

Annex 2c

Value Chain Analysis

to the GCF Funding Proposal

Climate-resilient landscapes in Central Asia

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List of abbreviations

AFC	Agriculture and Food Cluster
BAU	Business-as-usual (scenario)
CAG	Conservation Agriculture
CBA	Cost-benefit analysis
CIF	Cost, Insurance, and Freight
CIS	Commonwealth of Independent States
CSA	Climate Smart Agriculture
CRLE	Climate-resilient and low-emission
ESP	Extention Service Providers
EU	European Union
EUR	Euro
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer field schools
FOB	Free on Board
FV	Fergana Valley
GHG	Greenhouse gas
GIZ	German International Cooperation Society
ha	Hectare
HP	Horsepower
IAF	International Accreditation Forum
IFAD	International Fund for Agricultural Development
ILO	International Labour Organization
IPM	Integrated Pest Management
IRR	Internal Rate of Return
KG	Kyrgyz Republic
KGS	Kyrgyz Som (Currency of Kyrgyz Republic)
LLC	Limited Liability Company
MT	Metric ton (= 1,000 kg)
MTS	Machine-technological stations
NGO	Non-governmental Organization
NPV	Net Present Value
NTFP	Non-Timber Forest Products
OCOP	One country one priority product
SOM	Soil organic matter
TJ	Tajikistan
TJS	Tajik Somoni (Currency of Tajikistan)
UN	United Nations
UNDP	United Nations Development Programme
USA	United States of America
USAID	United States Agency for International Aid
USD	US-Dollar
UZ	Uzbekistan
UZS	Uzbekistani Sum (Currency of Uzbekistan)
WFP	World Food Programme

This report provides detailed information on the five value chains that have been selected as part of the feasibility study of this programme. The climate risk assessment presented in Annex 02b of the funding proposal uses a slightly different classification per land use systems. The table below provides an overview of the correspondence between these two classifications.

Table 1: Land use systems and value chains

Land use systems (used for impact chains in the climate risk analysis)	Value chains
Rainfed agriculture	Wheat
Irrigated agriculture	Fruits
	Horticulture
	Seed potato
Forest	Non-timber forest products

1. Wheat

1.1 Relevance

Wheat is one of the most important food crops in the Kyrgyz Republic (KG), Tajikistan (TJ), and Uzbekistan (UZ). In all three countries, wheat is crucial for domestic consumption and food security. Due to its relevance, wheat production affects food prices and inflation rates. It is an integral part of the rural economy in the target countries, providing employment and income to farmers.

Wheat not only has high economic importance, but it also symbolizes independence, sovereignty, food security, and self-reliance. Hence, achieving wheat self-sufficiency is an important political goal, and agricultural policy in the three target countries aims at increasing wheat production and productivity in wheat farming. E.g., after independence from the former Soviet Union in 1991, UZ started to make concerted efforts towards food self-sufficiency. Consequently, the wheat area increased significantly from about 0.63 million hectares in 1991 to about 1.2 million hectares in 2023 (35% of total arable land), making wheat the second most important crop after cotton. Likewise, total annual wheat production has increased significantly since 1991, reaching approximately 6 million MT in 2023, with 80% grown on relatively large, irrigated farms. The increase in production has mainly been achieved through area expansion and yield gains from using new, higher-yielding varieties and intensive crop-management practices. In 2017- 2018, domestic wheat production met more than 70% of Uzbekistan's food and feed demand, illustrating the country's progress towards becoming self-sufficient in wheat (Yigezu et al., 2022).

However, wheat production in all three countries is adversely affected by climate change, water scarcity, and outdated farming techniques, compromising current and future wheat productivity and food security. The proposed programme interventions are targeted at **rainfed** wheat which is particularly susceptible to climate change effects. The share of rainfed wheat in the target countries amounts to 2.9% in KG (Peeters et al., 2018), 54.4% in TJ (Agency on statistics under the President of the Republic of Tajikistan, 2024), and 19.8% in UZ¹. In KG the share of rainfed wheat is particularly small because, on the one hand, the country is characterized by a lack of rainfall during the vegetation growth period in spring and summer and, on the other hand, irrigation water is collected and supplied in abundance by mountain areas (Peeters et al., 2018).

Wheat and cotton are the main cash crops in Tajikistan, covering approximately 66% of the cropped area (36% for wheat and 30% for cotton). Wheat is sown between September and November and harvested in July. Wheat production reached an above-average level of 1.05 million MT, compared to 852,000 MT in 2021. Despite domestic production, Tajikistan imports wheat. For example, in the 2021/22 marketing year (November/October), the wheat import requirement was forecast at about 1.19 million MT, while in 2020/21, it was forecast at about 974,000 MT. In 2020, Tajikistan imported wheat worth USD 244 million, making it the 49th largest wheat importer globally. During this period, wheat was the most imported product in Tajikistan. The primary sources of wheat imports were Kazakhstan (USD 235 million), Uzbekistan (USD 6.95 million), and Russia (USD 1.59 million)(FAO, 2023a).

In Uzbekistan, wheat is produced mainly by large farms as a rotation crop with cotton, primarily on irrigated land. Since this does not align with the programme's target group or its focus on more climate-vulnerable rainfed areas, the wheat value chain is included only in programme interventions in the Kyrgyz Republic and Tajikistan. Figures and information for Uzbekistan are still provided in the value chain description for illustrative purposes and regional completeness.

¹ Source: MoA, personal communication

1.2 Production volumes and key production areas

Based on the latest agricultural statistics available, Table 2 summarizes the area devoted to wheat, total wheat production, and average productivity. Apart from providing statistics at national level, the table includes data for the provinces that make up the two intervention areas, i.e. (i) the 'Fergana Valley' (FV) which encompasses provinces in all three target countries (shaded in light blue) and (ii) 'Khatlon & Surkhandarya' (KS), two bordering provinces in Tajikistan and Uzbekistan. In FV and KS areas, wheat cultivation is of great relevance, occupying close to 469,000 and 275,000 ha and producing approximately 2.14 and 0.86 million MT, respectively. The table shows that wheat productivity within FV ranges from 1.7 MT/ha in Batken province of KG to close to 7.1 MT/ha in Andijan province of UZ, while in KS wheat yields are at par in both provinces at around 5.5 MT/ha. Production statistics specifically for rainfed wheat are not available.

Table 2: Wheat production statistics (2023) for the target countries and intervention areas

Country/province	Wheat area (ha)	Wheat production (MT/year)	Average wheat yield (kg/ha)
Total Kyrgyz Republic (KG)	232,100	440,400	1,897
Batken (KG)	14,327	24,400	1,703
Jalalabad (KG)	19,820	47,000	2,371
Osh (KG)	40,519	82,200	2,029
Total Tajikistan (TJ)	275,037	860,489	3,129
Khatlon (TJ)	168,165	546,612	3,250
Sughd (TJ)	55,077	174,628	3,170
Total Uzbekistan (UZ)	1,212,567	6,026,656	4,970
Andijan (UZ)	74,037	523,052	7,065
Fergana (UZ)	107,952	632,507	5,859
Namangan (UZ)	84,576	421,768	4,987
Surkhandarya (UZ)	110,891	614,101	5,538
Total 'Fergana Valley'	468,582	2,140,689	4,568
Total 'Khatlon & Surkhandarya'	308,763	1,700,272	5,507

Fergana Valley Khatlon/Surkhandarya

Source: Various national and provincial agricultural statistics

Both at national level and within the provinces making up the intervention areas, Table 3 lists the major wheat producing areas and their relative production shares.

Table 3: Major wheat production areas in the target countries and intervention areas

Country/province	Wheat production (MT/year)	Major Provinces/Districts	% production
Total Kyrgyz Republic (KG)	440,400	Chuy Issyk kul Osh	36.7 20.5 18.7
Batken (KG)	24,400	Leylek Kadamjay Razzakov	40.0 32.3 16.3
Jalalabad (KG)	47,000	Suzak Ala Buka Bazar Korgon	32.7 22.2 21.0
Osh (KG)	82,200	Nookat Kara Suu Aravan	33.6 21.9 11.1
Total Tajikistan (TJ)	1,754,890	Khatlon Sughd	61.9 23.3
Khatlon (TJ)	1,086,171	Dangara Farkhor Vose Qubodiyon Shahrituz	9.1 7.4 7.2 5.4 4.6
Sughd (TJ)	409,762	Istaravshan Devashtich Ghafurov	16.6 14.0 13.0
Total Uzbekistan (UZ)	6,026,656	Fergana Surkhandarya Andijan Namangan	10.5 10.2 8.7 7.0
Andijan (UZ)*	523,052	Paxtabod Qo'rg'ontepa Jalaquduq	11.0 10.0 10.0
Fergana (UZ)*	632,507	Dang'ara Rishton Bag'dod	9.2 8.9 8.8
Namangan (UZ)*	421,768	Pop Mingbuloq Uchqo'rg'on	16.1 13.5 13.0
Surkhandarya (UZ)*	614,101	Muzrabot Sherobod Denov	15.5 14.0 11.9

Source: Various national and provincial agricultural statistics N/A = not available

*Major production areas and percentages based on 'cereal production' since crop specific information is not available

1.3 Description of the value chain

1.3.1 Physical and legal entities involved in the value chain

Stakeholders in the wheat value chain can be categorized into five groups:

- i. Governmental entities at national and regional levels, e.g. the state-controlled joint-stock company *Uzdonmakhsulot* in UZ; these entities include state-run mills, purchase and store wheat, produce flour, bread and other wheat products, and sell them at subsidized prices;
- ii. Wheat clusters
- iii. Farmers (see 'Production' below).
- iv. Private sector actors, such as input providers (see 'Inputs' below), mills, bakeries, traditional bread makers, and intermediaries engaged in the purchase, transportation and marketing of wheat grain and processed products; and
- v. Consumers, i.e. the entire rural and urban population who has access to subsidized wheat bread and other wheat-based products.

1.3.2 Inputs

Wheat seeds are both domestically produced in the three target countries as well as imported from Russia, Kazakhstan, and China. Depending on variety and origin, the prices of wheat seeds vary widely, from approximately 0.30 USD/kg for domestically produced seeds in UZ to 5.73 USD/kg for imported varieties in KG. The seed sector is supported by government programs and international NGOs with the aim of improving seed quality and, hence, productivity.

Mineral fertilizers are domestically produced in UZ, whereas in KG and TJ they are mostly imported from Russia, Kazakhstan, China, and UZ. Table 4 provides an overview of the prices of major types of mineral fertilizers in the three target countries.

Table 4: Average prices of major mineral fertilizers in the target countries (2023; USD per kg)

Type of fertilizer	Kyrgyz Republic	Tajikistan	Uzbekistan
Urea	0.41	0.42	0.28
Ammonium nitrate	0.33	0.39	0.24
Superphosphate	0.26	0.22	0.19
Ammonium phosphate	0.57	0.55	0.54
Potassium chloride	0.41	0.64	0.38

Table 5: Major input providers in the target countries

Type of input	Kyrgyz Republic	Tajikistan	Uzbekistan
Seeds	Seed farms located in different regions Various seed import businesses	Seed farms located in different regions Various seed import businesses	Seed farms located in different regions Various seed import businesses
Fertilizers	ATS Group Ltd. Agrostyle Ltd. Agrokhimia Ltd. Alem Agro Keidji Ltd.	Local producers (esp. TAJIKO Chemical, Azot) Imported fertilizers: UralKhim (Russia), Uzkimiyosanoat (UZ)	Uzkimiyosanoat and its sub-organizations, esp. MAXAM-Chirchiq, Farg'onaazot, Am-mofos-Maksam

Agricultural machinery is mostly imported in the target countries (esp. from Belarus, Russia, China, Europe, USA and India), whereas local workshops provide maintenance and repair services. Uzbekistan has its own agricultural machinery production company² which produces local brand agricultural machineries and sells to local farms and agricultural organizations operating in the country. Another company which is called LLC "Toshkent Tractors" (Tushkent Tractors, 2022) is engaged in the supply of large agricultural machinery, both

² Toshkent Agro Traktor LLC has been operating since March 2021. The main activity of the Company is the production, supply of machinery and means of mechanization of various brands for agriculture in accordance with the needs of the domestic and foreign markets, expansion and export of various types of agricultural machinery, marketing research. (AgroTech Klaster, 2025)

from well-known global manufacturers and locally produced ones. In Tajikistan, the tractor manufacturing company LLC "TojIron" is a joint venture between Tajik and Iranian companies. The Tajik-Belarusian joint venture Closed Joint Stock Company "Agrotekhservis", based in Gissar, is actively developing the industrial production of agricultural machinery: tractors are already being supplied to local farmers and exported to two countries.

1.3.3 Production

In KG and TJ, predominantly smallholder farms are engaged in wheat cultivation. Cooperatives support farmers in accessing inputs and sharing machinery. In UZ, about 80% of wheat is produced by relatively large farms (50 ha on average) on land that is leased from the government. Another 18% of wheat is produced by small (dehkan) farms (0.5 ha on average), and the remaining 2% by large specialized agricultural enterprises with land sizes ranging from 200 to 1,000 ha. These specialized enterprises are also engaged in seed production. Same as the dehkan farms, the specialized farms are not part of the state order system (Yigezu et al., 2022).

At close to 5 MT/ha, average wheat yields in UZ are no lower than the global average, but this yield level is relatively low considering that most of wheat production is irrigated. In parts of the fertile FV average wheat yield are well above 5 MT/ha, exceeding 7 MT/ha in Andijan province (see Table 2).

An analysis of gross margins in wheat production based on 2017 data shows that the large farms achieved a profit of about 273 USD/ha, while dehkan farms achieved about 584 USD/ha. The analysis of the gross margins of wheat production carried out on the data of 2024 in Sughd region of Tajikistan shows 507 USD/ha. The higher profitability of small farms can be attributed to lower machinery and fuel costs (as cultivation is mostly manual using family labor, which is not accounted for), higher yields due to better crop management practices, use of larger quantities of organic fertilizers, and higher prices as they sell in the open local markets (Yigezu et al., 2022).

A recent study by Unique in TJ shows that gross margins in conventional wheat production amounted to 152 USD/ha, while, with conservation agriculture practices, 475 USD/ha can be achieved (Unique land use, 2024).

1.3.4 Processing/storage

Farmers typically sell their wheat to processing companies which then sell the processed products on to wholesalers or directly to retailers. Up to five intermediaries are involved in the post-harvest handling of wheat. In all three countries, both state-run and private flour mills are operating, and further processing is accomplished by both traditional tandoor-based bread makers as well as modern bakeries.

In UZ, 34 enterprises within Uzdonmakhsulot receive wheat procured by the government and store it in special warehouses. The grain is processed in flour mills there to produce subsidized bread. Wheat produced by dehkan farms is stored at farm level, in warehouses at clusters³, wholesalers and private enterprises. Dehkan farmers typically keep part of their harvest as seed for the next season, use some of it as concentrate feed for their animals, and sell the remainder in local markets or to feed mills.

Flour mills usually mix locally produced Uzbek wheat with the relatively higher-quality imported wheat of Kazakh origin. This produces various flour types for domestic consumption. Over the years, Uzbek mills have increasingly imported Kazakh wheat, milled it, then exported flour to Afghanistan and other neighboring countries. Some of the flour produced from cheap wheat bought under the state order is exported instead of being sold in UZ, increasing the demand for domestic production. Flour milling is competitive. Many small private flour mills compete with large state-owned mills to supply small and large private bakeries with a wide range of flour products (Yigezu et al., 2022).

Tajikistan imports about 1 million MT of wheat annually from Kazakhstan, which produces about 750,000 MT of flour. Domestic production covers over 90% of flour consumption, although village milling is declining. In 2021, about 80,000 MT of flour will be imported, mainly from Kazakhstan. The milling industry in Tajikistan is highly consolidated, with the four largest companies producing around 60% of the country's flour. The three largest millers are located in the Sughd region and the fourth in Dushanbe. Nationally, about 3,000 MT of wheat are milled daily, with the leading millers accounting for 30% of this output (WFP, 2022). Table 6 summarizes production quantities and average retail prices of major processed wheat products.

Table 6: Production and retail prices of major processed wheat products in the target countries and intervention areas

Country/province	Annual production (MT)	Average retail price (USD/kg)
Total Kyrgyz Republic (KG)	Bread & bakery products: 109,024	High-grade flour: 0.73
	Pasta and similar: 23,723	Lower-grad flour: 0.60
		Bread: 0.74

³ The cluster system was introduced through Resolution #806 of the Cabinet of Ministers (September 26, 2019). It aims to optimize use of farmland by increasing the size of farms producing wheat, re-allocating land to more efficient clusters, and improving crop rotation options (Yigezu et al., 2022).

Total Tajikistan (TJ)	Pasta and similar: 13,048 MT	Vermicelli: 0.99 High-grade flour: 0.49
Khatlon (TJ)	Pasta and similar: 505 MT	High-grade flour: 0.45
Sughd (TJ)	7,318 MT	High-grade flour: 0.48
Total Uzbekistan (UZ)	Flour: 3,246,059 Livestock feed: 184,400	High-grade flour: 0.78 Wheat bran: 0.27
Andijan (UZ)	Flour: 129,655	High-grade flour: 0.78 Wheat bran: 0.27
Fergana (UZ)	Flour: 422,725	High-grade flour: 0.78 Wheat bran: 0.27
Namangan (UZ)	Flour: 158,097 Livestock feed: 54,842	High-grade flour: 0.78 Wheat bran: 0.27
Surkhandarya (UZ)	Flour: 135,630	High-grade flour: 0.78 Wheat bran: 0.27

Fergana Valley Khatlon/Surkhandarya

Source: Various national and provincial agricultural statistics

Table 7 provides a qualitative assessment of the adequacy of wheat storage facilities in the target countries in terms of both capacity and quality. While UZ shows relatively good storage conditions, KG and especially TJ suffer from undersized and poor quality storage facilities.

