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Tajikistan's Agrifood Sector Review

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ABSTRACT

This study examines the growth and challenges in Tajikistan's agriculture sector, highlighting its role as a key driver of the country's development despite significant constraints and challenges, including inputs scarcity and climate change. The agriculture sector has seen an increase in gross outputs and sectoral value added, contributing to domestic needs due to population and income growth. However, Tajikistan still has the lowest agricultural value added per worker in Central Asia and remains a net importer of agrifood products, primarily due to the underdevelopment of the food processing sector. Key growth drivers include sectoral reforms, shifts in land allocation, and government incentives. Despite these efforts, regional disparities in productivity persist, and access to inputs such as fertilizers and mechanization remains limited. The paper emphasizes the need for improved access to finance, agricultural inputs, and extension services to ensure sustainable development and food security. Recommendations include enhancing the capacity of national agricultural research and development institutions, promoting climate-smart agriculture, and improving water and irrigation management. Additionally, the study underscores the importance of developing the livestock sector through improved feeding, breeding, and veterinary services. Overall, a comprehensive approach addressing policy, institutional, economic, and technological gaps is crucial for the sustainable advancement of Tajikistan's agriculture sector.

Keywords: agriculture, development, policy, reforms, challenges and constraints

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ACRONYMS

AAS	Agricultural advisory services
AKIS	Agriculture Knowledge and Information System
ARP	Agriculture reform program
ASSADP	Agrifood System and Sustainable Agriculture Development Program
BMAR	Badakhshan Mountainous Autonomic Region
CIS	Commonwealth of Independent States
COVID-19	Coronavirus disease 2019
CSA	Climate-smart agriculture
DRS	Districts of Republican Subordination
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization of the United Nations Statistics
GDP	Gross domestic product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ha	hectare
HS	Harmonized System
IFPRI	International Food Policy Research Institute
kg	kilogram
kWh	kilowatt-hour
MoA	Ministry of Agriculture
M&E	Monitoring and evaluation
MEWR	Ministry of Energy and Water Resources
NDS	National Development Strategy
NGO	nongovernmental organization
TAJSTAT	Agency of Statistics under President of Tajikistan
TJS	Somoni
US$	U.S. dollars
VAT	Value-added tax
WDI	World development indicators
WTO	World Trade Organization
WUAs	Water user associations

1. INTRODUCTION

Tajikistan's agriculture sector has experienced significant changes in recent years (Akramov and Shreedhar 2012). Despite Tajikistan's harsh environment, a range of challenges and constraints, high exposure to climate hazards, and limited natural resources, the agriculture sector has been one of the main engines of the country's economy for more than three decades. An acceleration in agricultural diversification[1] and advancement in agricultural land reforms[2]—and to some extent an increase in crop and livestock productivity—have been the main drivers of growth in the agriculture sector (World Bank 2021b). Between 2000 and 2023, agriculture value added, on average, grew by 7.7 percent (TAJSTAT, Agriculture Sector in Tajikistan 2023; MEDT 2024). For the 1991–2022 period, on average, agriculture accounted for 23.8 percent of gross domestic product (GDP) (WB, WDI, June 2024).

However, Tajikistan's agrifood sector faces many challenges and risks, including: relatively small public expenditure on agriculture in general, extremely low public expenditure on research and development (R&D) and on advisory and extension services; soil erosion and waterlogging; poor irrigation infrastructure and wasteful irrigation methods, inadequate drainage system, and unreliable electricity supplies to pump stations; overgrazing of pastures (85 percent of which are subject to erosion), severe degradation of pastures due to poor pasture management system, and increased pressure on pasture due to rapidly growing livestock numbers; limited access to high-quality inputs and high dependency on imported agricultural inputs (seeds, seedlings, fertilizers), which are often not adapted to the local agroecology; limited access to and use of high-quality feed, and thus high dependency on imported feed concentrates; low productivity; limited capacity for postharvest storage, handling, and processing; weak agrifood processing, export, and other agribusiness sectors; excessive food price volatility, amplified by weak public capacity to detect and respond to various shocks; high rates of food insecurity (seasonality) and malnutrition; stunting among children under five years; and fragmented, small-scale agricultural production systems, with many small

[1] Area under cotton dropped from 32 percent in 2005 to 22 percent in 2022, and area under horticulture (potatoes, vegetables, fruit, melons, grapes) increased from 18 percent in 2005 to 30 percent in 2022 (TAJSTAT, Agriculture Sector in Tajikistan 2023).
[2] Land is under state ownership, but use rights can be transferred to individuals.

farms. Furthermore, rapid population growth is increasing pressure on the demand side (Khakimov et al. 2023; World Bank 2021b). In addition, climate change is a key obstacle to achieving an improved living standard and presents huge challenges for food security.

This paper is a stocktaking analysis, focused mainly on sectoral development trends[3] during the more than 30 years since the country gained independence. It aims to define constraints and challenges the agriculture sector faces in order to fill some research gaps and provide the basis for further in-depth analysis.

The paper is organized as follows. The first section provides an introduction, justification, and objective of the analysis, and the second section reviews economic and population development trends. The third section summarizes sectoral programs and reforms, challenges, and constraints, including climate change, development of crop and livestock subsectors, agrifood trade, agricultural inputs, agriculture sector finance and subsidies, and extension services. The paper concludes with a summary and direction for further research.

[3] When data allow, the analysis focuses on agriculture sector development by regions and district levels.

2. ECONOMIC AND POPULATION TRENDS

Since Tajikistan gained independence on September 9, 1991, its economy has experienced a U-shape transition. Post-Soviet civil unrest had a severe impact on the country's economic development, but the peace agreement in 1997 marked the beginning of recovery (Akramov and Shreedhar 2012). On average, between 1991 and 1999, real GDP and real GDP per capita in constant 2015 US dollars dropped by 10.6 percent and 11.8 percent, respectively. The economic recovery started in 2000, and the country experienced robust economic growth for the 2000–2022 period; on average, GDP and GDP per capita in constant 2015 US dollars grew annually by 7.6 percent and 5.4 percent, respectively. As a result, by 2022 GDP per capita, measured in constant 2015 US dollars, had increased by 1.14 compared with 1991 and 3.15 times compared with 2000. However, GDP per capita measured in purchasing power parity (PPP) constant 2015 US dollars had dropped by 7 percent compared with 1991 and increased by 1.8 times compared with 2000 as of 2022 (Figure 2.1). GDP per capita grew at a slower pace than total GDP because of rapid population growth (Figure 2.2).

Figure 2.1: GDP per capita, annual average

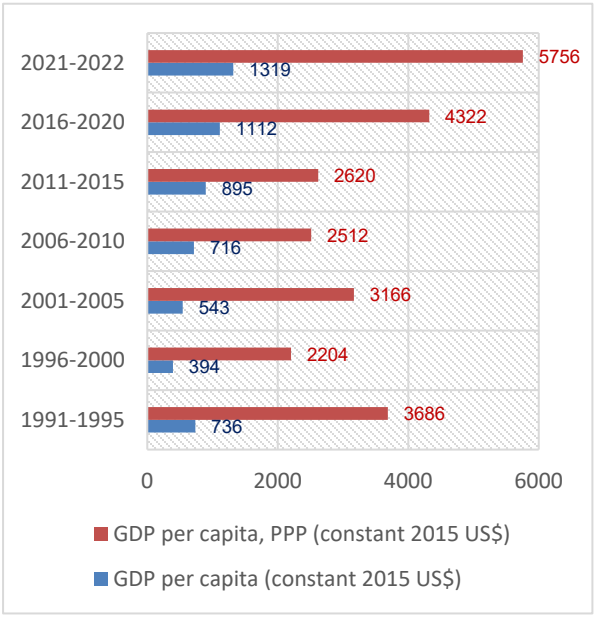
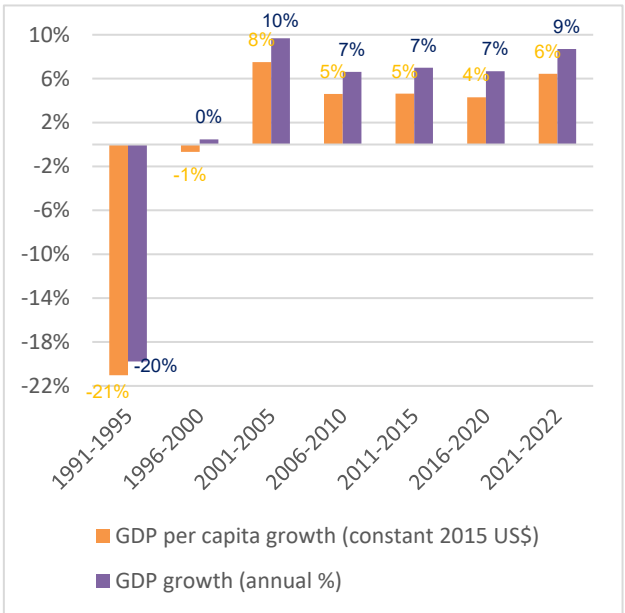


Figure 2.2: GDP and GDP per capita growth, annual average



Source: Authors' compilation based on World Development Indicators (WDI) of the World Bank. Accessed May 2024.
Note: GDP = gross domestic product; PPP = purchasing power parity.

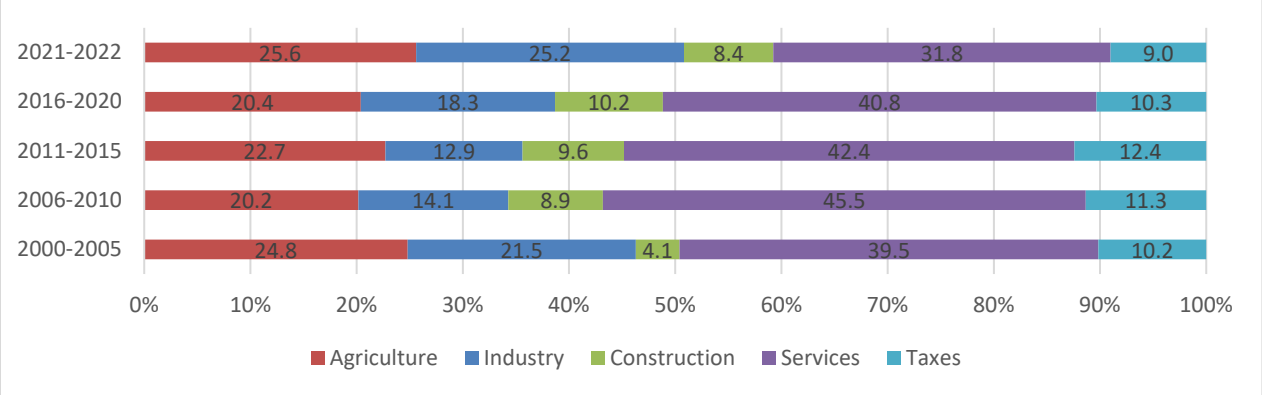
One of the main engines of recent economic growth was the agriculture sector, which grew on average by 7.5 percent in real terms between 2000 and 2020 (Figure 2.3).

Figure 2.3. Real GDP growth by sectors, %

Source: Authors' illustration based on Ministry of Economic Development and Trade of the Republic of Tajikistan data.

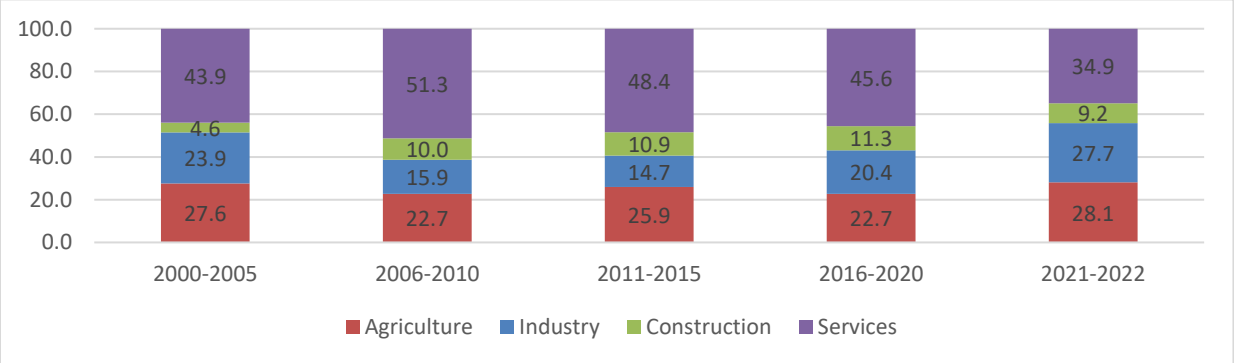
For the 2000–2022 period, on average, the sectoral weight of agriculture (including hunting, forestry, and fishery) in GDP was 22.7 percent including taxes and 25.4 percent excluding taxes (Figures 2.4 and 2.5).

Figure 2.4. GDP: Sectoral weights (including taxes), %



Source: Authors' compilation based on Agency of Statistics (TAJSTAT) under the President of the Republic of Tajikistan data.

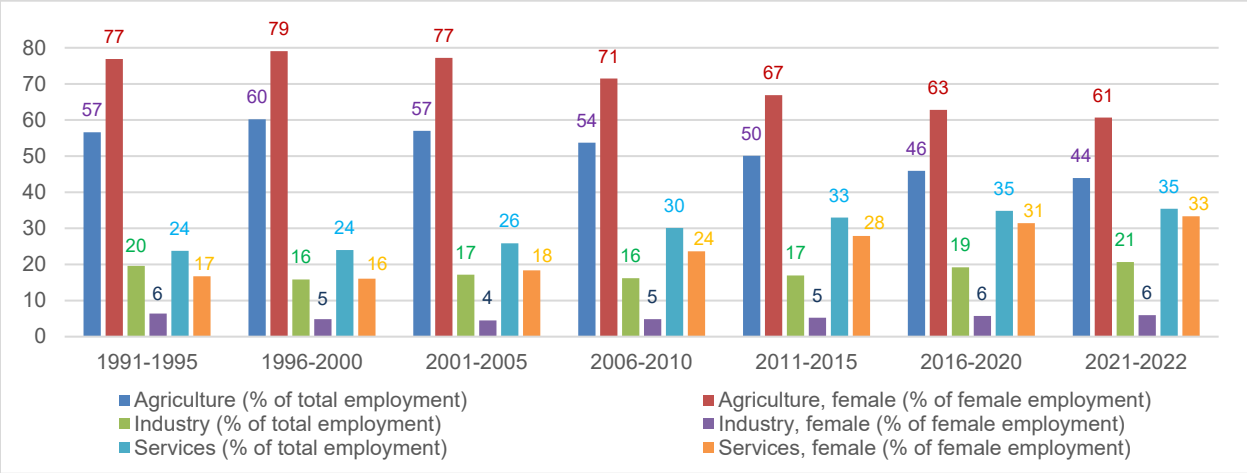
Figure 2.5. GDP: Sectoral weights (excluding taxes), %



Source: Authors' compilation based on Agency of Statistics (TAJSTAT) under the President of the Republic of Tajikistan data.

The agriculture sector remains a major employer in rural areas, where. most of the working-age population lives and is employed in the agriculture sector. The majority of women working outside the home are employed in the agriculture sector and services (Figure 2.6). Although the number of workers in the agriculture sector dropped recently, the sector is still a mainstay for the economy in its contribution to GDP and employment.

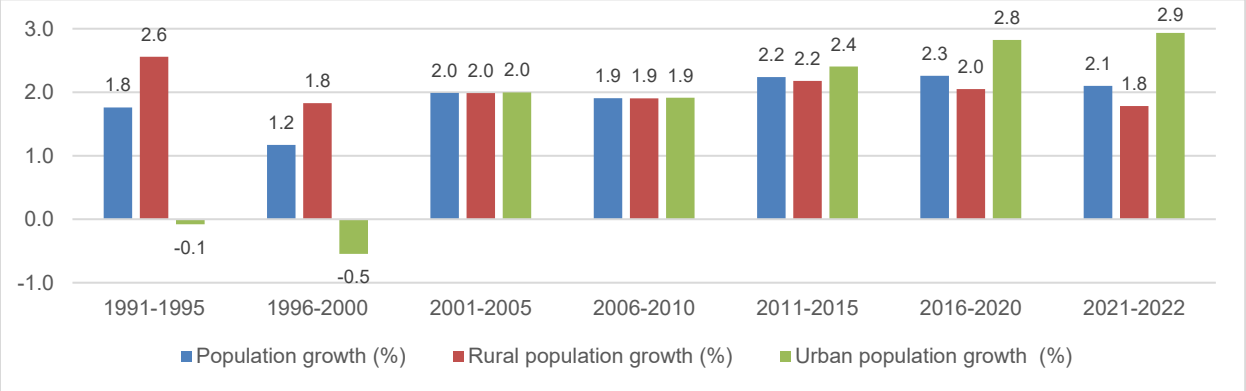
Figure 2.6. Employment by sector



Source: Authors' compilation based on the World Development Indicators (WDI) of the World Bank. Accessed May 2024.

Tajikistan's population is growing rapidly (Figure 2.7). Intercensal period population data show that the country's population more than tripled between 1970 and 2020, and has doubled since 1989. The rural population grew more rapidly than the total population over this period, almost quadrupling between 1970 and 2020 and doubling between 1980 and 2020 (Figure 2.8). This reflects country's annual average population growth rate 1.9 percent over the 1991–2020 period, and faster growth in rural areas (2.1 percent) than urban areas (1.5 percent) (Figure 2.7).

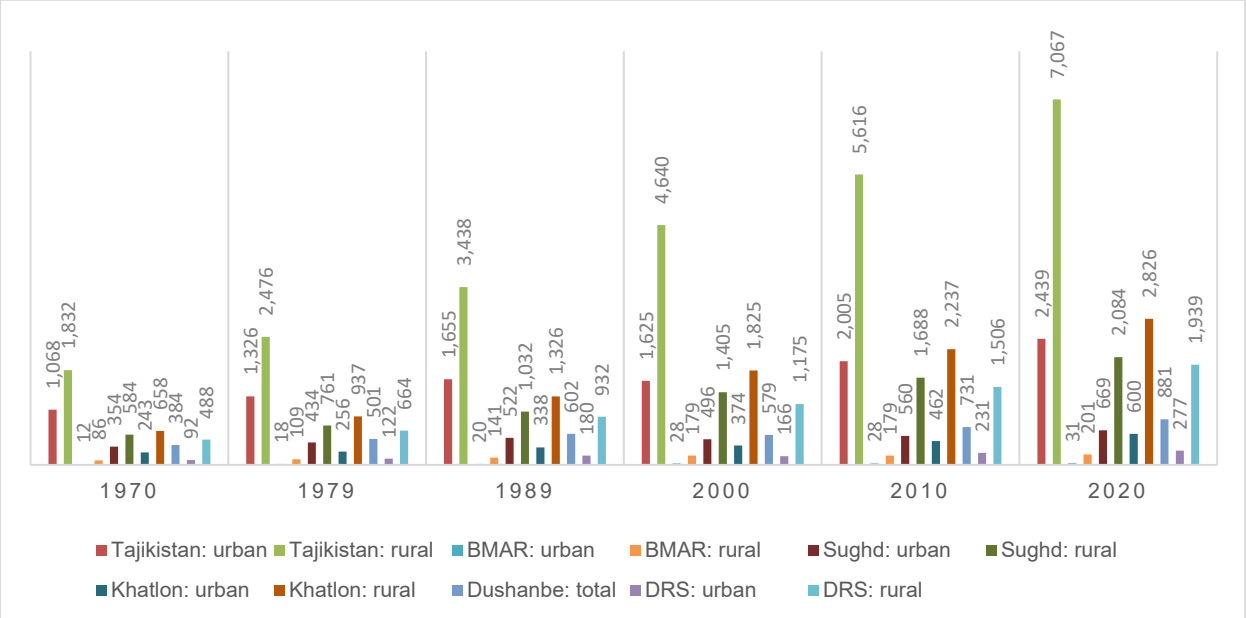
Figure 2.7. Population growth



Source: Authors' compilation based on the World Development Indicators (WDI) of the World Bank. Accessed May 2024.

