Public Disclosure Authorized

Public Disclosure Authorized

Food and Agriculture Organization of the United Nations

ევროკავშირი საქართველოსთვის
Project funded by the European Union

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

Climate-Smart Agriculture in Georgia

Climate-smart agriculture (CSA) highlights

P Agriculture has traditionally been a significant part of the Georgian economy. Georgia can count on fertile soil and favorable climate conditions, which support the production of a wide variety of high-value agricultural products including grapes and wine, nuts (hazelnuts, almonds, walnuts, and chestnuts), citrus fruits (tangerines, mandarins, clementines), stone fruits (peaches, plums, and apricots), apples, and honey.

P Water resources are unevenly distributed in Georgia (mostly concentrated in western regions). Irrigation and drainage (I&D) investments are vital against climatic extremes and are critical for high-value agriculture production.

A I Climate change risks for Georgia include increasing temperatures, eroding soils, fluctuating rain precipitation, and increased aridity and drought.

A I Georgian agriculture is expected to be negatively affected by the direct impact of temperature and precipitation changes on crops. This is expected to increase irrigation demand required to maintain and increase yields. Also surface and groundwater resources availability supply is expected to decrease due to higher evaporation and lower rainfall, including the potential for more dry days. Climate change trends are expected to also intensify floods, frost, and hail in addition to aiding new pests and diseases affecting crops, forests, and livestock.

P A M Key practices implemented by some farmers in Georgia to respond to climate change include conservation agriculture (crop rotation, mulching, no tillage, or minimum tillage), drip irrigation, wind breakers, anti-hail, and anti-frost system as well as investment in pastures.

I A M $ P Most of the practices and technologies identified for water management, crop and livestock systems have a low degree of adoption rates (<30 percent) despite their multiple Climate Smart Agriculture (CSA) benefits. The key cross-cutting barriers to wider-scale adoption of CSA include limited financial capacities, lack of knowledge and practice, lack of equipment and skills.

$ Climate finance can act as a catalyst for the broader adoption of climate-smart agriculture practices by demonstrating the feasibility these approaches have in terms of social, environmental, and financial returns.

I Due to the diversity of the Georgian landscape and the country's different climate zones, climate change can have a different impact across the country. Regional coordination strengthening, CSA demonstration fields, as well as reinforcement of regional communication platforms are key to facilitate the adoption of agronomic practices by farmers.

A Adaptation **M** Mitigation **P** Productivity **I** Institutions **$** Finance

Climate-smart agriculture (CSA) is an approach aiming to transform and reorient agricultural systems, in a way to support the development and ensure food security in the face of climate change. CSA aims to tackle three main objectives: i) sustainably increasing agricultural productivity and farmers' income, ii) adapting and building resilience to climate change, and iii) reducing and/or removing greenhouse gas emissions in line with national development priorities [1]. The CSA approach can help to identify and address synergies and trade-offs involved in pursuing these three objectives by addressing the environmental, social, and economic dimensions of sustainable development across agricultural landscapes, ultimately ensuring food and nutrition security. This approach helps to align the needs and priorities of different stakeholders to achieve more resilient, equitable, and sustainable food systems. This also helps to align with the objectives of Georgia's updated Nationally Determined Contribution (NDC), since developing CSA supports the decarbonization and low-carbon development of the agriculture sector.

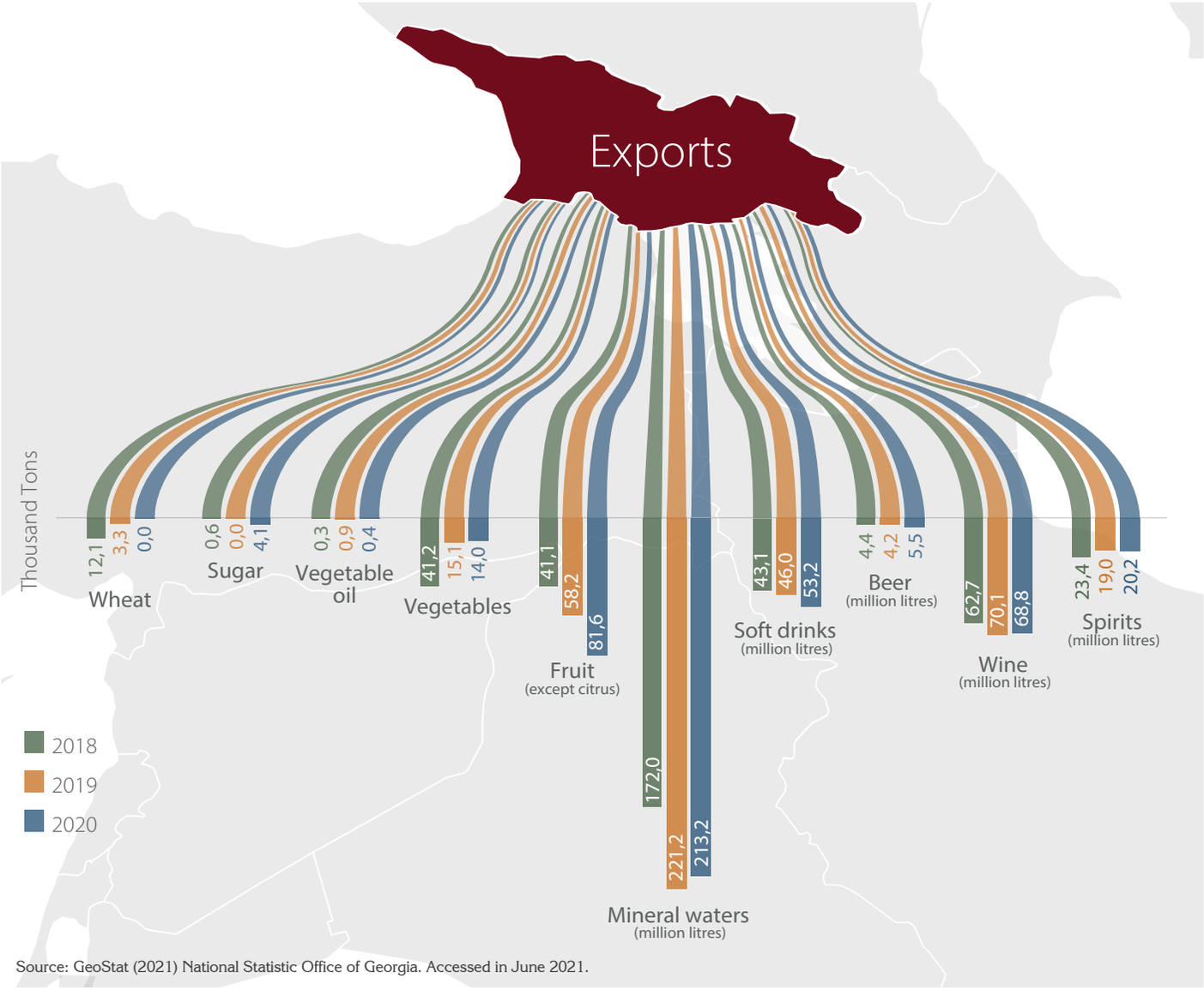
Although the CSA concept is still evolving, many of the practices and technologies that make up CSA have been successfully implemented globally [2]. Mainstreaming CSA in Georgia will require the systematic identification of locally effective CSA practices, diagnosis of barriers to adoption of those practices, evaluation of strategies to overcome the barriers, and ensuring the presence of institutional and financial enablers. This CSA Country Profile describes the risks posed by climate change to agriculture in Georgia, discusses the potential of CSA to attenuate those risks, identifies factors that can influence the adoption of CSA practices, and highlights potential entry points for investment in CSA at scale.

National context

Economic relevance of agriculture

Georgia, with a total area of 69,700 square kilometers and a population of around 3.7 million [3], is classified by the World Bank as an upper-middle-income country in the South Caucasus. Following the governance transition from the country's independence, Georgia has enjoyed strong economic growth of five percent per annum between 2005 and 2019 [4]. Georgia has achieved strong results in terms of macroeconomic and financial stability, business environment, security, and governance. Strong growth has led to a reduction of the poverty rate (from 43 percent in 2006 down to 19.5 percent in 2021) [5], but with growing inequalities between urban and rural areas. Agriculture has traditionally been a significant part of the Georgian economy. The agriculture sector, that also includes forestry, and fisheries, contributed 8.4 percent to GDP in 2020 [6]. The sector's contribution is typically underestimated when measured without taking forward and backward linkages and the associated multiplier effects into account. In fact, agro-processing accounts for a further 7-8 percent of Georgian GDP. This positive economic impact is even more important in a country where agriculture is a large employer. Agriculture accounts for 19.1 percent of total employment [7][1].

Figure 1. Food Exports (thousand Tons) (for 2018 - 2020)



Source: GeoStat (2021) National Statistic Office of Georgia. Accessed in June 2021.

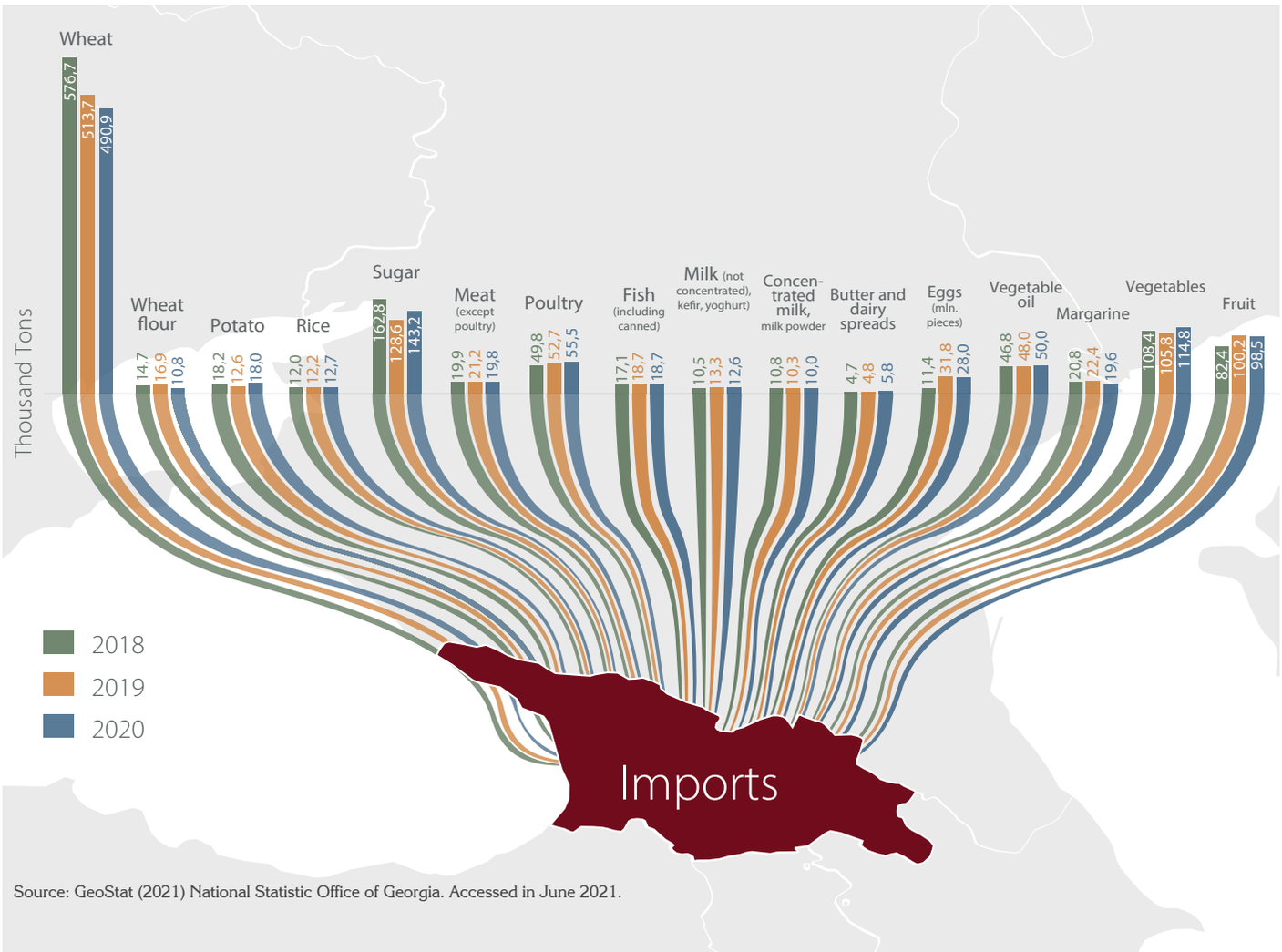
[1] In 2020, Geostat updated the methodology for calculation of employment and unemployment statistics in accordance with the International Labour Organization (ILO) in Labour Force Statistics. According to the new methodology, self-employed persons who are not market-oriented and produce mainly agricultural products (more than 50 percent) for their own consumption are no longer considered as self-employed. Persons with this status were reclassified into other categories (unemployed, population outside the labour force) depending on whether they are looking for or ready to start a job. As a result, the percent of employed persons in agriculture out of total employment changed from 41 percent in 2019 to 19.1 percent in 2020.

Approximately 41 percent of the total population lives in rural areas. The majority of those (around 75 percent) living in rural areas still rely on agriculture for their livelihoods. Georgia's fertile soil and favorable climate support the production of a wide variety of high-value agricultural products including grapes and wine, nuts (hazelnuts, almonds, walnuts, and chestnuts), citrus fruits (tangerines, mandarins, clementines), apples, stone fruits (peaches, plums, and apricots) and honey. Georgia also grows an increasing quantity of crops, including vegetables and corn, for domestic consumption. The country relies on imported powdered milk, imported meat products (mostly poultry), and imported wheat, but does produce fresh milk domestically.

