultural development throughout the country. The agency undertakes various responsibilities, including planning and managing projects initiated by the Ministry of Environment and Agriculture.

RDA's projects encompass comprehensive support for various stages of the potato supply chain, except seeds, fertilizer and pesticide suppliers, transportation, sales, and export. Please refer to the table below for further information about RDA's programs.

Table 10: RDA's programs supporting the actors of the potato value chain

	Preferential Agrocredit Project: Annual Crop Financing	Preferential Agrocredit Project: Fixed Assets	Preferential Agrocredit Project: Agroleasing	Bioproduction promotion program	Co-financing program for harvesting agricultural machinery	Co-financing of Agro processing and storage enterprises	Agro insurance
Input Supply – Seed							
Input Supply - Fertilizers and pesticides							
Input Supply - Machinery & Equipment							
Primary Production							

Storage							
Processing							
Transportation (Distribution)							
Sales (Retailers)							
Export							

Source: RDA

Enterprise Georgia

Enterprise Georgia operates under the Ministry of Economy and Sustainable Development of Georgia, primarily focusing on stimulating domestic production and fostering entrepreneurship. One of the notable programs implemented by Enterprise Georgia is "Micro and Small Business Support," which explicitly targets rural small and medium enterprises (SMEs). Under this program, Enterprise Georgia provides grants of up to GEL 30,000 to support the development of micro and small businesses. However, beneficiaries must contribute 20% of the total project cost as co-financing. While the program does not finance primary agricultural production, it must be noted that it finances the processing. In addition to financial assistance, the program offers technical support to help beneficiaries develop essential entrepreneurial skills. This includes training in business plan writing before receiving financing.

The research findings indicate that most of the interviewed farmers in the target regions are aware of the government programs offered by RDA and Enterprise Georgia. However, none of the farmers reported applying for Enterprise Georgia's "Micro and Small Business Support" program. On the other hand, some farmers mentioned that they have successfully received grants from RDA's "Preferential Agrocredit" program and expressed satisfaction with the support received.

Among RDA's programs, agro insurance is primarily essential for some farmers. They recognize the significance of ensuring their potato production, mainly to mitigate risks associated with hail. However, these farmers perceive the cost of insurance to be high. Given their current income levels, they believe they cannot afford the expenses associated with insurance. Additionally, some farmers view insurance as unnecessary for potato production, considering the risk of hail relatively low, with only 20-30% of the output potentially being affected. Assessing this lower risk, they believe that the insurance cost outweighs the potential benefits.

4.2.2. International organizations

Two donor organizations, the United States Agency for International Development (USAID) and the Austrian Development Agency (ADA), have played a crucial role in the potato value chain. These

organizations have financed projects implemented by the International Potato Center (CIP). It should be noted that both projects have been completed.

In 2017, the International Potato Center (CIP) established its regional office in Tbilisi, Georgia. CIP is dedicated to the research and improvement of tuber crops, with a broader goal of addressing global challenges such as hunger, poverty, gender equality, climate change, and the sustainable use of natural resources.

United States Agency for International Development (USAID)

The USAID Potato Program, funded by the United States Agency for International Development (USAID), was initiated in 2019 to enhance productivity and incomes for small-scale potato producers in Georgia. The program, implemented by the International Potato Center (CIP), focused on providing farmers with new knowledge and locally produced, high-yielding seed potatoes. The project had several specific objectives: to establish a model farm to produce and demonstrate quality seed potatoes, introduce new potato genotypes, establish proper seed potato standards, and improve the existing seed certification system.

With a budget of USD 1.89 million, the program aimed to achieve outcomes such as a 233% increase in annual sales per hectare and an improvement in productivity to approximately 20 tons per hectare. By completing the program in 2022, a domestic supply chain of disease-resistant potatoes with high yields had been established. More than 2300 farmers benefited from the program's interventions¹².

The Austrian Development Agency (ADA)

The International Potato Center (CIP), in collaboration with the Austrian Development Agency (ADA), implemented a three-year project titled "Enhancing Rural Livelihoods in Georgia: Introducing Integrated Seed Health Approaches to Local Potato Seed Systems." The project commenced in July 2017 and aimed to improve the livelihoods of Georgian farmers by enhancing the profitability and sustainability of their potato crops while strengthening the capacity of stakeholders in the potato seed value chain.