The population of the Khatlon and the District of Republican Subordination (DRS) regions (especially in rural areas) is growing at a faster pace than the country's population, as well as that of the Sughd region and the Badakhshan Mountainous Autonomous Region (BMAR).[4] In 2020, nearly 74 percent of the country's population lived in the countryside, compared with 63 percent in 1970 (Figure 2.8).

Figure 2.8. Population development trends: Urban and rural (intercensal period), 1,000 people

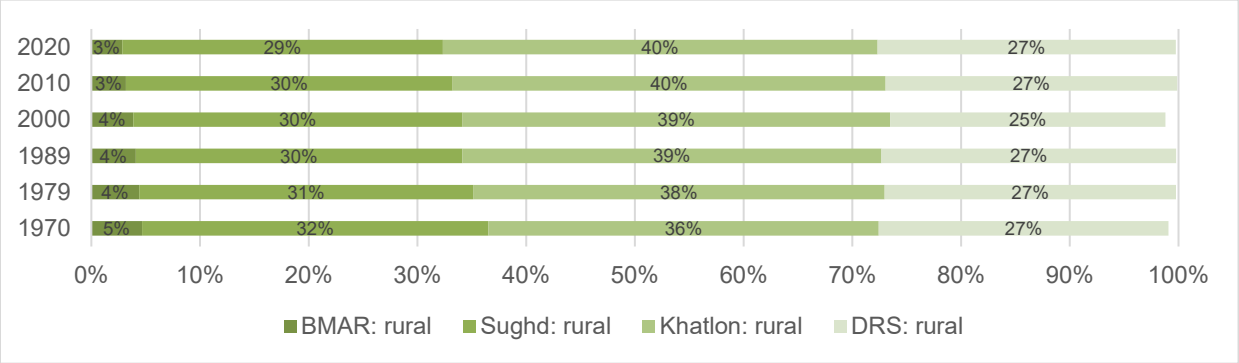


Source: Authors' compilation based on Agency of Statistics (TAJSTAT) under the President of the Republic of Tajikistan data.
Note: BMAR = Badakhshan Mountainous Autonomic Region; DRS = Districts of Republican Subordination.

[4] This is an official name of this region in English. The region name in other literature is Gorno-Badakhshan Autonomous Region, which was translated into English through the Russian language rather than the Tajik language.

For the whole observed period (1970–2020), the share of rural population residing in the Khatlon region is the highest, followed by the Sughd and DRS regions (Figure 2.9).

Figure 2.9. Share of rural population by regions in total rural population: Intercensal period

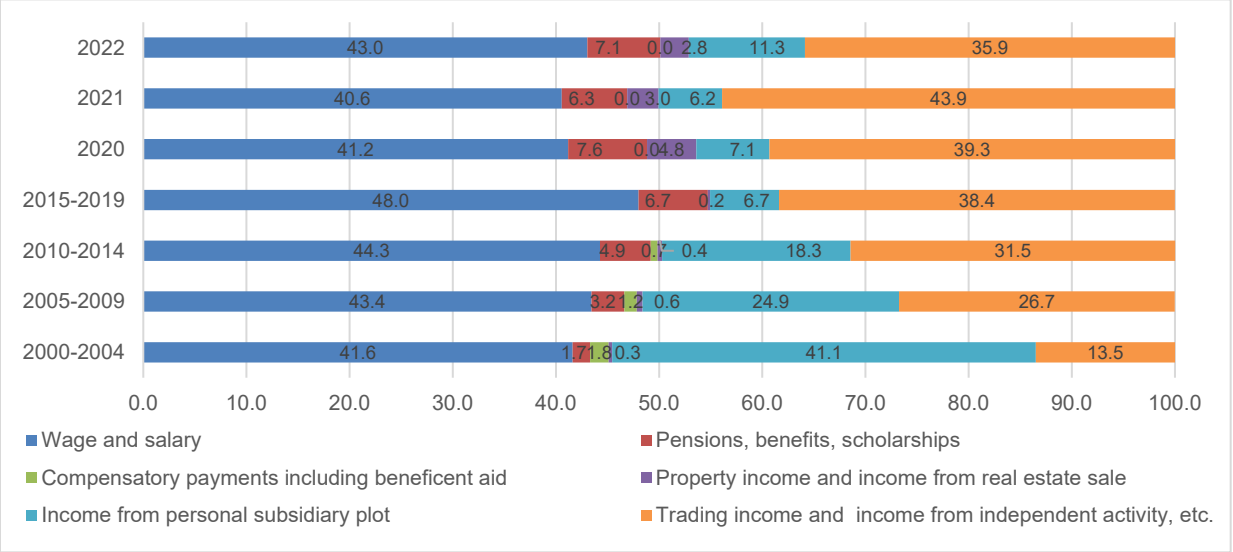


Source: Authors' compilation based on the World Development Indicators (WDI) of the World Bank. Accessed May 2024.
Note: BMAR = Badakhshan Mountainous Autonomic Region; DRS = Districts of Republican Subordination.

Wages and salaries, as well as trading income and income from independent activity (which includes labor migrants' remittances),[5] constituted nearly 79 percent of the aggregate income of Tajikistan's population in 2022. The share of trading and independent activity expanded from 13.5 percent on average between 2000 and 2004 to 36 percent in 2022, whereas income from personal subsidiary plots[6] shrank from 41 to 11 percent (Figure 2.10). The rate growth of trading income and income from independent activity (labor migration) was much higher than that of income from personal subsidiary plots (for more details, see subsections 3.4 and 3.5).

[5] Migrants' remittances play a crucial role in improving population livelihoods, especially in rural areas.
[6] Personal subsidiary plots include subsidiary farms of households, collective gardens and land plots under vegetables, and summer cottages.

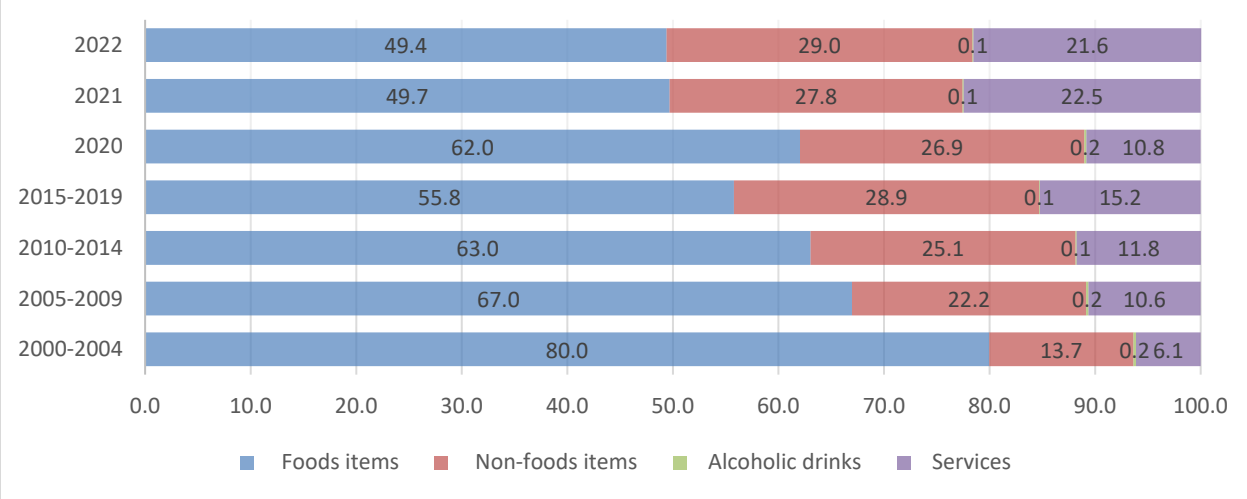
Figure 2.10. Aggregate income of population, %



Source: TAJSTAT. Main Indicators of Household Budget Survey, 2023.

Between 2000 and 2004, almost 80 percent of the average household's income was spent on food items, approximately 14 percent on nonfood items, and 6 percent on services (Figure 2.11). By 2022, spending on food items had dropped (to around 49 percent), and expenditure had increased for nonfood items (to 29 percent) and services (to nearly 22 percent). In the preceding years, the COVID-19 pandemic had a severe impact on household income: The share of spending on food items spiked to 62 percent versus 56 percent on average between 2015 and 2019.

Figure 2.11. Use of aggregate income, %



Source: TAJSTAT. Main Indicators of Household Budget Survey, 2023.

3. AGRICULTURE SECTOR RECENT DEVELOPMENT TRENDS

3.1. Agriculture sector reform and sectoral programs

The constitution of the Republic of Tajikistan clearly emphasizes that the land is solely state property and cannot be privatized; however, land use rights can be transferred to individuals. In the early 1990s, land reform was initiated to enhance agricultural productivity and ensure sustainable development of the agriculture sector (Robinson et al. 2008). The land reform process redistributed arable land to individual farms, leading to expanded land access for household plots, a shift in crops grown, and thus to increased agricultural production and improved family incomes (for more details on types of land ownership, see subsection 3.4) (Akramov and Shreedhar 2012). Land reform has led to increased productivity in Tajikistan, with significant growth in household plots and a shift in cropping patterns (Akramov and Shreedhar 2012; Lerman and Sedik 2009). The area sown to cotton has decreased, while grain and horticultural crops have increased (Lerman and Sedik 2009). Land reform has resulted in privatization, especially in mountainous areas, although collective farms remain prevalent in lowland areas. Pasture access and management practices are evolving due to new legislation (Robinson et al. 2008).

However, inefficiencies remain in unreformed farms, and administrative constraints hinder full potential realization (Lerman and Sedik 2009). The effectiveness of land reform is influenced by local institutions and governance, including practices such as *bobogi*[7] that affect how land reform and agricultural development are implemented (Mandler, 2012). The transition from collectivized to privatized land has been slow and inconsistent, influenced by government reluctance to disrupt the cotton production system. The case of the Hisor Valley highlights the challenges of balancing communal practices with privatization efforts (Rowe 2010). This valley has seen significant land use changes, including privatization and diversification, but these changes have been piecemeal and do not challenge the entrenched system of cotton production, which is influenced by vested interests at various administrative levels (Rowe, 2010).

[7] Local practice of restoring land tenures to previous proprietors.

Despite the challenges, in 2012, the agriculture sector remains a major employer in rural areas. Recent developments in crops, livestock, and horticulture are influenced by a blend of outdated Soviet practices and newer methods introduced by international development agencies. Efforts to modernize agriculture face obstacles due to the limited experience of many farmers and inadequate infrastructure. The transition from Soviet-era systems to modern agricultural advisory services (AAS) has been challenging because of resistance from government entities and conflicting interests among non-governmental organizations (NGOs) and donors (Shtaltovna, 2013).

In 2020, Tajikistan's agriculture sector has demonstrated notable growth despite its challenging environment. The government's focus has shifted toward integrated agrifood value chain development, with an emphasis on smallholders. This approach aims to enhance not only agricultural production but also the broader agrifood system. In recent years, Tajikistan has also made strides in addressing food insecurity and malnutrition. However, challenges remain, including low agricultural productivity stemming from depleted natural resources and a fragmented farm sector. These issues, compounded by reliance on either imported or low-quality local inputs and inadequate public programs, hinder further growth. (World Bank 2021b). Recent efforts focus on strengthening water user associations (WUAs) and improving land tenure rights, which are essential for fostering agricultural development and diversification (Babu and Akramov 2022).

In 2011, agriculture reform program (ARP) for 2012–2020 was adopted and later extended for two additional years. The ARP has two objectives: (1) structural reforms to improve the situation in agriculture and water in the country, and (2) reform of the Ministry of Agriculture (MoA) to equip it to fulfill its new role as facilitator and regulator (rather than planner and controller) of the sector. In this period, some structural reform successes were achieved in the agriculture and water sectors. Nine laws and seven resolutions were adopted between 2012 and 2020. The Water Sector Reform Program introduced river basin management (an integral part of integrated water resources management) as one of the main principles of water sector reform. Institutional reforms of the water sector, such as structural changes to current water sector organizations and establishment of new organizations at national, basin, and sub-basin levels,

supported the water sector reform. Management of water resources is now divided into areas on the basis of the hydrological boundaries of four major river basins (FAO 2020).

The ARP laid the basis for agricultural growth. The increase in employment in the sector was a direct result of the formation of individual *dehkan* farms[8], which expanded labor-intensive production, as a part of land reform. The number of *dehkan* farms grew from 51,000 in 2010 to 179,000 in 2020 (TAJSTAT, Agriculture sector in Tajikistan 2021). At the same time, limited success was achieved in reforming the MoA to fulfill its new role as facilitator and regulator. The program also addresses the need for continued land reform and the elimination of land corruption (Asadov 2013).

One of the main lessons learned is that without a proper monitoring and evaluation (M&E) system, program implementation often falters. The findings of recent World Bank study (Khakimov et al. 2023) on implementation of the ARP 2012–2020 can be summarized as follows:

- The ARP agenda is unfinished despite the extension of the program implementation period by two years, and even though MoA ARP implementation reports indicate that 18 of 22 measures were achieved. Much has been achieved in enforcement of land rights, freedom to farm, and creation of a land market, but there is still a long way to go. Water reform is also being implemented. Pasture, water, and land governance institutions are in the early stages of development.
- Some proposed actions were not implemented because of lack of public financial commitment, such as establishing consultation centers to support family farms at the national, regional, and district levels; introducing an insurance system for the agriculture sector and mechanisms to finance the agriculture sector; and introducing a value added tax (VAT) and import duty exemptions in line with World Trade Organization (WTO) commitments for imported fertilizers and pesticides to minimize farmers' input costs.
- Structural reforms of the ARP were delayed for seven years and are still being implemented.

[8] A *dehkan* farm is an independent business entity created by a family/household or an individual or jointly with others who produce agricultural products by using property, land, and other natural resources that are in their private ownership.

- Agricultural research and extension services must be expanded by public and private sectors to raise crops and animal yields.
- For several reasons, the ARP was not sufficiently monitored and managed, even though its implementation period was extended by two years. First, although its financing mechanism was developed and agreed upon with relevant state institutions in the second half of 2012, as initially planned, it was not implemented because of lack of financial commitment from the government. Second, it did not include capacity building for MoA staff on monitoring and implementation. Monitoring was viewed as part of a report to be submitted to the government on a nonsystematic basis, and a monitoring plan with relevant short-, medium-, and long-term indicators was not developed. Third, there was no comprehensive government program to monitor implementation of the program in collaboration with development partners. The government (Resolution #615 from December 29, 2018) recently adopted an M&E system to monitor implementation of strategy and programs at the national, sectoral, and regional levels, which is a positive sign, but it is only a partial solution; the capacity of relevant staff for M&E must be built in all government institutions. Because of the many government agencies responsible for implementation of the reforms, M&E of the program would have required an interministerial committee, possibly under the authority of a deputy prime minister. Such a committee should be created for implementation of the Agrifood System and Sustainable Agriculture Development Program (ASSADP) for the 2023–2030 period, and the government should take an active part in monitoring and implementing the remaining reforms (now within ASSADP 2030) and maintain ownership of them.
- A future sectoral program should also extend reforms to the Agriculture Knowledge and Information System (AKIS) and address the challenges that the MoA outlined in its assessment of the reform program.
- No sectoral program can provide the basis for sustainable agricultural growth without improving the business environment for agribusiness.

On March 1, 2023, the Government of Tajikistan adopted a new sectoral program, "Agrifood System and Sustainable Development Program," for the period up to 2030. The program defines six priorities, namely (1) strengthening institutions, (2) enabling physical infrastructure, (3) creating an agriculture extension system, (4) ensuring food and nutrition security, (5) ensuring food safety and veterinary and plant protection, and (6) establishing effectively functioning value chains. Under these strategic priorities, 21 subpriorities are defined that clearly identify the implementation process with 72 actions for the 2023–2025 period, The ASSADP aims to further these reforms by diversifying agricultural production, improving land and water management, and strengthening value chains (FAO 2023). Lessons learned from the ARP should guide implementation of the ASSADP to achieve program goals and priorities.

3.2. Agriculture sector development challenges and constraints

Tajikistan's agrifood sector faces many challenges. These include low productivity[9] and high reliance on import of farm inputs (seeds,[10] seedlings, fertilizers) and feed concentrate[11] (World Bank, 2021b); the seasonal nature of food insecurity and malnutrition in rural areas due to excessive food price volatility, amplified by weak public capacity to detect and respond to various shocks; low agricultural mechanization levels and low public spending on provision of machinery and equipment; limited capacity for postharvest storage, handling, and processing; weak agrifood processing and agrifood export sectors; soil erosion and waterlogging[12]; and poor irrigation infrastructure and wasteful irrigation methods, with inadequate drainage systems, unreliable electricity supplies to pump stations, and so on (Khakimov et al. 2023). Moreover, the poor pasture management system results in overgrazing of pastures (85 percent subject to erosion); rapid growth in livestock numbers has increased pressure on pastures, as the actual stocking rate has reached 205

[9] Low value added per agricultural worker: $1,820, constant prices (WDI 2018); low labor productivity: $1,819 per worker (WDI 2018); low livestock productivity (milk yield); low crop yields: 2.2 tonnes/ha for wheat, 1.7 tonnes/ha for cotton, and 21.9 tonnes/ha for potatoes. Subsections 3.4 and 3.5 compare Tajikistan's commodity levels with those of other countries.

[10] These seeds often are not adjusted to the local agroecology.[11] About 70 percent of the seed used is either produced by the private sector or imported; fragmented, small-scale agricultural production systems, with many small farms and some actors; access to and use of high-quality feed is limited. Feed concentrates are not produced at all in the country, and 99 percent is imported.

[11] About 70 percent of the seed used is either produced by the private sector or imported; fragmented, small-scale agricultural production systems, with many small farms and some actors; access to and use of high-quality feed is limited. Feed concentrates are not produced at all in the country, and 99 percent is imported.

[12] In 2020, 60 percent of irrigated land was waterlogged (420,000 hectares) and 97 percent of cultivated land was affected by salinization).

percent of the carrying capacity (FAO NIAP 2022). Effective institutional reforms, improved stakeholder engagement, and better infrastructure investment can address some of these constraints (Babu and Akramov 2022).

Kawabata et al. (2020) stress the need for holistic analysis, integrating various agriculture sector components, of issues that continue to hamper productivity, including underdeveloped agricultural input markets and limited access to modern inputs, to address constraints effectively. Husenov et al. (2020) define three main constraints that hinder sustainable high-yield wheat production: farmers' lack of knowledge, limited use of certified seeds and resistant varieties, and inadequate weed management systems. Bobokhonov et al. (2017) cite growing reliance on imports, along with inadequate infrastructure and inefficient trade facilitation, as significant constraints. Additionally, exchange rate fluctuations and the impact of global market conditions further complicate the sector's ability to adapt and thrive.