Approximately 9.2 percent of total exports and 12 percent of total imports are related to the food sector [8]. Leading food products for export are wine and fruits (Figure 1). Commonly imported food products include wheat, sugar, vegetables, and fruits (Figure 2). In 2020, Georgia's food exports increased to US$ 317 million , while the respective total food import was registered at US$ 958 million. Therefore, the trade balance – the difference between exports and imports - remained almost unchanged at US$(-641) million (Figure 3).

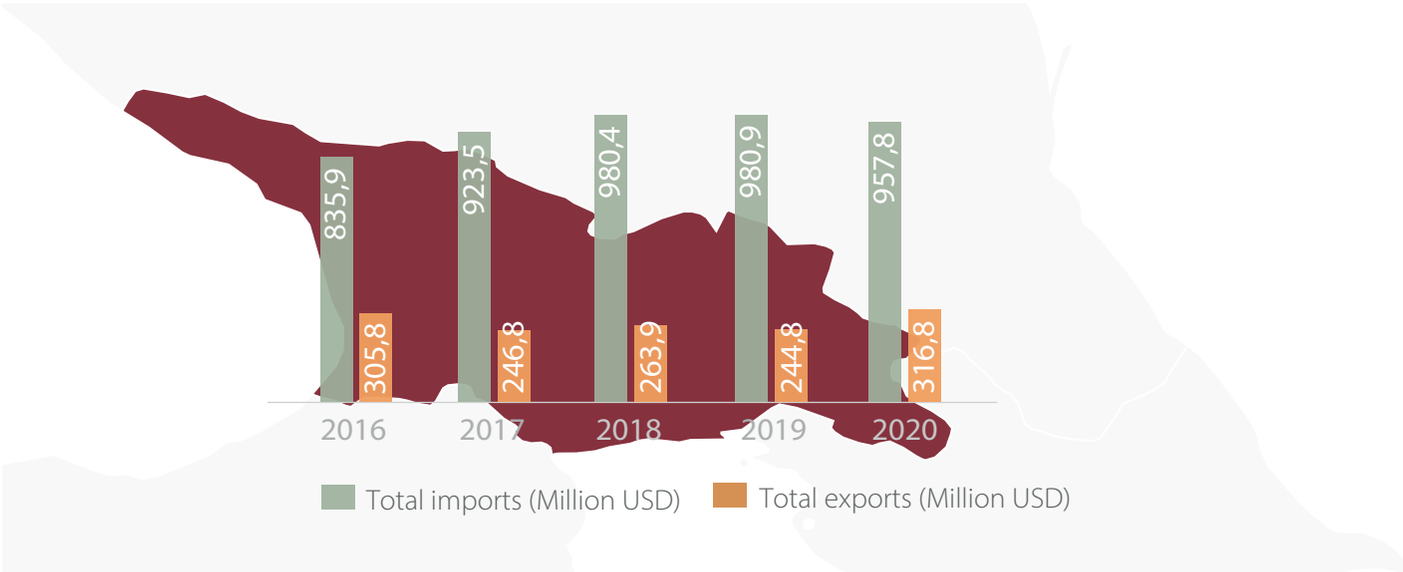
According to the most recent agricultural census conducted in 2014, the share of commercial farms in agricultural production remained low. Almost 80 percent of holdings own no land or operate less than one hectare of agricultural land, 14.9 percent operate one to two hectares, 4.3 percent operate two to five hectares and only 1.3 percent (8,577) have five hectares or more [9]. The products from smallholdings are often primarily for subsistence or semi-subsistence purposes.

Figure 2. Food Imports (thousand Tons) (for 2018 - 2020)



Source: GeoStat (2021) National Statistic Office of Georgia. Accessed in June 2021.

Figure 3. Trade of food (imports and exports) (for 2016 - 2020)



Source: GeoStat (2021) National Statistic Office of Georgia. Accessed in June 2021.

Land use

The agricultural area accounts for more than 2.3 million hectares, or 34 percent, of the whole territory of Georgia [10]. Agricultural land includes 13 percent of arable land; five percent of permanent crops; and 81 percent of permanent meadows and pastures [10]. Forests cover around 40 percent of Georgia's territory while the alpine/subalpine meadows and glaciers account for roughly ten percent of the land [10]. Mountains cover a significant part of the country, with 54 percent of the territory at an altitude over 1,000 meters above sea level [10].

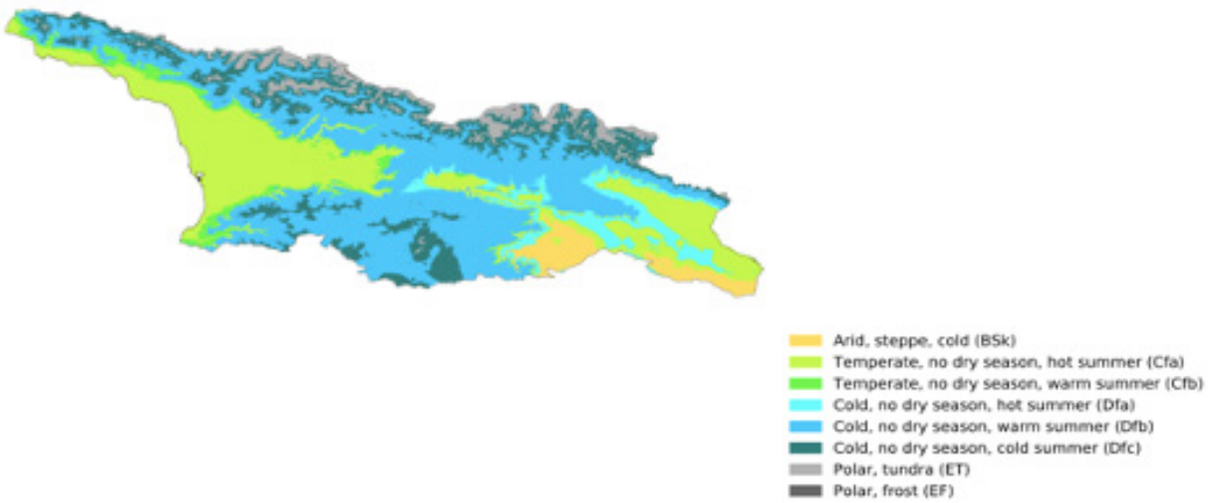
In terms of soils, the country has 16 diverse types. In most mountainous areas the following types of soils are found: forest light brown soils; mountain-valley landscape with alluvial soils; and mountain meadow soils. The fertile soils of the country (specifically cinnamonic soil - Hromic Cambisols in the Kvemo Kartli and Shida Kartli regions; Alluvial soil – Fluvisols in the west coast and northern Kakheti region; Grey cinnamonic soil - Calcic Kastanozems in Shida Kartli region; and Yellow podzolic soil – Stagnic Acrisols in the west coast) provide favorable conditions for land cultivation, as well as animal husbandry [10].

Despite ongoing land reform, so far only 40 percent of land plots are registered. This figure is even lower in rural areas where it stands at around 20 percent. Overall, there are 1.2 to 1.4 million unregistered agricultural land plots in rural areas (around 255,000 ha). Approximately one million hectares of Georgia's unallocated state-owned land is classified as pasture. Most of the country's pastures have not been privatized, and only 48 percent of state-owned pastureland is leased [11]. A portion of unallocated pastureland is located on the administrative boundaries of South Ossetia and Abkhazia. Access to pastureland is limited in some areas, which constrains households' livelihoods. As of 2020, only 32 percent of the land is operated by holdings owned by women [12] who, in general, have less access to land than men. The lack of land ownership limits women from participation in some agricultural programs, and the associated lack of collateral limits women from qualifying for credit and grant schemes that operate in the regions [13].

Agricultural production systems

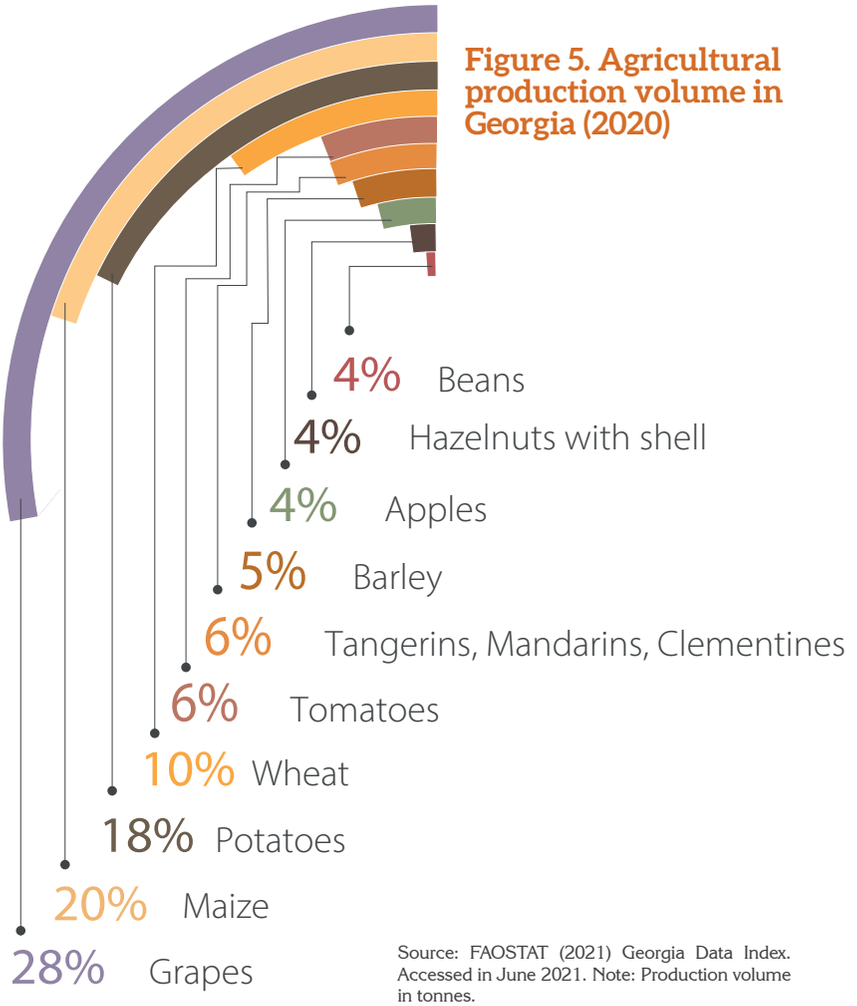
Although covering only one-seventh of the Caucasus region, Georgia aggregates almost all types of landscape present throughout the area. Considerable differences between the climates in the country (from humid-subtropical and temperate to sub-alpine and alpine zones) have led to significant differences in ecosystems and vegetation types (Figure 4). There are four main altitudinal zones in western Georgia: forests (up to 1,900 m), subalpine (1,900 to 2,500 m); alpine (2,500 to 3,100 m) and nival (> 3,100 m). In eastern Georgia, there are six zones: semi-desert; dry grassland (steppes) and arid woodland (150 to 600 m); forest (600 to 1,900 m); subalpine (1,900 to 2,500 m) alpine (2,500 to 3,000 m); sub-nival (3,000 to 3,500 m) and nival (> 3,500). In mountain forests and alpine zones, treeless formations of semi-arid ecosystems are also found.

Figure 4. Present Climatic zones in Georgia (2018)



Source: Beck, H. E. et al. (2018). Present Köppen-Geiger climate classification maps at 1-km resolution: Georgia Climate Classification 1980-2016. Note: The present Köppen-Geiger classification map was derived from three climatic datasets for air temperature (WorldClim V1 and V2, and CHELSA V1.2) and four climatic datasets for precipitation (WorldClim V1 and V2, CHELSA V1.2, and CHPclim V1; Table 1). All datasets have a 0.0083° resolution with the exception of CHPclim V1.2, which has a 0.05° resolution. For consistency CHPclim V1.2 was downscaled to 0.0083° using bilinear interpolation. (Reprinted with permission by the authors).

Figure 5. Agricultural production volume in Georgia (2020)

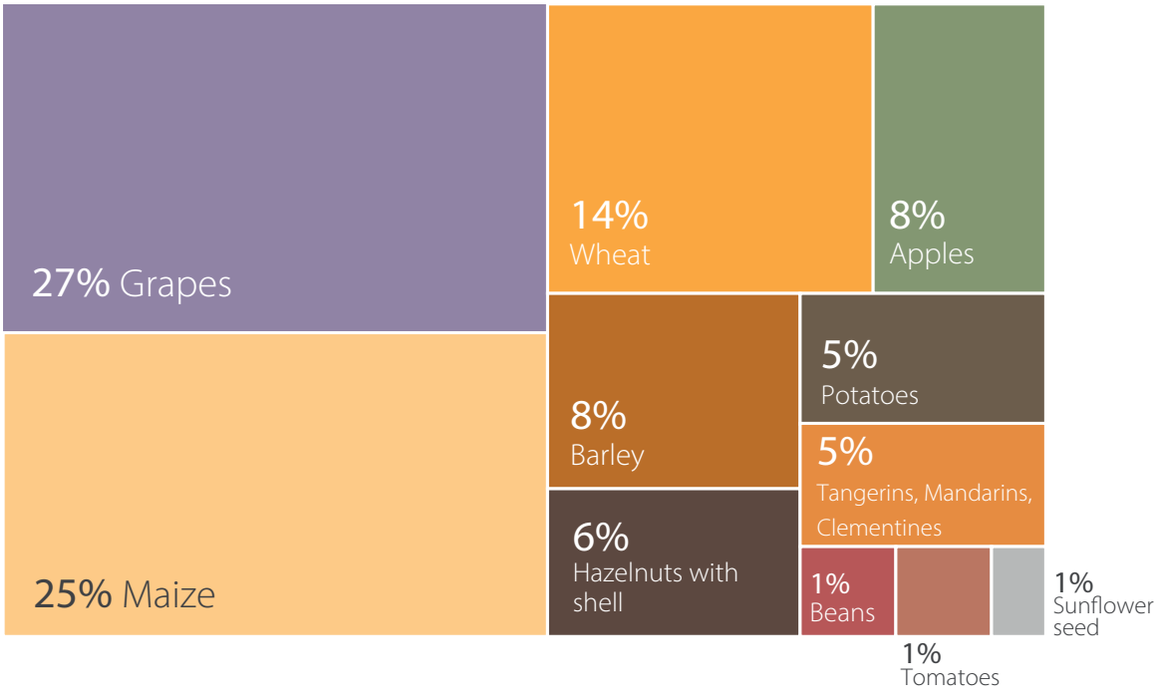


Source: FAOSTAT (2021) Georgia Data Index. Accessed in June 2021. Note: Production volume in tonnes.