Table 7: Adequacy of wheat storage facilities in the target countries

Criteria	Kyrgyz Republic	Tajikistan	Uzbekistan
Storage capacity (1 = clearly insufficient; 2 = slightly insufficient; 3 = just sufficient; 4 = fully sufficient)	1	1	3
Storage quality in terms of infrastructure and service (1 = large storage losses; 2 = moderate storage losses; 3 = minor storage losses; 4 = fully adequate storage quality)	2	1	3

Note: Assessment based on expert judgment by the consultant team; the national-level scores also apply to the provinces in the intervention areas

1.3.5 Trading

Table 8 provides an overview of the value of raw wheat exports from the target countries, indicating the main countries exported to. KG and TJ depend on wheat/flour imports for food security. Hence, exports of this commodity are negligible. UZ exports some wheat to TJ and much less to KG. Starting from a very low level, wheat exports to Afghanistan have grown over recent years, reaching a value of 10 m USD in 2023.

Table 8: Imports and exports of wheat (unprocessed grain) in the target countries, indicating major export partners (in USD)*

	2021	2022	2023
Total imports Kyrgyz Republic:	53,882,032	77,916,983	67,855,253
Total exports Kyrgyz Republic:	5,757	18,999	N/A
Main countries exported to:			
	Kazakhstan	3,952	18,999
	Russian Federation	1,805	-
Total imports Tajikistan:	265,938,677	329,102,231	N/A
Total exports Tajikistan:	161,000	118,033	N/A
Main countries exported to:			
	Pakistan	-	65,133
	Afghanistan	161,000	52,900
Total imports Uzbekistan:	616,417,003	781,125,261	764,977,621
Total exports Uzbekistan:	6,452,215	1,507,189	10,002,814
Main countries exported to:			
	Tajikistan	5,794,570	-
	Kyrgyzstan	392,072	-
	Afghanistan	265,573	1,507,189
			10,002,814

Source: UN Comtrade; *Imports are CIF values, exports are FOB values; N/A = data not available

Much more than wheat grain, UZ exports wheat flour to Afghanistan; from 2022 to 2023, these exports have substantially increased from approximately 269 m USD to 456 m USD. Afghanistan also receives small amounts of wheat flour from TJ.

*Table 9: Imports and exports of wheat flour in the target countries (in USD)**

	2021	2022	2023
Total imports Kyrgyz Republic:	14,752,151	14,129,186	27,140,496
Total exports Kyrgyz Republic:	-	63,446	593,242
Main countries exported to:	Uzbekistan	63,000	572,139
	Afghanistan	-	21,103
Total imports Tajikistan:	18,848,958	22,356,528	N/A
Total exports Tajikistan:	1,149,986	3,400,423	N/A
Main countries exported to:	Afghanistan	1,149,986	2,868,055
	Pakistan	-	532,368
Total imports Uzbekistan:	95,541,243	141,953,692	160,062,216
Total exports Uzbekistan:	281,179,876	268,529,510	455,933,012
Main countries exported to:	Afghanistan	281,179,876	447,699,169
	Turkmenistan	-	148,693

*Source: UN Comtrade; *Imports are CIF values; exports are FOB values; N/A = data not available*

1.4 Enabling environment

Various laws and regulations in the target countries are aimed at increasing wheat production, productivity, and exports, such as:

Kyrgyz Republic

Within the framework of the project “Financing of Agriculture”, agricultural producers are provided with preferential loans for the purpose of growing grain crops at an interest rate of 10% for a period of up to 3 years with a full exemption from paying contributions on the principal amount of debt for up to 6 months. Within the framework of the project “Financing of Export-oriented and Import-substituting Enterprises – 1”, preferential lending is provided to producers of the flour-milling industry on similar terms. Other relevant regulations include:

- i. Law No. 38 of June 19, 1997, “On Seeds”: the state subsidy reimburses 30% of seed costs for seed farms multiplying certified seeds of winter and spring wheat included in the State Register of Plant Varieties and Hybrids Approved for Use on the Territory of the Kyrgyz Republic.
- ii. Law No. 70 of June 11, 2004, “On Cooperatives”: agricultural cooperatives may be established (i) to carry out joint activities in the production of agricultural products (crop growing and livestock farming); (ii) to engage in the processing of agricultural products; (iii) to engage in the sale of agricultural products, as well as storage, sorting, packaging, drying, washing, packaging and transportation, providing melioration, transport, construction, veterinary services, work on the application of fertilizers and pesticides, the provision of scientific consulting, marketing and other services.
- iii. Law of the Kyrgyz Republic of February 2, 2019 No. 22 “On state subsidies in seed production”: allocation of budgetary funds to reimburse seed farms of the Kyrgyz Republic for *30% of the cost of production of sold seeds* of super-elite, elite, first and second reproductions of varieties and hybrids of the first generation of priority agricultural crops (such as wheat).
- iv. Law of the Kyrgyz Republic of August 4, 2008 No. 183 “On Food Security of the Kyrgyz Republic”: the main areas of state support are (i) guarantees for payment for food products delivered by agricultural producers at pre-announced prices; (ii) subsidies for the production of basic food products; (iii) development of leasing activities aimed at strengthening the material and technical base of rural producers; (iv) financing of research programs for the development of seed production and selection of agricultural plants and animals, breeding, improvement of production technologies, processing, storage and rational use of food products.
- v. Decree of the President of the Kyrgyz Republic No. 202 of July 22, 2024, “On Measures for the Further Development of the Agro-Industrial Complex of the Kyrgyz Republic”: among others, aimed at improving and simplifying preferential lending for large-scale production in the agro-industrial sector and attracting foreign private investment for introducing green biotechnologies, climate change adaptation technologies, artificial intelligence and other modern technologies in the agriculture sector.
- vi. Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 574 of September 13, 2024, “On Approval of the Program for the Development of Trade and Logistics Centers in the Agro-Industrial Sector of the Kyrgyz Republic for 2024-2028”.
- vii. Resolution of the Cabinet of Ministers of the Kyrgyz Republic No 81 of February 20, 2025, “On Approval of the Program for the Formation and Development of Growth Points in the Regions of the Kyrgyz Republic for 2025-2030”.

- viii. Order of the Cabinet of Ministers of the Kyrgyz Republic No. 120 of March 16, 2022, "Lending to the Agro-Industrial Complex".
- ix. Order of the Cabinet of Ministers of the Kyrgyz Republic No. 416 of May 26, 2025, "Development of Seed Production and Nursery Farming in the Kyrgyz Republic".

Tajikistan

- i. Law No. 473 of December 31, 2008, "On state support for the sectors of the agro-industrial complex of the Republic of Tajikistan"; aimed to develop the agro-industrial complex, provide the domestic market with food and raw materials, and increase the export potential of Tajikistan. Financial support is provided to specific sectors of the agro-industrial complex. Both natural persons and legal entities, regardless of ownership, can receive these subsidies.
- ii. Law No. 1506 of February 21, 2018, "On grain and products of its processing": this defines the legal, organizational and economic basis for the circulation of grain and products of its processing, quality requirements for grain destined for food, as well as for animal feeding and seed production. Moreover, based on biological and technological indicators according to standards and technical regulations. The objectives of the law cover: i) reduce consumer dependence on external grain markets. ii) establish a legal framework for state control of grain turnover. iii) promote commercialization and competitive grain market development. iv) establish quantitative and qualitative accounting of grain and its products. And v) optimize grain production structure to adapt to climatic and market conditions. The law regulates the principles of Grain Circulation and sowing of grains consider selection achievements, zoning of varieties, and modern agrotechnological measures.
- iii. Seed Industry Development Program (2021–2025): medium-term action program based on the priorities of the National Development Strategy until 2030 to increase the production and yield of agricultural crops by cultivating new varieties. The main goal of the program is to implement the government's policy on the development of plant breeding and seed production in accordance with international standards, addressing gaps, e.g., with regard to quality control, registration and certification of seeds, and phytosanitary measures.

Uzbekistan

- i. Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 684 of August 24, 2018, "On measures to provide additional support to grain processing enterprises and increase their export potential"
- ii. Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 806 of September 24, 2019, "On additional measures to ensure high yields through the phased introduction of the cluster system in grain production".
- iii. Resolution of the President of the Republic of Uzbekistan No. 4634, dated 06.03.2020, "On measures for the widespread introduction of market principles in the production, purchase and sale of grain": the practice of growing grain on the basis of a state order and selling at a fixed price was phased out. State purchases were completely abolished, and the grain produced is sold to all consumers, including grain processing enterprises, grain clusters and traders, through exchange trading or on the basis of direct contracts (futures, forwards, etc.) at free prices. Furthermore, a subsidy of 15% on the purchase price of agricultural machinery was introduced, as well as a compensation of 80% of the transportation costs of combine harvesters for servicing abroad.
- iv. Resolution of the President of the Republic of Uzbekistan No. PP-144, dated 01.03.2022, "On measures to further improve the introduction of water-saving technologies in agriculture": up to 50% of the costs of purchasing equipment such as renewable energy sources and portable generators for cotton and grain fields with an area of at least 10 hectares are reimbursed, but not more than 100 million UZS. Also, 9.0 million UZS is provided as a subsidy for sprinkler irrigation systems introduced in grain crops.

1.5 Climate risk and impact

Different climate models unanimously indicate potential **temperature increases** of over 6°C by 2050 in different regions of the target countries. E.g., there is a high likelihood that temperatures will more regularly exceed 40°C, particularly in lowland regions such as the Fergana Valley (World Bank & Asian Development Bank, 2021). While higher temperatures may extend the growing season, this poses challenges in already heat-stressed areas like Khatlon, where peak summer temperatures are likely to exceed 50°C, which can make cultivation impractical altogether (WFP, 2017). Especially during sensitive stages like flowering and grain filling, temperature increases affect wheat productivity. In Kyrgyzstan, for every 1°C increase in temperature in the flowering stage, wheat yields may decrease by 3–10%. This pattern is consistent with other regions of Central Asia (Park et al., 2021), and the impacts on wheat production could endanger economic growth and food security in the region (USAID, 2018).

With respect to rainfall projections there is greater uncertainty. However, an increase in the frequency of **heavy rainfall events** is already being observed, particularly during spring, coinciding with the cultivation period. These extreme rainfall events are expected to become even more frequent under all emission scenarios. On the other hand, there is evidence of **increasing drought conditions**, with rainfall in parts of Khatlon province and northern Sughd having declined by 30% since 2001. Drought is a short-term threat to rainfed wheat production while heavy rainfall can lead to increased soil erosion and landslides in sloping areas (Khakimov et al., 2020). In the Fergana Valley, annual precipitation ranges from 410 – 730 mm, but significant rainfall variability is already being observed, leading to both periods of drought and periods of excessive soil moisture (Park et al., 2021). The biggest risk for wheat production on rainfed land is drought during critical development stages (especially germination, flowering, and grain formation), making production on these lands very risky. However, production risks related to drought can be addressed through a set of measures that not only reduce drought risks but also promote regenerative agriculture.

1.6 Climate-resilient technologies and adoption

1.6.1 Status quo regarding the adoption of direct seeding

Kyrgyz Republic

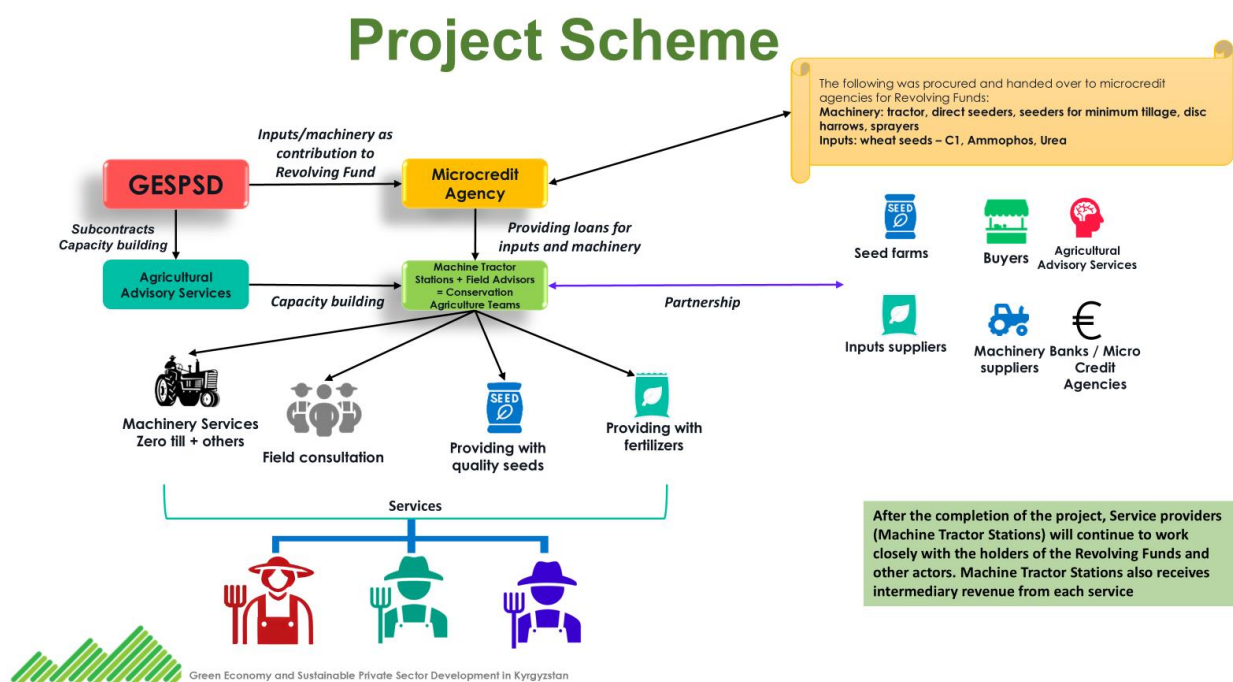
Rainfed lands are a crucial factor in the agricultural production system of the Kyrgyz Republic, accounting for almost 30% of the country's arable land. Due to specific climate conditions, these lands are most suitable for cereal production, as winter crops benefit from the good availability of moisture during the winter season. Quality wheat production on rainfed land has the potential to significantly increase food independence and food security. Currently, most wheat and barley produced is used as animal fodder, while an estimated 90% of wheat and flour for human consumption is imported. Producing quality wheat on rainfed land could reduce dependency on imports by more than 50% (Based on the results of interviews with no-till coordinators from FAO, WFP and GIZ projects).

In the Kyrgyz Republic, no-till technology is being implemented as an element of resource-saving and climate-resilient agriculture. According to recent demonstrations and local reports, approximately 4,200 ha of rainfed land was cultivated using no-till technology in 2025 (Based on the results of interviews with no-till coordinators from FAO, WFP and GOPA/AFC projects). The technology is used primarily for direct seeding of wheat and is accompanied by the introduction of improved seed varieties, crop rotation, and moisture conservation measures. Key stakeholders involved in the implementation and dissemination of no-till are:

- Farms and agricultural cooperatives- primarily small and medium-sized farms interested in reducing costs and maintaining soil fertility.
- Machine-technological stations (MTS) and service organizations- providing direct seeding services and equipment rental. The use of specialized seeders (mainly Turkish-made) is being expanded via leasing through preferential lending provided by donor-funded projects. Support services and resources are provided primarily through international projects.
- Conservation Agriculture Teams paired with micro-credit institutions supporting knowledge dissemination (demonstration plots, field days and training for agronomists and farmers) and access to selected seeds and fertilizers through revolving funds, variety testing programs, and advisory support (e.g. on balanced plant nutrition, timely planting and plant protection, and crop monitoring).
- Development projects and international organizations (GIZ, FAO, AFC and others) and local NGOs provide demonstrations, training, and methodological support.

Access to machinery and advisory services is provided via locally based Conservation Agriculture Teams in a bundled package for farmers who can access microfinance (for seed and balanced fertilizer). The different types of services are provided through brigadiers, machine service providers, rural advisory services and micro-credit institutions (see intervention logic below).

Figure 1: Intervention logic of no-till cereal production in the Kyrgyz Republic



Source: GIZ, 2024

Table 10: Statistics on no-till wheat production in the Kyrgyz Republic

Region	Number of ha	Number of machinery service	Number of farmers
Osh	1,800	10	600
Jalal-Abad	1,400	7	466
Chui	850	5	283
Issyk-Kul	150	1	50
Total	4,200	23	1,399

Note: The proposed activity only covers the Osh and Jalal-Abad regions

Tajikistan

No-till cereal production was introduced to Tajikistan in 2008 as part of a FAO project in close cooperation with the Tajik Soil Scientific Research Institute of the Academy of Agricultural Sciences (AAS). Later on, the AAS introduced no-till seeding machinery with the support of ICARDA. From 2013–2014 onwards, Sarob Cooperative began working more closely with FAO and GIZ projects to promote no-till technologies, testing different models and dimensions of seeding machinery and equipment to encourage the adoption of no-till in the country. According to Sarob Cooperative data, no-till is currently practiced on a total area of around 1,200 ha, mainly in Devashtich district in Sughd Region, Hisor district in DSS Region, and Danghara and Kulob districts in Khatlon region.

Positive results have been demonstrated by Sarob, with no-till leading to a 40% yield increase of rainfed wheat compared to conventional tillage, and to up to 100% yield increase when combined with improved seed varieties (M. Muminov, personal communication, 2025). This approach also promotes water conservation and mitigates soil salinization, and the time saved compared to conventional tillage can enable double cropping, thus offering substantial benefits to local farmers (Khakimov et al., 2020). Double cropping of no-till maize after no-till wheat in one season has been successfully tested by Sarob in Hisor district.