A review of literature reveals that most of these challenges and constraints have remained unaddressed for decades. For instance, Akramov and Shreedhar (2012) stated that institutional, policy, and resource constraints are among the agriculture sector's main challenges. Lerman and Sedik (2009) included inefficiencies in unreformed farms, administrative controls limiting cotton production, and inadequate focus on long-term agricultural needs. Mandler (2012) focused on local governance issues indicating that the effectiveness of land reform is affected by the interaction between local knowledge and formal policies. Robinson et al. (2008) defined structural challenges that include insecure tenure, poor land quality, and land degradation, pointing to issues such as inefficient collective farms and high levels of soil salinity from intensive cotton farming. Rowe (2010) cited the persistence of communal agricultural practices and government resistance to fully embrace privatization, noting that vested interests in the cotton industry and cultural tendencies toward communalism complicate land reform efforts. Shtaltovna (2013) emphasized limited resources, inadequate infrastructure, and gaps in farming knowledge, and Khakimov et al. (2014b) stressed the unreliability of agricultural support indicators and the inefficiencies in the policy process that further exacerbate these challenges.

In addition to the above challenges and constraints, rapid population growth and income growth, as mentioned in section 2, can increase domestic demand for food. Addressing growing demand requires either increasing domestic agrifood production and productivity or expanding agrifood imports. However, growing domestic demand due to population and income growth can be considered a huge opportunity for the sector if measures are taken to increase productivity and develop the agrifood processing sector.

3.3. Agriculture sector and climate change

Climate change is a major threat to Tajikistan's agrifood sector and its food security. Climate change leads to less water availability; changes in average monthly temperatures and precipitation patterns; higher evapotranspiration; frequent floods and mudflows[13]; reduced snow accumulation in mountain glaciers; fluctuations in the hydrological cycle; increased insect and pest invasions; increased frequency of extreme events, and more (Khakimov et al. 2020). All these changes threaten food security (availability, accessibility, utilization, and stability of the food system), quality nutrition, and the food supply, which are a priority of the National Development Strategy (NDS) for the period 2016–2030 and of the current ASSADP. According to University of Notre Dame GAIN index (University of Notre Dame, ND GAIN), Tajikistan is considered highly vulnerable to climate change (101st out of 181 countries) with low adaption capacity (readiness 142nd out of 181 countries).

In addition, the agriculture sector contributes significantly to greenhouse gas emissions, particularly methane, thus accelerating the climate change process. Tajikistan's agriculture sector was responsible for 40 percent of the country's greenhouse gas emissions (nearly 50 percent from the livestock sector) in 2022; 68 percent of methane (CH_4) emissions in 2021 originated from the livestock sector (World Bank 2024b). Incorporating climate change mitigation strategies and water-saving technologies into agricultural reform programs is crucial to address emerging challenges (Khakimov et al. 2020).

Climate change poses a direct and indirect threat to crops and livestock yields. Projections show there will be an increased occurrence of extreme heat days and tropical nights, which could intensify drought

[13] Floods and mudflows will become more frequent, damaging infrastructure and disrupting production.

conditions and heat waves. And although the growing season length may increase, the benefits may be offset by more frequent pests and diseases due to reduced frost days (GIZ, 2020). The findings of a recent study indicate that climate change negatively affects most crop yields but may benefit a few crops, including cotton and potatoes, and show negative impacts from climate change on barley, wheat, maize, and fruit and vegetable yields in Tajikistan, with yield declines of 5 to 10 percent by 2050 (Khakimov et al. 2020). Minor yield gains of less than 5 percent are expected for potatoes and cotton in Tajikistan. Notably, rice yield, is projected to increase by approximately 40 percent during the same period. An analysis of crop types, including vegetables, fruits, potatoes, and cotton, shows that under the climate change scenario, yields are expected to increase moderately until 2030 but then decrease through 2050. Resulting changes in producer prices may benefit export crops and improve the trade balance, but the effects on farmers and consumers are mixed, with potential challenges due to higher food prices (Khakimov et al. 2020). Findings of a recent World Bank study (World Bank 2024a) in terms of vulnerability of crop production align with the study findings above. Rising temperatures are projected to reduce crop yields significantly. Under a hot and dry scenario, vegetable productivity could decline by 36 percent and wheat by 16 percent by 2050.

Tajikistan's livestock sector faces significant challenges due to climate change. Increased temperatures, changes in precipitation, and extreme weather events are likely to reduce grassland productivity and forage quality (Lian-Lian et al. 2021; Okhonniyozov et al. 2024) and exacerbate heat stress among livestock, with negative impacts on both their health and productivity (World Bank, 2024b). The study findings indicate that a continuation of business-as-usual (BAU) practices—increasing livestock numbers (mainly large ruminants) rather than increasing productivity through improving breeding and feeding practices—will result in a twofold surge in methane emissions by 2050 (more than 4 million metric tons of carbon dioxide equivalent [MMT CO_2-eq]) compared with 1990 (more than 2 MMT CO_2-eq). The study authors compare four mitigation scenarios to the reference scenario. These all include sectorwide improvements and advancements in herd and manure management, mitigation of overgrazing, and transition from pastoralist to zero-grazing systems, complemented by better practices in herd and manure management, improved feed quality, and the use of dietary additives to further reduce enteric emissions. The authors compare the four

scenarios to the reference year (2000): BAU; scenario 1 (SC1)—increase in efficiency; scenario 2—SC1 plus herd control and additives; and scenario 3—SC2 plus a shift to broiler production.

The authors modeled and projected both methane emissions in the cattle sector and grams of protein production per capita per day by 2050 compared with 2000. In the BAU scenario (continued herd growth), total protein production increases by 1.8 times compared with the reference scenario, but per capita protein production per day increases by only 17 percent (that is, 25.4 grams of protein per day) versus 21.7 grams in the reference scenario. In addition, CH_4 emissions increase by 79 percent with no change per kilogram of produced protein. In scenario 1 (an increase in efficiency), total protein production increases by 2.6 times, and per capita production per day increases by 1.7 times in 2050 compared with 2000. This scenario sees an increase of total CH_4 emissions by 83 percent; however, CH_4 emissions per kilogram of produced protein decrease by 28 percent. In scenario 2 (scenario 1 plus herd control and use of feed additives), total protein production increases by 79 percent and protein production per capita per day further increases by 17 percent compared with scenario 1. Moreover, total CH_4 emissions are less than in the two previous scenarios, while the level of CH_4 emissions per kilogram of produced protein decreases further by 28 percent. In addition, in scenario 3 (a shift to broiler production as a buildup to scenario 2), total protein production further increases by 66 percent, protein production per capita per day increases by 9 percent, and total CH_4 emissions fall by 12 percent, while CH_4 emissions per kilogram of produced protein decrease by 33 percent (for more details, see World Bank 2024b).

Climate change will also reduce Tajikistan's water resources. The country's agriculture sector relies heavily on irrigation, with 68 percent of permanent cropland under irrigation systems. Accelerated glacier melting will increase river flows in the shorter term but reduce river flows in longer term, compounding water scarcity issues in future. Such changes are expected to reduce yields of key crops such as wheat, potatoes, and fruits, with potential declines of 5 to 10 percent by 2050. This dependency on water resources for irrigation also heightens the country's climate vulnerability in addition to global supply chain pressures (World Bank Group and Asian Development Bank 2021). Effective management of irrigation and drainage systems is crucial for adapting to reduced water availability and maintaining crop yields (IFPRI 2023).

The projected yield declines and potential water shortages could negatively impact national food security and community well-being. Households in arid regions might face declining income, while those in more humid areas could see slight gains. However, the overall impact is expected to be negative, particularly affecting the poorest communities with limited access to technology and infrastructure (World Bank Group and Asian Development Bank 2021). Climate change may also worsen Tajikistan's net trade situation through increased domestic demand and reduced production of most commodities. This situation necessitates adjustments in trade policies to manage the effects of climate variability on trade balances (Khakimov et al. 2020).

A food systems approach should integrate climate considerations into agricultural policies and practices, aiming to mitigate the impacts of climate change on food security (Kawabata et al. 2020). Scaling up climate-smart agriculture (CSA) practices could mitigate these impacts. Recommended strategies include improving crop resilience through stress-tolerant seed varieties, adopting conservation agriculture, and enhancing water and nutrient use efficiency. For key crops such as wheat and cereals, the focus should be on conservation agriculture and improved irrigation practices (World Bank 2024c). However, the challenges of nutrient management underscore the need for careful consideration of fertilizer use to avoid adverse effects on biodiversity while enhancing productivity (Lian-Lian et al. 2021; Okhonniyozov et al. 2024).

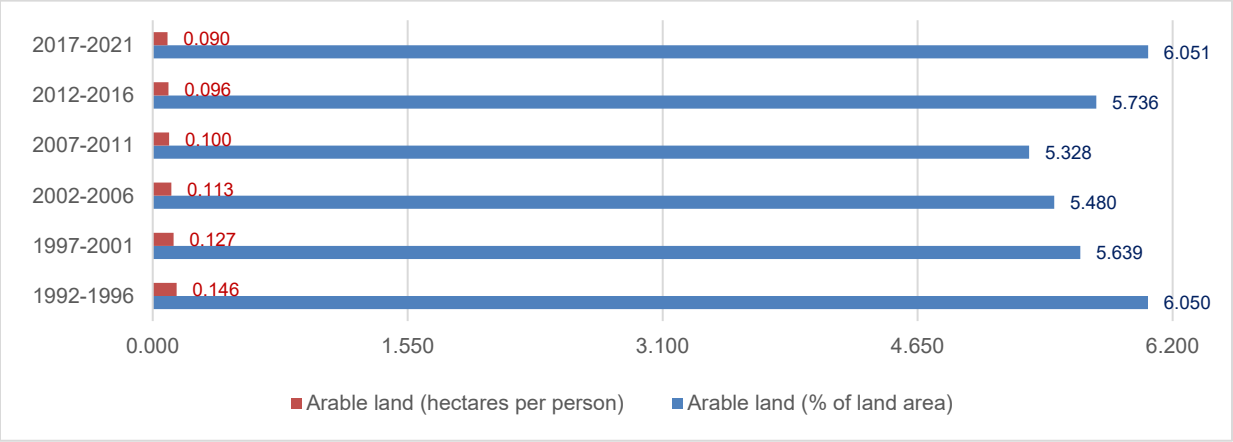
3.4. Crop sector development trends

Despite the challenges summarized in subsections 3.2 and 3.3, the agriculture sector has grown in recent years. This section provides a summary of development trends of the past 30 years, during which Tajikistan's agriculture sector has undergone significant changes. The country's land reform, initiated in the early 1990s, transitioned land ownership from predominantly state-run *kolkhozes* and *sovkhozes* to *dehkan* farms and private ownership. This structural shift has played a major role in reshaping the production and productivity of various crops, as well as in diversifying agricultural activities.

Before the land reform in 1991, 95 percent of Tajikistan's agricultural land was managed by 568 kolkhozes and sovkhozes. The land reform has resulted in more fragmented land ownership and the emergence of *dehkan* farms as key players in the agriculture sector. By 2022, the number of *dehkan* farms surged to 172,107, while number of agricultural enterprises dropped significantly to 4,877 (TAJSTAT, Agriculture Sector in Tajikistan 2023).

Tajikistan is largely mountainous, and arable land is very limited per capita as percentage of total land area. Rapid population growth during the past 30 years has further shrunk per capita arable land (Figure 3.1).

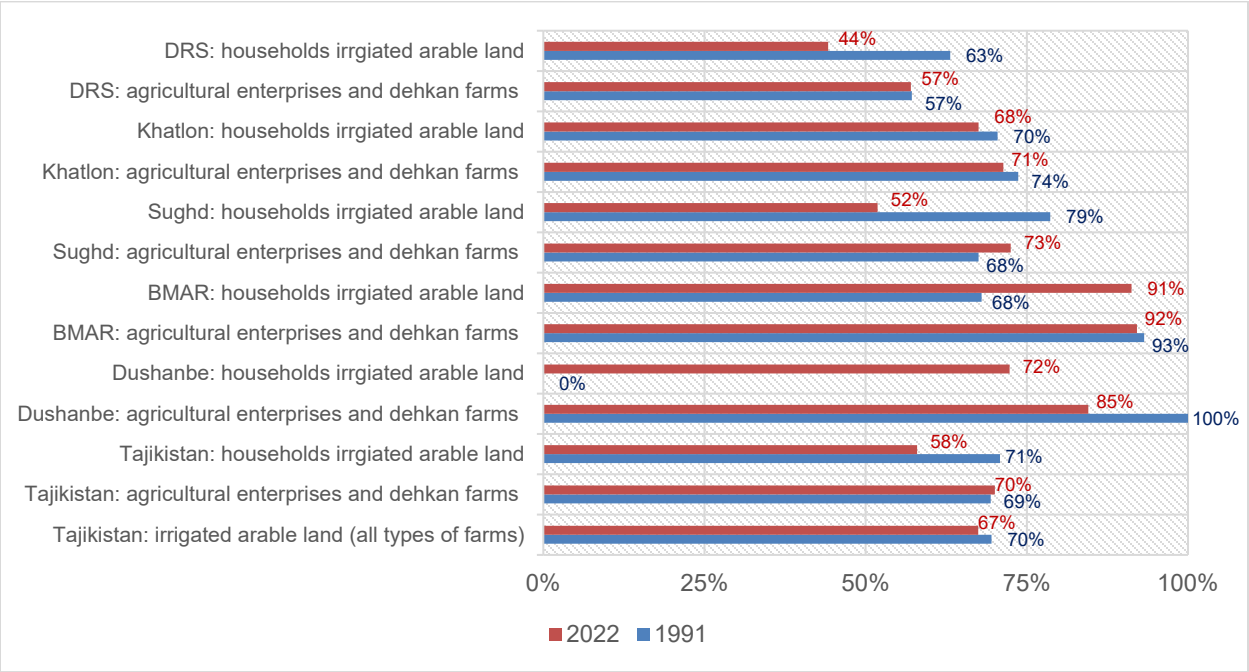
Figure 3.1. Arable land: Hectares per person and percentage of land area



Source: Authors' compilation based on the World Development Indicators (WDI) of the World Bank. Accessed May 2024.

According to the government's Committee of Land Management and Geodesy, the percentage of irrigated land also decreased, dropping from 70 percent in 1991 to 67 percent in 2022. The share of irrigated land dropped across the country, except among the households in the BMAR, with no or small changes in the DRS and BMAR regions among agriculture enterprises and *dehkan* farms (Figure 3.2).

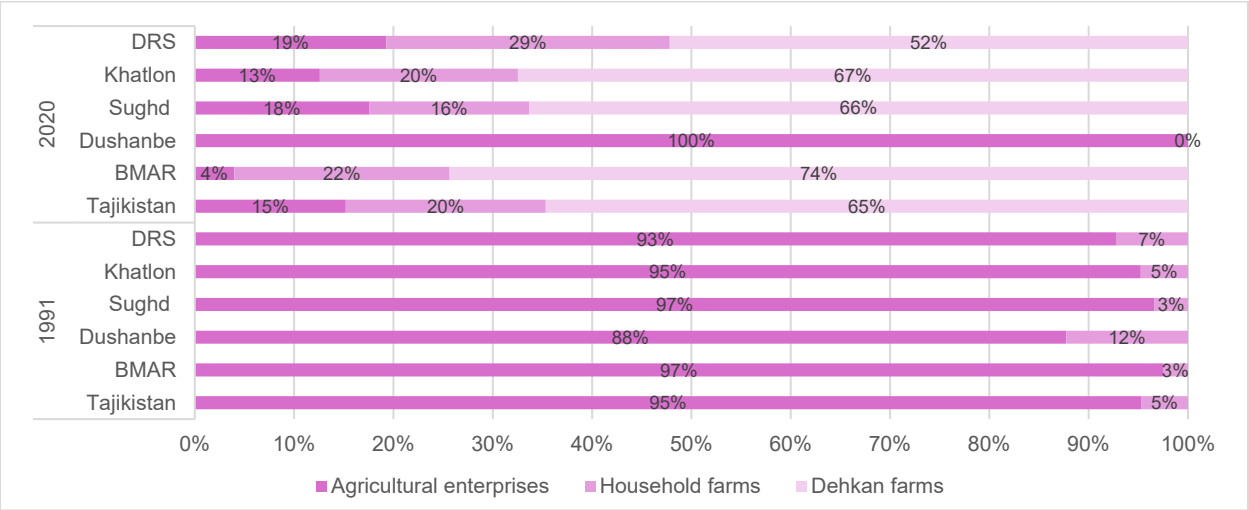
Figure 3.2. Irrigated arable land, %



Source: Authors' compilation based on TAJSTAT, Agriculture Sector in Tajikistan (2023).
Note: BMAR = Badakhshan Mountainous Autonomic Region; DRS = Districts of Republican Subordination.

In 2020, *dehkan* farms held 65 percent of arable land nationwide, and households accounted for 20 percent. Similar patterns are observed in Khatlon and Sughd regions, while the share of *dehkan* farms is higher in BMAR and less than the national level in DRS. The share of agricultural enterprises is higher in the DRS and Sughd regions (Figure 3.3).

Figure 3.3. Arable land distribution by types of farms in 1991 and 2020



Source: Authors' compilation based on TAJSTAT, Regions of Tajikistan, 2022 (168–201).
Note: BMAR = Badakhshan Mountainous Autonomic Region; DRS = Districts of Republican Subordination.

In 2021, sowing areas of agricultural crops increased by 4 percent compared with 1991 due to the return of abandoned land to agricultural activities. Between 1991 and 2021, sowing areas for grains (including maize) and pulses increased by 1.7 times across Tajikistan. Notably, significant expansions were observed in the Khatlon and DRS regions, with increases of 2.1 times and 1.6 times, respectively (TAJSTAT, Regions of Tajikistan, 2022). Grain and pulse production also skyrocketed during this period. Nationwide, production rose by 5.4 times, with the Khatlon region experiencing a remarkable 7.9-fold increase. Households and *dehkan* farms, unlike agricultural enterprises, mainly grow grains and pulses. These growth trends can be attributed not only to the expansion of sowing areas but also to yield improvements. For example, grain and pulse yields in Khatlon were 2.5 times higher in 2021 compared with 1991 (TAJSTAT, Regions of Tajikistan 2022).

Comparing Tajikistan's grain yield to that of neighboring Central Asian countries and global averages shows that while it remains lower than Uzbekistan's yield and the world average, Tajikistan performs better than Kazakhstan, Kyrgyzstan, and Turkmenistan. However, discrepancies exist between data from the Food and Agriculture Organization of the United Nations Statistics (FAOSTAT) and national data, with FAO reporting higher grain yields for Tajikistan than official data.

The production of cotton, once a key agricultural product in Tajikistan, has declined notably. Since 1991, sowing areas for cotton have decreased by 1.6 times nationwide, leading to a 2.1-fold drop in production. The Khatlon and Sughd regions, which account for the majority of the country's cotton output, experienced similar declines in sowing areas and production. The decline in productivity is also reflected in cotton yields, which dropped from 2.7 metric tons per hectare in 1991 to 2.3 metric tons per hectare in 2021 (TAJSTAT, Regions of Tajikistan 2022). Based on FAOSTAT data, Tajikistan's cotton yield is now the lowest in the Central Asian region, and its output lags significantly behind that of Uzbekistan.