4.2.3. Financial institutions

Adjara has a significant presence of banks, with 12 out of the total 14 banks in Georgia operating in the region. However, the concentration of bank diversity is mainly observed in Batumi, while other municipalities have limited representation. Specifically, the selected municipality of Khulo has five branches and service centers belonging to 4 banks.

Table 11: Banking entities in Adjara and selected municipality

Region/Municipality	Branches and Service Centers	ATMs	Number of Banks
Adjara	79	304	12
Khulo	5	7	4

Source: National Bank of Georgia

¹² https://cgspace.cgiar.org/bitstream/handle/10568/106941/1410-USAI_pp_the-USAID-potato-program_Georgia.pdf?sequence=4&isAllowed=y

In Kvemo Kartli, there are 7 out of the total 14 banks operating in Georgia. All these banks are accessible in Marneuli, while four banks have branches in Bolnisi and Tsalka. The fewest banks are in Dmanisi, with only three in the area.

Table 12: Banking entities in Kvemo Kartli and selected municipalities

Region/Municipality	Branches and Service Centers	ATMs	Number of Banks
Kvemo Kartli	77	140	7
Bolnisi	8	9	4
Marneuli	16	23	7
Tsalka	5	6	4
Dmanisi	7	6	3

Source: National Bank of Georgia

Samtskhe-Javakheti has the lowest representation of banking entities among the selected regions, with only four banks operating within the area. However, it is essential to note that all the banks present in the region are located in selected municipalities, with only one missing in Ninotsminda.

Table 13: Banking entities in Samtskhe-Javakheti and selected municipalities

Region/Municipality	Branches and Service Centers	ATMs	Number of Banks
Samtskhe-Javakheti	42	74	4
Akhalkalaki	9	12	4
Akhaltzikhe	11	28	4
Ninotsminda	7	7	3

Source: National Bank of Georgia

The research illustrates that in all target municipalities, financial institutions exist to which producers can apply, however, access to finance challenges farmers in all target municipalities within the potato sector, hindering them from expanding their land area or purchasing machinery and equipment. Some farmers mentioned they had taken loans from commercial banks for their potato production, primarily to acquire machinery. Additionally, one farmer from Akhalkalaki municipality stated they had taken a loan to establish a potato storage facility.

For most farmers, bank loans are a significant burden with high risks. Consequently, they tend to avoid any involvement with financial institutions. They believe that the interest rates on loans are excessively high,

and due to the income instability, they experience, they cannot afford to take on such risks. There is fear that they will not meet credit payments if loans are taken.

4.2.4. Sectoral associations

In Georgia, there are several associations at the national level that potato-producing farmers can join, including the Georgian Farmers Association, Biological Farming Association Elkana, and the Association of Business Consulting Organizations of Georgia (ABCO).

At the local level in the targeted municipalities, most potato farmers' associations do not exist. However, the "Association Akhalkalaki Potato" operates actively in Akhalkalaki with 250 farmers as its members. This association offers valuable services such as consultations, training, and information on potato production and prices to its members. To protect the potatoes produced in Akhalkalaki, the association started the process of obtaining Geographical Indication (GI) status for the Akhalkalaki potato. Despite having GI status, Akhalkalaki potato is not adequately protected, as some respondents from Akhalkalaki reported cases where Turkish potatoes were sold in markets falsely labeled as Akhalkalaki potatoes. The association faces challenges such as the lack of office space and staff. Its representative emphasizes the importance of creating services demonstrating the association's value to its members. One potential benefit suggested by the representative is establishing a laboratory for land analysis, which would provide farmers with recommendations based on the analysis results.

During the field research, it was found that some interviewed potato farmers in the target municipalities were members of associations. For example, an organic potato farmer from Akhaltsikhe mentioned being a member of Elkana and expressed satisfaction with the association's consultations. Another farmer from Akhaltsikhe said being a member of the Georgian Farmers Association, highlighting regular information received from the association.