Sarob Cooperative is one of the main promoters of no-till in the country. As an active extension service provider, the cooperative promotes no-till among local farmers and offers no-till equipment for rent or purchase. It also supplies high-quality seeds and provides training and consultations. Lately, Sarob Cooperative has introduced a new leasing programme via its affiliate, 'Agrotijorat' LLC. Targeting small and medium-sized producers, the programme leases out two- and four-wheel tractors ranging from 7 to 65 horsepower (HP). Lease terms are flexible, ranging from 12 months at 0% interest to 24 months at 6% interest, and up to 36 months for 24–65 HP models (12% interest). The 65 HP variant is required for operating a no-till seeder. These preferential conditions make mechanization accessible to farmers and service providers who cannot afford to make upfront purchases (M. Muminov, personal communication, 2025).

The Neksigol Group is also providing extension to local farmers to promote no-till and other climate-smart agricultural techniques and advise on the use of respective tools and equipment (Neksigol, 2025).

1.6.2 Potential and barriers preventing the adoption of the direct seeding

Kyrgyz Republic

Outside the areas where GIZ has supported the establishment of revolving funds for no-till cereal production the following technical, knowledge-related, and financial barriers still exist in the Kyrgyz Republic:

- Farmer hesitation due to fear of crop loss.
- Farmers' poor knowledge of agricultural technology.
- Lack of information about the conservation agriculture approach and lacking simple training material in Kyrgyz language.
- Poor access to mechanization through service centers/rental (custom-hire).
- Equipment/spare parts shortages.
- Lack of revolving funds to provide farmers with seeds, fertilizers, and plant protection products. Seed and fertilizer supply mechanisms must be flexible and responsive, especially during the transition period, so working with banks carries significant risks.
- Crop residue and weed management issues requiring farmer training and the introduction of cover crops.

These barriers can be overcome by providing specific technical assistance and financing support along the following key aspects:

- Training for agronomists, service providers, and farmer group leaders on proper preparation and calibration of no-till equipment, crop residue management, weed control, use of cover crops, and crop rotation. Development of simple teaching materials in Kyrgyz/Russian.
- Support for the creation of rental centers and/or private service providers equipped with no-till seeders (single- or double-row rotary or disc seeders, disc tines, etc.).
- Embed leasing into revolving funds and development of local repairs; support for local production/assembly.
- Support credit/leasing schemes for service providers; guarantees for machinery service centers.
- Creating and supporting cooperatives/groups of service providers. Financing/assistance in establishing machine service providers that share equipment among farmers and ensure regular service and maintenance.
- Organizing demonstration plots on typical regional farms, distinguishing between "no-till" and "conventional" farming to demonstrate the economics and yields.
- Connecting practicing farmers with buyers, certification or carbon-related financing instruments to generate additional revenue/bonuses through participation in offsetting schemes for emissions reductions and soil carbon sequestration.
- Incentive policies and government engagement. Collaborating with local authorities (Ministry of Agriculture, District Agricultural Department) to include no-till farming in agricultural support programs, training government agents, and developing brief recommendations on safety precautions and regulations.
- Systematic data collection on costs, yields, water consumption, and soil quality; preparation of brief case studies for various typical farms.

If most of the barriers above are addressed, revolving funds are set up, and existing and new mechanization service providers are equipped with no-till seeders, accompanied by an advisory support program, the following results are projected to be achieved within the first 3-5 years of the programme:

20 to 50 machinery service providers will provide direct seeding services, each on approximately 1,000 ha annually using 4-5 no-till seeders, resulting in a total area of 20,000-50,000 ha.

The share of farmers implementing no-till technology on a regular basis will increase by 20-30% annually.

With an average farm size of 2 hectares, the adoption of direct seeding technology is expected to reach 10,000 to 25,000 farmers nationwide, assuming overall no-till adoption to reach 20,000 to 50,000 ha.

These projections are based on the current pace of no-till adoption in pilot projects in the Kyrgyz Republic, as well as the proven economic and environmental benefits of this technology, including reduced fuel costs, improved soil water management, and increased yield resilience in a changing climate.

Tajikistan

Despite growing interest in climate-smart agriculture, the adoption of direct seeding and CAg in Tajikistan faces multiple challenges:

Logistical Barriers

- Limited availability of no-till seeders and adapted machinery; most equipment is imported and expensive.
- Spare parts shortages and lack of local repair services.

- Crop residue management difficulties, especially in rainfed areas: due to widespread pasture degradation and limited access to still productive pasture lands, it is common practice for farmers to graze their animals on stubble left after harvest. In irrigated systems, it is important to integrate fodder crops into the crop rotation system and accommodate fodder needs.
- Weed control challenges under CAg systems, requiring integrated solutions.

Knowledge Related Barriers

- Low awareness of CAg benefits among farmers and extension agents.
- Lack of practical training materials in Tajik language.
- Insufficient technical capacity for the preparation/calibration of the no-till seeder, residue handling, and crop rotation planning.

Financial Barriers

- High upfront cost of machinery and limited access to credit/leasing.
- Absence of revolving funds or flexible financing mechanisms for seeds, fertilizers, and plant protection products.
- Limited number of private service providers offering mechanization services.

Other Barriers

- Cultural preference for conventional tillage due to perceived yield risks.
- Weak policy support; CAg is not yet mainstreamed into national agricultural programs. (Muminov, 2020; Khakimov, 2025)

To overcome these barriers, the following interventions at the level are key:

Institutional arrangement and Capacity Building

- Training for agronomists, service providers, and farmer leaders on direct seeding, residue management, weed control, the use of cover crops, and crop rotation.
- Development of simple teaching materials in Tajik language.
- Farmer Field Schools and demonstration plots comparing CAg vs. conventional tillage.

Mechanization and Technology Access

- Support the creation of rental centers, private service providers, and cooperatives equipped with no-till seeders (disc seeders, rotary seeders).
- Promote local assembly and repair services.
- Provide guarantees and credit support for machinery service providers.

Financial Mechanisms

- Facilitate partnerships with banks and microfinance institutions to reduce risk during transition.

Advisory and Technical Services

- Offer guidance on weed control, cover crops, biomass management, and residue levelling.
- Organize farm-level demonstrations to show economic and yield benefits of CAg.
- Increase the number of Extension Service Providers (ESPs) and agriculture advisors to promote CAg among larger groups of farmers.

Drawing on Tajikistan's agricultural structure and lessons learned from Kyrgyz Republic, the following projections outline the potential for scaling direct seeding and other CAg practices:

1. Projected Service Providers and support of ESPs

Within the first 3–5 years, it is anticipated that 15–30 specialized machinery service providers will be supported (demand-based). These providers will play a critical role in offering custom-hire services for direct seeding, reducing the need for individual farmers to invest in expensive equipment. Service providers may operate as private enterprises, cooperatives, or rental centers, ensuring wider accessibility for smallholder farmers.

2. Annual Coverage per Provider

Each service provider is expected to manage 800–1,000 ha annually, utilizing 4–5 no-till seeders adapted to local conditions. This level of coverage will allow providers to serve multiple districts and ensure timely planting during the short sowing windows typical in Tajikistan's agro-ecological zones.

3. Total Area Covered

By the end of the initial 3–5-year period, the cumulative area under direct seeding could reach 10,000–15,000 ha. This expansion will significantly contribute to soil conservation, water-use efficiency, and climate resilience, particularly in rainfed farming systems where erosion and moisture loss are major concerns.

4. Farmer Adoption

Assuming an average farm size of 2 ha, the adoption would involve 7,500–15,000 farmers nationwide (up to 5,000 farms in the target regions). These farmers will benefit from lower fuel costs, improved soil health, and enhanced yield stability, making CAg an attractive option for smallholders facing climate variability.

5. Adoption Growth

The adoption rate is expected to increase by 15–25% annually, driven by:

- Demonstration effects from pilot farms showcasing economic and agronomic benefits;

- Financial incentives such as revolving funds, leasing schemes, and subsidies for machinery services;
- Capacity-building programs that strengthen farmer knowledge and confidence in CAg practices.

Several actors, such as the Cooperative Sarob, have extensive experience with promoting and implementing CAg through capacity building and organization of demonstration plots.

1.6.3 Proposed climate-resilient technology: conservation agriculture in rainfed cereal production

Soil organic matter (SOM) is a crucial buffer against the increasing rainfall variability that is already being observed in the target countries (see Section 1.5). SOM enhances soil structure, water infiltration and the water storage capacity of soils, thus reducing surface runoff and erosion during heavy rainfall events and enhancing soil moisture, which mitigates water stress for crops during extended drought conditions. In the target countries, unsustainable agricultural practices have led to extensive soil degradation, i.e. to a loss of SOM and, ultimately, to reduced soil fertility. Traditionally, seedbed preparation involves several operations, including ploughing, disking and harrowing, aimed at killing emerging weeds prior to seeding the crop and creating a bed to plant seeds. However, the combination of inversion tillage, failure to apply nutrients at sufficiently high and balanced levels, and low biomass restitution to the soil results in a progressive degradation of its natural structure and fertility. Such degradation is the consequence of both mechanical damage to the soil (compaction and pulverization) and an associated decline in SOM and biodiversity (Corsi & Muminjanov, 2019).

Conservation agriculture (CAg) is a globally recognized management practice that can prevent soil degradation and regenerate degraded lands by protecting the soil against erosion and restoring SOM. CAg is based on three principles (Corsi & Muminjanov, 2019):

1. **Minimum mechanical soil disturbance** through minimum/zero tillage;
2. **Maintenance of a permanent soil cover** through crop residues and/or cover crops; and
3. **Diversification of plant species**, especially through rotation of grain and nitrogen-fixing legume crops.

The combination of all three CAg principles provides a particularly broad range of benefits in terms of (i) enhanced productivity, (ii) climate resilience (adaptation), (iii) reduced GHG emissions (mitigation), (iv) enhanced soil health, and (v) water savings (FAO, 2022a; WWF, 2018). More specifically, CA related benefits are:

- **Reduced production costs and time savings** (crop establishment in one single tractor operation) while typically leading to increased yields;
- **Increased water infiltration and water storage**, and reduced evaporation;
- **Enhanced soil fertility** (especially if crop rotation with legumes is applied)
- **Soil protection** against water and wind erosion; consequently
- **Reduced dust loads**; dust impairs photosynthesis of plants; and
- **Reduced GHG emissions** (CO₂, N₂O) through reduced fuel use and reduced soil degradation processes.

Hence, taking CAg to scale as a climate change mitigation and adaptation initiative has multiple co-benefits for farmers, the environment, and society at large (WWF, 2018). CAg provides substantial benefits in terms of reduced soil erosion and improved soil health also under conditions of only partial residue retention, e.g. where livestock graze on stubble after harvest, which is of great relevance to its application in the target countries. No-till technology has been successfully adopted at significant scale in neighboring Kazakhstan (World Bank, 2013). CAg has expanded rapidly as a farming practice in recent years, increasing from 106.5 million hectares in 2008/2009 to 205.4 million hectares in 2018/2019 worldwide, commensurate to roughly 14.7% of the world's total cropland. This trend demonstrates a significant rise in farmer engagement with this practice. This expansion is driven by two principal factors: (i) improved networking and organization among farmers, and (ii) increased allocation of resources and attention from stakeholders to support adoption and knowledge dissemination.

Proposed programme interventions

To promote the use of CAg among the target beneficiaries, the programme will support the following technologies and practices through investments and technical assistance:

- **No-till seeding**: the continuous use of plows at the same depth and the passage of machinery result in the creation of compact subsurface layers ('plow pan'). This leads to a breakdown of soil aggregates and a reduction in the pore spaces within the soil that are vital for plant growth. Water infiltration and retention are drastically reduced, with a simultaneous increase in surface run-off and loss of soil, nutrients, and organic matter (Corsi & Muminjanov, 2019). No-till seeding prevents these harmful effects

and provides crucial adaptation benefits in view of increasing rainfall variability, with both prolonged periods of drought and high-intensity rainfall events (see Section 1.5).

- **Cover crops** are both an adaptation and mitigation strategy to climate change, offering diverse services including erosion control and biological control of nematodes and weeds; cover crops can enhance soil fertility when legumes are used (Corsi & Muminjanov, 2019). Cover crops are not intended to be harvested, but they contribute to the quality and fertility of the soil. Common cover crops include legumes (e.g., red clover, peas, beans), grasses (e.g., barley ryegrass, millet), and broadleaf species (e.g., buckwheat, mustard; GIZ/Risha Solutions, 2023). Apart from protecting the soil against erosion and enhancing soil organic matter and fertility, legumes such as clover can also serve as fodder to reduce the grazing pressure on pasture.
- **Crop rotation** enhances soil fertility (as crops have different nutrient requirements) and prevents the accumulation and spread of soil-borne pests and diseases and pests, thus providing important adaptation benefits. Smallholder farmers in the programme area do not usually practice crop rotation because they may not be aware of its benefits, or they may not know how to transition to a crop rotation system. In particular, the inclusion of **drought resistant oilseed crops** (e.g. sunflower, safflower) and **legumes** (chickpeas, green peas, lentils) should be promoted. The latter produce and store nitrogen in the soil and thus improve soil fertility while most of these crops are also important for pollinators (GIZ/Risha Solutions, 2023). Legumes in crop rotations can also include protein-rich fodder crops such as alfalfa to help ease the pressure on pasture land.
- **Improved plant nutrition and pest management:** good agronomic practices with respect to balanced use of mineral fertilizers and effective pest management complement the use of no-till seeding, cover crops, and suitable crop rotations. The use of mineral fertilizers is indispensable for achieving acceptable yield levels, especially under the conditions of a rapidly growing population and scarcity of arable land found in the target countries. An issue of greater concern than the total quantity of nutrients applied is the typically imbalanced use of fertilizers, which tends to be heavily biased towards nitrogen (i.e. urea application) while the application of phosphorus and potassium is largely neglected. Hence, training farmers on proper usage of mineral fertilizers would likely lead to significant productivity increases in the cropping sector, thus further enhancing the sector's resilience against climate change conditions, while reducing GHG emissions, nutrient loss and eutrophication of water bodies.

The **financial support** by the programme will focus on making no-till seeders available and accessible to smallholder farmers. **Technical assistance** will encompass the training of farmers and no-till service providers (see below) as well as capacity development on the other components of CAg listed above, which are crucial for reaping maximum climate resilience benefits.

2. Fruit trees

2.1 Relevance

Fruit production plays a vital role in the economies and agricultural landscapes of Central Asia, being of high relevance for food security and providing employment to many. In KG, diverse climatic conditions favour the cultivation of various fruits, thereby boosting local economies. The country's mountainous terrain contributes to the production of unique and high-quality fruit varieties. TJ leverages its fertile valleys to produce fruits that are both consumed domestically and exported. UZ is renowned for its extensive orchards, which supply a significant share of the region's fresh fruits produce. The export of fresh and dried fruits from the target countries enhances regional trade and strengthens economic ties with other countries.

2.2 Production volumes and key production areas

Based on the latest agricultural statistics available, Table 11 summarizes the area devoted to fruit trees, total fruit production, and average productivity. In the area considered, fruit production is largely dominated by apricot. Apart from providing statistics at national level, the table includes data for the provinces that make up the two intervention areas, i.e. (i) the 'Fergana Valley' (FV) which encompasses provinces in all three target countries (shaded in light blue) and (ii) 'Khatlon & Surkhandarya' (KS), two bordering provinces in Tajikistan and Uzbekistan. In FV and KS areas, the cultivation of fruit trees occupies around 90,500 ha and 32,300 ha, respectively. Production amounts to approximately 491,000 MT in FV and 291,000 MT in KS. The table shows that the productivity of fruit orchards within FV ranges from around 3.8 MT/ha in Batken province of KG to 25.2 MT/ha in Andijan province of UZ. In both Khatlon and Surkhandarya, yields of around 9 MT per ha are achieved.

In Tajikistan, statistics show that around 47.8% of orchards are located in Sughd, with only 33.5% of the volume of production, as they are often low yielding apricots. Khatlon accounts for 41.5% of production on 25.6% of the area. Apricot orchards dominate especially in Sughd region with about 46000 ha, in Khatlon region total apricot orchards are estimated at about 5000 ha.

Table 11: Fruit production statistics (2023) for the target countries and intervention areas

Country/province	Area covered by fruit trees (ha)	Fruit production (MT/year)	Average yield (kg/ha)
Total Kyrgyz Republic (KG)	12,769	59,871	4,689
Batken (KG)	7,445	28,228	3,792
Jalalabad (KG)	850	4,514	5,311
Osh (KG)	1,141	6,717	5,887
Total Tajikistan (TJ)	119,701	664,343	5,550
Khatlon (TJ)	30,591	276,234	9,030
Sughd (TJ)	57,205	222,526	3,890
Total Uzbekistan (UZ)	39,343	451,263	11,470
Andijan (UZ)	2,686	67,697	25,200
Fergana (UZ)	18,872	138,335	7,330
Namangan (UZ)	2,263	23,349	10,320
Surkhandarya (UZ)	1,734	15,227	8,780
Total 'Fergana Valley'	90,462	491,366	5,432
Total 'Khatlon & Surkhandarya'	32,325	291,461	9,017

Fergana Valley Khatlon/Surkhandarya

Source: Various national and provincial agricultural statistics

Both at national level and within the provinces making up the intervention areas, Table 12 lists the major fruit producing areas and their relative production shares.