The production of potatoes has increased tremendously since 1991, with a fourfold expansion in sowing areas across Tajikistan. Nationwide, in 2020, *dehkan* farms and households accounted for more than 90 percent of potato production. The surge in production is especially notable in the Sughd and Khatlon

regions, where sowing areas expanded by 7.5 and 3.5 times, respectively. Alongside increased sowing areas, yield improvements also contributed to the rise in potato production. Nationwide, potato yields in 2021 were 1.3 times higher than in 1991. However, the yield performance varies by region, with notable increases in Khatlon and Sughd but stagnation in the BMAR and a slight decline in the DRS (TAJSTAT, Regions of Tajikistan 2022). Yield increases were observed in all Central Asian countries in 2021 compared with 1992. The potato yield in Tajikistan is slightly higher than in Turkmenistan and less than the yields of three other Central Asian countries and the world average (FAOSTAT 2024). However, comparing the yield figures in 2021 for Tajikistan, as reported by FAO and by TAJSTAT, reveals that the official yield figure from TAJSTAT is higher than the FAO figure by 2.6 metric tons per hectare. This is higher than the figure in neighboring Kyrgyzstan, but still below the average for the Central Asian region, the world average, and the average for Uzbekistan and Kazakhstan.

Vegetable production has also surged, with sowing areas and yields both seeing significant increases. In the Khatlon region, the vegetable yield per hectare was 2.3 metric tons higher in 2021 compared with 1991, surpassing the national average (TAJSTAT, Regions of Tajikistan 2022). Tajikistan's vegetable yield compares favorably to that of its Central Asian neighbors, with higher yields than in Kazakhstan and Kyrgyzstan but lower than those of Uzbekistan, according to FAOSTAT data.

The production of melons and gourds has expanded significantly, with nationwide production increasing 15 times since 1991. The Khatlon and BMAR regions experienced particularly sharp increases, with production rising 17.4 and 16 times, respectively. Yields have also improved, with a 4.6-fold increase in 2021 compared with 1991 (TAJSTAT, Regions of Tajikistan 2022). When compared using FAOSTAT data, Tajikistan's melon yield surpasses that of Kazakhstan and the Central Asian average.

Fruit production has similarly experienced tremendous growth, with land allocated to fruit trees increasing 3.5 times nationwide. The Khatlon region saw the most dramatic increase in fruit production, rising by 26 times since 1991. However, despite these gains, Tajikistan's fruit yield remains lower than the Central Asian average and significantly below global averages (FAOSTAT 2024). Grape production has grown by 7.4 times in DRS and by 2.9 times nationwide since 1991. Grape yields have also improved, with significant

gains in the DRS and Khatlon regions. While households and *dehkan* farms have been the primary drivers of grape production, agricultural enterprises have shown lower productivity across all regions (TAJSTAT, Regions of Tajikistan 2022). Unlike the significant yield gaps noted for the other products, for grapes there are only small gaps between officially reported TAJSTAT data and FAO- estimated values for Tajikistan. The grape yield in Tajikistan is higher than in Kyrgyzstan, Kazakhstan, Turkmenistan, and Uzbekistan and lower than the world average and the Central Asian average.

In contrast to the growth in other crops, fodder crop production has declined since 1991, with sowing areas shrinking by half nationwide. This reduction comes despite an increase in livestock numbers, raising concerns about the adequacy of feed supplies for livestock production (TAJSTAT, Regions of Tajikistan2022).

In sum, over the past three decades, the crops subsector has seen significant shifts in land use, crop production, and productivity. While the country has achieved notable increases in the production of grains, pulses, vegetables, and fruits, challenges remain in maintaining competitive yields, especially for cotton and fodder crops. The role of *dehkan* farms has been crucial in driving agricultural output, but yield gaps between Tajikistan and its Central Asian neighbors suggest room for further improvements.

3.5. Livestock and fisheries sectors development trends

Over the past three decades, Tajikistan's livestock and fisheries subsectors have experienced significant growth and transformation, driven by government policies, structural shifts, and sector-specific incentives. Below is a summary of the development trends in large and small ruminants, poultry, meat production, and fisheries, supported by data from TAJSTAT, FAOSTAT, and the MoA.

Between 1991 and 2021, the cattle population in Tajikistan grew by 1.8 times, with variations across regions. The most substantial growth occurred in the Sughd and DRS regions, where cattle numbers increased by 1.9 times, followed by the Khatlon and BMAR regions, which saw increases of 1.7 and 1.4 times, respectively. Along with the overall cattle population growth, the number of dairy cows increased

nationwide by 2.2 times, with Sughd and DRS experiencing increases of 2.5 and 2.3 times, and Khatlon and BMAR reporting increases of 2.1 and 1.5 times, respectively (TAJSTAT, Regions of Tajikistan 2022). Milk production followed a similar upward trajectory, growing by 1.8 times nationwide over the same period. However, growth rates varied by region. In the Khatlon and BMAR regions, milk production rose by 2.1 and 1.9 times, respectively, while in the DRS and Sughd regions, it grew by 1.6 and 1.5 times, respectively. Notably, this increase in production was driven primarily by the increase in the number of cows rather than productivity, which fell by 20 percent nationwide compared with 1991. Milk yield in the Sughd and Khatlon regions dropped by 30 percent, while the DRS region saw a modest 10 percent increase in yield per cow (TAJSTAT, Regions of Tajikistan 2022). Thus, despite the surge in production, milk yield in Tajikistan remains low. In 2021, it stood at 0.8 metric tons per cow, which is lower than the Central Asian region and world averages, according to FAO estimates (FAOSTAT 2024). However, TAJSTAT's official figure for the same year is 1.9 metric tons per cow, which is still below the yields in Uzbekistan and Kazakhstan but higher than those in Kyrgyzstan.

The population of small ruminants (sheep and goats) also grew between 1991 and 2021, though the growth rate varied by region. Nationwide, the small ruminant population increased by 1.8 times, with the Khatlon and DRS regions leading the way, with increases of 2.2 and 2.1 times, respectively. The Sughd and BMAR regions experienced smaller increases, with growth rates of 1.5 and 1.1 times, respectively (TAJSTAT, Regions of Tajikistan 2022).

Poultry meat and egg production both declined sharply in 1995, when the poultry population decreased by nearly 10 times compared with 1991. However, recent years have witnessed a significant rebound. By 2021, the nationwide poultry population had increased by 1.7 times compared with 1991, with the BMAR region experiencing the most dramatic growth at 4.4 times. Poultry populations in the Khatlon and Sughd regions increased by 2.5 and 2.1 times, respectively, while DRS saw only an 8 percent increase (TAJSTAT, Regions of Tajikistan 2022). Egg production per bird also doubled between 1991 and 2021, and Tajikistan now boasts one of the highest egg yields in the Central Asian region, surpassing the world average, according to FAOSTAT data. This impressive recovery can be attributed to the government's introduction of tax and

customs exemptions in 2017 for the poultry sector, covering hatching eggs, day-old chicks, equipment, and construction materials (MoA 2023). From 2018 to 2022, the government's incentives resulted in significant improvements: The total poultry population increased by 2.2 times, poultry meat production grew by 6.4 times, and egg production grew by 3.6 times. Domestic production of poultry feed, which satisfied only 10 percent of national demand in 2017, rose to cover 70 percent of domestic needs by 2022. This rapid growth also led to a fivefold increase in the value of production within the poultry subsector, accounting for 5 percent of the total agricultural output in 2022, up from 1.8 percent in 2017 (MoA 2023).

Meat production in Tajikistan, including cattle, small ruminants, and poultry, increased by 2.2 times between 1991 and 2021. Significant growth occurred in the Khatlon region, with meat production increasing by 3.3 times, while the Sughd and DRS regions reported increases of 1.7 and 1.4 times, respectively. In contrast, the BMAR region experienced a 7 percent decline in meat production (TAJSTAT, Regions of Tajikistan 2022). The poultry sector's rapid expansion played a crucial role in the overall increase in meat production. In 2021, poultry accounted for 13.5 percent of total meat production, and recent trends suggest that poultry's share will continue to rise as the sector benefits from ongoing government support and incentives (MoA 2023).

The fisheries sector has also grown significantly since 2017, following the introduction of government support measures, including tax and customs exemptions for equipment and materials. Between 2018 and 2022, domestic fish production increased by 2.3 times, and the number of jobs in the fisheries sector grew by 1.3 times. The value of fisheries products surged by 2.8 times during the same period, raising the sector's contribution to the total value of agricultural products from 0.14 percent in 2018 to 0.21 percent in 2023 (MoA 2023).

3.6. Agrifood trade

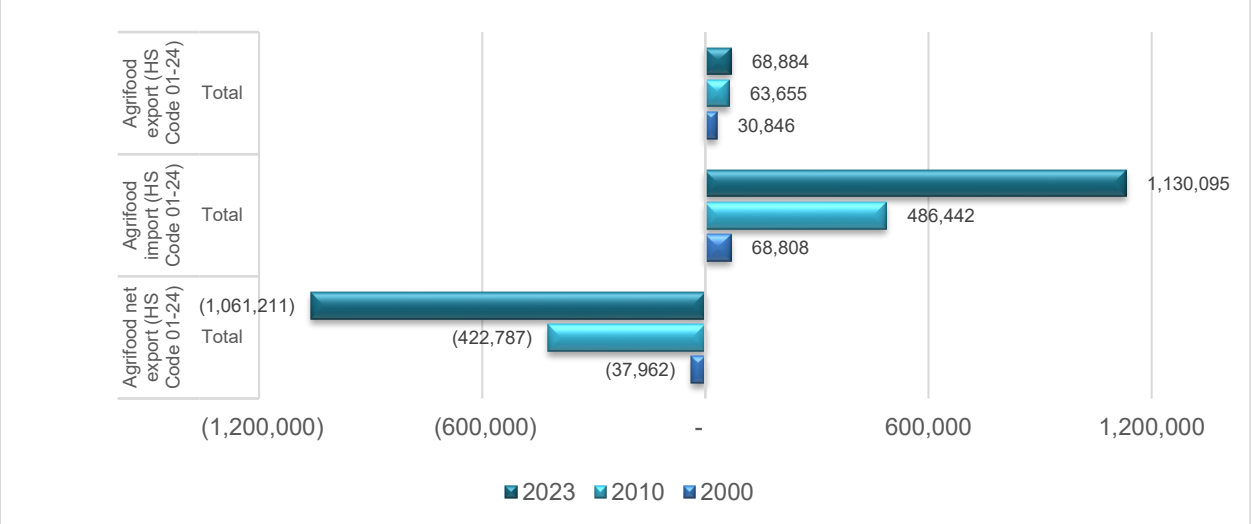
This subsection reviews agrifood trade and provides an overview of the types of agrifood commodities that Tajikistan exports and imports; explains why Tajikistan, as an agrarian economy, depends on agrifood imports; and shows how the situation has changed in recent years.

Tajikistan became a full-fledged member of the WTO in March 2013, and is part of several other multilateral free trade agreements, including the Commonwealth of Independent States (CIS), the Economic Cooperation Organization (ECO), and the Central Asia Regional Economic Cooperation (CAREC).[14] The country also has bilateral trade agreements with most CIS countries as well as with Afghanistan, China, Iran, Pakistan, and Turkey (Khakimov et al. 2014a).

Availability and reliability of agrifood international trade data are crucial to understanding total domestic demand (production minus exports plus imports) and consumption of each agrifood product. Regardless of the significant increase in crop and livestock production (as mentioned in subsections 3.4 and 3.5), Tajikistan remains a net importer of agrifood products, and the gap between agrifood exports and imports has increased significantly due to growing domestic demand accelerated by population and income growth (for more details, see section 2).

Though Tajikistan is an agrarian economy, the share of its food imports on average, between 2016 and 2022 was 22.4 percent of goods imports. For the same period, food exports as a percentage of total merchandise exports was 3 percent (WB, WDI, June 2024). Agrifood imports and exports increased by 16 and 2 times, respectively, in 2023 compared with 2000 (Figure 3.4).

Figure 3.4. Agrifood net exports, US$1,000

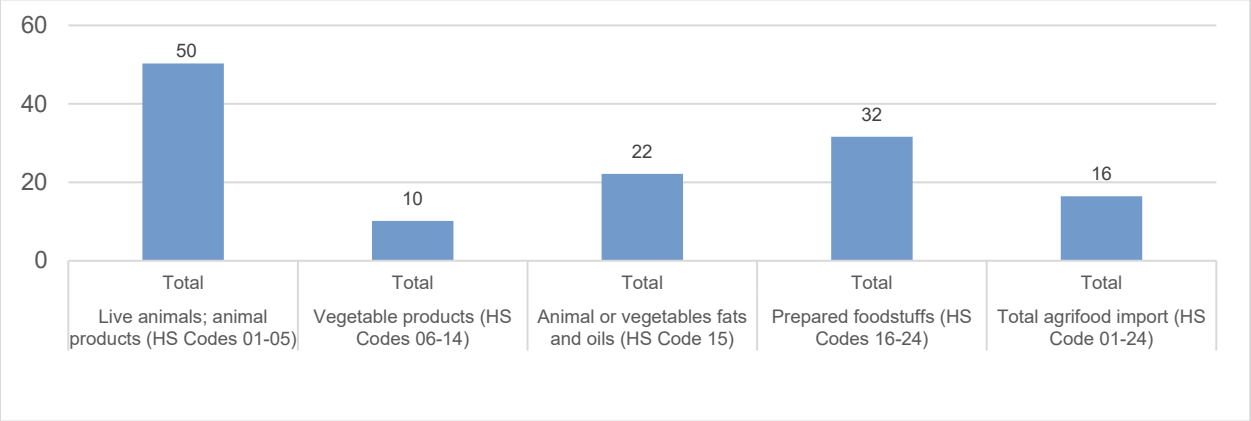


Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan Statistics.

[14] The CAREC program includes Afghanistan, Azerbaijan, People's Republic of China, Georgia, Kazakhstan, Kyrgyz Republic, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan.

A deep dive into agrifood imports by types reveals that the most significant agrifood import increases were due to growth in vegetable product imports (HS Codes 06-14, mainly cereals)[15] and prepared foodstuffs (HS Codes 16-24).[16] For further details, see Figures 3.5 and 3.6.

Figure 3.5. Agrifood import changes, 2023 compared with 2000, percentage change



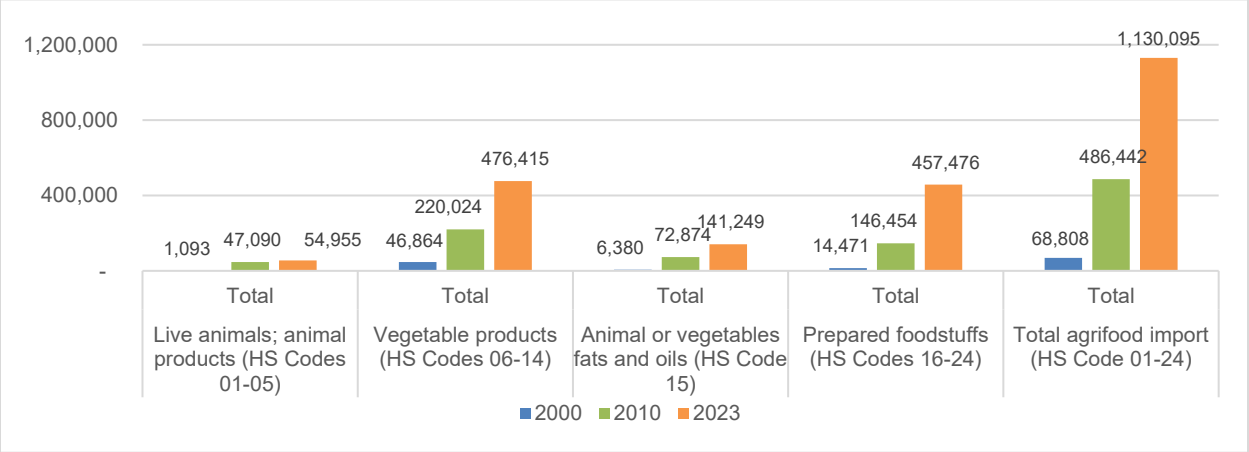
Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan Statistics.

Vegetable products (mainly cereals) and prepared foodstuffs (mainly sugar, prepared animal fodder, and flour) constituted 75 percent and 83 percent of total imports in 2000 and 2023, respectively (Figure 3.6).

[15] The breakdown of vegetable product imports (HS Codes 06-14) in 2023 was as follows. Cereals (HS Code 10) were 70 percent of total vegetable product imports in 2023, with edible fruit and nuts and peel of citrus or melons (HS Code 08) at 10 percent. Wheat and cereal products (HS Code 11); oilseeds and oleaginous fruits; miscellaneous grains, seeds, and fruits; industrial or mechanical plants; and straw and fodder (HS Code 12) were 6 percent each. Edible vegetables and certain roots and tubers (HS Code 07) were 4.8 percent, and coffee, tea, mate, and spices (HS Code 09), 1.7 percent.

[16] The breakdown of prepared foodstuff imports (HS Codes 16-24) in 2023 was as follows. Sugar and sugar confectionery (HS Code 17) were 25 percent. Food industry waste and residues—prepared animal fodder (HS Code 23)—were 19 percent. Preparations of cereals, flour, starch, or milk and pastrycooks' products (HS Code 19) were 18 percent. Cocoa and cocoa preparations (HS Code 18) and miscellaneous edible preparations (HS Code 21) were 10 percent each. Preparations of vegetables, fruits, nuts, or other parts of plant (HS Code 20) were 4 percent.

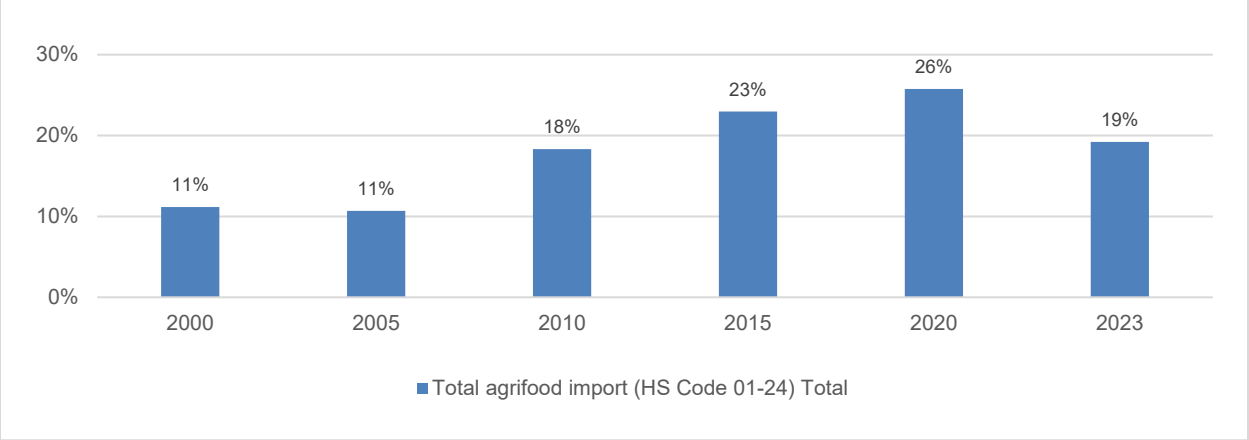
Figure 3.6. Agrifood imports, US$1,000



Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan statistics.