Agricultural production is mostly rainfed. Non-irrigated areas are used for livestock and rainfed cereal crops (sunflower, wheat, and maize), while cultivated irrigated land, which amounts to 28.3 percent [14], is devoted to a wide diversity of fruits and vegetables. The total harvested irrigated crop area (full control irrigation) amounts to 126,000 ha [14], of which 88,500 ha support temporary crops, and 37,500 ha support permanent crops. The Irrigation Strategy for Georgia for 2017-2025 has a goal to increase the total irrigated area to 200,000 hectares by 2025.

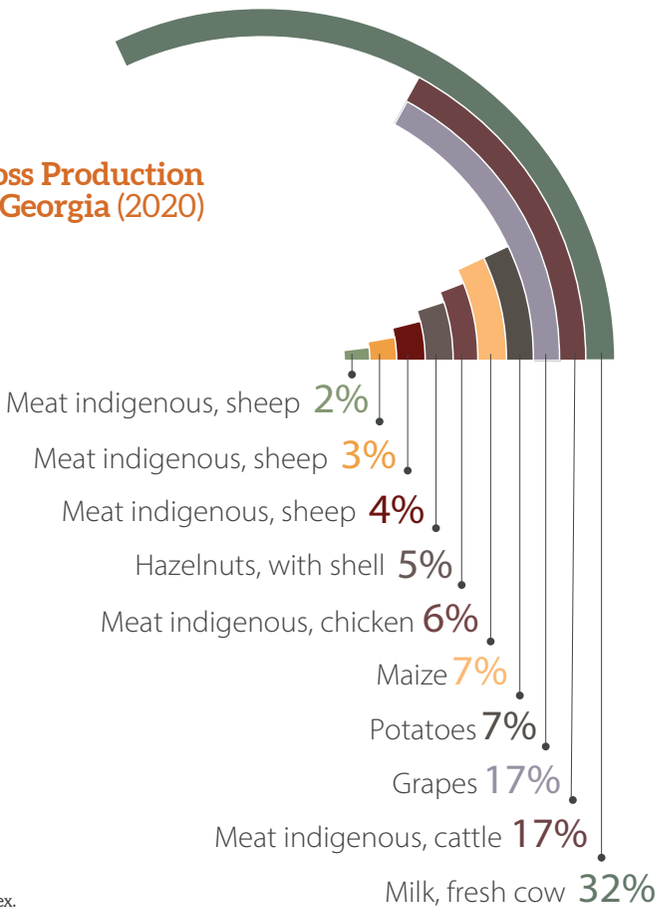
In terms of quantity, grapes, starchy vegetables (potatoes), and grains (maize and wheat) dominate production (in tons) (Figure 5). In terms of total harvested area, grapes and maize represent the bulk of it (Figure 6). Animal source products (specifically cattle meat, cow milk, and meat from sheep, pig, and chicken) lead in terms of value generated; grapes and hazelnuts and maize follow (Figure 7). Livestock is mainly composed of cattle and sheep (Figure 8).

Figure 6. Area harvested in Georgia (2020)



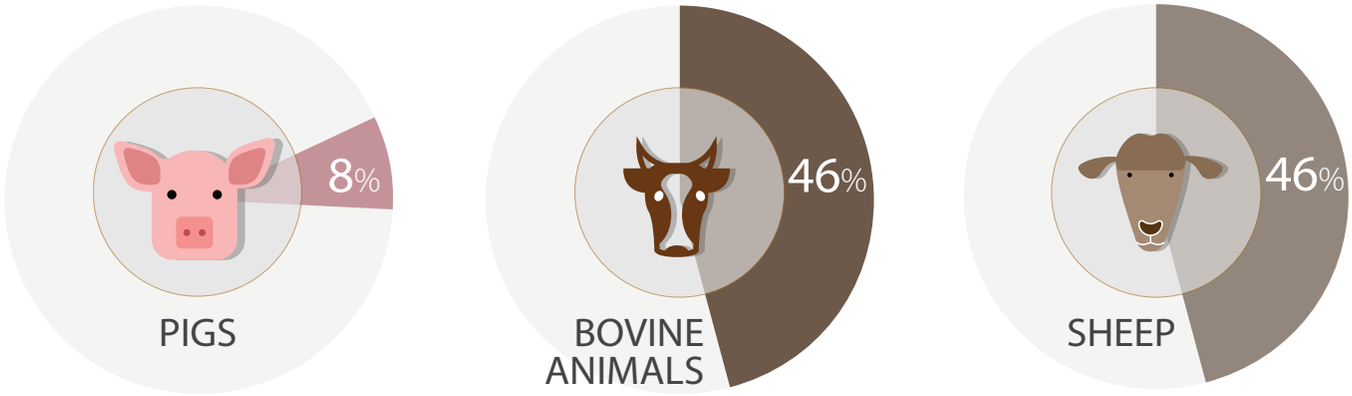
Source: FAOSTAT (2021) Georgia Data Index. Accessed in June 2021. Note: Area harvested in hectares (ha).

Figure 7. Gross Production Value in Georgia (2020)



Source: FAOSTAT (2021) Georgia Data Index. Accessed in November 2021. Note: Gross production value in US$1000.

Figure 8. Livestock in Georgia (% of total livestock in thousand heads) (2020)



Source: GeoStat (2021) National Statistic Office of Georgia. Accessed in June 2021.

Food security and nutrition

Georgia has been exhibiting some worrying food security and malnutrition trends. Prevalence of undernourishment estimates from 2004 to 2019 in Europe and Central Asia (ECA), place Georgia among the countries with the highest rates of prevalence of malnutrition in the region (at 8.2 percent) [15]. On the prevalence of moderate food insecurity, Georgia is among the four ECA countries that have rates higher than the world average (38.3 v. 25.5 percent). At the other end of the malnutrition spectrum, the prevalence of overweight among children younger than five in Georgia was 19.9 percent (2012) – almost four times the global average (5.6 percent in 2019). Lastly, of all the ECA countries, only Georgia (and Moldova) was found to not have access to the 400 grams per day of fruits and vegetables[2] recommended by the Food and Agriculture Organization and the World Health Organization. High rates of prevalence of undernourishment, moderate food insecurity and overweight prevalence, in combination with low availability of fruits and vegetables indicate that both hunger and regular access to healthy food are issues of concern for Georgia [15].

Agricultural greenhouse gas emissions

According to the latest National Greenhouse Gases (GHG) Inventory Report, Georgia emitted 10.29 million metric tons of carbon dioxide equivalent (MtCO2e) in 2019 [16]. The agricultural sector was responsible for 21 percent of emissions. One of Georgia's key development challenges is to accelerate economic growth while limiting GHG emissions by boosting investments in low carbon technologies. According to the Fourth National Communication of Georgia to the United Nations Framework Convention on Climate Change (UNFCCC), agriculture GHG emission amounted to 3,488 Gg CO2 – eq (19.6 percent) in 2017 [23]. The energy sector generated 10,726 Gg CO2 – eq (60 percent). The Industrial Processes and Product Use (IPPU) generated 1.99 Gg CO2 – eq (11.2 percent). Waste amounted to 1,562 Gg CO2 – eq (8.8 percent) [18]. Georgia's agriculture sector, as source of GHG emissions, comprises of four subcategories: enteric fermentation, manure management, agricultural soils, and field burning of agricultural residues. More specifically between 1990 and 2017, enteric fermentation has been consistently the largest source of sector methane (CH4) emissions, while agriculture soils have been the largest source of nitrous oxide (N2O) [17] (Figure 9).

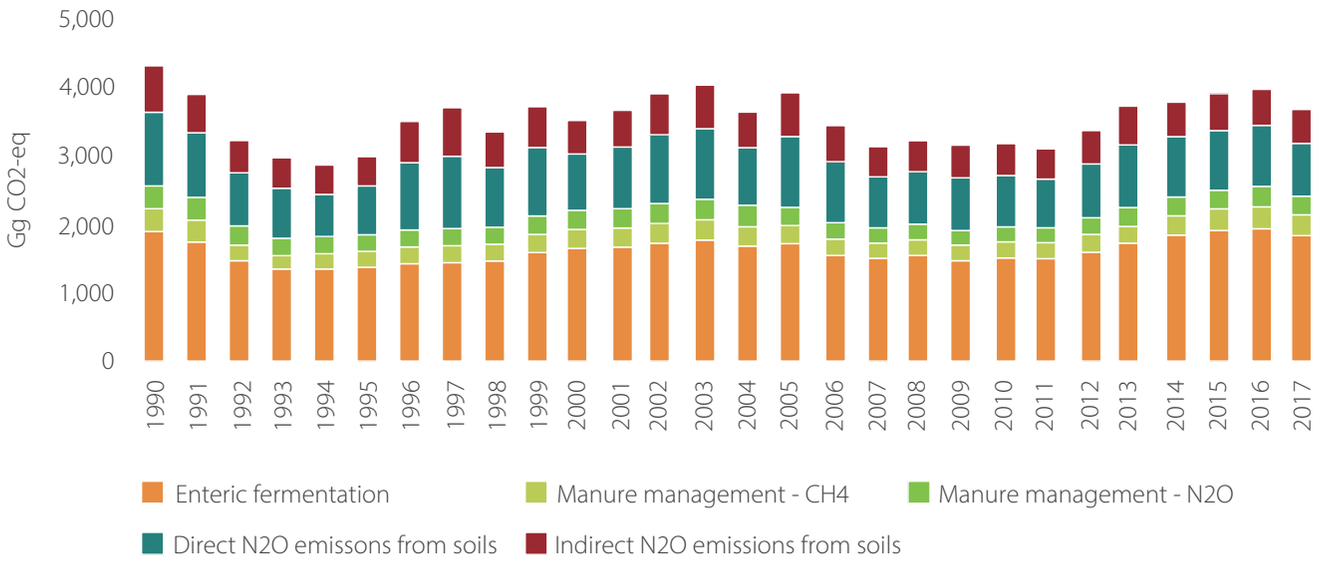
Challenges for the agricultural sector

Several challenges hamper the efficiency and productivity of the country's agricultural sector.

Availability of water resources. Water resources are unevenly distributed in Georgia (mostly concentrated in western regions). Due to issues in the water supply system, people in rural areas rely mostly on wells and boreholes for their water [4]. This increases their vulnerability to potential reduction in groundwater and to drought periods. Rivers that are fed by glaciers and snow, including Khrami-Debed and Alazani, are projected to see reduced flow levels of between 30 and 55 percent by the end of the 21st century, posing a threat to an important source of water supply specifically for Kvemo Kartli and Kakheti regions. Irrigation and drainage (I&D) investments are vital against climatic extremes and are critical for high-value agriculture production. The eastern part of the country, which is subject to frequent droughts, requires the use of irrigation to buffer

[2] Measured in availability of fruits and vegetables for consumption.

Figure 9. GHG emissions from agriculture sector by sources in Georgia (1990-2017)



Source: MEPA (2021) Georgia Greenhouse Gas Inventory. Report of Georgia (1990 – 2017) National Inventory Report under the United Nations Framework Convention on Climate Change. (Reprinted with permission by the authors).

climatic extremes. The western part of the country, which is wetter, is confronted with drainage problems. The I&D services have been falling short of what would be optimal for the country, in both quantitative and qualitative terms [18]. Further investments in I&D systems are necessary to support the growing production of high-value food products such as fruits and vegetables. Indeed, I&D systems are in the process of being developed and improved, with areas of land served by I&D infrastructure increasing every year with the help of state programs. Modern irrigation systems are also gradually being introduced [18]. However, there are still institutional challenges with I&D service delivery in Georgia due to poor schemes for irrigation management and operation, and maintenance; poor financial cost recovery of I&D capital investments; and human resources constraints in the I&D sector in Georgia.

Soil salinization is also a concern in Georgia, particularly in eastern Kakheti region, where salinized soil accounts for 22 percent of the total area [4]. Soil salinization is a process of accumulation of water-soluble salts in the soil in amounts that are toxic to plants. It is observed as a natural process in certain parts of the Caucasus region but is also a direct consequence of unsustainable land use. Saline soils are often found in dry lowlands, where mineralized ground water is close to the soil surface. The increase in the probability of severe drought, could exacerbate the problem of soil salinization in Kakheti. Lack of cultivation and over-irrigation due to future droughts could further increase soil salinization as has already occurred on the Alazani Plain. Soil erosion processes are caused by unsustainable grazing / farming practices, mining and construction, unsustainable land management practices, uncontrolled logging, and poorly regulated urbanization in Georgia [19]. In addition, hydrometeorological hazards further increase the rate of erosion and the negative impact on soil (nutrient leaching losses), water quality, as well as on key infrastructure. Illustratively, soil erosion in Georgia is often associated with sedimentation of reservoirs and irrigation canals. In the south-western region of Adjara, high levels of precipitation have increased soil erosion and led to landslides and avalanches, resulting in a net reduction in agricultural land area of 7.4 percent between 1980 and 2010 [4]. Windbreak infrastructure, that was traditionally favored for providing lower temperatures, increasing relative humidity, and retaining soil moisture, used to contribute to reducing damage of soil erosion caused by intense winds, but has been in steady decline.