Table 12: Major fruit production areas in the target countries and intervention areas

Country/province	Fruit production (MT/year)	Major production areas	% production
Total Kyrgyz Republic (KG)	59,871	Batken Issik kul Osh	47.1 32.2 11.2
Batken (KG)	28,228	Batken Kadamjay Leylek	44.9 30.8 18.5
Jalalabad (KG)	4,514	Nooken Toktogul Aksiy	33.8 19.5 15.5
Osh (KG)	6,717	Nookat Karasu Aravan	42.9 24.1 21.8
Total Tajikistan (TJ)	664,343	Khatlon Sughd	41.6 33.5
Khatlon (TJ)	276,234	Dangara Jayhun Shamsiddin Shohin Kushoniyon	12.2 7.5 6.4 6.2
Sughd (TJ)	222,526	Asht Isfara Konibodom Ghafurov	26.0 19.6 18.4 14.3
Total Uzbekistan (UZ)	451,263	Fergana Bukhara Andijan Samarkand	30.7 20.3 15.0 7.5
Andijan (UZ)*	67,697	Asaka Marhamat Shahrihon Andijon	20.5 11.0 10.4 10.3
Fergana (UZ)*	138,335	Beshariq Rishton Farg'ona Bag'dod	15.3 14.9 13.0 8.0
Namangan (UZ)*	23,349	Chotoq To'raqo'rg'on Yangiqo'rg'on Chust	22.3 20.0 17.7 14.7

Surkhandarya (UZ)*	15,227	Sherobod	23.3
		Qumqo'rg'on	19.8
		Boyson	9.5
		Termiz	8.9

Fergana Valley Khatlon/Surkhandarya

Source: Various national and provincial agricultural statistics

2.3 Description of the value chain

2.3.1 Physical and legal entities involved in the value chain

Stakeholders in the fruit value chain can be categorized into five groups:

- Governmental and non-governmental entities at national and regional levels, e.g. the state-controlled LLC “Uzagrostar xolding”, "Union of exporters of fruit and vegetable products of Uzbekistan", Chamber of Commerce in UZ; Association for Development of the Agro-Industrial Complex, Association of Berry Growers, The Chamber of Commerce and Industry in KG, Chamber of Commerce and Industry, Committee on Food Security in TJ. These entities in addition to Ministries of Agriculture of three countries, support to the development of fruit and vegetable production, their processing and export and also provide consulting services.
- Farmers (see ‘Production’ below) and other types of producers;
- Cooperatives
- Private sector actors, such as input providers (see ‘Inputs’ below), intermediaries engaged in the purchase, storage, transportation and marketing of apricot, processing companies and exporters
- Consumers, i.e. the entire rural and urban population.

2.3.2 Inputs

Apricot seedlings are mainly domestically grown in the three target countries where price of seedling is almost the same as around 1.00 USD/per seedling. The seed sector is supported by government programs and international NGOs with the aim of improving seedlings quality and productivity. Additionally, seed research and educational institutes are also conducting research to increase the resistance of apricot seedlings to climate and various diseases, as well as to increase their yield.

Mineral fertilizers are domestically produced in UZ, whereas in KG and TJ they are mostly imported from Russia, Kazakhstan, China, and UZ. Average fertilizer prices are presented in Table 4 (Section 1.3.2). Table 13 lists major input providers for apricot production.

Table 13: Major providers of inputs for fruit tree cultivation in the target countries

Type of input	Kyrgyz Republic	Tajikistan	Uzbekistan
Seedlings	• Fruit nurseries located in different regions • Farmer's own seedling (rare) • Experimental stations of the research institutions • Import of seedlings from Europe, Turkey, and informally from UZ and TJ	• Seedling farms located in different regions • Farmer's own seedling • Experimental stations of the research institutions	• Seedling farms located in different regions • Farmer's own seedling • Experimental stations of the research institutions
Fertilizers	• ATS Group Ltd. • Agrostyle Ltd. • Agrokhimia Ltd. • Alem Agro Keidji Ltd. • Bai Diykan Ltd.	• Local producers (esp. TA-JIKO Chemical, Azot) • Imported fertilizers: Uralkhim (Russia), Uzkimiyosanoat (UZ)	• Uzkimiyosanoat and its sub-organizations, esp. MAXAM-Chirchiq, Farg'onaazot, Ammofos-Maksam

Agricultural machinery is mostly imported in the target countries. Further details are provided in Section 1.3.2.

2.3.3 Production

In all three target countries, dehqan farms and households are predominant in apricot production. Cooperatives (especially well developed in TJ) support farmers in accessing inputs and sharing machinery. In the Kyrgyz Republic, most machinery services are private. The share of farms in total apricot production in Uzbekistan is 39%, dehqan farms and households 58.6%, and organizations engaged in agriculture activity 2.4% (National Statistics Committee of the Republic of Uzbekistan, 2024). See section 4.2 for total production, average yield and key production areas data. In TJ, average production costs amount to USD 2,178 per ha (no data available for KG and UZ).

2.3.4 Processing/storage

Farmers typically sell their fruits to processing companies, wholesalers and exporters who then sell the processed products onto foreign markets or directly to local retailers. Dehqan farms and households sell their products in local markets themselves or sell to intermediaries. Therefore, the number of intermediaries of the

apricot value chain in the target countries depends on producers, on the availability of cold storage, on the level of processing etc.

The level of cold storage is a problem in all three republics. The level of cold storage in farmers' and peasant farms is limited, although in the main production areas, a number of small, often home-made, cold stores exist. If farmers are members of cooperatives, the situation is somewhat better. Otherwise, farmers are forced to sell apricots at low prices, because they cannot afford to store them in cold storage; storage in private sector cold storage can be expensive for them. This also prevents access of smallholders in the export market, as post-harvest cold storage of apricots is key to preserving their quality while filling 20t trucks for export.

Small-scale producers, such as dehqan farms and households, have relatively limited participation in the value chain, are cut off from external markets, and are therefore limited to traditional apricot processing, such as drying and making jam for their own consumption. In Batken (Kyrgyz Republic) and Khujand (Tajikistan), there are also apricot varieties that are specially made for drying. In Batken district around 70% of all apricots are drying varieties. Most primary drying and storage is done on-farm which in the case of poor storage condition leads to insect infestation. Most farmers sell their dried apricots in the local market, where they are bought by traders linked to processors in Tajikistan (doing washing, sorting, calibration, redrying, packing, exporting). There are also one or two such companies operating in Batken district in the Kyrgyz Republic.

The marketing appearance, quality, and added value of apricots dried in the open air using traditional methods are significantly lower and do not generate high profits. They do not meet food safety (hygienic) requirements and do not have certificates. Fruit processing is mainly carried out by large processing enterprises under conditions consistent with international certificates and is exported to foreign markets at high prices.

The dried apricot VC in Batken district goes as follows:

Table 14 provides a qualitative assessment of the adequacy of fruits storage facilities in the target countries in terms of both capacity and quality.

Table 14: Adequacy of fruits storage facilities in the target countries

Criteria	Kyrgyz Republic	Tajikistan	Uzbekistan
Storage capacity (1 = clearly insufficient; 2 = slightly insufficient; 3 = just sufficient; 4 = fully sufficient)	2 (cold storage capacities slightly improved following investments in 2024 and 2025)	1	1
Storage quality in terms of infrastructure and service (1 = large storage losses; 2 = moderate storage losses; 3 = minor storage losses; 4 = fully adequate storage quality)	1	1	1

Note: Assessment based on expert judgment by the consultant team; the national-level scores also apply to the provinces in the intervention areas

2.3.5 Trading

Table 15 provides an overview of fresh fruit exports from the target countries, indicating the main trade partners. KG and, in particular, UZ export significant amounts of fresh fruits, while in TJ such exports are much more limited. The Russian Federation and Kazakhstan are the primary countries exported to. In UZ, fruit exports exceed imports manyfold, while in the other two countries imports and exports are somewhat more balanced, although this is highly contingent upon the yield of individual years.

*Table 15: Imports and exports of fresh fruits in the target countries (in USD)**

		2021	2022	2023
Total imports Kyrgyz Republic:		18,777,242	14,452,382	18,721,130
Total exports Kyrgyz Republic:		10,214,637	15,835,845	9,753,568
Main countries exported to:	Russian Federation	6,818,983	11,663,905	5,632,344
	Kazakhstan	2,715,255	4,074,609	3,737,812
	Uzbekistan	564,772	40,207	157,923
Total imports Tajikistan:		1,601,923	1,685,496	N/A
Total exports Tajikistan:		2,486,482	3,785,918	N/A
Main countries exported to:	Russian Federation	1,160,552	2,037,597	
	Kazakhstan	1,263,273	1,656,646	
	Kyrgyz Republic	45,850	-	
Total imports Uzbekistan:		10,274,861	19,018,804	25,177,376

Total exports Uzbekistan:		202,125,850	213,963,559	258,395,338
Main countries exported to:	Russian Federation	98,308,982	144,193,742	170,744,689
	Kazakhstan	55,448,529	50,337,394	34,878,191
	Other countries	N/A	N/A	18,000,000

Source: UN Comtrade; *Imports are CIF values, exports are FOB values; N/A = data not available

The export of dried fruits is of relevance in all three target countries, as shown in Table 15. Apart from the Russian Federation and Kazakhstan, dried fruits are also exported to the EU and to China. For KG and TJ, the value of dried fruit exports is much higher than that of fresh fruit exports, while for UZ the opposite is the case.

Table 16: Imports and exports of dried fruits in the target countries (in USD)*

		2021	2022	2023
• Total imports Kyrgyz Republic:		2,311,315	1,427,302	517,884
• Total exports Kyrgyz Republic:		17,018,488	33,003,911	18,025,217
Main countries exported to:	Russian Federation	15,114,885	28,865,562	13,910,832
	Germany	1,120,987	1,628,008	2,440,889
	Kazakhstan	90,913	1,768,399	1,095,964
Total imports Tajikistan:		1,452,147	2,367,962	N/A
Total exports Tajikistan:		15,553,584	25,181,101	N/A
Main countries exported to:	Russian Federation	8,185,595	13,412,596	
	Kazakhstan	5,610,869	9,915,780	
	Belarus	780,773	1,334,357	
Total imports Uzbekistan:		143,042	1,086,172	1,065,662
Total exports Uzbekistan:		44,047,374	52,714,182	87,173,633
Main countries exported to:	China	650,524	7,436,214	23,755,213
	Russian Federation	8,892,124	15,470,591	19,059,175
	Kazakhstan	15,646,770	10,523,043	11,724,971

Source: UN Comtrade; *Imports are CIF values, exports are FOB values; N/A = data not available

The export of dried apricots accounts for a significant share of dried fruit exports, especially in TJ (Table 17).

Table 17: Imports and exports of dried apricots in the target countries (in USD)*

		2021	2022	2023
• Total imports Kyrgyz Republic:		1,163,994	587,960	83,276
• Total exports Kyrgyz Republic:		9,100,645	2,671,646	1,146,487
Main countries exported to:	Russian Federation	8,929,375	2,393,069	991,033
	Kazakhstan	25,468	113,762	25,551
	Azerbaijan	29,400	100,000	-
Total imports Tajikistan:		1,422,800	2,352,514	N/A
Total exports Tajikistan:		9,888,029	15,118,998	17,600,000
Main countries exported to:	Russian Federation	5,489,765	9,235,982	
	Kazakhstan	3,091,966	4,748,090	
	Belarus	555,633	771,607	
Total imports Uzbekistan:		98,744	952,776	776,004
Total exports Uzbekistan:		6,573,613	5,803,278	19,764,319
Main countries exported to:	Russian Federation	1,827,210	2,483,141	2,726,709
	China	304,107	46,169	4,253,840
	Türkiye	47,602	17,378	4,262,286

Source: UN Comtrade; *Imports are CIF values, exports are FOB values; N/A = data not available

2.4 Enabling environment

Kyrgyz Republic

- i. State Program "Financing of Agriculture": The program is intended to provide financial state support to farmers and entrepreneurs at preferential interest rates. The program offers preferential loans at an annual interest rate of 10% for crop production, livestock farming, water-saving irrigation technologies, greenhouse farming, and agricultural machinery leasing. Loan terms vary: up to 300,000 soms for livestock and crop production without collateral, up to 1 million soms with collateral, up to 1 million soms for irrigation and greenhouse projects with collateral, and up to 50 million soms for machinery leasing over seven years with a 20% initial payment, where the leased equipment serves as collateral. In 2024, a total of 4.8 billion KGS in preferential loans were issued under the "Financing of Agriculture-12" program.
- ii. Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 671, dated December 12, 2023, "On the Approval of the Program for the Development of the Food and Processing Industry of the Kyrgyz Republic for 2023-2027 with the Application of Cluster Development".
- iii. Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 574, dated September 13, 2024, "On the Approval of the Program for the Development of Trade and Logistics Centers in the Agro-Industrial Sector of the Economy of the Kyrgyz Republic for 2024-2028".
- iv. Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 270, dated November 17, 2021, "On the Approval of the Program for the Support and Development of Women's Entrepreneurship in the Kyrgyz Republic for 2022-2026".
- v. Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 81, dated February 20, 2025, "On the Approval of the Program for the Formation and Development of Growth Nodes in the Regions of the Kyrgyz Republic for 2025-2030".
- vi. Order of the Cabinet of Ministers of the Kyrgyz Republic No. 285, dated May 29, 2023, Action Plan for the Implementation of the National Economic Project "One Village - One Product" until 2026.
- vii. Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 633, dated October 14, 2024, "On the program for the development of horticulture and viticulture in the Kyrgyz Republic for 2025-2029".
- viii. Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 138, dated March 5, 2026, "On approving the action plan for the creation of agricultural cooperatives and providing them with accessible support".
- ix. Order of the Cabinet of Ministers of the Kyrgyz Republic No. 107, dated March 25, 2024, "On the Program for Increasing Soil Fertility in the Kyrgyz Republic for 2024-2028".

Tajikistan

- i. Program for the Development of Horticulture, Viticulture, and Citrus Growing Sectors (2025-2029): The program's purpose is to provide the population with respective food products, supply raw materials to processing enterprises, develop the country's exports, and reduce its dependence on imported products. For the target sectors, the program analyses the current situation and main constraints and, with job creation, conservation of agricultural lands, and greenhouse gas mitigation in mind, defines goals, tasks, and development pathways for the period 2025-2029.
- ii. Program for the Development of the Agrifood System and Sustainable Agriculture for the period up to 2030 (Government Resolution No. 54, dated 01.03.2023): The program is aimed at ensuring food security, increasing crop yields, implementing digital technologies, and creating effective production and marketing chains.

Uzbekistan

- i. Presidential Decree No. PF-22 dated 14.02.2025 "On additional measures for the implementation of a modern organizational system and the financial support of the activities of owners of household plots and peasant farms": Through these measures, financial support is provided through grants, subsidies, and preferential loans, including annual grants for exemplary farm projects, subsidies for master farmers conducting training and export-oriented production, and loans for agricultural production, processing, and storage at a rate of 4 percentage points above the Central Bank's base rate. Additionally, leasing options for agricultural equipment and greenhouses are available with a 24-month grace period, and from May 1, 2025, the Council will introduce a rating system for exemplary farms and greenhouses to enhance their prestige and market competitiveness.
- ii. Presidential Decree No.151 dated 30 September 2024 "On additional measures to introduce new market mechanisms in the agro-industrial sector in the Republic and create industrialized orchards and vineyards". Through this decree, starting in 2025, only certified seedlings from specialized nurseries will be used in new orchards, with a three-year guarantee until they bear fruit, and modern water-saving technologies will be mandatory. Financing for new orchards will be provided through commercial banks in stages, covering land preparation, seedling acquisition, irrigation system installation, and orchard maintenance, with loans available at 4 percentage points above the Central Bank's key rate for seven years, including a three-year grace period; similar conditions apply to fruit sorting, packaging, and processing projects. Additionally,

USD 8 million from international grants will be allocated to build an in-vitro laboratory and seedling complex in Tashkent, and until 2028, orchard creators are exempt from VAT and customs duties on imported grafted seedlings and equipment.

- iii. Presidential Decree No. PF-36 dated 16.02.2024 "On additional measures to ensure food security in the Republic". According to this decree, by March 1, 2024, USD 220 million from international financial institutions will be transferred to commercial banks to provide preferential loans at 4 percentage points above the Central Bank's key rate, with terms of up to 10 years for food sector projects and 18 months for working capital. Additionally, the Export Support Fund will offer preferential loans for up to two years to food exporting enterprises based on their export volume, with interest rates not exceeding 4% annually; however, if the export volume does not grow by at least 20% within a year after receiving working capital, the loan will be reclassified as a commercial loan. Furthermore, subsidies covering 50% of costs (up to 500 million UZS) will support businesses in implementing international quality management systems and purchasing essential equipment for compliance with International Accreditation Forum (IAF) standards.
- iv. Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 458 of 24.07.2021 "On approval of the regulation on allocation of subsidies to members of agricultural associations, participants of fruit and vegetable clusters and business entities for reimbursement of partial costs on purchase of intensive seedlings of fruit and vegetable, grape products and seedlings of industrial vineyards and cuttings grown in local conditions": based on this resolution, applicants who have established or plan to establish new intensive orchards, food, and raisin vineyards will receive subsidies to cover part of the costs of purchasing seedlings and grafts. The subsidy amounts are set per unit, with UZS 8,000 for intensive fruit seedlings, UZS 2,500 for intensive fruit grafts, and UZS 5,000 for both vine seedlings and vine grafts. These financial incentives aim to support the expansion of modern orchards and vineyards by reducing the costs of high-quality planting materials.