The share of agrifood imports in total imports between 2000 and 2023, on average, was 18 percent and increased significantly in the last 8 years (Figure 3.7).

Figure 3.7. Agrifood imports, share of total imports

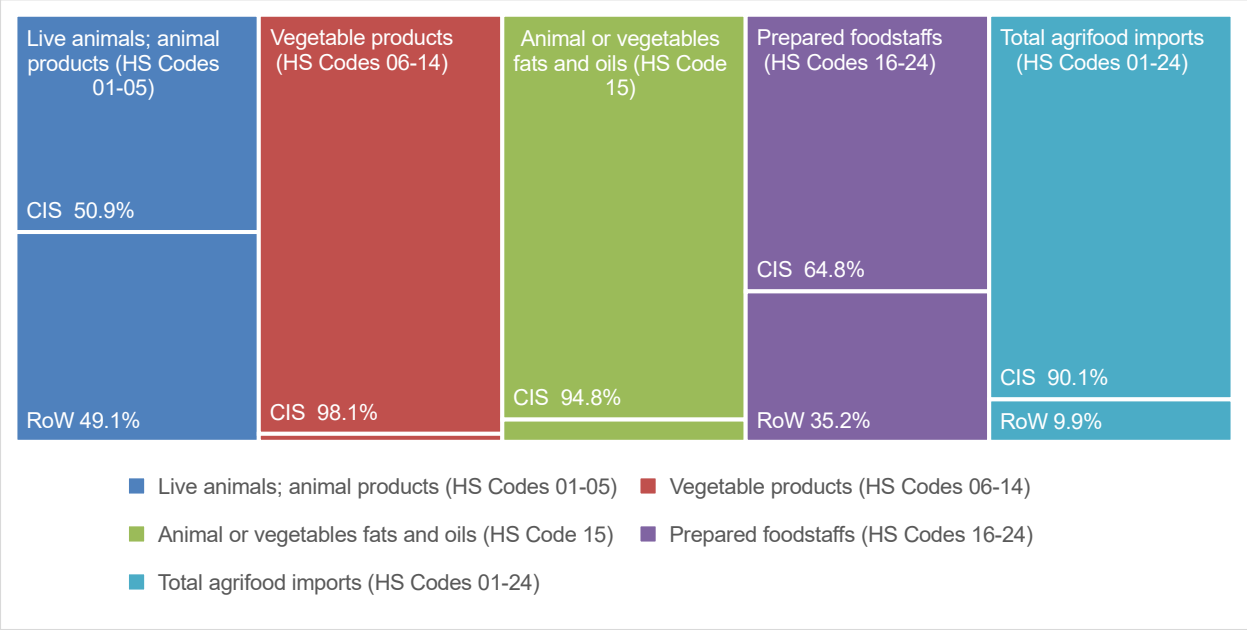


Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan Statistics.

A review of agrifood imports reveals that CIS countries[17] were Tajikistan's main trading partners in 2000 and 2023, though there were some shifts in their share of product group types (Figures 3.8 and 3.9).

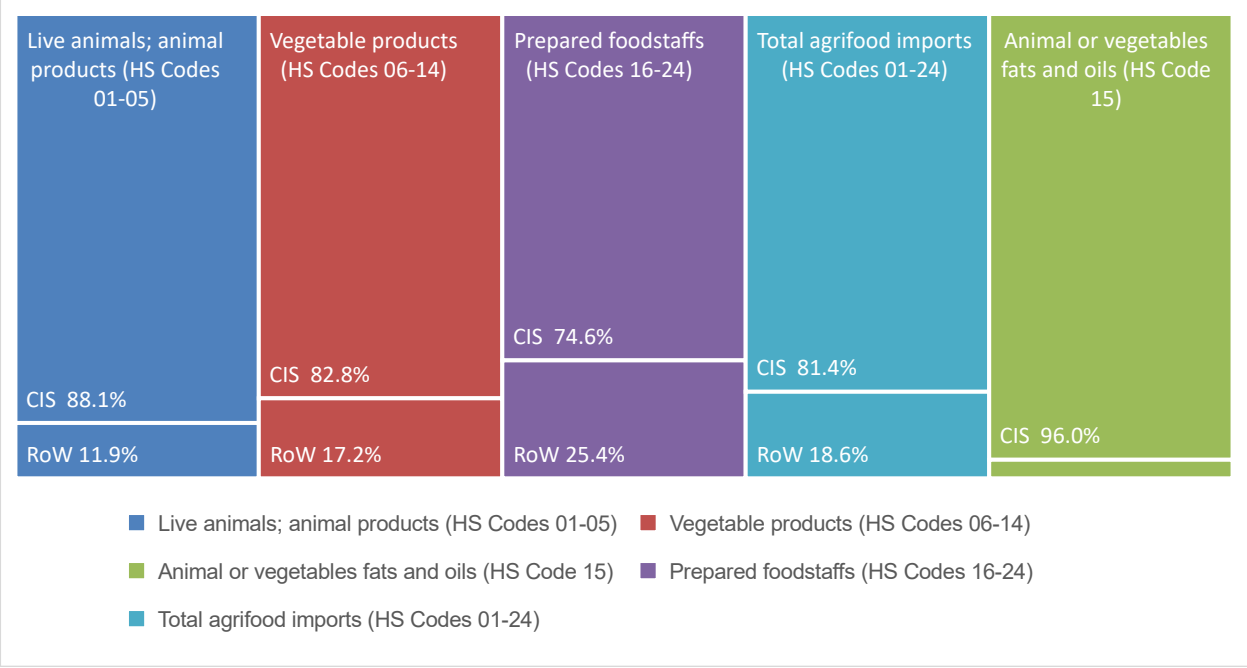
[17] The CIS was established in December 1991. In the adopted declaration, commonwealth participants declared their interaction on the basis of sovereign equality. At present, the CIS consists of Azerbaijan, Armenia, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, and Uzbekistan. Georgia and Ukraine withdrew from the CIS in 2009 and 2018, respectively. Eight of the nine CIS member states participate in the CIS Free Trade Area.

Figure 3.8. Agrifood imports by trade partners, 2000



Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan Statistics.
Note: CIS = Commonwealth of Independent States; HS = harmonized system; RoW = rest of the world.

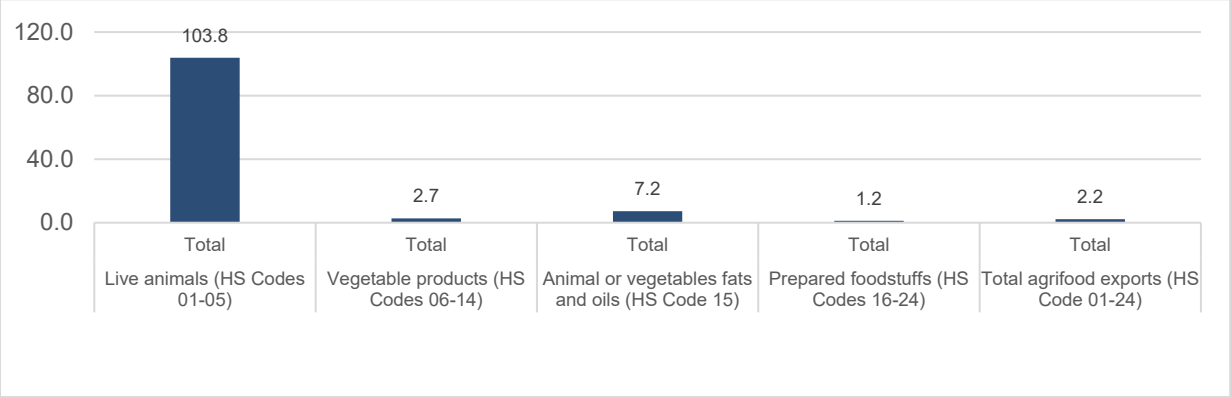
Figure 3.9. Agrifood imports by trade partners, 2023



Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan Statistics.
Note: CIS = Commonwealth of Independent States; HS = harmonized system; RoW = rest of the world.

In contrast to agrifood imports, agrifood export increases were modest, increasing 2.2 times by 2023 compared with 2000 (Figure 3.10).

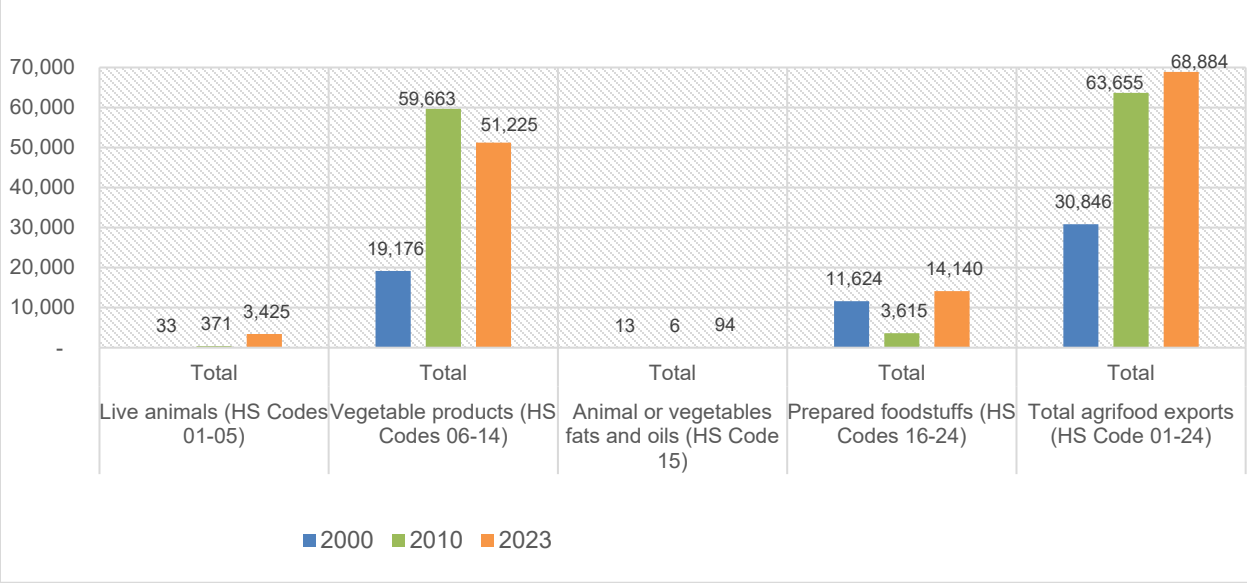
Figure 3.10. Agrifood export changes, 2023 compared with 2000, percentage change



Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan Statistics.

The export of vegetable products (HS Codes 06-14) and prepared foodstuffs (HS Codes 16-24) together constitute 95 percent of total agrifood exports in 2023 (Figure 3.11). A deep dive at the commodity level shows that 75 percent of the total exports in 2023 were edible fruits and nuts and peel of citrus fruits or melons (HS Code 08, mainly dry fruits and nuts).

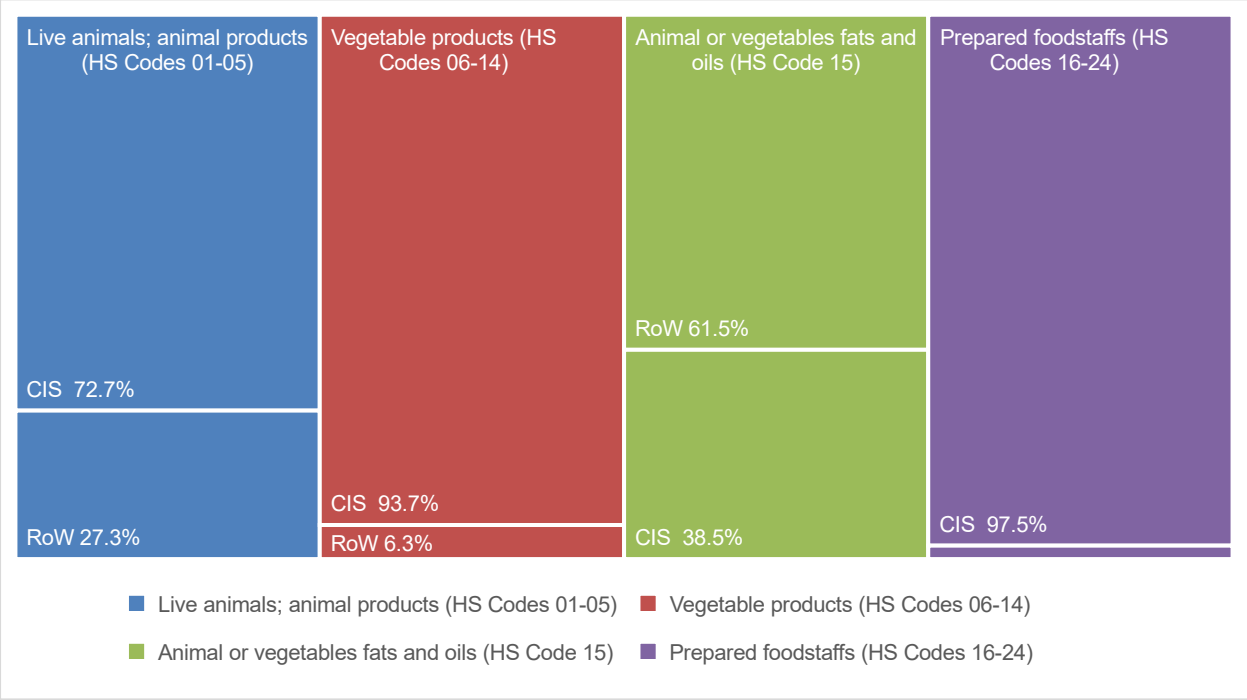
Figure 3.11. Agrifood exports, US$1,000



Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan Statistics.

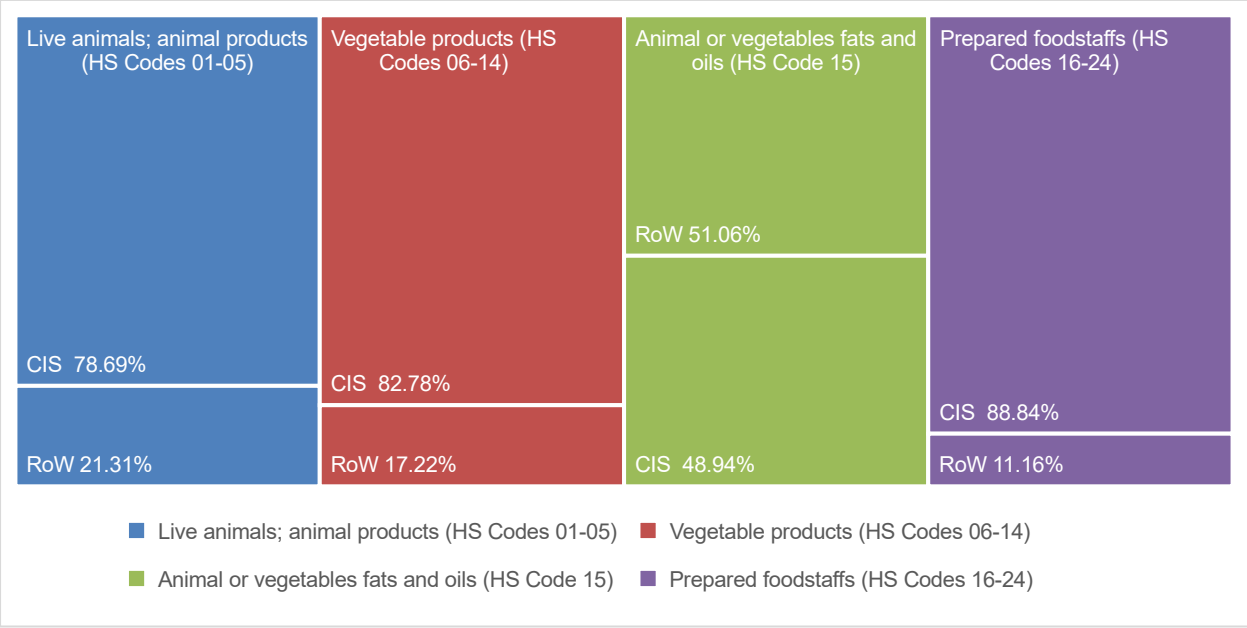
The main destinations of Tajikistan's agrifood exports in 2000 and 2023 were CIS countries (Figures 3.12 and 3.13), except for the export of animal or vegetable fats and oils (HS Code 15).

Figure 3.12. Agrifood exports by trade partners, 2000



Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan Statistics.

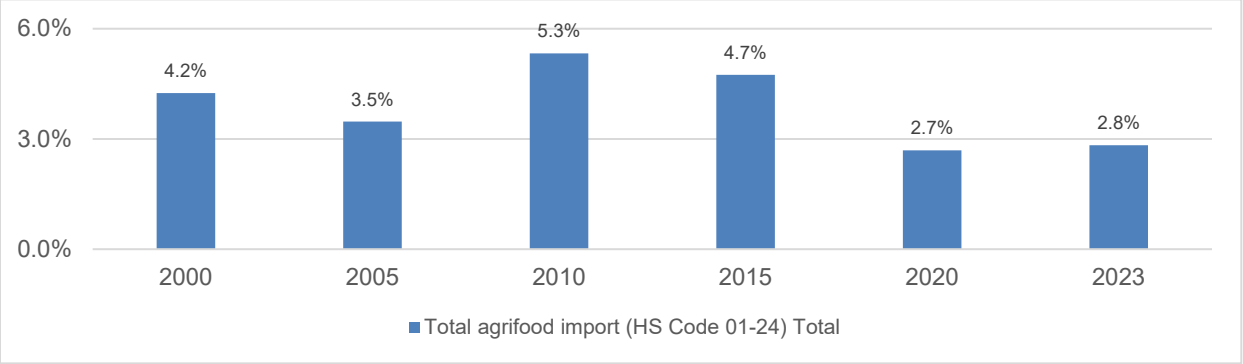
Figure 3.13. Agrifood exports by trade partners, 2023



Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan Statistics.

Agrifood exports' share of total exports was small: 3.9 percent, on average, between 2000 and 2023 (Figure 3.14).

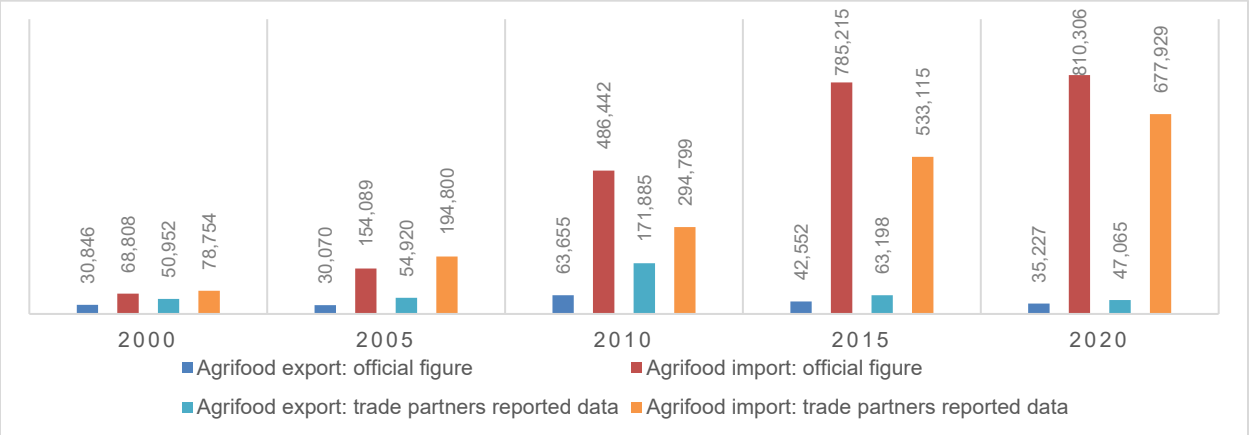
Figure 3.14. Agrifood exports, share of total exports



Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan Statistics.