Desertification, which is an extreme case of soil erosion, is generating an increase of semi-arid and arid areas in Georgia [4]. Climate change (specifically increased temperatures, severe droughts, and intense winds) increase the effect of desertification in the country. Desertification has reduced the quality of the soil, as for example in the eastern Shiraki plain, where the humus content of black soil has decreased from 7.5 to 3.2 percent during the period 1983-2006 [4]. Degraded soils are also prone to soil erosion and contribute to reducing surface and groundwater availability (because compacted and less fertile soils have lower water infiltration and soil moisture retention capacities). The predicted increase in temperatures and dry periods over the coming decades is likely to compound the problem of desertification and water availability in East Georgia [4].

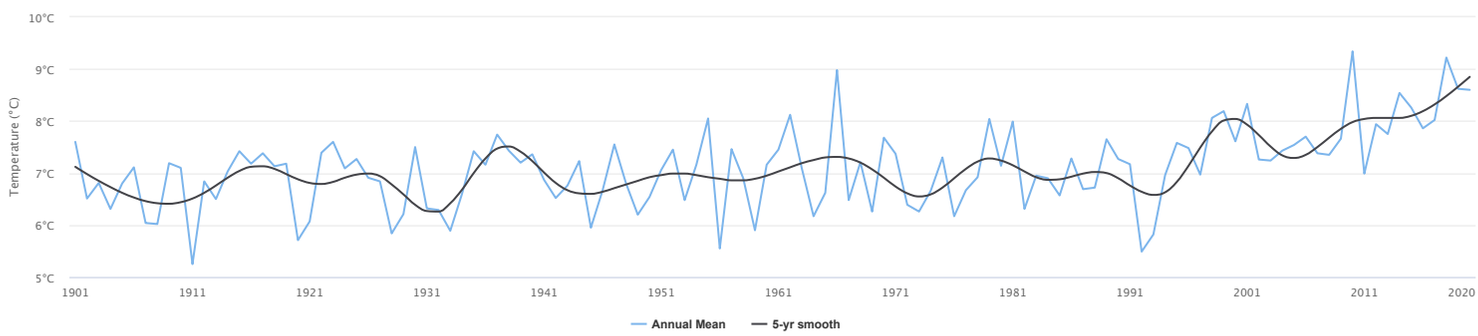
Forest degradation. About 40 percent of Georgia's territory is covered by forests (natural and plantation) which, with over 800 diverse types of trees and bushes, contribute to high biodiversity in the country. However, the sector is facing new challenges as a result of projected climate impacts such as rising temperatures, extreme rainfall events, and changing precipitation patterns. Rising temperatures can affect the distribution and growth of woody species. Moreover, temperature and precipitation changes can also lead to abiotic disorders from extreme events such as fires, storms, floods, and droughts. Biotic disorders that can occur are changes in the frequency of activation of different pathogens and pests and in geographic areas of their distribution [4].

Agriculture and climate change

Historical trends show that climate change impacts in Georgia, such as increasing average annual temperature (by 0.3 degrees Celsius (°C) in western areas and by 0.4–0.5°C in eastern areas compared to 1960s data [4]), eroding soils, and intensifying floods, droughts, frost, and hail in addition to new pests and diseases affecting crops, forests, and livestock, are likely to reduce yields in major agricultural regions. Direct and indirect effects of climate change on crop growth and livestock productivity are expected to affect food production. Direct effects of climate change include reductions to soil, water, temperature and carbon dioxide availability, precipitation, and temperatures. Indirect effects include alterations of water resource availability patterns and seasonality due to rain and snow melt, soil organic matter alteration, soil erosion, changes in pest profiles and the arrival of new invasive species, as well as declines in arable areas due to the subsistence and submergence of coastal lands [4].

Temperature. The Greater Caucasus range to the north of Georgia moderates the local climate by serving as a barrier against cold air from the north, while the Likhi range, crossing from the north to the south, divides the country into the Caspian Sea and the Black Sea catchments. The western part of Georgia is affected by temperate humid influences from the Black Sea with an average annual temperature of 15°C, winter temperatures well above freezing, and relatively hot summers with higher humidity and higher average precipitation. Black Sea coastal areas average annual temperatures that typically range from 9 to 14°C. Mountainous regions have a colder climate, with average annual temperatures of 2 to 10°C. The plains of eastern Georgia are shielded from the influence of the Black Sea by mountains that provide a more continental climate. Summer temperatures average from 20 to 24°C, and winter temperatures range from 2 to 4 °C (Figure 10) [4].

Figure 10. Observed average annual temperature of Georgia (1901-2020)

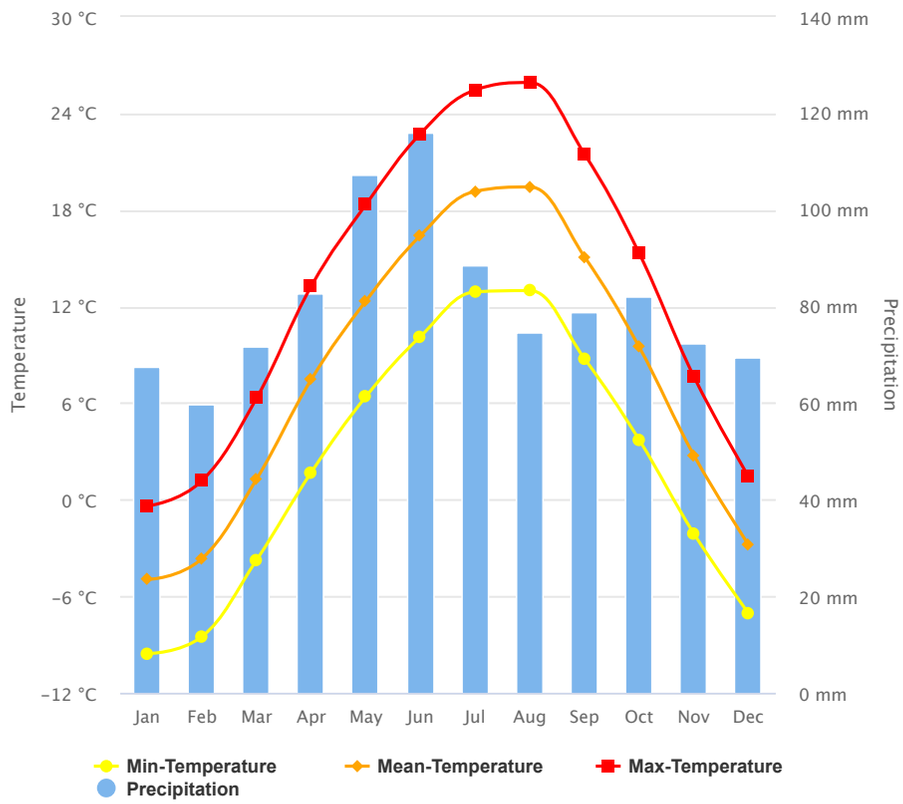


Source: WBG Climate Change Knowledge Portal, (CCKP 2021) Georgia Climatology Data https://climateknowledgeportal.worldbank.org/country/georgia/climate-data-historical

Precipitation. The distribution of annual precipitation presents a clear division between the country's humid western areas and the arid eastern part of the country. Relatively large amounts of precipitation are received in the western region (between 1,500 and 2,500 millimeters per year) [4]. In the mountainous areas, annual precipitation ranges from 1,200 to 2,000 mm. The plains of eastern Georgia are shielded from the influence of the Black Sea by the Likhi Range mountains that provide a more continental climate. Humidity is lower, and rainfall averages from 400 to 600 mm in the plains and from 800 to 1,200 mm in the mountains. The alpine and highland region in the east and west, as well as the semi-arid region on the Iori Plateau to the southeast, have distinct microclimates[3]. Figure 11 shows Georgia's seasonal cycle for monthly mean, minimum and maximum temperatures and precipitation, for the latest climatology.

[3] Iori plateau: temperate dry steppe climate with cold winter and hot summer; Caucasus Mountains: sharp temperature contrasts between the summer and winter months due to continental climate.

Figure 11. Georgia's Seasonal Cycle for Monthly Mean, Min and Max Temperatures and Precipitation, (1991- 2020)



Source: WBG Climate Change Knowledge Portal, (CCKP 2021) Georgia Climatology Data https://climateknowledgeportal.worldbank.org/country/georgia/climate-data-historical

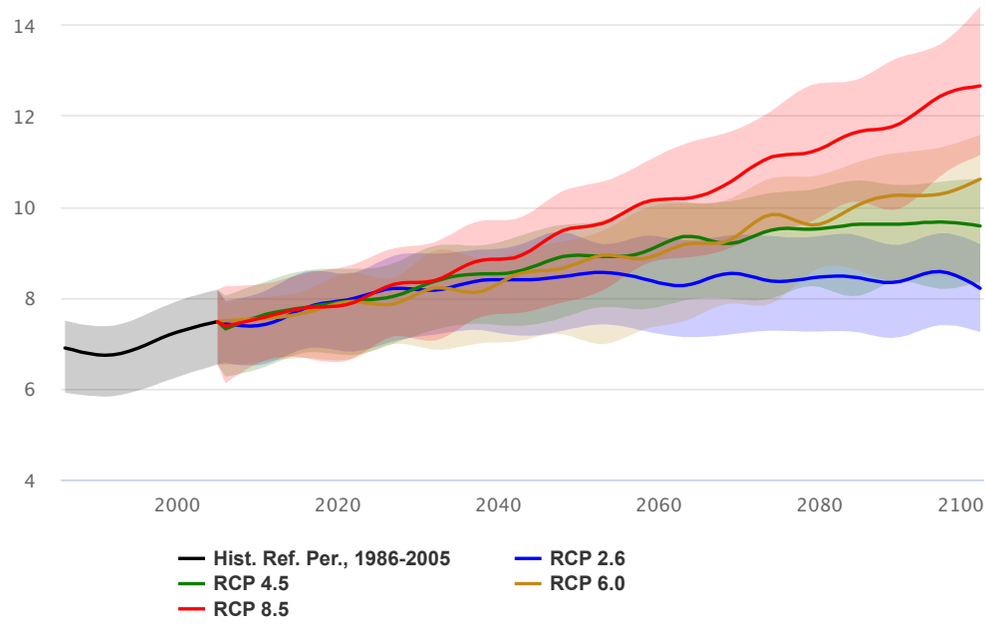
Observed changes. Since the 1960s observed temperatures have increased across the country. Georgia has experienced increased average mean temperatures of 0.3°C in the western regions with a maximum increase registered in Dedoplistskaro (0.9°C), and 0.4-0.5°C in eastern regions with the maximum increase of mean temperature registered in Poti (0.6°C). In the region of Mtskheta-Mtianeti and Kakheti the trend of warming increased by 0.5°C. Across the South Caucasus sub-region, climate trends show a slight decrease in mean precipitation. Precipitation since the 1960s increased in Western Georgia, specifically in Svaneti low hill zones, Adjara Mountain areas, Poti and Imereti mountain areas – with a few exceptions such as the eastern part of Adjara at Goderdzi Pass. Apart from the Lagodekhi municipality where precipitation slightly increased, eastern Georgia registered a reduction trend in precipitation [4]. Georgia faces significant disaster risk levels and is ranked 84th out of 191 countries by the 2021 Inform Risk Index [20]. Earthquakes, droughts, and floods are significant hazards in Georgia [4]. The incidence of destructive natural disasters such as landslides and mudflows has increased considerably. Over the last 40 years, 70 percent of the country has experienced disasters from hydrometeorological and geological hazards (earthquakes) [21].

Climate projections[4]. Georgia is expected to continue to experience changes in its annual and seasonal temperature and precipitation regimes. The regions of Kakheti, Kvemo Kartli and Samtskhe-Javakheti show temperature increase (median) of 2.55°C, 2.59°C and 2.63 °C, respectively, for the period 2040-2059. For the period 2060-2079 a respective temperature increase of 3.74°C, 3.67°C and 3.74°C is expected. By the end of the century, 2080-2099, projected temperature increases are 5.02°C, 5.05°C and 5.18°C for the same regions (Figure 12) [4].

Temperature changes in Georgia are projected to continue to increase significantly from present day through the end of the century under all four emissions pathways (Table 1) [4]. Under the highest emissions pathway, RCP8.5, average temperatures in Georgia are projected to rise by 4.9 °C by the 2090s, compared with a global average rise of 3.7°C [4].

[4] Climate data presented in this section, unless otherwise noted, is from CMIP5 and represents RCP8.5, under the historical reference period, 1986-2005. Data values presented represent the median of the multi-model ensemble.