2.5 Climate risk and impact

According to a study conducted in the Fergana valley covering nine districts across the Namangan and Fergana regions, rising temperatures during growing seasons have already led to delayed flowering of fruit crops, reducing yields and fruit quality. Prolonged heatwaves have decreased fruit quality and reduced the viability of certain species, such as figs, which are increasingly nonviable in some regions (Salokhiddinov et al., 2020a). Mild winters have become more common, which can reduce chilling accumulation (critical for breaking dormancy and bud development in spring) and induce relatively early-flowering of apricots and other fruit trees; in parallel, late frosts in March and early April have also become more frequent, e.g. in Sughd province which is one of the major apricot growing areas in TJ. Late frosts during the critical flowering period necessitate effective protection, or else entire harvests can be lost. Apart from apricot trees, also apple, plum, pear and cherry trees are very sensitive to late frosts (FAO & WFP, 2023).

The fruit crops most sensitive to winter frost in the intervention area are pomegranate, almonds, grapes, citrus, and figs, with harvest losses following particularly cold winter temperatures of -25°C in 2023 ranging from 20 to 100%, depending on species and location; in some cases cambium and sapwood froze, causing death of branches or entire trees. By contrast, apricot, apple, and pear orchards were reported as not affected by the 2023 winter frost (FAO & WFP, 2023).

Shifting precipitation patterns and decreasing snow cover have lowered water availability for irrigation, impacting fruit trees that depend on consistent watering. Moreover, a 20% decrease in Syr Darya river flows under high-emission scenarios threatens irrigation systems that sustain fruit tree productivity. Additionally, heavy and irregular rainfall can increase soil erosion and damage the roots of perennial fruit trees (Salokhiddinov et al., 2020a).

A decline in fruit and tree product quality due to temperature extremes and water scarcity was already reported by 93.5% of surveyed farmers (Salokhiddinov et al., 2020a). By 2030, the Fergana Valley is expected to experience more frequent heatwaves, with temperatures surpassing 40°C during peak summer months. Hence, the productivity of fruit trees is expected to further decline as heat stress and water scarcity intensify (Salokhiddinov et al., 2020a).

However, the intervention area is also a center of origin and diversity for many fruit crops (Kotowski et al., 2022), and local traditional cultivars include traits such as drought and frost resistance. Hence, vulnerability to climate risks can be highly cultivar-specific, even within species, as shown in Table 18 for apricots.

Table 18 Apricot cultivar-level differences in vulnerability to climate related risks

Cultivar	Frost sensitive	Relatively frost resistant	Relatively drought resistant	Relatively disease resistant
Arzami		X	X	X
Gulistan		X		
Kandak	X			
Kich Pishar		X		X

Kursadik	X		
Navruz		X	
Rukhi djuvanon miona		X	X
Supkhani	X		
Zarafshansky pozdny		X	

Source: (Zaurov et al., 2013)

Implications for pests and diseases

With progressing climate change, rising temperatures and changing precipitation are likely going to (FAO & WFP, 2023):

- increase overwinter survival of some pests
- allow one to five extra life cycles per year
- shift pest ranges northward and upslope
- alter the timing of pest emergence relative to host phenology
- increase some fungal and bacterial diseases in wetter/humid periods
- intensify mite and sucking-insect pressure in hotter, drier conditions

Pest and disease groups that are likely to proliferate under changing temperature and precipitation regimes include (*ibid.*):

- Sap-sucking insects: aphids, psyllids, whiteflies, leafhoppers
- Mites: favored by hot, dry conditions
- Borers and moths: e.g., codling moth-type pressures in pome and stone fruit systems
- Fruit flies
- Fungal blossom and fruit rot after irregular rain or humidity spikes
- Canker and wood diseases on stressed trees
- Scab and shot-hole-type diseases in susceptible orchards under wet conditions

Regarding the major fruit tree species in the intervention area, the following pests are likely to exert increasing pressure (*ibid.*):

- Apricot: codling moth, moniliasis, shot-hole blight
- Apple: aphids, codling moth, apple scab, wood canker
- Peach/cherry: wood canker; cherry fruit fly
- Walnut: codling moth

Implications for natural enemies and pollinators

Climate change is likely to affect not only pests and diseases, but also the beneficial organisms that help regulate them. In orchard systems, predators, parasitoids, and entomopathogenic microorganisms may become less effective when climate change alters temperature, humidity, and seasonal timing. More variable conditions can disrupt the synchrony between pests and their natural enemies, potentially allowing pests to emerge earlier or increase more rapidly than the beneficial organisms that normally suppress them (Jeffs & Lewis, 2013; Thomson et al., 2010). As a result, biological control may become less reliable under warmer and more unstable climatic conditions (FAO & WFP, 2023; Salokhiddinov et al., 2020b).

In practical terms, this means that orchard systems may face:

- earlier pest outbreaks before parasitoids or predators are fully active;
- weaker natural suppression of aphids, moth larvae, and other orchard pests;
- reduced effectiveness of microbial biocontrol agents under hotter, drier, or otherwise less favorable environmental conditions.

Climate change can also alter pollinator distributions, seasonal activity, and interactions with flowering plants. Warmer temperatures, drought, and extreme weather may disrupt pollinator–flower synchrony, reduce floral resource quality, and constrain pollinator foraging, with possible consequences for fruit set and yield (Hegland et al., 2009; IPBES, 2016; Scaven & Rafferty, 2013; Vanbergen, 2013). This risk is especially important in apricot systems, because many Central Asian apricot cultivars are self-incompatible and therefore require compatible pollinizers for good fruit set. Cultivars such as ‘Arzami’ and ‘Kursadik’ have proven to perform well as pollinizers for many other Central Asian apricot cultivars, underlining the importance of orchard pollination design in climate-stressed production systems (Zaurov et al., 2013).

2.6 Climate-resilient technologies and adoption

2.6.1 Status quo regarding the adoption of climate-resilient fruit production

Kyrgyz Republic

In 2023, the Government of the Kyrgyz Republic adopted legal changes to bring low-productivity pastures into productive agricultural use. A key strategy is to convert some of this land to intensive fruit orchards to enhance food supply, support exports, and raise competitiveness.

It is estimated that currently around 10% of fruit farms in the Kyrgyz Republic use improved, intensive production practices and technologies, i.e. semi-dwarf and dwarf cultivars. In the target regions, this share is lower; however, the actual adoption rate depends on what constitutes an 'improved' production practice. In Masaliev municipality of Kadamjay district, for example, around 60% of fruit farmers are estimated to have adopted some improved practices. In Orozbekov municipality, also in Kadamjay district, however, this figure is less than 5%. In Batken region, a local agronomist estimated that around 5% of farmers have adopted improved practices, in particular following recommendations of agronomists regarding fertilizer types and doses, pest and disease management practices, and better pruning.

Of the climate-resilient fruit cultivation technologies, only drip irrigation systems combined with pumps and water reservoirs are used, albeit not widely. Few farmers use drip irrigation if they have access to irrigation water through channels; however, cases where farmers do not receive sufficient water through these channels are becoming more frequent. Drip irrigation systems are almost exclusively used on unproductive, rainfed land where, without such systems, fruit cultivation would be impossible.

Information about climate-change-resilient rootstocks and cultivars is not widely accessible in the Kyrgyz Republic. Rootstocks and cultivars are selected according to market potential and growth rather than their resilience to climate change hazards such as drought, late frost, and extreme heat.

Despite the increasing frequency of early flowering and subsequent frost damage or weak pollination due to rain or cold weather during the flowering period of apricots in Batken, no systematic efforts have yet been undertaken to protect apricots against frost or promote pollination under cold and rainy conditions. In some cases, farmers burn straw and old tires to raise temperatures in frosty nights, leading to air pollution and significant GHG emissions. Due to lacking irrigation water in early spring, frost protection irrigation using sprinklers is not an option.

In the apple-growing areas of Nookat district (Osh region), hailstorms frequently affect the apple harvest. So far, no hail protection nets have appeared in the area, probably because they are more suitable for dwarf and semi-dwarf trees, which are still rather rare, and due to prohibitive costs. Same as hail nets, shade nets are also barely used in the target regions.

Farmers rarely use ecologically-sound plant protection methods for fruit crops. While some farmers use high-quality, effective chemical plant protection products, many rely on low-cost products which are often ineffective/adulterated (i.e. the amount of active ingredients listed on the label does not match the actual amount). Some organic plant protection products commonly used in other countries are unavailable in the Kyrgyz Republic. Some laboratories produce entomophagous insects, but not in sufficient quantities, and they are only partly suitable for the main fruit pests. Furthermore, the government intends to close those laboratories.

Tajikistan

Despite the country's limited institutional capacity to adapt to the diverse challenges of climate change, numerous climate-resilient techniques have been introduced and promoted across different regions through donor-supported projects. However, efforts to date have been insufficient to scale up the most successful measures.

Official data indicate the total area of fruit orchards, including citrus and berry plantations, was 166,612 ha in 2023 (TAJSTAT, 2023), of which 1,224 ha are considered intensive orchards (MoA, 2025). Anti-hail nets were installed in super-intensive orchard plots covering 30 ha only (MoA, 2025).

Out of a total irrigated area of 766,303 ha in Tajikistan (GoT. The Committee on Land Management and Geodesy of Tajikistan., 2025, p. 250), less than 1.5% (approximately 10,000 ha) utilizes drip irrigation systems (ALRI, 2025). Katra is one of the most active private companies promoting drip irrigation and providing a full package of design and installation services, primarily in the Sughd region. The company supports farmers in selecting optimal designs and calculating technical parameters for drip irrigation kits for both annual and perennial crops (Katra, 2025). However, the scaling of this technology has been slow due to its high upfront cost, the requirement for clean water to prevent emitter clogging, a shortage of extension services, and farmers' limited technical knowledge.

The promotion of organic farming and Integrated Pest Management (IPM) in Tajikistan is primarily driven by a few key organizations. For instance, the Sarob Cooperative advocates for organic cotton production. Having collaborated with the Better Cotton initiative since 2013 to implement its standards, this partnership was reinforced in 2023 when Better Cotton and Tajikistan's Ministry of Agriculture signed a Memorandum of

Understanding (MoU). This agreement, signed at the Tajikistan Investment and Development Forum in London, aims to support more sustainable cotton production across Central Asia (Sarob, 2025).

Under the leadership of the Ministry of Agriculture, 12 laboratories for producing and promoting entomophagous insects have been established in various districts. However, due to underfunding, a lack of highly qualified specialists, and outdated equipment, production is insufficient to meet the constantly growing demand.

A wide range of Nature-based Solutions (NbS) and Climate-Smart Agriculture (CSA) measures have been promoted by various projects in Tajikistan (Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, Rome, 00153, Italy et al., 2023; Nicole Pfefferle et al., 2019), including initiatives in the Tajik part of the Ferghana Valley (Domullodzhanov D.Kh., 2018; Domullodzhanov D.Kh, 2020). Approximately 180 techniques and approaches from all regions of Tajikistan have been documented in the WOCAT network (WOCAT, n.d.). This existing repository of knowledge and expertise presents significant potential to promote and scale up climate-resilient technologies among local farmers.

Uzbekistan

Uzbekistan has a large and expanding fruit orchard base. However, the share of 'improved' or 'modern' orchards (i.e. high-density or semi-intensive systems using certified planting material and climate-smart water and risk management) remains relatively small, even if it is growing quickly where finance and structured support exist. Adoption is therefore best described as uneven: more advanced production and post-harvest practices tend to be concentrated around stronger commercial clusters, larger farms/SMEs, and project-supported areas, while most smallholders still rely on traditional management and marketing channels.

Across fruit systems (with apricot as a representative stone-fruit case), the dominant risk shaping farmer behaviour is climate volatility, especially spring frosts (the single most damaging hazard because apricots flower early), followed by heatwaves/sunburn and drought/water scarcity. These risks are widely recognized, but systematic protective investments are not yet mainstream. Frost and heat early-warning information is emerging through pilots and increasing use of digital channels, but integration into routine extension and local service delivery remains incomplete, and tailored tools for stone fruits are not yet available nationwide. Water-saving irrigation is increasingly discussed and financed in some areas, yet many orchards still depend on inefficient irrigation practices and face rising constraints on water availability, which reduces yields and quality and can force earlier harvesting decisions.

On production practices, there is growing interest in improved varieties, better orchard designs, drip irrigation/fertigation, and IPM, but uptake is constrained by weak advisory systems and limited access to reliable inputs. Many orchards continue to use uncertified/low-quality saplings and outdated varieties, and advisory support is often insufficient for pruning, irrigation scheduling, nutrition, frost/heat stress management, and modern IPM—leading in some cases to excessive pesticide use and export residue risks. Pest and disease pressure (including brown rot/monilia and other pathogens and pests) is rising, increasing costs and management complexity for farmers who lack consistent diagnostic and extension support.

Beyond the farm gate, adoption of climate-resilient and export-oriented practices is strongly limited by post-harvest infrastructure gaps. Many producing areas still lack affordable access to pre-cooling, cold storage, grading/sorting and packhouse services, contributing to quality losses and restricting access to higher-value domestic and export channels. Traditional drying remains common in dried-fruit segments, while investment in more hygienic and controllable drying technologies is not yet widespread. Market structure also shapes incentives: strong dependence on a few export markets (notably Russia and Kazakhstan for fresh fruits) increases exposure to sudden disruptions and price volatility, which discourages long-term upgrading investments by smaller producers and SMEs. Finally, finance is a cross-cutting constraint: despite existing credit lines, banks' risk perception of long orchard payback periods and climate exposure slows uptake, especially among smallholders; insurance coverage (particularly frost/weather-index products) remains limited.

2.6.2 Potential and barriers preventing the adoption of climate-resilient fruit production

Kyrgyz Republic

Currently, the main barriers to the adoption of climate-resilient technologies in fruit production are as follows:

- Know-how about practical technical solutions for climate-resilient technologies (e.g. drought-resistant rootstocks and cultivars, and frost protection methods) is not available in the country and needs to be acquired and developed.
- There is insufficient knowledge of the potential of these technologies among farmers and, for some of the technologies except drip irrigation, also among extension service organizations and independent agronomists.
- There is a lack of in-country experience with most climate-resilient technologies. Therefore, neither farmers nor agricultural experts can learn from local experience. This issue could be addressed through learning exchanges with other countries and video communication with stakeholders in countries where these technologies are used.

- Some materials for climate-resilient technologies are unavailable or of poor quality in the country, e.g. rootstocks and seedlings that can withstand climate change, environmentally friendly plant protection products, hail and shade nets, and concrete poles for fixing nets. Alongside creating demand for these through future programme activities, it is necessary to collaborate with relevant stakeholders to organize imports or domestic production.
- Insufficient financial resources among farmers for the necessary investments, e.g. in drip irrigation systems or climate-change-adapted seedlings.

IN terms of the potential for promoting climate-resilient fruit production, farmers in the fruit-growing areas of the target regions show high interest in improving fruit production. In Masaliev municipality (Kadamjay district), it was estimated that only 20% of fruit farmers were not interested in improvements; these were mostly people for whom fruits were not an important source of income. The remaining farmers are interested in introducing innovations that will increase the profitability of their orchards. These innovations include accurate soil fertility management, proper pruning techniques, climate resilient technologies, and effective plant protection measures, among others.

Many farmers are also interested in expanding their orchards, which is understandable given the typically small size (e.g. 0.16 hectares for cherries in Kadamjay district and 0.2 hectares for apples in Nookat district, on average).⁴ However, irrigated land for new orchards is limited in most municipalities. Conversely, in the target regions, there are large areas of unproductive, rainfed pasture land that could be used for new orchards and berry fields, provided that resources are available to establish the necessary irrigation infrastructure.

Thus, two basic groups of farmers can be encouraged to adopt improved fruit production practices: those who wish to enhance the management and productivity of existing orchards and those who wish to establish new orchards on unproductive degraded pasture land.

In the target regions, there are 280,000 ha of unproductive pasture land.⁵ While not all of this land is suitable for fruit cultivation, the available area is still substantial and does not limit the establishment of new orchards.

As climate-resilient practices are rarely used in the target regions except for drip irrigation, information and awareness-raising campaigns, including demonstration plots, will help to make these options known to farmers. To encourage the adoption of climate-resilient practices, a set of practical solutions to acute issues such as water scarcity, frost, hail, and pests can be tailored to the farmers' needs and connected through climate information via E-PICSA.

Tajikistan

Despite the significant potential for climate-resilient fruit production in Tajikistan, several barriers hinder the widespread adoption of climate-resilient and low-emission (CRLE) practices and technologies. Based on the recommended activities, the following barriers have been identified:

- Limited farmer awareness of CRLE practices and technologies, their benefits, and available technologies.
- Fragmented communication and limited dialogue between researchers, government agencies, NGOs, and farmer unions.
- High upfront investment costs for climate-resilient technologies (drip irrigation systems, anti-hail nets, etc.) that exceed the financial capacity of smallholder farmers; importantly, since 2016, the establishment of fruit orchards is permitted on rainfed land only, making investments in (water-saving) irrigation systems indispensable.
- Limited access to affordable credit or favorable financing mechanisms tailored to fruit producers.
- Absence of government subsidy schemes or cost-sharing programs to reduce the initial financial burden on farmers.
- Shortage of qualified local specialists and trainers with expertise in CSA and NbS for fruit production.
- Weak and under-resourced extension services with limited reach to fruit-growing communities.
- Absence of clear "scaling-up roadmaps" to guide the expansion of promising technologies with defined roles for stakeholders.

To overcome these barriers and effectively promote and disseminate climate-resilient technologies, the following interventions are key:

1. Enhance knowledge and awareness
 - Develop and disseminate tailored, easy-to-understand educational materials (booklets, videos, radio programs) on climate-resilient fruit production in local languages.
 - Organize demonstration plots and farmer field schools (FFS) across all agro-ecological zones to showcase successful technologies.