There is a concern regarding the accuracy of trade data. For our analysis in this section, we compare Tajik Customs Service data with FAOSTAT mirror statistics data (reported by Tajikistan's trade partners) for agrifood products. A comparison of the two data sources for the same types of products reveals that Tajik's agrifood export values, as reported by Tajikistan's trade partners, are 1.8 times higher, on average, than the Customs Service data for the reported periods (see Figures 3.15 and 3.16). The same is true for Tajikistan's agrifood import values for 2000 and 2005. However, agrifood import values for 2010, 2015, and 2020, reported by Tajikistan's trading partners, are 30 percent lower, on average, than the officially reported data from Tajikistan's Customs Service (see Figures 3.15 and 3.16).

Figure 3.15. Agrifood trade: Official versus trade partners' reported data, US$1,000

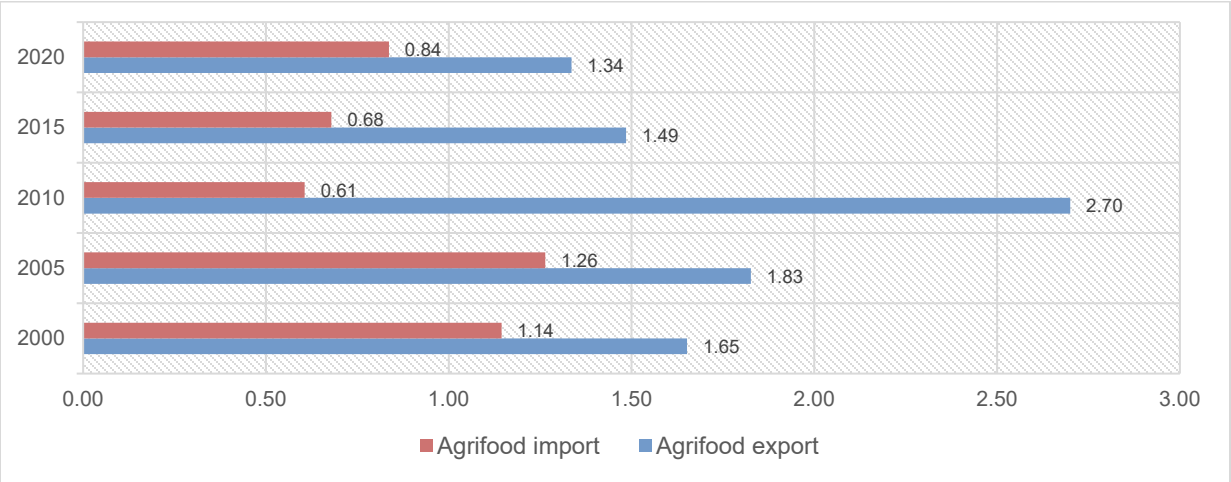


Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan and FAOSTAT data.

Because the discrepancies in trade statistics are significant, further examination is needed at the commodity level and by trading partners. Data on per capita food consumption by types of products and food and

commodity balance sheets enable us to estimate agrifood exports and imports. In addition, many re-exports and re-imports likely occur, which are reported as actual exports and imports. This topic requires further in-depth analysis.

Figure 3.16. Agrifood trade: Ratio of trade partners' reported data to Tajikistan's customs-reported data



Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan and FAOSTAT data.

Recall that in subsection 3.5, incentives for the poultry and fisheries subsectors introduced by the Government of Tajikistan for the 2018–2022 period impacted net trade of these commodities in recent years. Policy impacts can be summarized as follows: Import of edible eggs stopped; import of hatching eggs dropped by 39 percent; import of day-old chicks climbed by 4.5 times; import volume and import value of poultry meat dropped by 12.5 and 19.4 times, respectively; and import volume and import value of fish dropped by 5.0 and 3.6 times, respectively (MoA 2023).

3.7. Agricultural inputs

Tajikistan's agriculture sector (especially the crops subsector) relies heavily on imported inputs, except for labor and to some extent livestock feed. The quality of these inputs varies, and low-quality or poorly adapted inputs are a significant constraint to improving agricultural performance (Khakimov et al. 2023; World Bank 2021b).

In subsections 3.4 and 3.5, we show that the yields of most crops in Tajikistan are significantly lower than those of neighboring countries that have similar climate conditions and significantly lower than the world

average, except melon yields and eggs per poultry, which are higher in Tajikistan compared with other Central Asian countries. In this subsection and next two subsections, on the basis of available data on employment, fertilizer and water use, agriculture machinery, access to finance, and availability and use of extension services, we attempt to answer two questions: (1) What is behind the recent sectoral growth in addition to land reform, which previous studies identified as a main source of recent growth? and (2) why is productivity of some crops higher in some regions than in others?

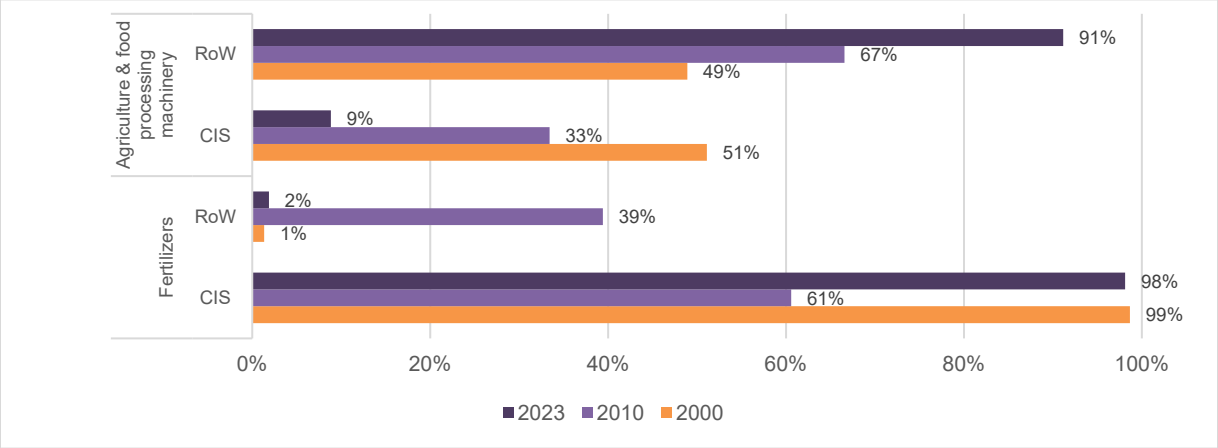
Employment

For the 1991–2022 period, around 53 percent of the economically active population was employed in the agriculture sector, predominantly women (71.5 percent women vs. 42.6 percent men) (WB, WDI, June 2024). In 2021, of 1.526 million people employed in the agriculture sector, 559,000, or nearly 37 percent, were hired as wage-earning employees by agricultural enterprises, while the rest were self-employed in *dehkan* farms and/or household plots. Since 2000, agriculture has created 52 percent of new jobs in the economy, although since 2010, it has created only 16 percent of new jobs, and total employment in the sector has fallen 2.5 percent since 2015 (TAJSTAT, Labor Market in Tajikistan 2022). Pay for workers in the agriculture sector is notably lower than other sectors: For the 2008–2022 period, agriculture sector workers received a salary three times lower than average for the economy.

Fertilizers

Tajikistan is a net importer of fertilizers, and any increase in fertilizer prices in global markets has made them less available to the farmers, thus affecting crop yields and farmers' incomes. Fertilizers are imported mainly from neighboring countries, while agricultural and food processing machinery is imported from the rest of the world (Figure 3.17).

Figure 3.17. Import of fertilizers and agricultural and food processing machinery



Source: Authors' compilation based on Customs Service under the Government of the Republic of Tajikistan Statistics.
Note: Fertilizers are HS Code 31; agricultural and food processing machinery are HS Codes 8432-8438. CIS = Commonwealth of Independent States; RoW = rest of the world.

The application of chemicals and fertilizers is key to improving agricultural productivity. Nitrogen and phosphorus play a significant role in boosting biomass and vegetation quality. However, careful management is required to balance productivity gains with potential impacts on biodiversity and ecosystem health (Lian-Lian et al. 2021; Okhonniyozov et al. 2024). This involves enhancing seed systems, improving access to quality inputs, and promoting sustainable practices through support for seed farms, certification mechanisms, and targeted subsidies for modern inputs (FAO 2023).

Fertilizer use varies by land tenure and crop types. Next, we explore the whether the yield gaps by regions and types of crops and land tenure are related to the application of fertilizers. Nationwide, use of mineral fertilizer is higher in agricultural enterprises than in *dehkan* farms, except its use on corn for grains as well as on melons and gourds.

Subsection 3.4 notes that households in all regions are more productive than *dehkan* farms and agricultural enterprises in terms of grain yield. Khatlon farmers (all types) are more productive than farmers in other regions. In cotton yield by region, agricultural enterprises are more productive than *dehkan* farms. Cotton yield in the DRS is lower than in the Sughd and Khatlon regions, though cotton yields dropped in 2021 in all regions compared with 1991, and decline in the DRS was more significant. The potato yield is higher in the Sughd region, where *dehkan* farms followed by agricultural enterprises are more productive than

households. Productivity in the DRS is lower than productivity in the Sughd region, but higher than in Khatlon and the BMAR in terms of potato yield. In the DRS region, *dehkan* farms are more productive than the other two types of farms. In the Khatlon region, potato yield is almost the same in all types of farms, increasing in 2021 compared with 1991.

Vegetable yield is highest in the Khatlon region, followed by the Sughd and DRS regions. *Dehkan* farms, followed by agricultural enterprises, are more productive than households, but the vegetable yield in the latter is higher by only 10 to 15 percent depending on the region. Vegetable yield increased significantly in 2020 compared with 1991, especially in Khatlon and the DRS. Recall that in Figure 3.26, melon and gourd yields surged in 2020 compared with 1991, especially in the Khatlon and Sughd regions, while DRS productivity increased comparatively less so. In terms of melon and gourd yields, households and *dehkan* farms are more productive than agricultural enterprises in these regions.

Fruit yields increased among household farms by more than 5 times in the Khatlon and BMAR and by 2.5 times in the DRS, while in the Sughd region they rose by only 20 percent in 2020 compared with 1991. Household farms are more productive than other types of farms in all regions. Among household farms, grape yield in 2020 compared with 1991 increased by 3.5 and 3 times in the Khatlon and DRS regions. Household farms are more productive in the Khatlon region, while *dehkan* farms' productivity is higher in the Sughd and DRS regions in terms of grape yield. In all regions, the grape yield is the lowest among agricultural enterprises.

In 2022, the MoA, in collaboration with the Tajik Academy of Agricultural Sciences (TAAS), developed a handbook on application of mineral fertilizers (indicating proportion of different types for each crop) and organic fertilizers (however, the handbook does not cover all crops). Next, we compare MoA-recommended fertilizer norms with TAJSTAT data on fertilizer applications by regions and types of farms, assuming that the farmers are aware of the proportion of mineral fertilizer use recommended across the country and by types of farms.

Table 3.1 summarizes the application of mineral fertilizer by regions, types of farms, and MoA-recommended norms. In all regions, applied per hectare mineral fertilizer by crops in both types of farms is lower than the MoA-recommended norm.

Table 3.1. Mineral fertilizers used in 2022, by types of farms, kilograms per hectare

Crop	MoA-recommended norms	Tajikistan (AE)	Tajikistan (DF)	BMAR (AE)	BMAR (DF)	Sughd (AE)	Sughd (DF)	Khatlon (AE)	Khatlon (DF)	DRS (AE)	DRS (DF)
Grains (excluding corn)	290	152	101	–	46	200	199	94	74	85	103
o/w wheat	290	121	90	–	51	171	197	98	72	63	95
o/w rice	900	382	301	–	–	406	339	95	165	240	367
Corn for grain	900	163	179	–	46	190	251	125	120	163	185
Cotton	630–800	203	160	–	–	292	154	164	162	207	140
Potato	560	407	254	–	76	350	408	83	96	970	284
Vegetables		201	171	–	91	312	296	92	134	198	204
Melons and gourds		137	165	–	–	131	101	144	171	–	295
Fodder crops		140	96	–	26	177	102	49	113	107	27
o/w fodder corn		194	180	–	–	222	189	80	175	263	119
o/w fodder grass		119	56	–	26	161	73	34	44	51	23
Gardens and vineyards		85	51	–	183	102	46	55	71	41	49

Sources: TAJSTAT (2023). Use of mineral and organic fertilizers in agricultural enterprises and *dehkan* farms in 2022; MoA (2022). Technological maps of agricultural crops. State Enterprises "Republican Normative Research Labor Station/"
Note: AE = agricultural enterprises; DF = *dehkan* farms; – = not applicable; o/w = of which

Accessibility, affordability, and quality of mineral fertilizers are crucial to increase yields (FAO 2023; Robinson et al. 2008). In addition to having a lower mineral fertilizer application rate, not all farmers are able to afford mineral fertilizers. For instance, in the Khatlon region in 2022, all cotton-growing farms (agricultural enterprises and *dehkan* farms) used mineral fertilizers for cotton, but only *dehkan* farms used these fertilizers for rice. In the Sughd region, all agricultural enterprise producers of potatoes, vegetables, and fodder corn used mineral fertilizers. The lowest rate of mineral fertilizer use in BMAR is among *dehkan* farms, except for potatoes and corn for grain. In the DRS, almost all cotton and corn for grain producers in both types of farms and rice and potato producers among *dehkan* farms used mineral fertilizers. The

percentage of mineral fertilizers used for other types of crops is lower in all regions and types of farms (for further details, see Table 3.2). Regardless of mineral fertilizer use of 100 percent or nearly 100 percent for some crops by both types of farms, application of fertilizers remains lower than MoA-recommended norms, resulting in lower productivity.

Table 3.2. Share of land for which mineral fertilizers were used, by types of farms in 2022, %

Region	Grains (excluding corn)	o/w wheat	o/w rice	Corn for grain	Cotton	Potatoes	Vegetables	Melons and gourds	Fodder crops	o/w fodder corn	o/w fodder grass	Gardens and vineyards
Tajikistan (AE)	69	64	82	79	92	92	90	77	38	63	37	17
Tajikistan (DF)	64	74	92	82	95	71	82	84	37	70	33	21
BMAR (AE)	–	–	–	–	–	51	0	–	–	–	–	–
BMAR (DF)	42	67	0	88	–	89	67	–	34	0	34	7
Sughd (AE)	89	92	84	71	76	100	100	95	60	100	63	22
Sughd (DF)	35	40	89	69	84	44	53	58	50	67	55	18
Khatlon (AE)	61	60	97	83	100	87	96	72	26	34	27	15
Khatlon (DF)	81	84	100	88	100	87	96	91	29	72	19	9
DRS (AE)	42	42	57	89	97	62	40	0	17	41	14	9
DRS (DF)	76	81	95	95	98	91	79	70	25	86	25	48

Source: TAJSTAT (2023); use of mineral and organic fertilizers in agricultural enterprises and *dehkan* farms in 2022.
Notes: AE =agricultural enterprises; DF = *dehkan* farms; – = not applicable; o/w = of which.

Even the application of organic fertilizers, despite a near doubling of livestock numbers (see subsection 3.5), remains below MoA-recommended norms. Except for *dehkan* farms in the BMAR, among *dehkan* farms that grow grains, wheat, potatoes, and vegetables and (in the DRS) cotton, application of organic fertilizers remains below MoA-recommended norms (Table 3.3).

Table 3.3. Organic fertilizers used by types of farms in 2022, metric tons per hectare

Crop	MoA-recommended norms	Tajikistan (AE)	Tajikistan (DF)	BMAR (AE)	BMAR (DF)	Sughd (AE)	Sughd (DF)	Khatlon (AE)	Khatlon (DF)	DRS (AE)	DRS (DF)
Grains (excluding corn)	10	2.1	5	3.1	10.4	3.1	4	0.4	0.5	0.4	1.9
o/w wheat	10	1.5	5.2	3.1	11.8	2.8	2.8	0.4	0.5	0.6	1.9
o/w rice	10	4	5.5	–	–	4.1	5.5	4.4	4.6	–	–
Corn for grain	13.3	10.5	1.9	–	1.3	10.9	1.5	–	1.3	–	5.9
Cotton	13.3	1.8	1.4	–	–	2.9	2.3	0.4	1.1	0.1	20.7
Potato	13.3	9.3	9.4	52	26.3	10.1	12.3	1.3	1	10.3	7.2
Vegetables	3.3	6.3	2.4	10	14.8	7.6	2.9	1.8	0.7	2.5	0.7
Melons and gourds		4.5	0.9	–	–	4.8	3.9	1.1	0.4	0	0.3
Fodder crops		2.5	4.6	3.2	3.8	2.6	5.8	3.1	1.4	1.1	0.8
o/w fodder corn		2.5	2.1	0	0	2.5	2.1	3.1	0	0	0
o/w fodder grass		2.5	5	3.2	3.8	2.7	6.8	3	1.4	1.1	0.8
Gardens and vineyards		1.7	0.9	52.2	1.7	1.7	1	0.2	0.2	1.4	0.5

Source: TAJSTAT (2023). Use of mineral and organic fertilizers in agricultural enterprises and *dehkan* farms in 2022; MoA 2022). Technological maps of agricultural crops. State Enterprises "Republican Normative Research Labor Station."
Note: AE = agricultural enterprises; DF = *dehkan* farms; – = not applicable; o/w = of which.

The application of organic fertilizers is not a common practice among all farmers, and the share of land for which organic fertilizers are used remains very low across the country in both types of farms. An exception is the *dehkan* farmers in BMAR who grow wheat, corn for grain, potatoes, and vegetables (Table 3.4).

Table 3.4. Share of land for which organic fertilizers were used by types of farms in 2022, %

Region	Grains (excluding corn)	o/w wheat	o/w rice	Corn for grain	Cotton	Potato	Vegetables	Melons and gourds	Fodder crops	o/w fodder corn	o/w fodder grass	Perennial trees (gardens and vineyards)
Tajikistan (AE)	6	4	21	13	13	52	23	8	7	15	6	18
Tajikistan (DF)	3	3	8	10	13	36	19	8	4	3	4	17
BMAR (AE)	65	88	–	–	–	51	0	–	24	–	24	18
BMAR (DF)	63	96	0	100	0	97	100	0	35	0	35	48
Sughd (AE)	8	5	23	26	21	52	42	17	15	35	13	30
Sughd (DF)	2	2	12	16	12	18	23	6	6	7	7	23
Khatlon (AE)	5	4	3	0	9	60	10	2	0	1	0	4
Khatlon (DF)	2	2	0	5	14	38	16	9	1	0	1	6
DRS (AE)	2	2	5	3	10	47	4	0	2	0	2	7
DRS (DF)	2	2	0	6	1	46	16	13	1	2	1	14

Source: TAJSTAT (2023). Use of mineral and organic fertilizers in agricultural enterprises and *dehkan* farms in 2022.
Note: AE = agricultural enterprises; DF = *dehkan* farms; – = not applicable; o/w = of which.