Figure 12. Projected average annual temperature in Georgia (under RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5)



Source: WBG Climate Change Knowledge Portal (CCKP 2020). Georgia Climate Data. Projections. Note: Shading represents the model range, 10th and 90th percentile, with solid lines presenting the median of the multi-model ensemble for each RCP. https://climateknowledgeportal.worldbank.org/country/georgia/climate-data-projections

Table 1. Projected anomaly (changes in °C) for maximum, minimum, and average daily temperatures in Georgia for 2040–2059 and 2080–2099, compared to the reference period of 1986–2005 for all RCPs

	Average Daily Maximum Temperature		Average Daily Temperature		Average Daily Minimum Temperature	
Scenario	**2040–2059**	**2080–2099**	**2040–2059**	**2080–2099**	**2040–2059**	**2080–2099**
RCP2.6	1.5 (–0.8, 4.0)	1.5 (–0.9, 3.9)	1.4 (–0.4, 3.3)	1.4 (–0.6, 3.2)	1.3 (–0.5, 2.8)	1.3 (–0.5, 2.8)
RCP4.5	1.9 (–0.4, 4.1)	2.6 (0.4, 5.0)	1.7 –0.3, 3.6)	2.3 (0.6, 4.4)	1.6 (–0.3, 3.2)	2.3 (0.4, 4.2)
RCP6.0	1.7 (0.0, 3.7)	3.4 (1.2, 5.8)	1.5 (0.2, 3.1)	3.1 (1.3, 4.9)	1.5 (0.0, 2.8)	2.9 (1.0, 4.5)
RCP8.5	2.6 (0.4, 4.8)	5.4 (2.8, 7.8)	2.4 (0.5, 4.1)	4.9 (2.9, 7.0)	2.3 (0.4, 3.8)	4.7 (2.6, 6.6)

Source: The World Bank Group and the Asian Development Bank. 2021. Climate Risk Country Profile: Georgia. https://www.adb.org/sites/default/files/publication/707481/climate-risk-country-profile-georgia.pdf

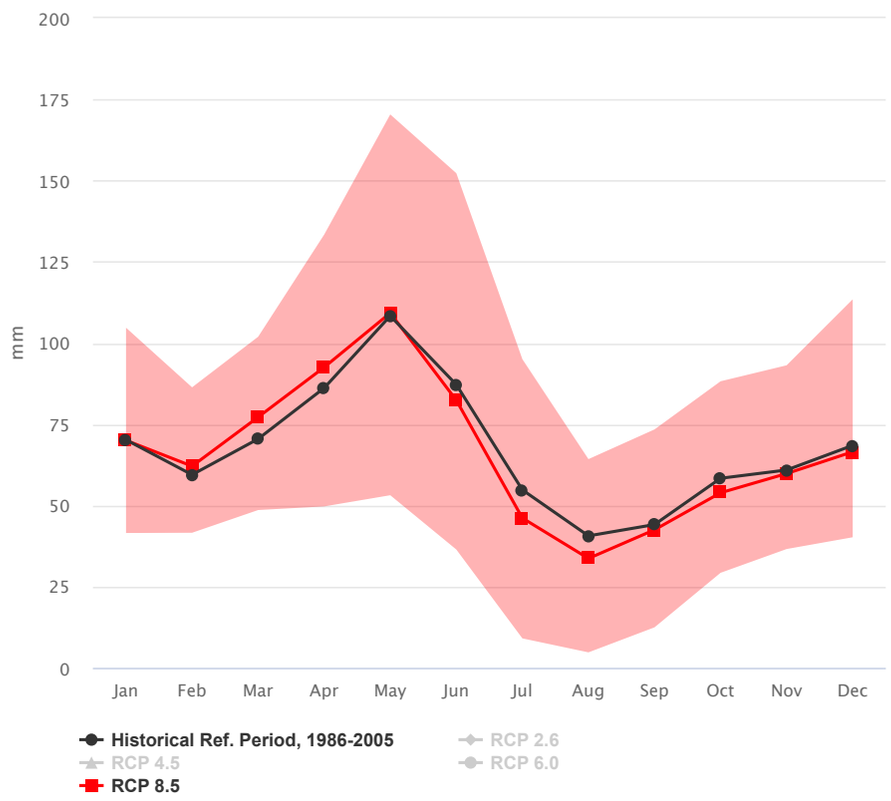
Rainfall projections for Georgia are much more variable and represent the areas' natural inter-annual variability. What has been observed, more generally, is that the intensity of daily extreme rainfall events increases with temperature increases, however this is a phenomenon highly dependent on local geographical contexts and it is not certain how it will affect different regions in Georgia. While overall, precipitation in Georgia is not projected to change substantially, climate projections indicate a likely increase in days with heavy precipitation, greater than 20mm, in western and northern areas of Georgia, especially along the Black Sea, and a likely reduction of these days in eastern and southern areas of the country [4]. Precipitation is projected to remain largely constant in western Georgia through mid-century. In eastern Georgia, the decreased pattern will be replaced by precipitation increase (average 3.4 percent) by 2050. [22].

Projected mean annual precipitation for the 2040-2059 period under RCP 8.5 is 796 mm (median) which is a negative anomaly (reduction in precipitation by 13 mm) as compared to the reference period 1986-2005. Seasonal precipitation for March, April, May is projected to reach 279 mm, with an increase of 14mm compared to the reference period 1986-2005. In the summer period (June, July, August), precipitation will decrease by 20 mm reaching an average mean of 162 mm compared to the reference period 1986-2005. Seasonal precipitation for September, October, November is projected to reach to 156 mm with a decrease of 7 mm compared to the reference period of 1986-2005.

At the subnational level for the timeline 2040-2059, precipitation is expected to decrease for the regions of Adjara (-31 mm, reaching a mean of 969 mm), Guria (-20 mm compared to the period 1986-2005, reaching a mean of 989 mm), Imereti (-31 mm compared to the period 1986-2005, reaching a mean of 960 mm), Shida Kartli (-24 mm compared to the period 1986-2005, reaching a mean of 799mm), Racha Lechkhumi – Kvemo (lower) Svaneti (-37 mm compared to the period 1986-2005, reaching mean of 947 mm) and slightly increase in the regions of Kakheti (+18 mm compared to the period 1986-2005, reaching a mean of 653 mm) and Abkhazia (+26 mm compared to the period 1986-2005, reaching a mean of 960 mm), while it will remain stable in the regions of Kvemo Kartli (+4 mm compared to the period 1986-2005, reaching a mean of 730 mm) and Samergelo – Zemo (upper) Svaneti (-3 mm compared to the period 1986-2005, reaching a mean of 1032 mm).

The mean of precipitation will further decrease for the period 2080-2099 (compared to the period 1986-2005) under RCP 8.5. Georgia precipitation is expected to be reduced over the entire territory reaching mean annual precipitation of 774 mm / year with a difference of -35 mm compared to the reference period of 1986-2005. The average mean will be 278 mm for the spring period (March, April, May) with a difference of +13 mm compared to the reference period of 1986-2005. In the summer period (June, July, August), precipitation will decrease by 46 mm reaching an average mean of 136 mm compared to the reference period 1986-2005. The average mean will be 148 mm for the autumn period (September, October, November) with a difference of -15 mm compared to the reference period of 1986-2005. Figure 13 shows the seasonal cycle of precipitation for the country.

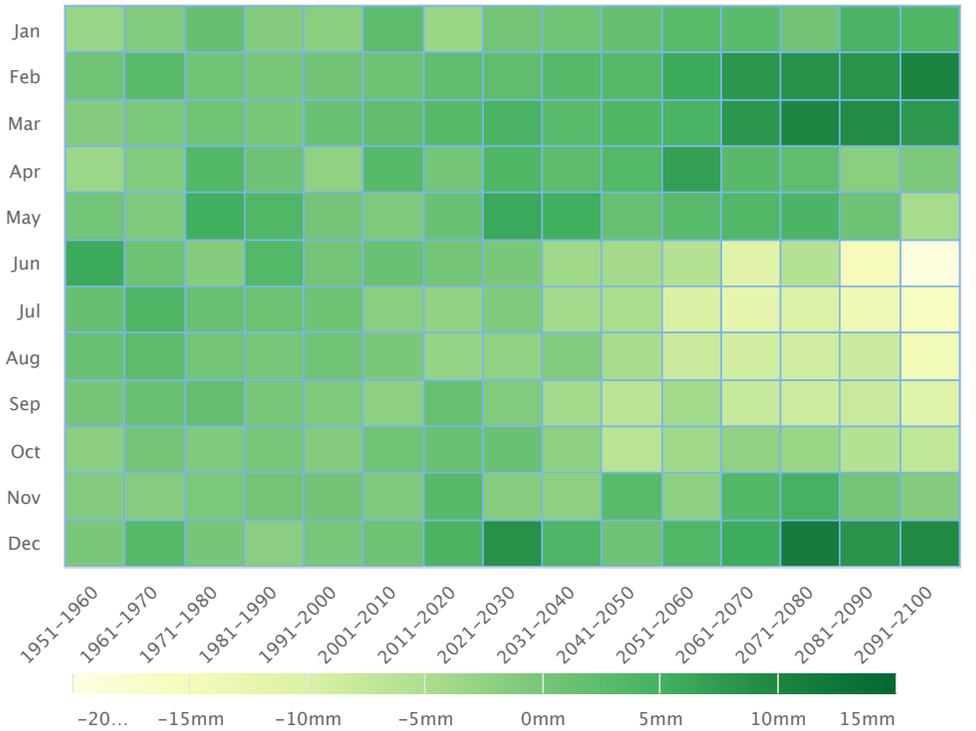
Figure 13. Projected seasonal cycle for Georgia's monthly precipitation for the period 2040-2059, under RCP8.5, reference period 1986-2005



Source: WBG Climate Change Knowledge Portal (CCKP 2021) Georgia. Climate Data. Projections.
Available at: https://climateknowledgeportal.worldbank.org/country/georgia/climate-data-projections Note: The black solid line represents the historical reference period, 1986-2005; the solid red line represents the multi-model ensemble median, with the shaded range representing the 10th and 90th percentiles of the multi-model ensemble range.

Projected precipitation patterns for Georgia for mid-century through to end of century indicate a slight reduction in precipitation with increased seasonal aridity for the country's key agricultural seasons (March-May and September to November). These changes in precipitation patterns are likely to have impacts across the agricultural sector. Figure 14 shows long-term monthly trends as precipitation anomalies. A clear reduction in precipitation is shown, under RCP8.5 for the key agricultural period for the second half of the century.

Figure 14. Projected Precipitation Monthly Anomaly for Georgia, 1951-2100, RCP8.5



Source: WBG Climate Change Knowledge Portal (CCKP 2021) Georgia. Climate Data. Projections.
Available at: https://climateknowledgeportal.worldbank.org/country/georgia/climate-data-projections

Expected impact of climate change on specific agricultural sub-sectors in Georgia

Georgian agriculture is expected to be negatively affected by the direct impact of temperature and precipitation changes on crops, the increased irrigation demand required to maintain yields, and the decline in water supply associated with higher evaporation and lower rainfall, including the potential for more dry days (consecutive days without rainfall events). The expected impact of climate change on specific agricultural produce is described below.

Wheat: Over 60 percent of wheat is produced in Kakheti (eastern region), and the rest is almost completely concentrated in other regions of eastern Georgia (Shida Kartli and Kvemo Kartli). In the current climatology, wheat is more frequently subject to drought during the tillering phase compared to the historical data (1956-1985) [23]. The last of these severe droughts happened in 2020, resulting in yields that were lower than average. The negative impact of warming will be more evident in rainfed and drought-prone regions like Shiraki and Eldari. If sufficient moisture is available, an increase in carbon dioxide concentration will have a positive effect on wheat productivity. The projected average annual temperature rise of 3.6°C expected in 2071-2100 will reduce wheat yields approximately by 15-25 percent, if the same agro-technology is applied. Higher expected temperatures will create favorable conditions for an increase in pest populations, which can also have adverse impacts on wheat yields [23].

Maize: About 70 percent of maize comes from western Georgia, where humidity is high and therefore production is not significantly dependent on the irrigation system. Kakheti in the east, also a maize producing region, has seen a change in rainfall pattern which requires the use of irrigation for short

periods in summer, at critical stages of grain filling. The projected average annual temperature rise of 3.6°C expected in 2071-2100 will reduce maize yields approximately by 15-25 percent, if the same agro-technology is applied. In addition, higher expected temperatures will create favorable conditions for an increase in pest populations, which can have adverse impacts on maize yields [23].

Viticulture: The cultivation of grapes is widely practiced in Georgia, particularly in the country's eastern region: approximately 38,000 to 40,000 hectares are currently dedicated to grape production, and there are more than 35,000 small-scale grape growers. Over the past two decades, Georgia has faced increasingly heavy rainfall, hail, and flooding events, which have affected the Kakheti wine region, causing severe damage to hundreds of vineyards. The expected climate change may have a significant negative impact on yields, primarily because of longer drought periods, which would result in significant deterioration of yield and quality characteristics [23].

Potatoes: Almost half of the potato production in Georgia comes from Samtskhe-Javakheti (central southern region), where the precipitation level (May - June) has increased by 10 percent in the past ten years. This has led to high water and flooding in areas of newly harvested potato seeds as well as higher infestations of fungus, especially phytophtora and alternaria. A joint assessment by Aquacrop (FAO) model and experts on the impact of present and expected climate changes on potato productivity in three regions of Georgia (Akhaltsikhe, Dusheti-Pasanauri, Khulo) revealed that, based on climate change scenario of A1B, non-irrigated potato productivity will probably increase in Mtskheta-Mtianeti, and will significantly decrease in the highland of Adjara (by 10-40 percent) and Khulo. Productivity of irrigated potato cultivation is expected to increase in all production areas; the effect of irrigation is especially high in Akhaltsikhe and is relatively insignificant in Mtskheta –Mtianeti, which is explained by different precipitation regimes and, also, the granulometric composition of soil [22].

Tangerines: Most of the tangerines in Georgia come from the Adjara and Guria region (south-western region). The expected increase in average temperatures, in general, will positively impact the sector in terms of expected yield, extension of suitable area, and duration of harvest season. However, currently the sector is characterized by huge production and price volatility due to frequent early fall frosts and hail, when fruits are not yet fully developed and are highly susceptible to climatic conditions. In addition, moisture needed for citrus production will substantially drop by 2100, thus zones favorable for tangerine (citrus) production will be reduced by three times if irrigation does not occur. Climate change could also increase the conditions suitable for pest and disease occurrence in the coastal areas which might affect tangerine productivity [23].

Hazelnuts: More than half of the hazelnut production comes from Samegrelo (western region). Increases in precipitation levels during the vegetation period have been observed along with droughts in July through August. Frequency duration and velocity of hot winds have been increasing in the last five years which have damaged the harvest and negatively also influenced the future harvest as the plant is weaker and poorly developed. Future climate projections indicate a negative impact on the yields, specifically in long dry periods and after warm winters. Increased amount of extreme precipitation in Samegrelo would cause temporary flooding of lowlands. Changes in temperature regime would increase the harmful pathogen load and cause the need for more comprehensive plant protection measures. Stronger hot winds would increase losses and decrease yield [22], [23].