⁴ Source: Unpublished data from the USAID Agro Horizon project, 2017

⁵ Source: <https://economist.kg/agriculture/2024/10/10/v-kr-naschityvaetsia-614-tysiach-ghiektarov-maloproduktivnykh-pastbishchnykh-ziemiel>

- climate-resilient targeted awareness campaigns to inform farmers about the benefits and suppliers of key climate-resilient technologies (e.g., drip irrigation, drought-resistant seeds).
2. Provide financial and technical incentives
 - Design and implement cost-sharing scheme to reduce the initial investment burden for farmers adopting verified climate-resilient technologies (e.g., for drip irrigation kits, anti-hail nets and others).
 - Facilitate access to financial products on favourable terms for climate-resilient investments.
 3. Build local expertise and capacity
 - Integrate training modules on climate-resilient and low emission practices into the curricula of agricultural universities and vocational colleges.
 4. Revitalize and expand extension services
 - Foster private-sector involvement in extension by training and certifying local agronomists and input suppliers to become climate-resilient practices and technologies advisors.

Uzbekistan

The main barriers (risks and constraints) preventing wider adoption include:

- Weak access to quality planting material and modern orchard systems.
- Continued reliance on uncertified saplings and older varieties; limited scaling of certified nurseries and modern rootstocks suitable for intensive, climate-adapted orchards.
- Fragmented smallholder orchards make it difficult to coordinate replanting and standardize varieties and quality.
- Shortage of trained horticulture advisors and limited transfer of practical skills in pruning, canopy management, irrigation scheduling, climate-risk management, and IPM.
- Rising pest and disease pressure; increasing pest and disease incidence, combined with limited IPM knowledge, can lead to excessive use of pesticides and resulting residue risks.
- Post-harvest, logistics, and processing bottlenecks: insufficient availability of pre-cooling, cold chain, sorting, packhouses, and modern drying infrastructure limits quality preservation and market access; traditional processing (especially drying) can reduce product quality and raise contamination risks, undermining competitiveness.

Market and price volatility

- Finance and risk-management constraints: banks remain cautious about orchard investments with long payback periods and climate risk; credit uptake by smallholders can remain below potential even where lines exist.
- Limited availability of insurance, especially frost and index-based weather insurance, restricts willingness to invest in modernization.
- Low financial literacy and limited tailored products for orchard renewal, irrigation equipment, and post-harvest assets.

To overcome these barriers and effectively promote and disseminate climate-resilient technologies, the following interventions are key:

- Significant scale-up potential for improved orchards if finance and technical support are bundled with nursery upgrades, improved varieties (including late-blooming varieties and those specifically suited for drying), extension, and water access and drip irrigation financing.
- Climate services and early warning: scaling agrometeorological services and making actionable frost and heat advisories part of standard extension support.
- Post-harvest and processing: pre-cooling/cold chain, grading/packhouses, hygienic drying and food-safety systems (HACCP/SPS/traceability) to reduce losses and access premium markets, thereby improving returns on climate-smart production investments.

2.6.3 Proposed climate-resilient technology

To address the climate risks affecting fruit tree cultivation as outlined in Section 2.5 above, the programme will support the following technologies and practices through investments and technical assistance:

- **Use of drought/heat/flood/ frost resilient root stocks and fruit cultivars:** Diversifying orchards with different species and varieties is a key strategy for enhancing resilience against climate-induced challenges while contributing to the overall sustainability of orchard ecosystems (Kotowski et al., 2022). For fruit trees, the use of drought- and salinity-tolerant rootstocks (e.g., specific apricot, apple, and grape rootstocks selected for arid and continental climates) can significantly improve water-use efficiency, root depth development, and resistance to soil-borne diseases. While imported stress-tolerant rootstocks are important and highly sought after, their effectiveness is compromised by poor soil quality, especially in highland areas. Grafted rootstocks from local nurseries prove more suitable for these challenging soil conditions, ensuring better adaptation and improved stress tolerance. Hence, programme activities will include supporting local nurseries in growing and crafting local varieties.

- **Improved orchard management technologies for better climate resilience:** Improved management practices such as maintaining soil cover through mulching are essential for retaining moisture, preventing soil erosion, and enhancing soil fertility. Proper pruning of trees enhances air circulation, reducing the risk of fungal diseases in moist conditions, while providing material that can be used as mulch. Summer pruning can incite later flowering and fruit formation, thus reducing the risk of frost damage; orchard resilience against late frosts can also be enhanced by spraying cryoprotectors such as aria oil, or through other management practices (Risha Solutions and GIZ, 2023).
- **Use of drip irrigation:** the establishment of drip irrigation is a key strategy for enhancing the climate resilience of high-value crops, such as fruit trees (EDB, 2023). Compared to traditional irrigation methods, the use of drip irrigation leads to water savings of 40-70% while having the potential to increase yields by 25-100% (Pushparaj & Punithkumar, 2024). Water will be supplied via water harvesting infrastructure (such as appropriate-scale reservoirs) or by installing tubewells for groundwater-based irrigation, depending on local conditions. Drip irrigation systems must be equipped with suitable filters to prevent pipe blockages due to sandy water. Depending on local contexts, the use of solar powered water pumps is preferred. The integration of fertigation systems is an option; drip irrigation can cut the use of mineral fertilizers and pesticides by 21—33%, at the same time preventing nutrient leaching and subsoil water pollution (EDB, 2023; Pushparaj & Punithkumar, 2024).
- **Use of insect-proof nets/shade nets:** The use of shade nets can be viable in intensive orchards of high-yielding, relatively short fruit tree species. The nets moderate orchard temperatures and enhance fruit quality by preventing sunburn. Furthermore, their use can significantly contribute to **Integrated Pest Management (IPM)**, by physically protecting orchards against pests which are expected to proliferate under progressing climate change conditions (FAO, 2025a).

The **financial support** by the programme will focus on making climate resilient root stocks and fruit cultivars, drip irrigation and fertigation equipment, and horticultural netting available and accessible to smallholder farmers. **Technical assistance** will encompass the training of farmers on improved orchard management practices, including IPM and frost protection.

3. Potato

3.1 Relevance

Potatoes are a crucial staple crop in the intervention areas and Central Asia more generally, often referred to as "the second bread." They play a significant role in food security and are vital for food independence.

3.2 Production volumes and key production areas

Based on the latest agricultural statistics available, Table 19 summarizes the area devoted to growing potatoes, total potato production, and average productivity. Apart from providing statistics at national level, the table includes data for the provinces that make up the two intervention areas, i.e. (i) the 'Fergana Valley' (FV) which encompasses provinces in all three target countries (shaded in light blue) and (ii) 'Khatlon & Surkhandarya' (KS), two bordering provinces in Tajikistan and Uzbekistan. In FV and KS areas, potato cultivation occupies close to 113,000 ha and 33,000 ha, and production amounts to approximately 2.1 million MT and 585,000 MT, respectively. While UZ lacks secondary data on potato yields, available information indicates that productivity ranges from around 15 MT/ha in Batken province (KG) to close to 24 MT/ha in Sughd province (TJ).

Table 19: Potato production statistics (2023) for the target countries and intervention areas

Country/province	Potato area (ha)	Potato production (MT/year)	Average potato yield (kg/ha)
Total Kyrgyz Republic (KG)	72,484	1,275,000	17,590
Batken (KG)	2,461	36,500	14,830
Jalalabad (KG)	7,973	122,700	15,390
Osh (KG)	12,840	206,600	16,090
Total Tajikistan (TJ)	57,735	1,144,883	19,830
Khatlon (TJ)	12,844	227,330	17,700
Sughd (TJ)	25,416	600,063	23,610
Total Uzbekistan (UZ)	200,086	3,574,000	17,863*
Andijan (UZ)	24,162	431,600	17,863*
Fergana (UZ)	20,859	372,600	17,863*
Namangan (UZ)	19,107	341,300	17,863*
Surkhandarya (UZ)	20,036	357,900	17,863*
Total 'Fergana Valley'	112,817	2,111,363	18,715

Total 'Khatlon & Surkhandarya'	32,879	585,230	17,799
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Fergana Valley	Khatlon/Surkhandarya
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Source: Various national and provincial agricultural statistics

*Due to non-availability of yield data and potentially unreliable area statistics, the yield in UZ is assumed to be the average of the remaining countries/provinces; assuming that the production data are accurate, the area is adjusted according to the (assumed) average yield.

Both at national level and within the provinces making up the intervention areas, Table 20 lists the major potato producing areas and their relative production shares.

Table 20: Major potato production areas in the target countries and intervention areas

Country/province	Potato production (MT/year)	Major production areas	% production
Total Kyrgyz Republic (KG)	1,275,000	Issik kul	35.4
		Osh	16.2
		Talas	14.7
Batken (KG)	36,500	Kadamjay	53.2
		Leylek	22.0
		Batken	13.7
Jalalabad (KG)	122,700	Alabukin	30.1
		Toktogul	19.2
		Suzak	17.1
Osh (KG)	206,600	Nookat	25.8
		Chonalay	18.4
		Alay	17.3
Total Tajikistan (TJ)	1,144,883	Sughd	52.4
		Khatlon	19.9
Khatlon (TJ)	227,330	Panj	9.0
		Kushoniyon	8.6
		Jomi	6.6
		Qabodiyon	6.2
Sughd (TJ)	600,063	Devashtich	38.3
		Mastchoh	17.9
		Panjakent	12.3
		Istaravshan	10.5
Total Uzbekistan (UZ)	3,574,000	Samarkand	20.3
		Andijan	12.3
		Tashkent	10.8
Andijan (UZ)*	431,600	Paxtaobod	12.4
		Jalaquduq	10.3
		Shahrison	10.0
Fergana (UZ)*	372,600	Quva	8.2
		Qo'shtepa	8.0
		Bag'dod	7.3
Namangan (UZ)*	341,300	Yangiqo'rg'on	33.8
		Chotoq	10.8
		Chust	9.4
Surkhandarya (UZ)*	357,900	Denov	23.6
		Sho'rchi	15.0
		Qumqo'rg'on	11.9

Fergana Valley	Khatlon/Surkhandarya
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Source: Various national and provincial agricultural statistics; N/A = not available

3.3 Description of the value chain

3.3.1 Physical and legal entities involved in the value chain

Stakeholders in the potato value chain can be categorized into five groups:

- Governmental entities at national and regional levels, e.g. Seed development center under Ministry of Agriculture, Farmer's Association, Agrologistics centers in UZ; Seed Association of Kyrgyzstan, relevant organizations under the ministry of agriculture in TJ. These entities mainly support for seed development, seed storage and seed delivery, purchase and store potato to maintain food security, consulting and information services etc.

- Cooperatives and potato seed producers (e.g. Potato seed production Cluster in Uzbekistan)
- Farmers (see 'Production' below).
- Private sector actors, such as input providers (see 'Inputs' below), intermediaries engaged in the purchase, transportation and marketing of potato; and
- Consumers, i.e. the entire rural and urban population who has access to subsidized potato.

3.3.2 Inputs

One of the major problems in the potato value chain is access to quality **seeds**. Farmers usually continue using seeds long after their productivity vigour is lost. Farmers cannot afford quality seeds, and they receive only a limited support from international donors and practically no support from the government (O'Connell & Kiparisov, n.d.). In all three target countries, the Ministry of Agriculture and its specialized seed organizations are responsible for developing, preserving, and distributing local varieties to farmers, but in most cases these seeds are not very productive. As a result, the private sector is increasingly playing a role in the sector by importing high-yielding varieties from abroad and selling them to farmers. Potato seeds in all three countries are mainly imported from European countries, such as Germany and the Netherlands, while the CIS countries are mainly Russia and Belarus. Depending on variety and origin, the prices of potato seeds vary widely, from approximately 0.44-0.5 USD/kg and 0.52 USD/kg for domestically produced seeds in TJ and KG to 1.40 USD/kg for imported varieties in UZ. The seed sector is supported by government programs and international NGOs with the aim of improving seed quality and, hence, productivity.

Mineral fertilizers are domestically produced in UZ, whereas in KG and TJ they are mostly imported from Russia, Kazakhstan, China, and UZ. Average fertilizer prices are presented in Table 4 (Section 1.3.2). Various private sector enterprises are engaged in the supply, especially import, of fertilizers and provide advisory services to potato growers. Table 21 lists major input providers for potato production.

Table 21: Major providers of inputs for potato production in the target countries

Type of input	Kyrgyz Republic	Tajikistan	Uzbekistan
Seeds	• Seed development centers under Ministry of Agriculture • Seed farms located in different regions • Various seed import businesses	• Seed development centers under Ministry of Agriculture • Seed farms located in different regions • Various seed import businesses	• Seed development centers under Ministry of Agriculture • Seed farms located in different regions • Various seed import businesses
Fertilizers	• ATS Group Ltd. • Agrostyle Ltd. • Agrokhimia Ltd. • Alem Agro Keidji Ltd. • Bai-Dyikan LLC	• Local producers (esp. TA-JIKO Chemical, Azot) • Imported fertilizers: UralKhim (Russia), Uzkimyosanoat (UZ)	• Uzkimyosanoat and its sub-organizations, esp. MAXAM-Chirchiq, Farg'onaazot, Ammofos-Maksam

Agricultural machinery is mostly imported in the target countries. Further details are provided in Section 1.3.2 above.

3.3.3 Production

In KG, potatoes are mainly grown by small-scale farmers in pre-mountainous areas. Due to the slow deterioration of seed quality in these regions, farmers only purchase new seed occasionally, typically after years with high ware potato prices (Swoboda, 2024). In Uzbekistan the share of producers in potato production include: farms 27.8%, dehkan and households 70.0% and organizations engaged in agriculture 2.2% where total production in 2023 was 3,574,100 MT. Despite the similarity of potato growing technologies, it can be seen that the costs of growing potatoes per hectare in the three target countries are different. In particular, these indicators are 2009 USD/1 ha in TJ and 4,264-4,651 USD/1 ha in UZ. The average potato yield is 17.6 MT/ha in KG, 19.8 MT/ha in TJ, and 17.9 MT/ha in UZ.

3.3.4 Processing/storage

Farmers typically sell their potato to wholesalers or directly to retailers. The number of participants in the potato value chain is not large and the level of processing is very low. Consumers are accustomed to buying potatoes mainly raw, and only fast food restaurant chains prepare secondary products from them and offer them to customers.

In all three countries, the Ministry of Agriculture, which is responsible for ensuring food security, and the relevant government bodies responsible for controlling the agro-industrial complex organize the purchase and storage of potatoes from farmers to create reserves. In order to avoid sharp fluctuations in potato prices and to ensure that there is enough for population consumption throughout the year, potatoes purchased for state reserves are stored in cold storage and ordinary warehouses belonging to system organizations.

Lack of modern cold storage facilities and qualified specialists is common in all three countries. According to food security experts, most of the storage facilities and warehouses in Tajikistan are of Soviet design and do not meet international requirements and standards. Some storage facilities lack or do not have a proper ventilation system or thermodynamics to allow vegetables to "breathe". The expert notes that the ventilation method in storage facilities is often traditional - the rooms are opened and closed, and the automatic ventilation system is either turned off or does not work. There are 45 warehouses for storing agricultural products in the country, as well as 3 cold storage rooms in different regions of the country. Due to the abnormal winter and the above-mentioned problems, approximately 10% to 20% of potato stored in warehouses are lost (ASIA-Plus, 2023).

Table 22 provides a qualitative assessment of the adequacy of potato storage facilities in the target countries in terms of both capacity and quality.

Table 22: Adequacy of potato storage facilities in the target countries

Criteria	Kyrgyz Republic	Tajikistan	Uzbekistan
Storage capacity (1 = clearly insufficient; 2 = slightly insufficient; 3 = just sufficient; 4 = fully sufficient)	1	1	1
Storage quality in terms of infrastructure and service (1 = large storage losses; 2 = moderate storage losses; 3 = minor storage losses; 4 = fully adequate storage quality)	2	1	1

Note: assessment based on expert judgment by the consultant team; the national-level scores also apply to the provinces in the intervention areas.

3.3.5 Trading

TJ and UZ import part of their potato consumption needs, while KG produces a surplus. Table 23 provides an overview of the value of all fresh potato exports (including seed potatoes) from the target countries, indicating the main countries exported to. In UZ, potato exports are irrelevant, while in KG, export values are quite significant, exceeding the value of potato imports by far (for TJ, data are not available). Potato prices are subject to fluctuations, mainly due to varying yields in Russia and Belarus. Favorable weather conditions in these countries can lead to a surplus that finds a market in UZ, resulting in lower prices for the region. In years with lower yields (e.g., less rain in Russia or Belarus), prices are significantly higher in the Central Asian potato market.

*Table 23: Imports and exports of potatoes in the target countries (in USD)**

	2021	2022	2023
Total imports Kyrgyz Republic:	1,586,626	2,737,039	1,195,893
Total exports Kyrgyz Republic:	5,929,763	10,712,389	6,202,866
Main countries exported to:	Uzbekistan	7,145,160	4,422,129
	Kazakhstan	2,820,091	1,604,438
	Russian Federation	673,645	143,842
Total imports Tajikistan:	4,370,850	1,129,112	N/A
Total exports Tajikistan:	N/A	N/A	N/A
Total imports Uzbekistan:	72,772,668	81,046,464	58,316,769
Total exports Uzbekistan:	498,487	606,784	694,966
Main countries exported to:	Kazakhstan	422,299	690,575
	Tajikistan	-	-
	Russian Federation	183,140	-

*Source: UN Comtrade; *Imports are CIF values, exports are FOB values; N/A = data not available*

Table 24 focuses on exports and imports of seed potatoes. It shows that a varying but significant share of potato exports in KG is in the form of seed potatoes, whereas seed potato imports are sizeable in UZ, implying that domestic production is insufficient.