Agricultural machinery

Agricultural mechanization is an essential input to increase labor and land productivity, as indicated by findings of the 2023 USAID/IFPRI Population Based Survey (PBS) in the USAID zone of influence (ZOI; 12 districts in the western part of the Khatlon region), where in terms of crop revenue, farmers from the two highest quintiles use machinery more often, and farmers in the lowest two quintiles use machinery less often.

Mechanization of Tajikistan's agriculture sector remains low because of limited access to finance, limited paying capacity of farmers, limited capacity of the state-funded leasing company Tajikagro leasing, and underdevelopment of the private-sector-financed agri-leasing market. In 2021 compared with 1991, the number of agricultural machines dropped significantly, and available machines were old or almost nonexistent in some regions. During the observed period, only the number of tractors in the DRS region

increased by 10 percent, and ploughs for tractors increased by 9 percent nationwide, by 20 percent in the BMAR, and by 83 percent in the DRS.

Table 3.5. Agricultural machinery changes, 2021 to 1991 ratio

Machinery	Tajikistan	BMAR	Sughd	Khatlon	DRS
Tractors	−0.26	−0.32	−0.29	−0.34	0.10
Trucks	−0.90	−0.98	−0.79	−0.96	−0.91
Grain harvesters	−0.21	−0.85	−0.08	−0.29	−0.21
Tractor trailers	−0.54	−0.48	−0.64	−0.61	−0.06
Rakes for tractors	−0.74	−0.99	−0.80	−0.78	−0.50
Mowers for tractors	−0.57	−0.77	−0.74	−0.62	−0.14
Forage harvesters	−0.89	n/a	−0.79	−0.96	−0.83
Corn harvesters	−0.94	n/a	−0.94	−0.99	−0.86
Cotton harvesters	−0.99	n/a	−0.97	−0.99	−1.00
Seeders for tractors	−0.63	−0.97	−0.58	−0.64	−0.74
Ploughs for tractors	0.09	0.20	−0.13	−0.05	0.83
Cultivators for tractors	−0.61	−0.48	−0.54	−0.62	−0.76
Cotton strippers	−0.98	n/a	−0.93	−1.00	−1.00
Cotton gins	−0.99	n/a	−0.96	−1.00	−1.00
Balers	−0.47	n/a	−0.19	−0.61	−0.43

Source: TAJSTAT, Agriculture of Tajikistan (2022).
Note: The number of cotton harvesters, cotton strippers, and cotton gins in the DRS region in 1991 was 177; and 118, 252, and 0, respectively, in 2021. In Khatlon, the number of cotton gins in 1991 was 1,152 and 0 in 2021. Because the BMAR is not a cotton-growing region, it is not applicable.

Seeds and seedlings

High-quality seeds adopted to local conditions by agroclimatic zones are crucial to increase crop yields (FAO 2023; Husenov et al. 2020; World Bank 2021b). Turner and Muminjanov's (2020) findings indicate that seed systems in Tajikistan face major challenges due to the inadequacy of policy guidelines, weak infrastructure for seed production and certification, and lack of technical know-how and experience in seed marketing and seed enterprise management.

Tajikistan imports more than half of all agricultural inputs, including fertilizer, pesticides, agricultural equipment, seeds, seedlings, and planting materials. The high cost of imports forces smallholder farmers to use cheap, poor-quality seeds, seedlings, and planting materials of local cultivars or of previously imported improved varieties that have lost their vigor and productivity (Khakimov et al. 2023). In addition, farmers

are not well equipped with the knowledge and skills required to cultivate and process many imported varieties (World Bank 2021a).

In the past, the seed sector was supported through various projects (see ADB 2015; Government of Austria n.d.; SIDA n.d.) and is currently supported by Tajikistan's World Bank–financed Strengthening Resilience of the Agriculture Sector Project. Addressing challenges and constraints is crucial to the development of the seed sector in Tajikistan, such as instituting national seed policies to ensure efficient cooperation and coordination of stakeholders involved in the seed industry, harmonizing legislation with international rules for seed certification, testing and protecting varieties and quarantining plants, promoting the private seed sector and nongovernmental organizations, and investing in the human and technical capacity of the national seed sector (World Bank 2021a).

Irrigation

Irrigation and timely access to sufficient volumes of water are vital to increase productivity, rural incomes, and food security, and to limit environmental stress (FAO 2023; World Bank 2021b). Because of severe underfinancing, the condition and performance of the country's irrigation infrastructure have declined. In Tajikistan, 85 percent of cultivated land is irrigated and provides more than 90 percent of the total value of crop production.[18] Findings from Tajikistan's World Bank–funded Strengthening Water and Irrigation System Project (2022–2027) indicate that in the absence of reform, investment, and adaptation, irrigation performance will further decline, limiting economic growth and contributing to poverty growth. Irrigation is heavily subsidized but still underfunded, leading to fiscal constraints and perverse incentives. Irrigation is financed through direct transfers for electricity, government subsidies for pumping station staff costs, revenue from irrigation service fees, WUA membership fees, and donor investments.[19] Moreover, more than 40 percent of irrigated areas in Tajikistan depend on pumping (with the highest dependency in Central Asia), and many high-lift, high-volume pumping stations are in poor condition. Pumping is inefficient

[18] See Aquastat database: https://www.fao.org/aquastat/statistics/query/index.html;jsessionid=B8C046FCED412AE645E775E6E8919107. Accessed August 16, 2024.

[19] More than 60 percent of irrigation capital expenditures (including flood protection) is donor financed, and low operations and maintenance spending is eroding the economic value of irrigation assets and increasing long-term costs (WB SWIM Project 2022).

(~0.28 kWh/m^3, which accounts for 20 percent of total national electricity use).[20] The economic productivity of irrigation is among the lowest 5 percent of countries in the world (~US$0.21/$m^3$[21]) because of high water loss, predominance of low-value crops, and low yields (for details, see World Bank 2022b). The irrigation sector faces several challenges and constraints such as: Aged, poorly maintained infrastructure and poor system management have led to low-quality irrigation services; limited investment in drainage infrastructure, inadequate maintenance, poor water management, and harmful irrigation practices have led to salinization and waterlogging in some irrigated areas; the ongoing process of climate change and rising temperatures will increase crop water demands, and water supply reliability will decline, leading to more-severe, more-frequent water stress; there is limited financing of the sector within the public budget, with the minimum required operation and maintenance on irrigation infrastructure estimated to be about US$35 million per year; hydrologic monitoring systems are currently improving but are incomplete; and although efforts to establish sub-basin-level irrigation service providers have been made in the Zarafshon, Panj, and Kofarnihon basins, with partial success, there is no national irrigation strategy (World Bank. 2022b).

3.8. Agriculture sector subsidies and access to finance

As noted previously, Tajikistan became a full-fledged WTO member as of March 1, 2013. Under the "green box," the agriculture sector can be supported (subject to WTO notifications) through providing infrastructure services, pest and disease control, and structural adjustment assistance by investment stimulation (ITC 2013). In addition, as a developing country, Tajikistan, under Article 6.2, "Domestic Support Commitment," can directly or indirectly support the sector to encourage agricultural and rural development under development programs or the so-called "development box," as well as provide assistance measures to the sector as a low-income country or resource-poor producer. Tajikistan is exempted from the domestic support reduction commitment and can provide input subsidies to farmers

[20] Based on government data for irrigation water withdrawals and electricity consumption in 2017.
[21] Based on latest values of GDP, share of agriculture in the economy, and annual irrigation withdrawals from data.worldbank.org. Accessed August 16, 2024.

(WTO, Uruguay Round of Agreement). Moreover, subsidies to the sector under the "amber box" are bounded to the total level of US$182 million per year. In developing countries, the *de minimis* threshold support under the amber box is 10 percent. Support to the sector under this box should not create trade or production distortions. In the past, under this category, the Government of Tajikistan supported the sector through a VAT exemption for imported agricultural inputs (feed, machinery, seeds) and a seasonal electricity discount for water pumping stations for irrigation. Under the WTO commitment, Tajikistan bound the level of export subsidies to zero, meaning no agricultural export subsidies are permitted (ITC, December 2013).

A review of recent studies indicates that the government support for the agriculture sector in Tajikistan remains limited (Shtaltovna 2013). Direct support includes consumer and taxpayer transfers, though budgetary payments are relatively insignificant, and there is little direct support for the domestic seed sector (Khakimov et al. 2014b). Indirect support measures include tax exemptions on agricultural machinery and related equipment, land tax reductions, and electricity subsidies for cotton producers. Current challenges highlight the need for comprehensive support mechanisms for the sector (for more details, see subsections 3.2 and 3.3).

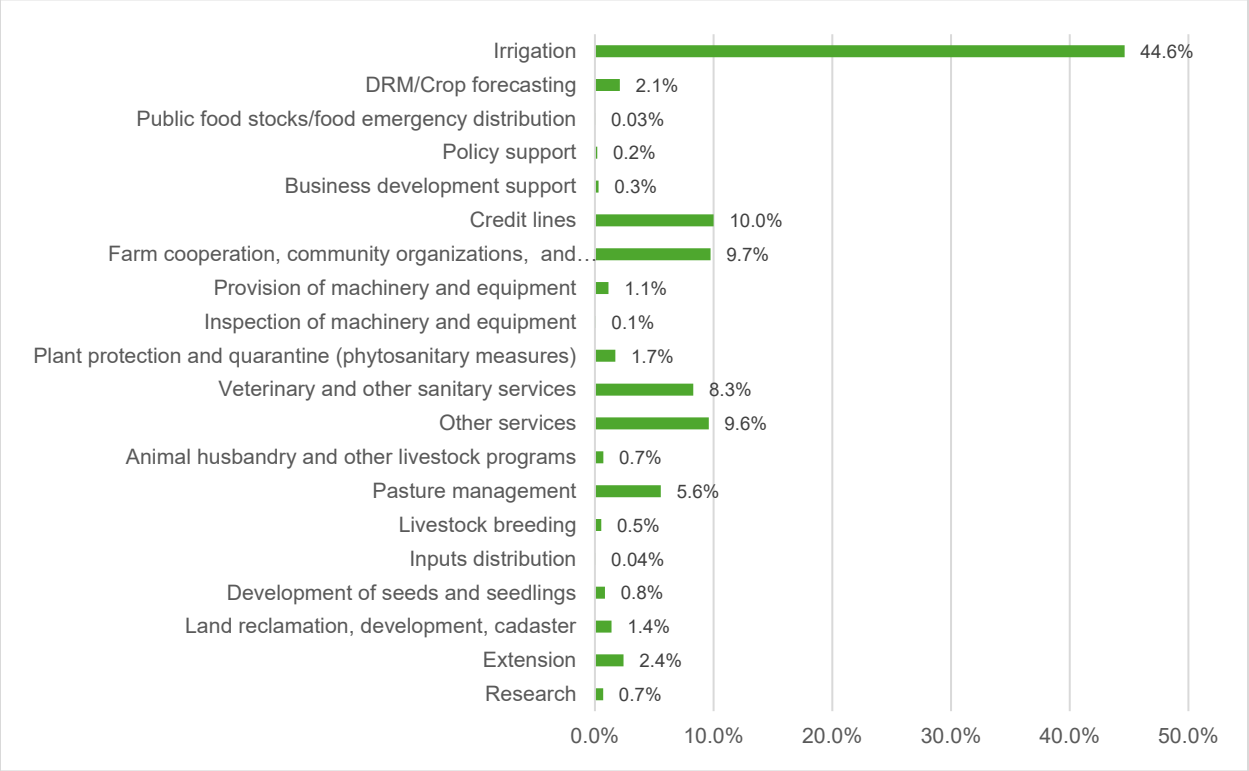
Limited public support and deteriorated infrastructure have impacted the agriculture sector (Akramov and Shreedhar 2012). Recent sectoral reform efforts and development programs for the sector include the State Program for Medium-Term Development (MTDP) 2021–2025 and FAO's Investment Plan for Food and Nutrition Security and Sustainable Agricultural Development (NIP) 2021–2030. The MTDP focuses on enhancing agricultural policies, increasing farmer access to inputs, and modernizing infrastructure. The NIP emphasizes sustainable development of natural resources, agrifood systems, and social inclusion (World Bank, 2021b). ASSADP, the newly developed and adopted sectoral program for the 2023–2030 period, proposes various support measures, including infrastructure financing, capacity building, and subsidies for sustainable practices (FAO 2023). Some studies emphasize the importance of multisectoral support to enhance agricultural productivity and resilience as a food systems approach (Kawabata et al. 2020).

The World Bank's recent agriculture sector public expenditure review report indicates that public expenditure on the sector remains relatively small at less than 1 percent of GDP, and the agriculture sector relies heavily on donor financing (54 percent),[22] though agricultural public expenditures in Tajikistan grew significantly between 2015 and 2020, with most funding coming from donors. These expenditures are concentrated in irrigation, veterinary services, and agricultural production support. However, there is a notable underinvestment in R&D, which impacts productivity and climate resilience. The government's fiscal space limits the extent of support and subsidies available (World Bank, 2021b).

Between 2016 and 2019, irrigation accounted for nearly 45 percent of total public agricultural spending . In this period, public agriculture expenditure was extremely low, especially on inputs distribution (0.04 percent), livestock breeding (0.5 percent), R&D (0.7 percent), animal husbandry and other livestock programs (0.7 percent), seed/seedling sector development (0.8 percent), land development and reclamation (1.4 percent), plant protection and quarantine and phytosanitary measures (1.7 percent), and advisory and extension services (2.4 percent). For more details, see Figure 3.18.

[22] Public expenditure, on average, grew annually by 21 percent in nominal terms and by 15 percent in real terms between 2015 and 2020 (WB, 2021 Agriculture Sector Public Expenditure Review).

Figure 3.18. Public agricultural expenditure, 2016–2019, %



Source: Authors' compilation based on Ministry of Finance data.
Note: DRM = Disaster Risk Management

Support to development of the poultry and fish subsectors introduced for the 2018–2023 period, includes exemption from the VAT, custom duties, and tariffs for imported hatching eggs, construction materials, and equipment. The total value of privileges and exemptions for the 2018–2022 period accounted for $170 million or 23 percent of the custom value of imported commodities.

Access to finance is crucial to address farmers' investment needs. To fill the existing financing gaps and support the government development agenda, in the past the World Bank supported Tajikistan's agriculture sector through the Agricultural Commercialization Project (ACP 2014–2021) to enhance private sector growth by improving access to finance and developing agricultural infrastructure. To address investment needs, the ACP employed several financing mechanisms: credit lines, matching grants, commercialization grants, and small grants programs. A review of findings of the ACP Implementation Completion Report and Results shows that access to finance with an affordable interest rate is vital for sustainable development of the sector. An overall efficacy and economic impact analysis shows that as agriculture sector

commercialization increased, enhanced productivity and investment had positive economic returns. "A sensitivity analysis revealed that any cost increase sharply reduces the economic internal rate of return (EIRR) and net present value (NPV) values, whereas an increase in benefits considerably increase the EIRR and NPV values… In relative terms, the EIRR is more sensitive to a decrease in benefits than to a cost increase… The ex-post economic analysis demonstrates an overall EIRR of 54 percent, which indicates the economic viability of the investment" (World Bank 2022a, 19-21). The ex-post economic analysis shows feasibility of the investment for apricots, lemons, tomato and cucumbers, apples and pears, and milk value chains, with an EIRR range between 40 percent for milk and 72 percent for apples and pears. Access to finance improved the performance of the business activity of 87 percent of project beneficiaries (for further details, see World Bank 2022a).

The investment needs of the sector are huge, and sustainable development of the sector cannot be ensured only through public funding and donor investment projects. However, the proposed current interest rates of loans to the agriculture sector by commercial banks[23] are high, ranging between 20 and 24 percent. Access to loans through commercial banks with affordable interest rates and preferential payment schedules is vital for enhancing agricultural productivity and fostering economic growth where agriculture remains a cornerstone of the economy.

3.9. Extension services

Improving AAS and infrastructure is crucial for enhancing food security in Tajikistan. Effective AAS can help farmers increase productivity and connect with markets, contributing to better food security outcomes (Shtaltovna 2013).

Bell and Payne (2011) describe the steps to take before providing agricultural extension services: Assess the audience and needs,[24] provide solutions,[25] and conduct evaluations.[26] Availability, accessibility, and

[23] For more details, see Amonatbonk. https://amonatbonk.tj/; Eskhata bank, https://eskhata.com/; Oriyonbonk, https://oriyonbonk.tj/; and the International Bank of Tajikistan (IBT), https://ibt.tj/. All accessed August 13, 2024.
[24] Assessment of audience and needs consists of collecting information and diagnosing problems.
[25] Provision of solutions can be subdivided into the following actions: raising awareness of general opportunities and technical options, providing hands-on training, facilitating access to credits and inputs, linking farmers to markets, and providing advisories.
[26] Conducting evaluations can involve assisting with business planning, and collecting and responding to farmers' feedback.

affordability of agricultural extension services, together with agricultural inputs (see subsection 3.7) and access to finance (see subsection 3.8), are key to increasing productivity in the sector, thus improving the livelihoods of people residing in rural areas and reducing poverty nationwide. In Ghana, for example, an agricultural extension program led to an increase in productivity by 11.3 percent, farm income per hectare by 11.3 to 111.3 percent, total household income by 23.3 to 85.3 percent, and per capita household income by 21.6 to 110.4 percent, depending on the estimation method used (Danso-Abbeam et al. 2018). In Tajikistan, an introduced zero tillage technology to the farmers[27] by the Sarob cooperative increased wheat yield in rainfed areas by 40 percent, and by 100 percent when combined with provision of new seed varieties. It also reduced water usage and salinization in irrigated lands while saving time, allowing for double cropping during a year (Khakimov 2019). In 2023, 1,600 Better Cotton Initiative (BCI)–licensed farmers in Tajikistan produced 18,000 tons of Better Cotton, achieving a 15 percent higher yield (Sarob 2023).

In Tajikistan, extension services are underdeveloped and underused. Roughly 5 percent of 180,000 farms and nearly 14 percent of arable land use professional extension services, and more than 90 percent of farmers need these services (Muminov 2021). Institutional reforms and improvements in agricultural support services are critical to advancing the agriculture sector (Babu and Akramov 2022).

Extension service actors in Tajikistan include Tajikistan's MoA, TAAS, Tajik Agrarian University (TAU), government extension specialists at the village level, the private sector, and NGOs, with a total staff of about 2,250 people, of whom about 600 are trained to provide professional extension services (Muminov 2021). While government support remains limited, NGOs and international donors play a significant role in providing agricultural knowledge and services (Shtaltovna 2013). Currently the main players and providers of agriculture extension services in Tajikistan are two nonprofit organizations, the Sarob and Neksigol Mushovir cooperatives.

[27] Benefiting about 1,000 hectares, at a cost of 250–300 Tajik somoni, (TJS) (US$28–34) per hectare, including fuel in 2019.