In Akhalkalaki municipality, some farmers mentioned being members of the Association Akhalkalaki Potato. A farmer from Ninotsminda also said that he is a member of the Association Akhalkalaki Potato. These members reported attending training sessions organized by the association and receiving consultations. None of the interviewed farmers in Khulo municipality were members of any associations.

4.2.5. Vocational educational institutions

In the target municipalities, there are a total of eight educational institutions that provide Vocational Education and Training (VET) programs. These institutions are situated in four out of the eight target municipalities, specifically Akhaltsikhe, Akhalkalaki, Marneuli, and Dmanisi. However, the remaining four target municipalities lack such educational institutions, namely Khulo, Ninotsminda, Tsalka, and Bolnisi.

Table 14: Vocational educational institutions

Region	Municipality	Educational institutions with VET programs	Program name
Samtskhe-Javakheti	Akhaltsikhe	College "Opizari"	Short-term program for potato production

	Akhaltzikhe	Samtskhe-Javakheti State University	Gardening
	Akhaltzikhe	Akhaltzikhe Public College ¹³	Do not have a program in the direction of potato production
	Akhalkalaki	Ltd.-Javakheti Vocational College	Do not have a program in the direction of potato production
	Akhalkalaki	Akhalkalaki St. Zosime Kumurdoeli Public College	Do not have a program in the direction of potato production
Kvemo Kartli	Marneuli	Marneuli Community College	Do not have a program in the direction of potato production
	Marneuli	College of Marneuli	Do not have a program in the direction of potato production
	Dmanisi	Swiss Agricultural School Caucasus	Farming

Source: Vet.ge; Field research

In Akhaltzikhe municipality, the college "Opizari" collaborates with Elkana and the Information-Consultation Center to offer a short-term potato program. This program covers potato cultivation training and practical work, with involvement from the International Potato Center. It has garnered significant interest from participants in Akhaltzikhe and other municipalities in Samtskhe-Javakheti. Moreover, the college partners with the private sector, actively assisting graduates in securing employment opportunities.

As for the college in Akhalkalaki, it currently doesn't provide a potato-growing program. Nonetheless, it recognizes the strong demand and interest within the municipality and expresses its openness to introducing agricultural programs in the future.

Conversely, the colleges in Marneuli don't have a potato program due to limited local demand and interest in this specific field. Therefore, they have no plans to introduce a potato program in the foreseeable future.

¹³ The college is not functioning for the last three years.

5. SWOT analysis

Analysis of the potato sector in target areas identified the strengths, weaknesses, opportunities, and threats. The results are presented in Table 15 below.

Table 15: SWOT analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> <input type="checkbox"/> Suitable climate for potato production <input type="checkbox"/> Potato production tradition <input type="checkbox"/> Diverse varieties of potatoes <input type="checkbox"/> Favorable soil structure <input type="checkbox"/> Variety of potato types <input type="checkbox"/> Available water resources <input type="checkbox"/> State and international donor support programs for the potato sector <input type="checkbox"/> Existence of potato association in Akhalkalaki 	<ul style="list-style-type: none"> <input type="checkbox"/> Limited access to high-quality seeds due to their high price <input type="checkbox"/> Absence of certified seed producers <input type="checkbox"/> High prices of pesticides and fertilizers <input type="checkbox"/> Limited pesticide and fertilizer options in remote villages <input type="checkbox"/> Insufficient and outdated modern machinery and equipment <input type="checkbox"/> Poor irrigation infrastructure <input type="checkbox"/> Inadequate access to laboratories <input type="checkbox"/> Scarce human resources due to the aging farming population, high emigration rates <input type="checkbox"/> Lack of knowledge about modern (highly productive) potato growing and care methods among farmers <input type="checkbox"/> Farmers' limited awareness of the importance of soil analysis <input type="checkbox"/> Farmers' limited awareness of crop rotation practices <input type="checkbox"/> Farmers lack knowledge in selecting and assessing seeds, fertilizers, and pesticides <input type="checkbox"/> Farmers lack knowledge of potato processing opportunities. <input type="checkbox"/> Farmers' lack of awareness of global trends in the potato sector <input type="checkbox"/> Lack of knowledgeable agriculture specialists <input type="checkbox"/> Small-sized and fragmented land plots <input type="checkbox"/> High land prices <input type="checkbox"/> Limited availability of land for sale <input type="checkbox"/> Unexploited cultivable land <input type="checkbox"/> Lack of access to finance <input type="checkbox"/> Inadequate storage facilities with proper ventilation for potatoes <input type="checkbox"/> Lack of processing facilities <input type="checkbox"/> Low level of farmer cooperation <input type="checkbox"/> High price variation of potatoes <input type="checkbox"/> Lack of awareness and willingness to convert to organic production