*Table 24: Imports and exports of seed potatoes in the target countries (in USD)**

	2021	2022	2023
Total imports Kyrgyz Republic:	1,472,548	2,467,687	648,337
Total exports Kyrgyz Republic:	878,611	4,708,371	1,774,382
Main countries exported to:	Kazakhstan	2,353,361	1,543,402

	Uzbekistan	-	1,985,876	115,183
	Russian Federation	47,441	337,008	97,386
Total imports Tajikistan:		575,262	482,126	N/A
Total exports Tajikistan:		N/A	N/A	N/A
Total imports Uzbekistan:		8,177,134	10,205,317	3,133,591
Total exports Uzbekistan:		8,850	1,289	982
Main countries exported to:	Kyrgyz Republic	876	945	825
	Tajikistan	-	344	157
	Turkmenistan	7,974	-	-

Source: UN Comtrade; *Imports are CIF values; exports are FOB values; N/A = data not available

Exports of processed potato products (e.g. potato powder or flakes) is very limited. In the case of UZ these amounted to USD 104,436 in 2021 and USD 35,600 in 2023 (UN Comtrade). For KG and TJ no quantities are available.

3.4 Enabling environment

Kyrgyz Republic

- i. **Project "Fund for agricultural development - 13"**: see Section 2.4 for more details.

Uzbekistan

- ii. **Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. ID-81060 dated 08.06.2023** "On additional measures to increase local potato production and further strengthen the seed base". According to this resolution, agroclusters, farms, and agricultural enterprises producing certified super-elite and elite seed potatoes will receive a 50% reduction in land tax, property tax, and small enterprise turnover taxes until January 1, 2025. Research institutions importing new potato varieties for adaptation to local soil and climate conditions will be exempt from quarantine permit fees. Additionally, certified high-generation seed potatoes grown by potato producers will be subsidized at 25% of the cost per kilogram, up to a maximum of UZS 2,000 per kilogram, using funds from the Horticulture and Greenhouse Development Fund.

3.5 Climate risk and impact

Different climate models unanimously indicate potential **temperature increases** of over 6°C by 2050 in different regions of the target countries. E.g., there is a high likelihood that temperatures will more regularly exceed 40°C, particularly in lowland regions such as the Fergana Valley (World Bank & Asian Development Bank, 2021). While this poses challenges to the target commodities in already heat-stressed areas (as emphasized in previous sections), rising temperatures prolong the growing season in higher-altitude areas where potatoes in Central Asia are mostly grown. In particular, they offer an opportunity for seed potato production in areas that were previously unsuitable for potato production.

Local seed potato production would address the following climate related and economic risks (Swoboda, 2024):

- Traditional suppliers of seed potatoes are European countries (e.g., the Netherlands and Germany). However, higher average temperatures reduce the areas with favorable climatic conditions for seed multiplication in Europe;
- Transportation costs for potato seeds from suppliers in Europe are high, with two-thirds of the seed price attributed to transport costs. Furthermore, transportation costs have significantly increased in recent years.

3.6 Climate-resilient technologies and adoption

3.6.1 Status quo regarding the adoption of seed potato production

Kyrgyz Republic

The production of potato seeds is underdeveloped in the Kyrgyz Republic. Currently, elite potato seeds are imported from European countries such as Germany and the Netherlands, with an average annual import of 1,500–2,000 MT. Seed potato producers in KG purchase elite seeds and grow first- and second-generation seeds (R1 and R2), which they then sell locally and export. Potatoes are cultivated across 65,000 ha in the country. The seed requirement for this area is approximately 240,000 MT. However, most farmers primarily use uncertified seeds of various generations, and many farmers still retain small tubers from their potatoes, which they then use as seeds. From 1,500 MT of imported elite seeds planted on 400 ha, approximately 10,000 MT of first-generation R1 seed are typically obtained. If 30% is exported and 20% is wasted during sorting and

storage, the remaining 5,000 MT of first-generation seed are sown on an area of 1,300 ha. From this, 30,000 MT of second-generation seed are generated (considering losses), they are sown on 8,000 ha, and approximately 200,000 MT of third-generation seed are obtained. Thus, the Kyrgyz Republic is self-sufficient in potato seeds for food potatoes. However, the quality of the seed is highly questionable, as farmers do not use proper agricultural practices. Considering that virtually all fields in KG (except those in high-altitude areas) are infected with diseases, including quarantine pests and nematodes, the quality of seed potatoes is a pressing issue since seed quality impacts potato yields and, thus, farmers' incomes.

According to the Department of Agricultural Crop Expertise at the Ministry of Agriculture of the Kyrgyz Republic, farmers have applied for seed certification for only 214 ha, representing approximately 6,000 MT of seed, commensurate to 0.3% of the total seed requirement. Independent experts estimate the total certified seed supply to be around 5,000 MT.

In 2024, the GOPA/AFC Agrifinance Value Chains project in the Kyrgyz Republic was launched to develop a seed potato value chain. The high-mountain zones of KG (specifically Chon-Alay, Aravan and Kara-Suu districts of Osh region) and At-Bashy and Kochkor districts of Naryn region were selected for the project. As part of this project, super-super elite and super elite reproduction seeds were imported from the Netherlands.

To ensure seed quality, several international agronomists are involved in implementing improved cultivation techniques. Drip irrigation systems are used to grow super-super elite seeds, and soil and tuber analyses are conducted. An internal seed quality control system is also implemented. Thanks to this project, the resulting high-quality elite potato seeds can be sold at a 40% lower price than imported seeds, ensuring economic and physical access to high-quality seeds for farmers.

Tajikistan

Potato seed production in Tajikistan is underdeveloped. A representative of the Ministry of Agriculture of Tajikistan indicates that in 2024 a total of 1,264,000 MT of potato were harvested from a cultivation area of 64,500 ha (Сайфиддин Караев, Asia-Plus, 2025), requiring an estimated 193,500 MT of high-quality seed potatoes annually. Alongside the challenges in the potato-growing sector, there is also positive experience: the Sarob cooperative actively supports potato farmers by providing them with high-quality seeds and advice on agro-technical issues. Over the past five years, mainly through EU-funded projects, Sarob has imported 200 MT of elite-class seed potatoes (160 MT of the variety Big Rose from Germany and 40 MT of the Dutch varieties Picasso and Manitou). Thanks to the introduction of new technologies and the efficient use of seeds, the cooperative has achieved yields of 80–90 MT/ha, which significantly exceeds the performance of other farms where yields are around 20 MT/ha (M. Muminov, personal communication, 2025). To meet the permanently increasing demand, elite potato seeds are imported from European countries such as Germany, France, and the Netherlands. For instance, in 2020–2022, an EU-financed FAO project supported farmers in different regions of Tajikistan by providing 60 MT of Picasso, Red Scarlett, and Gala variety of potato (Delegation of the European Union to Tajikistan, 2020; Protatopro, 2023). In 2024, the state institution “Agriculture Entrepreneurship Development” distributed high-quality certified elite seed potatoes of the Evolution, Picasso, and Arizona varieties (GoT, 2024b).

The country employs two primary methods of potato seed multiplication:

1. Whole Tuber Method

This is a traditional method that involves planting whole tubers which contain multiple eyes that sprout (FAO, 2023c). While this method is less time consuming it requires the import of high-quality super-elite seeds for local multiplication from EU countries or the Russian Federation. Similar to KG, multiplication is carried out as follows:

- First Year: import 60 MT of super-elite seeds; plant 20 ha (3 MT/ha) to yield 600 MT of Elite seeds.
- Second Year: plant the 600 MT of Elite seed on 200 hectares to yield 6,000 MT of R1 seed.
- Third Year: distribute the 6,000 MT of R1 seed to potato producers for the fresh market, covering 2,000 ha; the expected yield is 60,000 MT, with farmers potentially storing 50% of their harvest for future use as seed.

2. Seed Tuber Method (In Vitro)

This technique uses selected tubers from healthy plants to ensure the propagation of superior genetic material. It begins with in-vitro plantlets produced in laboratories to generate disease-free starter material. In the framework of previous projects and initiatives, institutions involved include the Institute of Botany and Plant Physiology under the National Academy of Sciences, the Biotechnology Center at Tajik Agrarian University, and Tajik Academy of Agriculture Science (TAAS) sub-offices in the Sughd region have potential to be a programme partner. However, their current production capacity is purely scientific and cannot meet the practical demands of the country's farmers (Eshbadalov, M., 2025).

Potato production in Tajikistan is concentrated in its northern mountainous zones, such as the Zeravshan Valley, Istaravshan, Shahristan, Devashchik, and Jiragatal. These regions contribute the largest share of the

national harvest. Given the high-altitude climate, farming is limited to a single growing season, typically involving April planting and a September harvest (EastFruit, 2021).

Specialists from the state institution “Development of Entrepreneurship in Agriculture” have established seed production and farming enterprises in the Tajik part of the Fergana valley, namely in Shakhriston, Devashtich, Istaravshan, and Isfara districts under the “Improving the Sustainability of Agriculture” project (GoT, 2024a). However, due to a shortage of qualified personnel as well as tools and equipment, these farms still require substantial technical support. This presents an excellent entry point for initiatives aimed at strengthening potato seed producers and building upon existing capacity of local stakeholders.

According to findings from an USAID project (USAID, 2016), introducing short-duration potato varieties, capable of producing tubers within 90–100 days, along with innovative early production technologies, could significantly benefit farmers in Khatlon. Traditionally, their potato harvest reaches the market in May, but fresh potatoes harvested in spring sell at nearly twice the price of those available in summer. Spring potato production (especially for Khatlon province) offers several key advantages (USAID, 2016):

- A short growing cycle frees up fields by June for planting vegetables (such as tomatoes, cucumbers, and carrots) or legumes for a fall harvest.
- Lower resource requirements, needing only 2–3 irrigations and one weeding operation during the growth period.
- Reduced pest risk as the crop is harvested before seasonal outbreaks of Colorado beetle and other pests.
- Higher market value, with spring potatoes commanding better prices than those harvested in fall.

Uzbekistan

Climate-resilient practices in Uzbekistan’s potato value chain are emerging but uneven, with adoption strongly shaped by risk exposure and by who has access to inputs, finance and infrastructure. In the target regions, seed potato production is concentrated in Namangan region with many producers operating on small dehqan (household) plots and a smaller number of specialized farms and seed suppliers using more advanced production techniques. Across the chain, the most binding risks are increasingly climate-related (notably irrigation water scarcity and drought stress, and heatwaves during critical growth stages), which drive yield instability and make seed production more input- and management-intensive.

Public and donor-supported efforts to strengthen seed systems, start to be visible. Government priorities include expanding domestic early-generation seed capacity (including in-vitro propagation, seed centers, and virus testing) and strengthening the institutional framework for seed quality and traceability. International initiatives (e.g., FAO-supported training and sustainable potato production system development) contribute to building specialist capacity, but the diffusion of this knowledge to ordinary district-level smallholders remains gradual, and uptake is constrained by finance, infrastructure, and coordination bottlenecks.

3.6.2 Potential and barriers preventing the adoption of seed potato production

Kyrgyz Republic

The main barriers preventing the dissemination of seed potato production include:

- Lack of land resources to comply with necessary agricultural technology complicates matters, as small plots make crop rotation and machinery use difficult. Crop rotation is especially critical in seed production and difficult for seed growers. One solution is for farmers to cooperate and request land from the state for lease.
- High cost of production, including high labor costs
- Lack of modern agricultural machinery. Manual labor is becoming increasingly expensive, particularly during harvesting. Farmers are unable to purchase high-performance equipment due to its irrelevance given the small size of their land holdings.
- Lack of knowledge among farmers regarding agricultural technology for growing seed potatoes, financial literacy, and business management.
- Lack of a post-harvest system; significant problems with product storage mean that losses sometimes reach up to 30%.
- Problems with seed certification. Most farmers do not prioritize seed quality or require quality certificates. Most seed farmers do not have their seeds tested by authorised bodies of the Ministry of Agriculture of the Kyrgyz Republic, nor do they undergo the certification process. Only a few farms, cooperatives, and advanced farmers undergo seed certification.
- Lack of qualified agronomists
- Nearly 90% of farmers have loans, but a survey showed that only around 10% receive preferential loans due to inflated requirements and long waiting lists (NGO Agrolead, unpublished report on fruits and berries, 2025).

The main opportunities to foster seed potato production relate to encouraging collaboration, reducing production costs (through mechanization, increased yields and purchasing inputs at wholesale prices), and developing value-added networks. Practical training for farmers is also required.

Currently, around 100 farmers cultivate certified, high-quality seeds on 214 ha. Many more farmers could be involved in cultivating high-quality, high-reproduction seeds (super-super elite and super elite seeds) in mountainous areas. These producers should be united in cooperatives or work through cooperatives, as this will make interventions and operations more efficient, such as the implementation of proper seed cultivation techniques, provision of inputs such as fertilizers and seeds, carrying out agricultural machinery work, consolidating land holdings, conducting certification work, and monitoring seed quality.

It is also important to promote the use of certified seeds among seed producers and farmers growing ware potatoes. This requires an information campaign to be conducted, the capacity of farmers and agronomists to be strengthened, and a legislative framework for seed production to be established. Primary seed farms (first-level seed farms) should be promoted, consisting of advanced seed farmers who will cultivate high-reproduction seeds (super-super elite and super elite). Secondary seed farms (second-level seed farms) that will purchase elite seeds from the primary farms and multiply them into R1, R2 and R3 reproduction seeds should also be supported.

To support this process, it is critically important to:

- Create a seed quality control system.
- Conduct publicity and informational work to ensure that only certified, high-quality seeds are used.
- Train agronomists and farmers in seed cultivation technology, financial literacy, and business planning.
- Assist in creating the necessary infrastructure for seed farms, including modern equipment, agricultural machinery, and storage facilities with sorting, calibration, and packaging lines.

Potato seeds generated at high altitudes perform particularly well when cultivated in the lowlands. Furthermore, seeds produced in the region are better adapted to local conditions than those imported directly from Europe.

Tajikistan

Key constraints in potato seed production in Tajikistan include:

1. Knowledge and skills
 - Limited specialized expertise in commercial seed potato production versus ware potato farming.
 - Weak farmer knowledge on fertilizer management, integrated pest and disease control, and pre-planting seed treatment.
2. Systemic and institutional

Weak agricultural extension services, lacking resources for effective training, demonstration plots, and farmer cross-visits.

The potato is of strategic importance to strengthen national food security in Tajikistan. The country's predominantly mountainous terrain offers favorable agro-ecological conditions suitable for both ware and seed potato cultivation. Capitalizing on this potential can significantly boost agricultural output and stimulate rural economic development, particularly in poverty-affected regions.

A critical barrier to realizing this potential is the chronic shortage of certified, high-quality planting material. This deficit forces a heavy and costly reliance on imported seeds, undermining the sustainability and resilience of the national potato sector.

The core strategy for establishing a sustainable domestic potato seed production system involves strengthening capacity in seed production, multiplication, and integrated crop management. Key needs include:

- System establishment: Building a functional domestic system for the production and multiplication of pre-basic and certified seed.
- Technology transfer: Introducing advanced agronomic practices and meristem-based propagation techniques through partnerships with national academies and research institutions.

The establishment of a reliable domestic seed system will generate multiple benefits:

- Economic resilience: Reduce foreign exchange expenditures and import dependency, while creating new income opportunities for farmers engaged in seed multiplication.
- Productivity gains: Increase potato yield per unit area, thereby reducing pressure on arable land in highland regions and enabling greater crop diversification.

The following activities are recommended to address the existing challenges in potato seed production:

- Develop protocols: Create guidelines for seed production, multiplication, and quality assurance tailored to local conditions.
- Improve crop management practices: Develop and promote advanced practices, including pest management, irrigation, and post-harvest storage techniques.
- Training modules: Design training materials on propagation techniques, seed quality standards, and crop management for local technicians and farmers.

- Workshops and demonstrations: Organize field demonstrations to showcase new varieties, advanced practices, and storage techniques to farmers, agronomists, and extension officers.
- Farmer support: Provide on-site and remote assistance to farmers and seed producers in adopting new technologies and crop management practices.

Uzbekistan

In Uzbekistan, the main barriers to the adoption of seed potato production are:

- Water scarcity and drought stress: Potatoes are water-sensitive, yet irrigation allocations are increasingly constrained and drought and heat conditions are rising. Farmers without wells and without modern irrigation are most exposed, and higher irrigation costs and yield losses in dry years reduce willingness and ability to invest.
- Weak seed system and limited access to certified or healthy seed: Limited domestic availability of early-generation seed and bottlenecks in disease testing and seed renewal cycles keep many farmers dependent on degenerated seed, sustaining low yields and high variability.
- High pest and virus pressure and limited IPM capacity. This increases pesticide dependence and costs.
- Coordination and organizational weaknesses: Weak producer groups and fragmented coordination among seed producers, farmers, traders and processors.

Important actions to increase adoption rates and reduce these barriers include the following:

- Water-saving irrigation and on-farm water management to reduce drought vulnerability.
- Improve seed supply for local multiplication, including early-generation seed production.
- Improve IPM capacity among farmers (to manage rising pest and disease risks and reduce costly pesticide dependence and overuse).
- Extension and digital advisory scaling: Expanding potato-focused training by extension services.