Livestock: Warm winters can increase the spreading of livestock diseases and even the introduction of new types of pests and diseases. Temperature and prolonged periods of hot days in summer may cause heat stress in animals that impacts animal health and productivity. Georgia counts about 1.9 million ha of meadows and pasture areas, half of which is in Kakheti (eastern region) [24]. The most severe impacts are expected in arid and semi-arid grazing systems, where higher temperatures and lower rainfall are expected to reduce yields and increase land degradation.

CSA technologies and practices

CSA technologies and practices present opportunities for addressing climate change, as well as for sustainable economic growth and development of the agriculture sector. For this profile, practices are considered CSA if they sustainably increase agricultural productivity and incomes while meeting at least one of the other objectives of the CSA approach (climate change adaptation and/or mitigation). Hundreds of technologies and approaches around the world fall under the heading of CSA. The Ministry of Environmental Protection and Agriculture (MEPA) of Georgia has identified three main research areas for CSA as follows: (i) reducing GHG emissions, (ii) sustainable agriculture productivity, and (iii) management of crop, soil, and water resources. According to the Technology Action Plans for Climate Change Adaptation (2012) and the Fourth National Communication to the UNFCCC (2021), Georgia has set specific climate priorities:

i. Increase of irrigated land parcels;

ii Carrying out of studies on degraded soils and take measures to recover and improve soil fertility as well as soil water retention;

iii Creation of legal framework for windbreak management and development;

iv. Introduction of new rules of legislation for protection and maintenance of biodiversity to ensure the sustainable use of biological resources;

v. Introduction of and support to the sustainable forestry management practice through the establishment of effective mechanisms of forest care, protection and recovery, which will facilitate the maintenance and improvement of qualitative and quantitative forest indicators;

vi. Extension and development of modelling capacity of the hydro meteorological surveillance network aimed at reducing the threats originated from natural disasters conditioned by the climate change, and introduction of national system of early warning;

vii. Improvement of atmospheric air, water and soil quality monitoring and assessment system, along with the systems of atmospheric air pollution with harmful substances and recordings of water use;

viii. Transition to the integrated water resource management system based on the sustainable management of water resources and European principles of basin management;

ix. Improvement of waste and chemical substance management system, introduction of various mechanisms in line with the applicable European Union (EU) standards, which will facilitate the prevention of waste generation and re-use of the waste.

The CSA practices identified in this study (Table 2) address important challenges faced by the country's agricultural sector and are the result of research as well as a participatory stakeholder workshop (held in June 2021) and consultations for each production system (carried out between June and October 2021). Most of the practices and technologies identified for crop and livestock systems have a low degree of adoption rate (<30 percent) in Georgia despite their multiple CSA benefits. The key cross-cutting barriers to wider-scale adoption of CSA include limited financial capacities, lack of knowledge and practice, lack of equipment and skills.

The selected CSA practices and technologies enjoy varied climate smartness scores on CSA indicators according to expert evaluations (Annex 3). The average climate smartness score is calculated based on the practice's individual scores on eight climate smartness dimensions that relate to the CSA pillars: yield (productivity), income, water, soil, risk (adaptation), energy, carbon, and nitrogen (mitigation). A practice can have a negative/positive/zero impact on a selected CSA indicator, with 10 (+/–) indicating a 100 percent change (positive/ negative) and 0 indicating no change. A detailed explanation of the methodology and a more comprehensive list of practices analyzed for Georgia can be found in Annexes 1, 2, and 3.

Table 2. Selected CSA practices and technologies for production systems in Georgia

Type of agricultural produce	Main region of production	Predominant farm scale S: small scale M: medium scale L: large scale	CSA Practice	Adoption rate	Impact
Wheat	Kakheti (65%) Shida Kartli (14%) Kvemo Kartli (14%) Other region (7%)	L	Conservation Agriculture (Crop rotation, mulching, no tillage)	>60%	**Productivity** Increase of crop yield and income. **Adaptation** Increase soil organic carbon, maintain productive soils enhance soil structure, enhance soil water holding capacity, decrease in erosion (water and wind). **Mitigation** Decrease of GHG emissions and GHG emissions intensity.
		L	Conservation Agriculture (Crop rotation, mulching, minimum tillage)	<30%	
Maize	Imereti (33%) Samegrelo – Zemo Svaneti (28%) Kakheti (15%) Guria (7%) Kvemo Kartli (6%)	M	Conservation Agriculture (Crop rotation, mulching, no tillage)	<30%	**Productivity** After 3 to 5 years increase of crop yield and income. **Adaptation** Increase soil organic carbon, maintain productive soils enhance soil structure, enhance soil water holding capacity.

Type of agricultural produce	Main region of production	Predominant farm scale S: small scale M: medium scale L: large scale	CSA Practice	Adoption rate	Impact
Potatoes	Samtskhe – Javakheti (46%) Kvemo Kartli (26%) Autonomous Republic (A.R.) of Adjara (6%) Other regions (22%)	M	Drip irrigation, water collectors and draining technologies[5] in potato fields of Samtskhe-Javakheti Set up special cellar to store harvest in winter period	<30%	**Productivity** Irrigation improvements can increase crop yield and income, then increase farm productivity. **Adaptation** Draining systems evacuate excess water in short. high precipitation periods. **Mitigation** Reduce GHG emissions.
Grapes	Kakheti	M	Drip irrigation with row middle grass cover Organic mulching with efficient use of fertilizer	<30% <30%	**Productivity** Supply localized water to crop to increase yields. **Adaptation** Reduce erosion and fertilizer leaching.
Tangerine	A.R. of Adjara	S	Introduction of high productivity and late tangerine varieties - Unshiu and Tiakhara Unshiu - in order to support tangerine harvesting and trading season in the Adjara region [22]	<30%	**Adaptation** Reduce erosion and fertilizer leaching.
Halzenuts	Samegrelo-Svaneti (50%) Guria (22%) Imereti (12%) A.R. of Adjara (6%) Other regions (10%)	M L S	Wind breaker (Wind protecting trees) Leaving inter-rows using mulcher mowers	<30% <30%	**Adaptation** and **Productivity** Increase hazelnut quality and yield in sheltered areas by providing lower temperatures, increasing relative humidity and retaining soil moisture, reducing damage of soil erosion due to strong winds. **Adaptation** Soil and weed management, mulching.

[5] While in Western Georgia, well developed draining canals were established, the central and eastern part of the country do not have this type of structure in place. A well-designed drainage system allows for quick evacuation of water during the short intense rains that are hitting the east in some years.

Type of agricultural produce	Main region of production	Predominant farm scale S: small scale M: medium scale L: large scale	CSA Practice	Adoption rate	Impact
Cattle (milk)	Kvemo Kartli, Imereti, Samegrelo Zemo Svaneti, Samtskhe Javakheti, and Shida Kartli.	ND	Free movement shelter with rotational grazing on improved pastures (grass-legume mixture), using cattle forage blend supplements (including feed supplements and premixes), and automatic milking. Grazing management is a key climate smart livestock intervention; by optimizing the grazing pressure on land and by improving grasslands for animal feed, grassland will be more productive and provide feed with a better nutritional quality for livestock.	<30%	**Productivity** Rotational grazing enhances the quality and digestibility of the forage. **Adaptation** Increase of food availability, soil quality, water & fertilizer use efficiency, biodiversity, reduction of soil erosion. **Mitigation** Reduction of GHG emissions and GHG emissions intensity.
		ND	Free movement shelter without grazing, using cattle forage blend (including feed supplements and premixes), and automatic milking		**Productivity** Increase of forage and farmers income. **Adaptation** Increase of food availability, water, and fertilizer use. **Mitigation** Increase of GHG emissions and GHG emissions intensity.
Sheep (meat)	Kakheti, Kvemo Kartli and Samstkhe Javakheti	ND	Free movement shelter (cold season) with rotational grazing (warm season) on improved pastures (grass- legume mixture) and feed supplements. Grazing management is a key climate smart livestock intervention; by optimizing the grazing pressure on land and by improving grasslands for animal feed, grassland will be more productive and provide feed with a better nutritional quality for livestock.	<30%	**Productivity** Rotational grazing enhances the quality and digestibility of the forage. **Adaptation** Increase of food availability, soil quality, water and fertilizer use efficiency, and biodiversity; and reduction of soil erosion. **Mitigation** Reduction of GHG emissions but increase of GHG emissions intensity.
		ND	Free movement shelter (cold season) with grazing (warm season) on improved pastures (grass- legume mixture) and feed supplements		**Productivity** Increase of yield and income. **Adaptation** Increase of food availability, soil quality, water and fertilizer use, and biodiversity; and reduction of soil erosion. **Mitigation** Reduction of GHG emissions but increase of GHG emissions intensity.

ND: No Data

Environmentally farming practices applied in Georgia that increase yields and save costs – Case study for no-tillage

Source: EU Delegation to Georgia
Photographer: Lasha Gigauri
Location: Khurvaleti Village, Gori Municipality, Georgia

No tillage is an environmentally friendly practice of cultivation when the farmer prepares land for planting crops without excessively disturbing the soil. This method keeps organic materials in the soil that helps to recycle nutrition elements, protecting beneficial flora and fauna in the soil, and altogether creating additional pores in the ground and keeps the levels humidity. No-till method is not only cost-efficient (as it contributes to improved use of water, and a reduced use of fuel for tractors), but also protects the soil from erosion and reduces the impact from droughts. Moreover, the farms do not need to burn the stubble anymore.

Since 2019, the EU and FAO have been working together under the third phase of the European Neighbourhood Programme for Agriculture and Rural Development (ENPARD) program to bring modern and environmentally friendly agriculture techniques to Georgia by arranging demonstration plots and farmer extension services, specifically on conservation agriculture (no-till practice). Since 2019, the program trained over 1,300 farmers in modern agricultural techniques, established more than 80 demonstration plots in Georgia, established 10 farmer field schools, and awarded farmers with 160 grants of more than US$ 3.1 million.

Giorgi Khosroshvili, a farmer from Dedoplitskaro municipality in the Kakheti region of Georgia has been growing wheat, barley and corn for 15 years. Owning a total of 130 hectares of land, the farmer proceeded with caution, trying it out only on one hectare. Giorgi was able to save up to 20 percent of costs on fuel and mechanization services. He also expects the summer harvest to be high, adding that in the coming autumn season (2021) he plans to expand the area with no-till approach to ten hectares (source: FAO in Georgia article on Kakhetian farmer increases yields and saves costs by introducing innovative no-till technology published on 30 July 2020.
http://www.fao.org/georgia/news/detail-events/en/c/1301050/).

In the Gori municipality, Gocha Danielashvili, a local wheat grower farmer, sowed on one hectare of his land with no-till method. He has already harvested 3.5 tons per hectare, which is about 800 kilograms more per hectare compared to the previous years (source: FAO in Georgia
Georgian farmers increase yields and lower costs with new environmentally friendly techniques introduced by EU and FAO published on 22 July 2020.
http://www.fao.org/georgia/news/detail-events/en/c/1418225/) .

Source: EU Delegation to Georgia
Photographer: Lasha Gigauri
Location: Khurvaleti Village, Gori Municipality, Georgia

All farmers confirmed their interest to continue using no-till for the next years, and they expect many other farmers to also join.

Cutting edge technology is used not only for wheat, barley and corn in Kakheti, but for the vegetables in mountainous regions as well, lacking good agricultural land. FAO agronomists, in close cooperation with Georgia's MEPA, organized Farmers Field Schools and numerous training for the farmers all around the country.

Enabling institutions and policies for CSA

Environmental concerns have been high on the priority list for the Government of Georgia. CSA has been gaining traction only recently, however, and efforts are ongoing to raise awareness on CSA, mainstream it at policy level, and to disseminate CSA practices. This CSA Country Profile is part of these efforts, as is the MEPA, FAO and EU CSA Working Group that was established in 2020 with the support of the European Neighborhood Programme for Agriculture and Rural Development (ENPARD).[6] In the framework of the 23rd ENPARD Stakeholders' Meeting (January 2020), representatives of MEPA led the establishment of the CSA Working Group under the Ministry's Environment and Climate Change Department. The CSA Working Group is charged to promote and monitor the implementation of CSA practices in Georgia as well as to mainstream CSA in the national strategic documents and policies.

Decision making over environmental issues is entrusted at ministerial level, while over climate issues to an inter-sectoral body. The Ministry of Environment and Natural Resources Protection (MoENRP) used to be the authority for implementing and enforcing environmental legislation and policy. Following restructuring in 2017, however, the MoENRP was merged to the Ministry of Agriculture, now named MEPA. Another government agency, the National Environmental Agency (NEA), under MEPA, is responsible for natural resources and environmental monitoring (e.g., extreme events, hazardous, soil and water monitoring of chemical pollutants). Georgia has established a high-level, inter-sectoral Climate Change Council, chaired by the MEPA Minister. The Council is intended to provide policy direction and guidance on climate action; improve cross-ministerial co-ordination; and oversee the country's measuring, reporting, and verification system [25].

Strategies to ensure environment management and climate change mitigation and adaptation have been developed in Georgia's Fourth National Communication to the UNFCCC. The country submitted its Intended Nationally Determined Contribution (INDC) in 2019. In 2021, the Government of Georgia adopted the updated NDC, and submitted it to the UNFCCC in the same year. Georgia's NDC expands the country's pledge to reduce its total GHG emissions and reflects the country's commitment to unconditionally reduce its GHG emissions to 35 percent below its 1990 baseline level (an approximately 16 percent per capita reduction) by 2030.