Opportunities	Threats
<ul style="list-style-type: none"> <input type="checkbox"/> Increased access to high-quality potato seeds <input type="checkbox"/> Increased access to modern equipment and machinery <input type="checkbox"/> Development of storage and processing facilities <input type="checkbox"/> Increased availability of insurance <input type="checkbox"/> Increased access to irrigation <input type="checkbox"/> Development of cross-border trade relations <input type="checkbox"/> Potato packaging and branding <input type="checkbox"/> Improving linkages within the potato value chain <input type="checkbox"/> Starting production of organic potatoes <input type="checkbox"/> Opening the road from Khulo to Akhaltsikhe (increase sale opportunities for Khulo) <input type="checkbox"/> Government program (RDA) and USAID program <input type="checkbox"/> The good entry point for low-skilled rural youth, women, and minorities 	<ul style="list-style-type: none"> <input type="checkbox"/> Spread of pests and diseases <input type="checkbox"/> Risk of soil erosion/damage <input type="checkbox"/> Climate change <input type="checkbox"/> Loss of harvest due to natural disasters and no insurance mechanisms used by farmers. <input type="checkbox"/> Market competition (competition from imported potatoes) <input type="checkbox"/> Aging population due to internal and external migration <input type="checkbox"/> Unstable economic situation

6. Recommendations

In this section, we present a summary of recommendations for the USAID Unity Through Diversity Program as potential solutions to address the challenges identified during the value chain analysis of potato production in the targeted area. These recommendations have been formulated considering the stakeholders' concerns and our observations.

Promoting the establishment and growth of certified seed producers to enhance seed quality and accessibility

Through research conducted in the target municipalities, it has been identified that certified local seed producers are currently non-existent, while the high cost of quality seeds further limits accessibility. To address these challenges, the project can support municipalities in establishing certified seed producers.

For instance, to work in that direction, the project can facilitate the establishment of partnerships between local farmers and reputable foreign seed producer companies. This collaboration would involve importing and reproducing seed varieties from these companies within Georgia. In addition to fostering collaborations, the project can offer financial support to cover the certification costs of local farmers.

Supporting the development of potato processing in the municipalities of Kvemo Kartli and Samtskhe-Javakheti

Supporting the development of potato processing in the municipalities of Kvemo Kartli and Samtskhe-Javakheti will enhance the value of the potato sector and create opportunities for local potato producers to directly supply their products to local processors rather than sell them to intermediaries.

The project can establish a sustainable model by providing financial support to create new local processing companies. Additionally, the project can focus on strengthening local producer farmers through training, technical support, and access to modern farming practices, ensuring a steady and high-quality supply of potatoes for the processing companies.

Facilitating and strengthening the collaborative linkage between Wellington and local potato producer farmers in target municipalities of Kvemo Kartli and Samtskhe-Javakheti

The presence of the Frixx storage facility in Akhalkalaki and Bolnisi municipalities, along with the company's forthcoming expansion plans for another storage facility and increased chip production, presents a significant opportunity for potato producer farmers in Samtskhe-Javakheti and Kvemo Kartli municipalities.

To capitalize on this opportunity, an initiative§ can be launched to facilitate collaboration between interested farmers and Frixx, forming a farmer cluster or just establishing a group of farmers in partnership with the company. This cluster or a group of farmers will play a crucial role as a dependable potato supplier to Frixx. Within the framework of this project, comprehensive support can be provided to the cluster/group of farmers, encompassing the provision of necessary equipment and techniques for potato production, the implementation of efficient irrigation systems, capacity development programs, and the promotion of awareness regarding contract farming practices. This collaborative effort will strengthen the linkage between Wellington and local potato producer farmers, creating mutual benefits such as increased production, and expanded market opportunities. The cluster or group of farmers can be created by the existing potato association in Akhalkalaki.