The Sarob cooperative, registered as a nonprofit organization in 2011, aims to promote rural economy growth in Tajikistan by providing consultation services to agricultural producers. With a network of more than 300 advisors, Sarob reaches more than 50,000 farms across 100,000 hectares of land. Its services include supporting the adoption of new technologies, input and machinery purchases, and tailored consultations. It also offers a range of programs based on the sector's current needs, such as consultation services, capacity building through the Sarob Academy, input supply and market linkages, R&D, and initiatives focused on climate change adaptation and sustainable agriculture transformation. Sarob's consultation services provide information about best practices through its advisory network and focus primarily on four types of crops: cotton, cereal and fodder, vegetables, and fruits. These services address climate-adapted varieties of crops, integrated pest management, and plant protection techniques and include nutrition procedures and effective irrigation technologies for soil management. In addition, the Sarob cooperative's capacity-building program incorporates four program levels: basic agriculture,[28] technology of growing,[29] innovation,[30] and sustainable agriculture.[31] Furthermore, the Sarob Academy aims to expand the number of advisors by building the capacity of trainees (mainly youths and women)[32] to provide further fee-based advisory services to farmers. In efforts to enhance agricultural productivity, the Sarob cooperative focuses on both supplying essential inputs and establishing robust market linkages (Table 3.6).

Table 3.6. Sarob's input supply and market linkage initiatives

Crop seeds	Machinery and equipment	Intensive fruit nursery	Market linkages
Provide a diverse range of adapted crop seeds: cotton, maize, potato, wheat, barley, soybeans, and more.	Provide machinery and equipment, including planters, sprayers, and other essential agricultural tools.	Increase the number of high-yielding fruit trees. Produce seedlings that are adapted to changing climatic conditions.	Provide up-to-date market prices. Foster partnerships among farmers, agribusinesses, and other stakeholders.

Source: Authors' compilation based on Sarob cooperative–provided information.

Familiarization with the basics of agriculture.

[29] Understanding the modern technology of growing crops and plant protection systems.

[30] Innovative technologies in agriculture for the rational use of water, integrated methods of plant protection, greenhouse production and precision planting, and so on.

[31] Agriculture technology topics, such as environmental protection, biodiversity, and soil fertility maintenance and improvement.

[32] The Sarob Academy stresses youth engagement and employment in the agriculture sector through its Youth School of Agronomy (YSA) and the Mentoring Program. Additionally, the Women's School of Agronomy (WSA) is a training cycle designed specifically to engage women in agriculture and increase female participation in the sector.

The Sarob cooperative's R&D program is designed to systematically evaluate and implement new technologies and crop varieties to ensure their suitability and effectiveness (Table 3.7).

Table 3.7. Sarob's R&D program

Selection	Testing	Adoption	Promotion
Selects innovative technologies from around the world through various sources. Identifies advancements that can be adapted to local conditions.	Tests potential technologies and crop varieties in fields over several years. For new crop varieties, submits samples to the MoA for official assessment.	Based on the results of these comprehensive tests, selects the most promising technologies and varieties for adoption.	Establishes demonstration plots nationwide to showcase the benefits of newly adopted technologies. Organizes open field days to engage with stakeholders and effectively promote these innovations.

Source: Authors' compilation based on Sarob cooperative–provided information.

The Sarob cooperative also promotes climate-smart agriculture (CSA) practices to address the challenges posed by climate change (Table 3.8).

Table 3.8. Sarob's climate change adaptation plan

Impact assessment	Selection	Testing	Adoption	Promotion
Analyze capacity and tools to assess vulnerability to climate change. Determine impact on different groups, locations, and crops.	Prioritize locally suitable interventions. Identify measures that can be effectively adapted to local conditions.	Test and verify selected interventions. Provide samples to the State Commission on Variety Testing.	Organize the adaptation process. Integrate new technologies or interventions into existing systems or workflows.	Showcase modified technologies through demo plots and open field events. Demonstrate the advantages and real-world uses.

Source: Authors' compilation based on Sarob cooperative–provided information.

The Sarob cooperative is dedicated to advancing sustainable agriculture by implementing various international standards and practices (Table 3.9).

Table 3.9. Sarob's sustainable agriculture transformation partnerships

Better Cotton	Fairtrade	Regenerative agriculture	Global GAP
Partners with the world's largest cotton sustainability program, Better Cotton.	Cooperates with Fairtrade NAPP (Network of Asian and Pacific Producers) in the Central Asian region.	Promotes and implements conservation agriculture. Serves as founding member of the Regional Alliance on Conservation Agriculture in Central Asia.	Promotes GLOBAL GAP standards to enhance agricultural exports from Tajikistan.

Source: Authors' compilation based on Sarob cooperative–provided information.
Note: Fairtrade certification represents a market-based movement that ensures fair trade practices; Global GAP is a body that sets voluntary certification standards for good agricultural practices.

Through these initiatives, the Sarob cooperative drives sustainable agriculture transformation, fostering practices that enhance productivity while preserving environmental and social integrity. Sarob also collaborates with TAU and TAAS to support PhD students' research on these technologies. Further growth is possible, but financial and personnel constraints have delayed the delivery of some technologies (Khakimov 2019).

Neksigol Mushovir is another nonprofit organization dedicated to enhancing the agriculture sector through a range of consulting, training, and research services. Since its inception in 2009, Neksigol Mushovir has been serving all actors of the agricultural value chain, from input suppliers and farmers to processing companies and relevant government agencies.

Table 3.10. Services provided by Neksigol Mushovir

Training and consultations	Research and surveys	Technologies and techniques	Digital solutions for agriculture
Training and consultancy on production, management, and marketing. Design of manuals and training materials.	Feasibility studies of product or service. Testing and demonstration of agricultural inputs. Soil analysis.	Natural resource efficiency techniques. Water-saving technologies. Maintenance of soil fertility. Protection of biodiversity. Adherence to CSA practices, integrated pest management, and vertical farming.	Access to markets. Sustainable farming and precision agriculture. Disaster risk management and early warning systems. Supply chain management. Farm automation. Farm management.

Source: Authors' compilation based on AgroInform TJ, "Agricultural Information Marketing System": https://agroinform.asia/en

Neksigol Mushovir's online platform, AgroSpace, provides comprehensive services and digital solutions for users that are summarized in the box below. Neksigol Mushovir offers a range of tools and resources designed to enhance efficiency, productivity, and sustainability for farmers. Its paid services and mobile applications, which include real-time data analysis, crop management advice, and market information, are tailored to address the specific needs of the local agricultural community.

Neksigol Mushovir's AgroSpace Online Platform

- Eighteen different mobile applications for agricultural production, sales, and remote consultations, available in English, Kyrgyz, Russian, and Tajik languages. The apps have been downloaded more than 170,000 times, with nearly 15 percent of users actively engaged.
- More than 600 electronic documents in the e-Library related to agriculture, economy, and regional development in Central Asia, with more than 360,000 downloads.
- An electronic announcement site for buying and selling 14 types of agricultural products, with the capability to post product photos via smartphone, with more than 3,000 users per month.
- A digital map that provides information on the production of 35 different agricultural products at the district level starting from 2012, along with the locations of processing companies, warehouses, greenhouses, and agricultural stores. More than 500 specialists from different countries use this tool each month.
- A remote consulting system that connects educational specialists, consultants, and businesses via a mobile application, featuring user registration, profile creation, and consultant evaluation. Development is ongoing for video conferencing and payment modules.
- A YouTube channel providing educational and informative videos on productivity, disease prevention, and pest control, with 125,000 views and more than 1,500 subscribers.
- Additional programs, including weekly retail market price tracking for Tajikistan and calculators for seeds, water, and fertilizer requirements, with more than 3,000 users annually.

Source: Authors' compilation based on Neksigol Mushovir's Agricultural Information Marketing System Platform.

Neksigol Mushovir has made a significant impact on the agriculture sector by reaching out to 20,000 farmers and 50 small and medium agricultural enterprises. Of those who have engaged with their services, a notable 92 percent have applied the knowledge they gained in practical settings. This has led to tangible improvements, with 89 percent of these participants reporting enhanced quality of their agricultural products (AgroInform TJ). A more comprehensive assessment of these impacts is needed to guide the development of future innovations and adaptations, and will be crucial for maximizing the potential of digital agriculture in driving sustainable growth and improving livelihoods in rural communities.

In sum, although farmers in Tajikistan have access to some extension services, the sector could benefit significantly from increased support from various stakeholders. Government agencies, particularly the MoA, TAAS, and TAU, should play a more proactive role in providing resources, training, and innovative solutions to enhance agricultural productivity and sustainability. Additionally, active engagement of the private sector and NGOs is crucial. These entities can offer valuable expertise, financial support, and innovative technologies that can address the specific challenges faced by farmers. By fostering a collaborative environment where public institutions, private enterprises, and NGOs work together, the Tajikistan's agriculture sector could achieve substantial improvements in efficiency, yield, and overall

resilience to climate change. Such concerted efforts will not only enhance food security but also contribute to the economic stability and development of rural communities across the country.

4. SUMMARY AND DIRECTION FOR FURTHER RESEARCH

Despite severe challenges and constraints, inputs scarcity, and climate change threats, Tajikistan's agriculture sector shows an increase in gross agricultural outputs and sectoral value added. It is one of the engines of recent development and, to some extent, addresses the country's growing domestic food needs resulting from population and income growth. Despite recent progress, as of 2021, agriculture value added per worker (in current international dollars) remained the lowest in the Central Asian region and 2.5 times less than the world average (WB, WDI, 2024). Although Tajikistan is an agrarian economy, the country remains a net importer of agrifood products, mainly due to its importation of processed foods and underdevelopment of the food processing sector.

This study's findings show that, to some extent, the main drivers of recent growth are related to the sectoral reforms, land allocation change due to land reform (that is, reduced land under cotton), and an expansion of land under vegetables, orchards and vineyards, and vegetables and melons. In addition, government-provided incentives to the poultry sector between 2018 and 2022 contributed to sectoral growth. However, there are productivity differences across the regions by types of farms that cannot be explained by recent farm and land reforms. Additional deep dives and analysis show that the recent sectoral growth is due to increased access to finance and extension services, as well as use of fertilizers. At the same time, it is worth noting that not all farms can afford fertilizer application; even for farmers who can afford fertilizer application (mineral and organic), the applied quantities are less than the MoA-recommended norms. Access to and affordability of inputs can increase the yields to some extent and are part of the solution. The lack of disaggregated data prevents us from determining whether farmers who have sufficient inputs are more productive than farmers with limited access. These data gaps need to be addressed through a survey of farmers. To ensure sustainable development of the sector and increase productivity, measures need to be taken to address all challenges mentioned in this report, develop the agricultural inputs market, provide access to finance, and promote climate-smart agriculture.

Agricultural inputs

Food security starts with security of inputs. Further sustainable development of crop sectors depends on availability and accessibility of agricultural inputs, including seeds, fertilizers, machinery, and finance and extension services.

The following steps need to be taken to develop the seed sector: Improve the policy and legal framework of the seeds, seedlings, and planting material systems; build the capacity of national agricultural R&D institutions;[33] invest in R&D, human capacity (including training), and infrastructure (buildings, offices, storage facilities, laboratory and greenhouses); develop new technologies, adapt to the local conditions, and promote CSA; build the capacity and infrastructure of seed-growing farms; adapt and multiply locally adapted varieties of seeds, seedlings, and planting materials; and provide quality assurances to end users. The emphasis should be on adapting climate-resilient crop varieties (including nutrient-rich crops, for example, horticulture)—those tolerant of low moisture or drought and high temperatures—and on promoting climate-smart farming practices to reduce greenhouse gas emissions (WB 2021a).

Using water efficiently and introducing water-saving technologies instead of flooding arable lands are vital to rapidly increase crop yields. In addition, it is crucial to increase capacity for water resources planning and irrigation management, increase public financing of the sector, strengthen the capacity of WUAs, develop an irrigation management information system,[34] improve the irrigation scheme, and enhance the Ministry of Energy and Water Resources capacity for regulation of water resources. Moreover, it is important to organize interministerial coordination and data exchange between the Agency on Land Reclamation and Irrigation and the MoA to guide agricultural land use and planting decisions, and to assess

[33] TAAS: Pamir Scientific Centre for Agriculture; Farming Institute; Institute of Horticulture, Viticulture, and Vegetable Growing; National Centre for Genetic Resources; Scientific Centre for Innovative Technologies and Agricultural Mechanization) and TAU (Scientific Research Institute of Biotechnology). It is important to support these organizations' capacity to develop market- and farmer-preferred, locally adapted, climate-resilient, affordable crop varieties and supporting technologies.

[34] Digitization of relevant historical meteorological, hydrological, and water resources datasets; development of technical and user documentation; enhancement and development of arrangements for interagency data exchange; development of remote monitoring tools such as drone applications and remote sensing; expansion of data visualization functionalities of the water information system; and development and dissemination of information products. For more details, see World Bank, Tajikistan Strengthening Water and Irrigation System Project (2022-2027).

climate impacts on irrigation delivery and agricultural production for better irrigation planning and service delivery (World Bank, 2022b).

Availability of the appropriate size of agricultural machinery is important to minimize input costs and intensify growth. Because of the low income levels and small size of Tajik farms, purchasing farm machinery does not make sense for individual farmers, even on credit. A more sustainable model is to promote farmer leasing from private sector suppliers. The public sector should be involved in facilitating the supply of mechanized inputs from the private sector (Van Loon et al. 2020). The government does provide an incentive for agriculture sector mechanization by introducing a tax and import duties exemption for imported agricultural machinery.

In this analysis, lack of data on labor by types of farms prevents us from examining whether yield differences between different types of farms are related to the number and knowledge of farmers.

Livestock

Livestock is an important source of livelihood for rural populations. They hold 93 percent of livestock and address the country's need for meat and dairy products. Sustainable development of the livestock sector can improve the livelihood of rural populations, improve their nutrition and health, and contribute to poverty reduction. Households should be part of the equation in the proposed solution of sustainable development of the sector, with an increase productivity supported by promotion of CSA and improved livestock feeding and breeding). Households are facing livestock feeding issues, and underdevelopment of milk value chains across the country means there is little incentive to invest in more productive cows. The measures should be complex — that is, alongside promoting CSA investment, it should focus on development of milk and meat processing value chains. Enhancing and improving the management of rangelands and pastures to avoid overgrazing are essential for maintaining livestock productivity, adapting to changing climate conditions, and being part of the solution of livestock sector development. For instance, adoption of semi-zero or zero-grazing systems and improved feed practices is crucial for enhancing sustainability. Moreover, improving veterinary services is essential for managing animal health and productivity. Strengthening technical capacity, expanding vaccination services, and enhancing disease control measures are the key

measures to further advance the livestock sector. In addition, improving livestock productivity and manure management could reduce methane emissions by up to 30 percent by 2050, and shifting to an alternative source of proteins could reduce the environmental impact of the livestock sector (World Bank 2024b).

Promoting CSA

Climate change threatens the agriculture sector and food security by reducing productivity. Investing in CSA technologies can address these challenges through adaptation solutions that mitigate consequences while also minimizing greenhouse gas emissions, especially methane (CH_4) emissions. Systematic approaches and inclusive processes, as well as close collaboration and coordination among all stakeholders (public, private, and donors), are the key for sustainable transition from business-as-usual practices to promoting CSA to ensure sustainable development of the agriculture sector and ensure food security. It is important to establish proper monitoring and evaluation mechanisms to track the process, engage stakeholders, develop financing mechanisms (matching grant program, cofinancing, low interest rate loans for CSA technologies), provide CSA technology incentives to farmers through non-production and non-trade distorting support (tax exemptions, financial and non-financial stimuli), establish knowledge sharing within Central Asian countries on advanced technologies and practices, and use information technologies to spread the knowledge among farmers (Khakimov 2019). At the same time, several gaps need to be addressed, including (1) policy, institutional, and governance gaps; (2) economic and financial gaps; (3) education and capacity-building gaps; (4) knowledge- sharing gaps; (5) technologies, methodologies, practice, and infrastructure gaps; and (6) science-based information and data gaps (University of Central Asia, January 2018). Tajikistan's updated nationally determined contributions (NDCs) prioritize several actions to address climate change. These include promoting green technologies in agriculture, improving livestock breeding, developing agroforestry and conservation agriculture, and enhancing seed production. Effective policy implementation requires increased awareness, better access to climate information, and support for alternative income options and risk-sharing strategies (IFPRI 2023). In line with the findings of recent studies (World Bank, 2024a; World Bank, 2024b; World Bank, 2024c), Tajikistan's agriculture sector NDC commitment in needs to be revised.

Access to finance

The literature review highlights the critical role of financing in advancing agricultural productivity and economic growth in Tajikistan. Continued efforts are needed to enhance access to finance at affordable interest rates, strengthen institutional capacities, and address sector-specific needs to ensure sustainable development. Findings of the World Bank Agriculture Commercialization Project (World Bank, 2022a) provide valuable insights into effective agricultural financing and highlight areas for future improvement and strategic focus. To address all challenges mentioned in this report (see subsections 3.2 and 3.3), the agrifood system requires significant investment and development support from public and private sectors as well as the donor community to promote CSA practices and to ensure food and nutrition security.

Agriculture clusters

The development of agriculture clusters in Tajikistan is supported by various donor projects and government initiatives. These clusters aim to improve value chains, enhance productivity, and support community organizations. However, progress is uneven, and substantial investment is needed to realize the full potential of these clusters (World Bank 2021b). Regional specialization in growing certain crops, which is dictated by climate conditions, can serve as an entry point for creation of agriculture clusters. The expansion of agriculture clusters is affected by trade policies, infrastructure improvements, and regional integration efforts. The positive effects of trade liberalization and international agreements could enhance the competitiveness and integration of agriculture clusters within the country (Mogilevskii and Akramov, 2017). The development of agriculture clusters in Tajikistan should be supported by integrating advisory services with other agricultural services and infrastructure. Combining AAS with input supply, processing, and market access can create a more cohesive support system for farmers (Shtaltovna, 2013). In-depth analysis is needed that summarizes better practices and finds better fits for Tajikistan's context.

Moreover, developing an insurance market in the agriculture sector and providing subsidies at the initial stages are vital to sustainably developing the sector and to protect farmers from harvest and livestock losses caused by disasters.

Overall, our analysis shows that a series of challenges and constraints must be addressed to further increase productivity in the crop sector, such as access to high-quality, locally adapted varieties of crops; affordability and application of high-quality, MoA-recommended fertilizers (mineral and organic) and pesticides; availability of machinery; capacity building for farmers, access to relevant information (such as weather forecasts and prices), and availability and accessibility of cold storages and logistics centers. It is important to advance and invest in hydroponics, aquaponics, and aeroponics to increase agricultural productivity and address land scarcity issues that are arising with growing domestic demands. In sum, policy and action plans (including sectoral ASSADP 2030 and NDC commitments); enhanced competitiveness and resilience; strengthened veterinary services; private sector engagement; increased access to finance; capacity building; policy development and coordination; scaled-up CSA technologies; and adaptation, mitigation, and climate resilience strategies can ensure sustainable development of the sector while minimizing the environmental impact and addressing growing demands due to population and income growth.

Further research

Available data enables us to understand and highlight recent development trends, while literature reviews allow us to understand sectoral challenges and constraints. However, because of data limitations, further in-depth analysis is needed, such as on total factor productivity, food security, efficiency, producer support, agrifood trade at the commodity level, the agriculture data collection system, alternative investment options for agriculture subsectors and food processing subsectors, and use of the RIAPA-AIDA modeling framework for translating investment into sectoral and subsectoral productivity.

In addition, the available official statistics do not enable us to delve into the differences in productivity among agriculture enterprises, *dehkan* farms, and household farms for different crops. A farmer's survey needs to be conducted that covers all types of farms to understand the relatively high productivity of some farms for some types of crops and the low productivity of other farms, and whether these differences are related to inputs (fertilizers, seeds, water, machinery, qualified labor), access to finance and investment, or the use of extension services.

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