CSA has started being explicitly featured in national strategies and policies. Georgia's updated NDC supports the low carbon development approaches of the agriculture sector through encouraging CSA and agrotourism. In addition to the NDC that advocates explicitly for CSA, the Rural Development Strategy of Georgia (2021-2027) also aims to disseminate climate-smart and environmentally adapted agricultural practices (under Goal 2 - Sustainable usage of natural resources, retaining the eco-system, adaptation to climate change). Furthermore, the 2030 Vision outlined in the Climate Change National Adaptation Plan for Georgia's agriculture sector calls for the practice of CSA in Georgia, and sustainability of agro-ecosystem services through the introduction of highly effective production methods and management of the climate change associated risks.

Georgia's National Climate Change Strategy 2021-2030 and Action Plan 2021-2023, adopted by the Government at the same time as the NDC, outline the concrete actions the country will take to implement this ambitious agenda. The Strategy outlines sectoral priorities, goals, and objectives for climate adaptation, lays out the institutional structure for the implementation of it, identifies financing needs and sources of funding, and sets forth the methodology for monitoring and evaluating the outcomes. The Action Plan identifies measures and actions that support the development of Georgia's economy and infrastructure in a way enabling to meet the country's international obligations and national ambitions for climate change mitigation. Measuring progress in the implementation of the Action Plan 2021-2023 will help Georgia to remain on track in the delivery against the current NDC and will also serve as an important orientation to inform the determination of an appropriate and realistic level of ambition when updating the NDC in future revision cycles.

Key components of Georgia's new climate pledge include:

- Unconditionally limiting its total GHGs by 35 percent below the 1990 level by 2030 and potentially increasing this commitment (with sufficient international support) to 50 to 57 percent;
- Continuing to record GHGs not regulated by the Montreal Protocol in its National GHG Inventory;
- Setting out feasible targets for limiting emissions in seven sectors (transport, buildings, energy generation and transmission, agriculture, industry, waste, and forestry);
- Shifting to low-carbon development approaches in the construction, waste management and agriculture sectors;
- Assessing specific impacts of climate change on coastal zones, mountain ecosystems, forests and water resources and introducing relevant adaptation measures;
- Assessing the economic, social and health impacts of climate change and introducing relevant adaptation measures;

[6] The programme ENPARD aims to (i) build capacity and support government institutions in the reform of the agriculture and rural development sector; (ii) improve employment and living conditions of rural populations by strengthening farmers' cooperation skills and access to resources; (iii) promote diversified social and economic opportunities in rural areas, particularly for women and youth, in due respect to the environment and the cultural heritage. More information is available here: https://eu4georgia.eu/enpard/

- Promoting biodiversity conservation with a focus on endemic, indigenous and endangered species;
- Taking measures to reduce losses and damage caused by climate-induced disasters and extreme weather events; and
- Upholding Georgia's commitments to the principles of gender equality and the Sustainable Development Goals by empowering women as agents of change and increasing their participation in decision-making in all NDC areas, including energy efficiency and the sustainable use of water resources.

Lastly, Georgia's Climate Change Strategy explicitly calls for building capacities to generate scientific evidence for development of climate-smart approaches in the agriculture sector (under Objective 5.2). The Strategy mentions the plan to undertake research and consultations to identify CSA practices that are economically and socially relevant for Georgia and to support implementation of CSA practices through extension and awareness-raising campaigns.

Financing CSA

Access to finance for farmers and the private sector is vital for agricultural development and to scale CSA. Climate finance can act as a catalyst for the broader adoption of CSA practices by demonstrating the feasibility these approaches have in terms of their social, environmental, and financial returns. To further facilitate this process, more research is needed on non-monetary benefits of CSA, in terms of ecosystem services flows and natural capital stock.

Georgia has relied on government programs that are primarily focused on subsidizing interest rates to expand lending to agriculture and agribusinesses. Since 2010, public expenditure on agriculture has increased significantly, both in absolute terms and as a share of total public expenditure,[7] signaling the prioritization of the agricultural sector development by the Government of Georgia [26]. Major initiatives include launching more than ten agricultural support programs managed by the Agricultural and Rural Development Agency (ARDA), the mission of which is to contribute to the competitiveness of the agricultural sector and the sustainable production of agricultural goods though introduction of international food safety standards. The main programs of the agency are: (i) Preferential Agro-Credit, which co-finances interest rates on investment loans; (ii) Plant the Future, which co-finances (with grants) projects for the growth of perennial orchards and creation of nurseries; and (iii) Processing & Storage Enterprises, which provides grant co-financing that can be matched with Agro-Credit loans. Other programs include the Program for Agricultural Modernization, Market Access and Flexibility (AMMAR) and Young Entrepreneurs. In 2020, the agency introduced several new programs in response to the COVID-19 crisis that include: (i) new sub-component for working capital under the Agro-Credit program; (ii) new sub-component for the food industry fixed assets and new purposes for fixed assets component of the Agro-Credit program; and (iii) new matching grant (50 percent grant) program for fixed assets in primary agriculture production (mainly focusing on machinery, drip irrigation and greenhouses) [27]. CSA-driven agri-initiatives could be introduced under state-funded programs that could boost introducing CSA practices in Georgia. This would also be in line with the Priority Actions for the Koronivia Joint Work on Agriculture, as per the "Submission from the International Centre for Tropical Agriculture and the World Bank" [28].

While these programs have led to an increase in both the absolute level and the share of total lending in agriculture and agribusiness, measures are still needed to enable more commercial bank lending without public support which would help to broaden and deepen the mobilization of private sector finance for investment, together with increased use of guarantees and other collateral substitutes (e.g., warehouse receipts) as an alternative to collateral-based lending. Such a move would also enable women to benefit from agri-finance products and services. Since women tend not to be registered as property owners of land, houses, capital equipment or other assets, they are less likely to qualify for and access agri-finance [29]. Wider use of loan guarantees could also be linked to a reduction of interest rates and a reduced consequent use of subsidized credit.

Indeed, over the last five years, commercial banks have shown a growing interest for investments in the agricultural sector with an increase of their agricultural portfolio by 133 percent in local currency (from 734 million Gel in 2015 to 1,816 million Gel in 2020). Other sources of financing include multilateral channels such as the UNFCCC financing mechanisms, multilateral development banks (MDBs), National Bank of Georgia (NBG), bilateral donors and other international institutions and funds such as the Green Climate Fund (GCF), the Global Environmental Facility (GEF), Special Climate Change Fund (SCCF) and the Adaptation Fund (AF).

[7] For the period 2010-2019 the average annual rate of growth for agricultural spending was ten times faster than that of total public spending. It has accounted for two to three percent of total expenditure since 2012 [24].

Outlook

Georgia has developed various policies and strategies related to CSA activities and climate change with the support of development partners. However, more institutional coordination is needed and concerted efforts on disseminating CSA practices. Support to climate change adaptation and mitigation among farmers rarely works when it is directed from outside or focused only on direct technology transfer. Farmers need incentives and enabling conditions to make transformations on the ground, which must be facilitated by institutions and policies. State institutions are particularly important for the production and dissemination of information related to technology options and management methods, climate variability, and value chain conditions. In addition to governmental institutions, non-governmental entities can play a major role in CSA adoption. Development partners such as the United Nations agencies, the EU, USAID, GIZ, the World Bank and others promote CSA in Georgia, and when implementing operations, also engage local entities (such as non-governmental organizations) building local capacity and further disseminating practices.

CSA development requires intensive communication between the farmers, authorities, and agribusinesses. Moreover, due to the diversity of the Georgian landscape, climate change can have a different impact in different regions of the country. Therefore, it is suggested to follow a regional approach – regional coordination strengthening as well as creation /reinforcement of regional communication platforms to facilitate the adoption of agronomic practices by farmers. Moreover, hands-on experience such as that gained through demonstration plots and farmer field schools allows farmers to better understand CSA good practices.

This profile has identified several promising CSA practices and technologies for Georgia. These practices can contribute to the diversification of farming systems and income sources, and address climate change challenges while attracting investments to develop the agricultural sector. Moreover, the analysis presented in this profile could be included in forthcoming climate policy planning, including mid-century long-term low GHG emissions development strategies or other strategies. Long-term investments in agricultural infrastructure (food supply chain, veterinary, machinery, etc.), capacity building of farmers and agricultural value chain actors and, implementation of CSA-related strategies and programs are all crucial to promote the sustainable development of agriculture in Georgia.

Works cited

[1] Food and Agriculture Organization of the United Nations (FAO). 2010. Climate-Smart Agriculture: Policies, practices and financing for food security, adaptation, and mitigation. Rome: FAO.

[2] FAO. 2013. Climate-smart agriculture sourcebook. Rome: FAO.

[3] GeoStat. 2021. National Statistic Office of Georgia. Population and Demography.

[4] World Bank Group and Asian Development Bank. 2021. Climate Risk Country Profile: Georgia. https://www.adb.org/sites/default/files/publication/707481/climate-risk-country-profile-georgia.pdf

[5] Geostat. 2021. National Statistic Office of Georgia. Georgia's population under absolute poverty line.

[6] GeoStat. 2021. National Statistic Office of Georgia. Georgia's agriculture data. https://www.geostat.ge/en/modules/categories/196/agriculture

[7] GeoStat. 2021. National Statistic Office of Georgia. Georgia's employment data. https://www.geostat.ge/en/modules/categories/683/Employment-Unemployment

[8] GeoStat. 2021. National Statistic Office of Georgia. Exports and Imports of Food.

[9] World Bank. 2020. Georgia – Maximizing Finance for Inclusive Development of Agri-Food Value Chains; Synthesis Report.

[10] FAOStat. 2019. Georgia: Land, Input and Sustainability Data.

[11] Ministry of Environment and Natural Resources of Georgia (MEPA). 2018, National target setting to achieve land degradation neutrality. https://knowledge.unccd.int/sites/default/files/ldn_targets/201811/Georgia%20LDN%20TSP%20Country%20Report.pdf

[12] GeoStat. 2021. National Statistic Office of Georgia. Distribution of agricultural holdings.

[13] FAO. 2018. Georgia at a glance. http://www.fao.org/georgia/fao-in-georgia/georgia-at-a glance/en/#:~:text=Georgia%20has%20favorable%20climatic%20and,area%20is%20covered%20with%20forest

[14] FAO. 2017. Aquastat Georgia database.

[15] FAO, WFP, UNECE, UNICEF, WHO, WMO. 2021. Regional Overview of Food Security and Nutrition in Europe and Central Asia 2020: Affordable healthy diets to address all forms of malnutrition for better health. Budapest. https://www.fao.org/documents/card/fr/c/cb3849en/

[16] Carbon Dioxide Information Analysis Centre (CDIAC). 2020. Georgia Profile.

[17] MEPA. 2021. Georgia National Inventory Report.

[18] World Bank. 2022. Agriculture, Water, and Land Policies to Scale Up Sustainable Agri-Food Systems in Georgia; Synthesis Report and Way Forward. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099455101282294918/p17570501890ab0b088ea0378110de9904

[19] World Bank. 2015. Georgia Country Environmental Analysis: Institutional, Economic, and Poverty Aspects of Georgia's Road to Environmental Sustainability. Environment and natural resources global practice country environmental analysis. Washington, DC. World Bank. https://openknowledge.worldbank.org/handle/10986/22287

[20] European Commission. 2021. INFORM Index for Risk Management. Georgia Country Profile. https://drmkc.jrc.ec.europa.eu/Inform-Index/Portals/0/InfoRM/CountryProfiles/GEO.pdf

[21] World Bank and Global Facility for Disaster Reduction and Recovery (GFDRR). 2017. Disaster Risk Finance Country Note: Georgia. https://www.gfdrr.org/en/publication/disaster-risk-finance-country-note-georgia

[22] MEPA. 2017. Climate Change National Adaptation Plan for Georgia's Agriculture Sector.

[23] MEPA. 2021. Fourth National Communication (2021) to the United Nations Framework Convention on Climate Change (UNFCCC). https://unfccc.int/dicuments/271341

[24] FAO. 2020. Smallholders and family farms in Georgia. Country study report 2019. Budapest. https://doi.org/10.4060/ca9822en

[25] Organization for Economic Co-operation Development (OECD). 2021. Sustainable Infrastructure for Low-carbon Development in the EU Eastern Partnership: Hotspot Analysis and Needs Assessment. Green Finance and Investment. https://doi.org/10.1787/c1b2b68d-en

[26] World Bank. 2020. Georgia – Maximizing Finance for Inclusive Development of Agri-Food Value Chains; Analysis of Public Spending in Agriculture in Georgia. Washington, D.C.: World Bank.

[27] World Bank. 2020. Georgia – Maximizing Finance for Inclusive Development of Agri-food Value Chains; Assessment of the Supply of Agriculture Finance in Georgia. Washington, D.C.: World Bank.

[28] CIAT and World Bank. ND. Future topics not listed in decision 4/CP.23 and views on the progress of the Koronivia Joint Work on Agriculture in order to report to the Conference of the Parties as per decision 4/CP.23, paragraph 4.https://www4.unfccc.int/sites/SubmissionsStaging/Documents/202111032230--World%20Bank%20%20CIAT%20Submission%20on%20Koronivia%20Joint%20Work%20on%20Agriculture%2003-11-2021.pdf

[29] FAO. 2018. Gender, agriculture and rural development in Georgia – Country Gender Assessment Series. Rome, pp. 80 License: CC BY-NC-SA 3.0 IGO

This publication is the product of a collaborative effort between the Food and Agriculture Organization (FAO) of the United Nations in Georgia, the European Union Delegation (EUD) in Georgia, and the World Bank, to identify country-specific baselines on CSA in Georgia /the South Caucasus. It is based on a methodology prepared by CIAT, the World Bank, and the Center for Research and Higher Education in Tropical Agriculture in 2014 and revisited in 2015 by Andreea Nowak, Caitlin Corner-Dolloff, Miguel Lizarazo, Andy Jarvis, Evan Girvetz, Jennifer Twyman, Julian Ramírez, Carlos Navarro, Jaime Tarapues (CIAT/CCAFS), Charles Spillane, Colm Duffy, and Una Murray (University of Galway) and modified to fit the Georgia case study.