Strengthening collaborative Linkages between supermarkets/hypermarkets in Georgia and local potato producer farmers in target municipalities of Samtskhe-Javakheti and Kvemo Kartli

In the target municipalities, local potato producer farmers encounter challenges when selling their potato harvest. Many currently rely on intermediaries or collectors who sell the potatoes to large supermarkets and hypermarkets in Georgia. However, establishing direct linkages between these retailers and the farmers can significantly increase the value created for the farmers and promote their economic well-being.

To address this issue, the project can support the target municipalities of Samtskhe-Javakheti and Kvemo Kartli in developing these direct linkages between supermarkets, hypermarkets, and local potato producer farmers.

To facilitate these collaborative linkages, the project can pursue the following approaches:

- Establishment of Storage Facilities and/or collecting centers: Encouraging big supermarkets and hypermarkets such as Carrefour, Spar, Ori Nabiji, Nikora, Magniti, and Agrohub to establish storage facilities or collecting centers in the target municipalities will provide a direct market channel for local potato producers. This would allow farmers to sell their produce directly to these retailers, eliminating the need for intermediaries and ensuring a fairer product value.
- Creation of Farmer Clusters or Unions: The project can support the formation of farmer clusters or unions in partnership with supermarkets and hypermarkets. These clusters or unions would bring together local potato producer farmers and establish direct supply agreements with supermarkets and hypermarkets for their potato production. The project can facilitate the establishment of these clusters or unions by providing guidance and assistance in negotiating fair contracts and fostering ongoing collaboration between the farmers and the retail partners.

Enhancing farmers' access to agricultural machinery and equipment for increased productivity

Based on interviews conducted with potato producer farmers in the target municipalities of Kvemo Kartli, Samtskhe-Javakheti, and Adjara, it has come to light that a significant portion of them face challenges due to either a lack of or outdated and ineffective machinery and equipment for potato cultivation. This limitation severely hampers their ability to maximize productivity in their farming operations, further exacerbated by the prevalent labor shortage issue.

To address these challenges, the project can support farmers by facilitating improved access to agricultural machinery. One way to achieve this is by offering grants to individual farmers or farmer groups, empowering them to acquire modern and efficient machinery, equipment, and aggregates. This assistance will enhance their productivity and efficiency and alleviate the impact of labor shortage.

Furthermore, addressing the specific challenges farmers face during the harvesting season is crucial, particularly the lack of suitable harvesters that can operate effectively on their land plots. To overcome this obstacle, the project can provide targeted support to the target municipalities by supplying appropriate harvesters.

Promoting the establishment of energy-efficient storage enterprises in target municipalities of Kvemo Kartli and Samtskhe-Javakheti

Through the research conducted, it has been revealed that farmers in the target municipalities experience significant losses, sometimes up to 25%, in their production due to the absence of adequate storage facilities. It has also been observed that most target municipalities lack storage options, with only limited enterprises

in Akhalkalaki and Khulo municipalities, which farmers hesitate to utilize due to cost concerns. In light of these findings, it is recommended that the project focuses on supporting the development of storage facilities in the target municipalities.

To address this issue, the project can assist the target municipalities of Samtskhe-Javakheti and Kvemo Kartli in establishing energy-efficient storage facilities. These facilities would be designed to operate on solar energy, reducing farmers' storage costs. By leveraging renewable energy sources, the project can mitigate the financial burden associated with storage and enable farmers to preserve their potato produce effectively.

Promoting the establishment of land analysis laboratories and increasing farmer awareness of the importance of land analyses

During the research conducted in the target municipalities, it was identified that there is a significant lack of land analysis laboratories. Furthermore, it was observed that farmers had limited awareness regarding the importance of land analyses, which often leads to improper use of fertilizers, resulting in lower potato productivity.

To address these challenges, the project can focus on two key strategies. Firstly, efforts should be made to increase farmer awareness about the significance of land analyses. This can be accomplished through targeted awareness campaigns, training programs, and workshops. Secondly, the project can support the establishment of land analysis laboratories in the target municipalities. These laboratories can be set up in a portable format, allowing flexibility and accessibility. Equipped with the necessary equipment, these laboratories will enable farmers to efficiently conduct land analyses, providing them with accurate information about soil quality and nutrient content.