Climate data presented in this assessment derives from CMIP5 – the Coupled Model Intercomparison Project, Phase 5. The CMIP efforts are overseen by the World Climate Research Program, which supports the coordination for the production of global and regional climate model compilations that advance scientific understanding of the multi-scale dynamic interactions between the natural and social systems affecting climate. CMIP5 is the foundational data used to present global climate change projections presented in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). CMIP5 uses four Representative Concentration Pathways (RCP), which are used to represent the response of the climate system to different future development and emission pathways, defined by their total radiative forcing (cumulative measure of GHG emissions from all sources, measured in W/m2) by 2100. For example, RCP2.6 represents a very strong mitigation scenario, whereas the RCP8.5 assumes a very high emissions scenario. The CMIP6 collection represents the next iteration of climate model compilations. However this was released after the production of this Climate Profile, thus this assessment relies upon CMIP5 data.

The authors of this study are Nicolò Massa Bernucci (FAO CFI Rome), Jumber Maruashvili (FAO Tbilisi), Allan Pineda Burgos (FAO Tbilisi) and Aira Htenas (World Bank).

Design and layout: Fernanda Rubiano (independent consultant) and CIAT (Alliance)

Infographics: Fernanda Rubiano (independent consultant)

This document should be cited as: WB and FAO (World Bank and Food and Agriculture Organization of the United Nations). 2022. Climate Smart Agriculture in Georgia. CSA Country Profiles for Africa, Asia, Europe and Latin America and the Caribbean Series. Washington D.C.: The World Bank Group.

Acknowledgements

Special thanks to the representatives of the following institutions for providing information for this study: Ministry of Environmental Protection and Agriculture of Georgia (MEPA), FAO of the United Nations Georgia, Scientific Research Center of Agriculture (SRCA) in Georgia, Caucasus Environmental NGO Network (CENN), and Georgian Farmers' Association (GFA).

The following parties were consulted in the CSA prioritization exercise: Scientific Research Centre of Agriculture (SRCA); University of Georgia (agriculture); MEPA, FAO and EUD Climate Smart Agriculture Working Group; Rural Development Agency (RDA); National Environmental Agency (NEA); Environmental Information and Education Center (EIEC); MEPA; and FAO Georgia.

This profile has benefited from comments received from colleagues: Ioannis Vasileiou, C. MacKenzie Dove, Nkulumo Zinyengere, Pierrick Fraval, Ranu Sinha, Darejan Kapanadze, and Sergio Vallesi (World Bank); Stephanie Jaquet (Alliance Bioversity-CIAT); Javier Sanz Alvarez, Federica Matteoli and Guido Agostinucci (FAO); and from the members of the MEPA, FAO and EUD Climate Smart Agriculture Working Group in Georgia.

Annex 1: Climate Smartness Assessment

The analysis of CSA practices and technologies is shaped around the landscape / agroecozones perspective. It aims to recognize that a CSA practice is not universally applicable and that its application depends on a broader set of social, cultural, institutional, policy, economic and agro-environmental variables. One practice may have different impacts (positive/negative) when applied to different production systems and different agroecozones. For collecting data on CSA practices in the country (types of practices, levels of adoption, climate-smartness scores, etc.) several processes and methods have been used, as described below.

Step 1: A first identification and initial listing of practices is carried out through literature review and were determined based on the feasibility of implementing them in the important production systems of the country. The list of practices was then confirmed with criteria from in-country experts (mainly agronomists with experience in the selected production systems or agricultural regions of interest in the country).

Step 2: After a first validation of the list of CSA practices identified in the country (and related to the main production systems), experts are asked to provide, via semi-structured interviews, surveys or focus group discussions, information on where, how, and to what extent the practice is adopted in the country and the production system it is associated with.

Step 3: Experts are then asked to characterize the practices and give qualitative evaluations of different components of the 'climate smartness' concept for each of the identified practices.

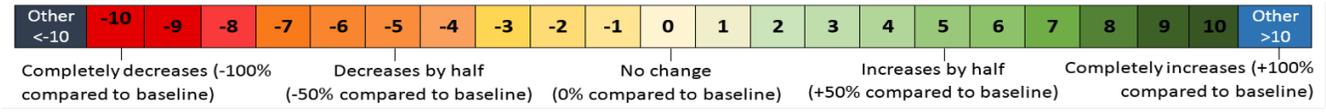
For characterizing the practices, several variables have been used, as follows:

- Agroecozone(s) where the analyzed practice is being implemented
- Predominant farm scale where the practice is implemented (small, medium, large)
- Practice adoption levels (out of the country's agricultural area)
- Climate-smartness levels of the practice (elaborated below)
- Impacts on productivity, adaptation, and mitigation pillars (qualitative description of the observed/ expected impacts)
- Barriers to adoption of the practice

For assessing climate-smartness levels of a practice we created categories of indicators and sub-indicators related to the CSA pillars:

- Productivity: yield smart (yields, post-harvest loss [only for crop systems]) and income smart (income),
- Adaptation: water smart (water availability, water use efficiency, water quality, ecosystem function, soils water retention capacity), soils smart (soil disturbance), and info smart (climate risks management, climate risk prevention, agriculture diversification, local/traditional knowledge use).
- Mitigation: energy smart (energy use from fossil fuels, energy use from renewable sources), carbon smart (above-ground biomass, below-ground biomass, soil carbon stock, methane emissions [only for livestock systems], manure management), and nitrogen smart (nutrient use efficiency).
- In order to operationalize the analysis of the practice's performance in the six categories of interest, we asked experts specific questions that offer insights into the indicators mentioned above. For each indicator they gave values from -10 to 10, which can also be associated with % change (-100 % loss to 100% gain). Table 7 below shows how the different indicators suggested were evaluated.

Indicators for assessing climate smartness of a practice, technology, or service.



Qualitative scale explained:

-10=completely decreases (-100% compared to baseline);
-5=decreases by half (-50% compared to baseline);
0=no change; =increases by half (50% compared to baseline);
10=completely increases (+100% compared to baseline);
Other: if the change is off the current scale (>-100% or >+100%)

Annex 2: CSA questionnaire

Pillar	Smartness category	Q#	Indicator	Expected change	Metric
PRODUCTIVITY	FOOD SMART (or Yield Smart)	Q1	YIELD	By implementing the practice, what are the expected changes in yields?	kg/ha
		Q2	POST-HARVEST LOSS	By implementing the practice, what are the expected changes in crop losses experienced after harvesting?	kg/ha
	INCOME SMART	Q3	INCOME	By implementing the practice, what are the expected changes in income?	($/ha/ season or year)
ADAPTATION	WATER SMART - Impacts on water use and management	Q4	WATER AVAILABILITY	By implementing the practice, what are the expected changes in the quantity of water available for agriculture?	(m3/ season
		Q5	WATER USE EFFICIENCY	By implementing the practice, what are the expected changes in the quantity of water used per unit of product? (refers to water used for crop irrigation and/or livestock production).	(liters/kg of product/ season)
		Q6	WATER QUALITY	By implementing the practice, what are the expected changes in water quality?	N/A
		Q7	ECOSYSTEM FUNCTION	By implementing the practice, what is the expected change in the water cycle equilibrium in the ecosystem?	N/A
		Q8	WATER RETENTION CAPACITY OF SOILS	By implementing the practice, what are the expected changes in soil's ability to retain water?	(mm OR % OR J/ Kg)
	SOIL SMART	Q9	SOIL DISTURBANCE	By implementing the practice, what are the expected changes in soil disturbance?	N/A
	RISK SMART (or Knowledge Smart, tbd)	Q10	CLIMATE RISKS MANAGEMENT	By implementing the practice, what are the expected changes in farmers' capacity to manage climate risks?	N/A
		Q11	CLIMATE RISKS PREVENTION	By implementing the practice, what are the expected changes in farmers' capacity to limit the exposure to climate risks?	N/A
		Q12	AGRICULTURE DIVERSIFICATION	By implementing the practice, what are the expected changes in the level of diversification of farmers' agricultural activities on the farm?	(number of ag. activities on the farm)
		Q13	LOCAL/ TRADITIONAL KNOWLEDGE	By implementing the practice, what are the expected changes in how much farmers use local and traditional knowledge for managing the farm?	N/A
MITIGATION	ENERGY SMART - (impacts on energy use efficiency	Q14	ENERGY USE (FOSSIL FUELS)	By implementing the practice, what are the expected changes in the quantity of fossil fuel energy used to manage every season?	(Kw/kg of product/ season)
		Q15	ENERGY USE (RENEWABLE)	By implementing the practice, what are the expected changes in the quantity of renewable energy used to manage every season?	(Kw/kg of product/ season)
	CARBON SMART	Q16	BIOMASS (ABOVE-GROUND)	By implementing the practice, what are the expected changes in the availability of above-ground biomass on the farm every season?	(ton/ha)

Pillar	Smartness category	Q#	Indicator	Expected change	Metric
MITIGATION	CARBON SMART	Q17	BIOMASS (BELOW-GROUND)	By implementing the practice, what are the expected changes in the availability of below-ground biomass on the farm every season?	(ton/ha)
		Q18	SOIL CARBON STOCK	By implementing the practice, what are the expected changes in the quantity of organic matter accumulated in soil?	(% OR kg/ha OR g/m3 OR kg/m3)
		Q19	METHANE EMISSIONS (only for livestock PS)	By implementing the practice, what are the expected changes in the quality of animal diet?	N/A
		Q20	MANURE MANAGEMENT	By implementing the practice, what are the expected changes in the quantity of manure that is left of pastures/fields? (-10 = much more manure left to 10 = decreased amount of manure)	N/A
	NITROGEN SMART (or Nutrient Smart tbd)	Q21	NUTRIENT USE EFFICIENCY	By implementing the practice, what are the expected changes in the quantity of fertilizers used per unit of product in a season?	Reduction of g N2O/m2/year per ton of product

Annex 3: Climate smartness assessment result findings

Crop / Livestock system	Wheat		Maize	Potatoes	Tangerine	Grapes		Hazelnuts		Cattle (milk)		Sheep (meat)	
Climate Smart Practice	C.A. (No tillage)	C.A. (Min tillage	C.A. (No tillage)	Drip irrigation, water collectors and draining technologies	Introduction of high productivity and early or late tangerine varieties	Drip irrigation with row middle grass cover	Organic mulching with efficient use of fertilizer	Wind breaker	Leaving inter-rows using mulcher mowers	Free movement shelter with rotational grazing on improved pastures	Free movement shelter without grazing, using cattle forage blend	Free movement shelter (cold season) with rotational grazing	Free movement shelter (cold season) with grazing
Q1	2,5	0	0	7,5	2,5	4	2	2,5	0	N/A		N/A	
Q2	2,5	2,5	2,5	7,5	2,5	0	1	0	0	N/A		N/A	
Q3	2,5	2,5	2,5	5	2,5	4	4	0	0	N/A		N/A	
Q4	5	N/A	2,5	5	5	6	4	0	2,5	N/A		N/A	
Q5	0	N/A	0	5	2,5	6	4	0	2,5	N/A		N/A	
Q6	0	N/A	0	0	5	4	2	0	0	N/A		N/A	
Q7	2,5	N/A	2,5	2,5	5	1	1	2,5	0	N/A		N/A	
Q8	5	0,5-1	5	7,5	2,5	3	4	2,5	2,5	N/A		N/A	
Q9	10	5	5	7,5	2,5	1	1	0	2,5	N/A		N/A	
Q10	2,5	2,5	2,5	5	2,5	3	2	2,5	2,5	N/A		N/A	
Q11	2,5	2,5	2,5	5	0	3	3	2,5	2,5	N/A		N/A	
Q12	5	N/A	0	0	5	7	5	0	0	N/A		N/A	
Q13	2,5	N/A	0	0	2,5	5	2	0	0	N/A		N/A	
Q14	5	N/A	5	2,5	2,5	1	0	0	2,5	N/A		N/A	
Q15	2,5	0	0	0	2,5	1	1	0	0	N/A		N/A	
Q16	7,5	2,5	2,5	0	2,5	4	2	2,5	0	N/A		N/A	
Q17	5	5	0	0	2,5	4	3	0	2,5	N/A		N/A	
Q18	7,5	1-1,5	2,5	0	2,5	6	3	0	2,5	N/A		N/A	
Q19	2,5	0	0	0	2,5	5	0	0	0	2,5		2,5	
Q20	2,5	0	0	0	5	1	1	0	0	5		5	
Q21	2,5	2,5	2,5	7,5	2,5	3	5	0	2,5	7,5		7,5	

Crop / Livestock system	Wheat		Maize	Potatoes	Tangerine	Grapes		Hazelnuts		Cattle (milk)		Sheep (meat)	
Climate Smart Practice	C.A. (No tillage)	C.A. (Min tillage	C.A. (No tillage)	Drip irrigation, water collectors and draining technologies	Introduction of high productivity and early or late tangerine varieties	Drip irrigation with row middle grass cover	Organic mulching with efficient use of fertilizer	Wind breaker	Leaving inter-rows using mulcher mowers	Free movement shelter with rotational grazing on improved pastures	Free movement shelter without grazing, using cattle forage blend	Free movement shelter (cold season) with rotational grazing	Free movement shelter (cold season) with grazing
Q22	Large scale	Large scale	Medium scale	Medium scale	Small scale	Medium scale	Medium scale	Medium scale	Small and Large scale				
Q23	>60%	<30%	<30%	<30%	<30%	<30%	<30%	<30%	<30%				
Q24	Lack of knowledge and practic	Lack of equipment and skills	Lack of knowledge and practice	Lack of knowledge and practice	Limited financial capacities	Lack of equipment and skills	Lack of knowledge and practice	Limited info	Lack of equipment and skills				

N/A: Not applicable