Strengthening the existing potato association in Akhalkalaki

The development of solid associations within the potato sector plays a crucial role in effectively utilizing limited resources and driving further growth in the industry. The project can contribute to the sector's progress and sustainability by supporting these associations.

One area where support can be directed is the development of new services for association members. This can involve introducing specialized training programs, workshops, or seminars that enhance members' skills and knowledge in modern cultivation techniques, efficient resource management, market trends, or financial literacy.

Another valuable service the project can support the association in developing is establishing a land analysis laboratory that exclusively serves its members. This dedicated laboratory would provide essential soil analysis services to association members, allowing them to access accurate and timely information about their land's composition, nutrient levels, and potential limitations.

Furthermore, the existing potato association in Akhalkalaki can play a crucial role in establishing linkages between farmers, Frxxx, supermarkets, and hypermarkets in Georgia. The association can serve as a facilitator in bringing these stakeholders together and fostering collaboration.

Enhancing farmers' awareness of organic potato cultivation and technologies and promoting public awareness of the importance of organic potato

The research conducted in the target regions has highlighted a lack of knowledge among farmers regarding organic potato cultivation and associated technologies. To address this gap and promote the adoption of organic practices, the project can raise farmers' awareness and knowledge through practical training in the target regions. Additionally, it is essential to generate awareness among the Georgian population, particularly in Tbilisi, about organic products, including potatoes. To achieve this, a targeted marketing campaign can be launched.

Enhancing the capacity and knowledge of potato producers

The research has revealed a lack of knowledge among potato farmers regarding modern, highly productive growing and care methods. Additionally, there is limited awareness about essential practices such as soil analysis, crop rotation, seed selection, fertilizer and pesticide use, potato processing opportunities, and financial literacy. To address these gaps, the project can increase the capacity and knowledge of potato producers by providing relevant training and coaching.

In addition to the areas mentioned, raising farmers' awareness of various government and donor programs available to support their agricultural endeavors is crucial. The project can play a vital role in providing brief training sessions to interested farmers, guiding them on navigating the application processes, and obtaining necessary documents if required.

Annex 1 - Price of Soil analysis according to Multitest

Table 16: Price of Soil analysis according to Multitest

Parameters	Price (GEL)
Mechanical composition	48.00
Hummus %	20.00
Assimilable nitrogen N	30.00
Assimilable phosphorus P ₂ O ₅	26.00
Assimilable potassium K ₂ O	22.00
Total nitrogen N	24.00
Total phosphorus P ₂ O ₅	24.00
Total potassium K ₂ O	24.00
Hydrogen indicator pH (KCL)	5.00
Hydrogen indicator pH (H ₂ O)	5.00
Carbonates CaCO ₃ %	12.00
Absorbed bases Ca	12.00
Absorbed bases Mg	12.00
Absorbed bases Na	24.00
Cation absorption capacity - CEC	46.00
Ammonia nitrogen mg.seq/100g	30.00
Nitrate nitrogen mg.seq/100g	42.00
Soluble phosphorus mg.seq/100g	25.00
Sulfates %	22.00
Chlorides %	22.00
Electrical conductivity EC, mmhos/cm	18.00
Total salinity %	15.00
Exchange acidity mg.seq/100g	12.00
Hydrolytic acidity mg.seq/100g	17.00
Movable aluminum Al mg.seq/100g	10.00
Exchangeable hydrogen	17.00

Hygroscopic water %	14.00
Roasting loss %	18.00
Microelements - assimilable forms Mn, Fe, Cu, Zn, Mo, B*, Ni* (value of each element)	38.00
Trace elements - common forms Mn, Fe, Cu, Zn, Mo, B*, Ni* (value of each element)	38.00
Humidity	14.00
Soil moisture %	22.00
The specific weight of soil g/cm ³	20.00
Soil Porosity %	20.00
The organic part of the soil	18.00
The mineral part of the soil	18.00
Organochlorine pesticides	200.00
Heavy metals Pb, Co (value of each element)	38.00

Source: Multitest