3.6.3 Proposed climate-resilient technology: seed potato production in highland areas

To enhance the intervention areas' resilience against climate risks affecting European suppliers of seed potatoes and taking advantage of the rising temperatures and prolonged growing seasons in higher-altitude zones, the proposed programme will support the production of seed potato. In the lowlands of the Fergana Valley, high-quality seed potato production is not feasible due to the unsuitable hot climate and the prevalence of vectors transmitting pests and diseases. However, areas with very suitable climate conditions for seed potatoes exist in the three countries at altitudes above 1,800 m a.s.l., with cold winters, practically no aphids that can transmit viruses, and suitable crop rotations since these areas only recently started producing potatoes; 30 years ago these areas focused on fodder production for animal husbandry as the climate was still too cold for potato cultivation (Swoboda, 2024). The cost of seed potato production largely depends on the transportation costs of potato seeds from European suppliers and the achieved multiplication ratio. The current ratio of 1:6 is competitive but at the low end. Improving the multiplication ratio through better irrigation and optimum plant nutrition can ensure a ratio of 1:8, which would significantly reduce per-tuber production costs (Swoboda, 2024). Consequently, in suitable highland areas, the programme will promote seed potato production through investment support for the following:

- **Upgrading local seed multiplication:** this is key to reducing transportation costs for imported material. The multiplication could start from Super-Super Elite (SSE) seeds instead of Elite seeds - as is currently done – which would reduce transportation costs per kg of seed to 2.5% of the current rate⁶.
- **Use of sprinkler irrigation:** compared to traditional furrow irrigation which is used for the production of ware potatoes, the installation of sprinkler irrigation allows a better management of soil moisture while reducing water consumption; the higher farmgate price of seed potatoes makes sprinkler irrigation financially viable. In most cases, local streams will be used as source of irrigation water, in other instances tubewells may be installed for groundwater-based irrigation, depending on local conditions.
- **Capacity building on improved plant nutrition:** the use of mineral fertilizers is indispensable for achieving acceptable yield levels, especially under the conditions of a rapidly growing population and scarcity of arable land found in the target countries. An issue of greater concern than the total quantity of nutrients applied is the typically imbalanced use of fertilizers, which tends to be heavily biased towards nitrogen (i.e. urea application) while the application of phosphorus and potassium is largely neglected.

The combined application of balanced plant nutrition and multiplication of demanded varieties (i.e. those that perform best in the climate of the ware potato producers) leads to both climate change adaptation (through reduced water consumption and adapted varieties) and climate change mitigation through reduced emission intensity (i.e. reduced CO₂, methane, and N₂O emissions per hectare and per kilogram of potato produced) and reduced nutrient loss and eutrophication of water bodies. In addition, emissions from seed transportation are reduced.

The **financial support** by the programme will focus on making SSE seeds and irrigation equipment available and accessible to smallholder farmers. **Technical assistance** will encompass the training of farmers on best irrigation and plant nutrition practices in seed potato production. In addition, farmers will be trained to implement suitable crop rotations to break soil-borne disease cycles and enhance soil organic matter and fertility after the potato crop. In particular, the integration of legumes such as alfalfa or clover, which can serve as fodder to reduce the grazing pressure on pasture, will be promoted.

4. Horticulture

4.1 Relevance

Horticulture is a high-value, labor-intensive subsector that contributes directly to food security and diet quality (fresh vegetables and fruits) and provides important income and rural employment opportunities for smallholders across the intervention areas, both in the Fergana Valley (Osh, Jalal-Abad and, Batken provinces in KG; Sughd province in TJ; Andijan, Fergana and, Namangan provinces in UZ) and in Khatlon & Surkhondarya provinces in TJ and UZ, respectively. Regional sector diagnostics highlight that strengthening horticulture value chains can generate employment and income in rural areas and support smallholder inclusion, but competitiveness depends on addressing binding constraints such as food safety compliance and post-harvest handling/cold chain to reduce losses and access higher-value markets (World Bank, 2020).

Within this proposal, the relevance is specifically tied to small-scale open-field onion, tomato and garlic, and greenhouse strawberry and tomato systems. Open-field vegetables are central to affordable, everyday diets and cash income, yet are increasingly exposed to heat and irrigation water stress in lowland production zones,

⁶ Illustrative example: imported Elite (E) seed cost around 1.5 EUR in Central Asia, with 1 EUR/kg for transportation and 0.5 EUR for the seed. If Super-Super Elite (SSE) seed is imported, the cost is about 2 EUR per kg—1 EUR for transportation and 1 EUR for the SSE quality seed. If multiplied for 2 years (SSE -> Super Elite (SE) -> Elite), the quantity of seeds increases 40 times, reducing transportation costs from 1 EUR per kg to 0.025 EUR per kg (Swoboda, 2024).

heightening yield variability and production risk under climate change (OECD/EBRD, 2023). Greenhouse production complements open-field supply by enabling off-season and more controlled production, supporting more stable availability and higher-value marketable produce; experience in Tajikistan shows that protected cultivation can improve diets and food security and increase incomes, supported by improved greenhouse design and management for water, heat and pest control (FAO, 2022b).

4.2 Production volumes and key production areas

Based on official statistics, Table 25 summarizes the production of selected horticulture products, including tomatoes, onions, garlic, and strawberries. Apart from the national statistics presented, the table includes data for the provinces that make up the two intervention areas, i.e. (i) the 'Fergana Valley' (FV) which encompasses provinces in all three target countries (shaded in light blue) and (ii) 'Khatlon & Surkhandarya' (KS), without the regions in TJ due to lack of data for these specific crops.

Data source for all tables (production totals): FAOSTAT extract in Excel (2024) + Production values sources docx.

Table 25: Tomato production statistics (2024) for the target countries and intervention areas

Country / province	Tomato area (ha)	Production (MT/year)	Average yield (centners /ha)	% production
Total Kyrgyz Republic (KG)	11859	278,081	231,3	N/A
Batken (KG)	864	17,562	201,0	6.32%
Jalal-Abad (KG)	3059	73,399	236,4	26.39%
Osh (KG)	2633	54,714	175,7	19.68%
Total Tajikistan (TJ)	N/A	462,080.34	N/A	N/A
Sughd (TJ)	N/A	N/A	N/A	N/A
Khatlon (TJ)	N/A	N/A	N/A	N/A
Total Uzbekistan (UZ)		2,303,966		
Andijan (UZ)		370,300		16.07%
Fergana (UZ)		146,300		6.35%
Namangan (UZ)		215,000		9.33%
Surkhandarya (UZ)		261,500		11.35%

Main tomato production provinces

Country / province	Main production areas	% production
Kyrgyz Republic (KG)	Chuy Jalal-Abad Osh	35.6% 26.39% 19.68%
Tajikistan (TJ)	N/A	N/A
Uzbekistan (UZ)	Andijan Samarqand Surkhandarya	N/A

Table 26: Onion production statistics (2024) for the target countries and intervention areas

Country / province	Onion Area (ha)	Production (MT/year)	Average yield	% production
Total Kyrgyz Republic (KG)	9308	212,663	228,1	
Batken (KG)	844	13,903 T (2024)	164,7	6.54%
JalalAbad (KG)	3705	97,822 T (2024)	263,0	46%
Osh (KG)	1504	29,362 T (2024)	195,3	13.82%
Total Tajikistan (TJ)		725,904		N/A
Sughd (TJ)	N/A	N/A	N/A	N/A
Khatlon (TJ)	N/A	N/A	N/A	N/A

Total Uzbekistan (UZ)	1,405,770.87	N/A
Andijan (UZ)	201,900 (2024)	14.26%
Fergana (UZ)	175,000 (2024)	12.45%
Namangan (UZ)	82,600 (2024)	5.88%
Surkhandarya (UZ)	179,200 (2024)	12.75%

Main onion production provinces

Country / province	Main production areas	% production
Kyrgyz Republic (KG)	Jalal-Abad	46%
	Chuy	25.5%
Tajikistan (TJ)	N/A	N/A
Uzbekistan (UZ)	Andijan	14.26%
	Surkhandarya	12.75%
	Ferghana	12.45%
	Samarqand	X

Table 27: Garlic production statistics (2024) for the target countries and intervention areas

Country / province	Area (ha)	Production (MT/year)	Average yield	% production
Total Kyrgyz Republic (KG)	4919	85,431	173,7	N/A
Batken (KG)	76	1,187 T	156,1	1.39%
JalalAbad (KG)	1118	23,862	213,4	27.93%
Osh (KG)	677	9,477 T	156,5	11.09%
Total Tajikistan (TJ)	14565.08 T (2024)			N/A
Sughd (TJ)		N/A		N/A
Khatlon (TJ)		N/A		N/A
Total Uzbekistan (UZ)		238,265.72		N/A
Andijan (UZ)		59,600		25.01%
Fergana (UZ)		26,000		10.91%
Namangan (UZ)		29,100		12.21%
Surkhandarya (UZ)		15,300		6.42%

Main Garlic production provinces

Country / province	Main production areas	% production
Kyrgyz Republic (KG)	Jalal-Abad	27.93%
	Chuy	31.3%
Tajikistan (TJ)		
Uzbekistan (UZ)	Andijan	
	Namangan	
	Tashkent	

Table 28: Strawberry production statistics (2024) for the target countries and intervention areas

Country / province	Total harvest area (ha)	Production (MT/year)	Average yield	% production
Total Kyrgyz Republic (KG)	1829	13,467.8	74,0	N/A
Batken (KG)	22	194	87,2	1.44%
Jalal-Abad (KG)	99	543	54,6	4.03%
Osh (KG)	48	626	131,4	4.65%
Total Tajikistan (TJ)	No data (FAOstat)			N/A
Sughd (TJ)		N/A		N/A
Khatlon (TJ)		N/A		N/A
Total Uzbekistan (UZ)		12,943.41		N/A
Andijan (UZ)		1,400		10.85%
Fergana (UZ)		1,900		14.73%
Namangan (UZ)		1000		7.75%
Surkhandarya (UZ)		300		2.33%

Main Strawberry production provinces

Country / province	Main production areas	% production
Kyrgyz Republic (KG)	Chuy	49.76%
	Bishkek city	22.62%
Tajikistan (TJ)		
Uzbekistan (UZ)	Samarqand	50%

Source: Various national and provincial agricultural statistics

4.3 Description of the value chain

4.3.1 Physical and legal entities involved in the value chain

The horticulture value chain is largely built around many small producers, supported and often mediated by traders, service providers and other actors who move produce into domestic markets, processing channels and, where conditions allow, export markets.

Stakeholders in the horticulture value chain can be grouped into five categories:

- i. **Governmental / public entities (regulation, inspection, standards, certification, trade facilitation)**, including sector regulation, data provision (e.g., Ministry of Agriculture) and the legal framework for operating as an individual entrepreneur in KG (ILO, 2018), as well as standards/certification and licensing/tax requirements for produce trade (including for traders transporting produce not grown on their own land) in TJ, and public initiatives supporting postharvest and trade functions, such as ag-logistic centers (ALCs) in UZ (ADB, 2018).
- ii. **Producers (farmers and other producer types)**, with supply dominated by fragmented smallholder structures (dehkan plots and small farms) (Lerman & Sedik, 2009) and, in some cases, specialized emerging production such as greenhouse vegetables (e.g., tomatoes in TJ).
- iii. **Cooperatives / producer organizations / clusters** used to varying degrees to address fragmentation through aggregation and coordinated marketing, particularly cooperatives and producer groups often linked to donors in KG (ILO, 2018), marketing groups/associations discussed as an enabling option in TJ, and horticulture cluster models in UZ, which are often linked to ALCs (ADB, 2018, 2025).
- iv. **Private sector value chain actors.** Multiple private intermediaries (middlemen and traders) are part of the long and fragmented value chains in Central Asia, where traditional retail still dominant and modern retail linkages developing gradually (Robalino et al., 2022; World Bank, 2019). In KG and TJ, emerging value added functions are linked to donor support (ILO, 2018) complemented by state programs. Private actors in UZ operate under the ALC model on a user pays basis (ILO, 2018).
- v. **Support services (extension/advisory, finance, inputs, quality/certification)**, with donor-supported advisory and value chain facilitation particularly prominent in KG and TJ.

4.3.2 Inputs

Horticulture producers access inputs through a mix of local production and imports. Planting material is supplied via seedling farms and research/experimental stations, with imports of seedlings from Europe and Turkey and some informal regional flows (see Table 13). In KG, limited access to quality inputs (including seeds, fertilizers, improved planting materials and appropriate technologies) remains a structural constraint; recent public/technical support has focused on strengthening nursery and planting material capacity, including establishment of nurseries and provision of equipment (e.g., drip systems, tools) to support local seedling supply (FAO, 2025b).

Mineral fertilizers are domestically produced in UZ, whereas in KG and TJ they are mostly imported from Russia, Kazakhstan, China and UZ (see Table 13). Limited access to finance constrains producers' ability to purchase higher-quality inputs and modernize production methods (World Bank, 2019).

UN Comtrade import proxies indicate sizeable cross-border flows in both horticultural products and input-related categories. Tomato imports (HS 070200) are particularly large for KG, indicating strong seasonality and competitive regional supply conditions (Table 29). This implies that producers' incentives to invest in higher-cost input packages (e.g., improved planting material, fertilizers, plant protection and protected cultivation) are sensitive to market timing and the ability to differentiate through quality and off-season supply (Table 29). Imports of prefabricated buildings (HS 9406) are substantial (especially in UZ) and remain material in KG and TJ, suggesting that modular structures relevant to greenhouse/packhouse/utility infrastructure are significantly linked to import channels (Table 29). In parallel, Kyrgyz imports of ag/hort mechanical appliances (HS 842482) are relatively stable across 2021–2024, while UZ shows very large values and strong variation over time, consistent with ongoing investment and/or periodic bulk procurement of application equipment; this supports intensification but also increases the importance of safe-use training, input quality assurance, and regulatory compliance (Table 29).

Table 29: UN Comtrade (imports; CIF import values, USD) – input proxies for agriculture/horticulture

HS code	Input proxy label	KG 2021	KG 2022	KG 2023	KG 2024	TJ 2021	TJ 2022	TJ 2023	TJ 2024	UZ 2021	UZ 2022	UZ 2023	UZ 2024
070200	Vegetables; tomatoes, fresh or chilled	18,690,105	N/A	11,991,644	14,185,392	1,090,597	N/A	1,871,918	N/A	67,151	216,115	91,670	N/A
81010	Fruit, edible; strawberries, fresh	159,727	64,984	224,171	240,215	N/A	N/A	N/A	N/A	N/A	108	93,383	287,316.99
9406	Pre-fabricated buildings (proxy for greenhouse/packhouse/utility structures)	N/A	4,277,719	3,302,852	6,588,989	2,624,379	4,663,804	1,592,614	N/A	N/A	N/A	56,972,458.90	39,874,745.94
842482	Ag/hort mechanical appliances	1,146,457	1,484,709	1,156,490	1,377,660	N/A	N/A	N/A	N/A	163,975,055.83	45,043,902.94	13,697,508.95	16,109,913.97

Source: UN Comtrade, 2025

4.3.3 Production

In KG, agricultural production in general is highly smallholder-based following post-Soviet land fragmentation, which makes commercial supply aggregation difficult and places high demands on farmer capacity for production planning and quality consistency. Production is also constrained by low mechanization, with much agricultural work described as still done manually and Soviet-era machinery characterized as obsolete and over-used, limiting productivity gains and modernization at farm level. In horticulture specifically, FAO identifies smallholders as the backbone of production but facing limited access to quality inputs, appropriate technologies and knowledge; improvements have focused on building capacity for improved planting material systems (fruit/berry nurseries and training) (FAO, 2025b).

In TJ, horticultural production spans both open-field vegetables and off-season protected cultivation. Open-field tomato production is substantial and varietally diverse, with the largest share produced on small farms. These tomatoes are largely directed to canning, while off-season fresh tomatoes are produced in greenhouses, especially centered in Khatlon. Onion production is geographically specialized, including multiple districts in Sughd and Khatlon, and shows clear seasonality: early onions ripen as early as end-April/early May in Shartuz (Khatlon), then early June in several northern districts, and later (Aug–Oct) in other areas.

Seasonal (unheated) greenhouses in TJ can produce multiple cycles per year, and up to three crops per annum for small seasonal greenhouses without heating (USAID, 2022). Vegetable output growth has been associated with higher-quality seeds, fertilizers, agricultural machinery, pesticides and plant protection chemicals, alongside improved farmer knowledge. However, farmers continue to face limited access to certified inputs and modern technologies. Production is also labor intensive, relying on family labor with hired labor used at land preparation, planting, and harvesting. Irrigation dependence is high, summing up to nearly 70% of

horticulture land being irrigated, with challenges including financing of canal maintenance and issues linked to saline lands and irrigation regime violations (USAID, 2022). Greenhouse tomato expansion has relied on solar energy rather than fuel heating across a range of structure types, but skill gaps and limited access to high-quality nursery and planting stock remain bottlenecks. Food-hygiene practices and record-keeping or traceability at farm level are weak, with ISO and GlobalGAP emerging but not widespread.

In UZ, both dehkan and private farms cultivate open-field vegetables at scale, including tomatoes and onions in Fergana. Agro-climatic conditions support two vegetable harvests in most locations and three in some provinces, including Surkhandarya, enabling early/medium/late ripening supply windows. Production is supported by ready availability of inputs and protected-cultivation materials. Plastic-sheet greenhouses and low tunnels are used for early vegetables, and drip irrigation systems can be obtained domestically (Larson et al., 2015). Farm-level tomato production costs in Fergana include seed, mineral fertilizers, organic fertilizer, chemicals, irrigation, machinery hire, energy and paid labor, and open-field tomatoes are produced in large volumes for processing, with expansion being constrained by further investment needs, e.g. for machinery, new varieties, and drip irrigation (Larson et al., 2015).

4.3.4 Processing / storage

Post-harvest handling, storage, and processing remain key points where horticultural value is either preserved or lost across the target countries, with evidence of weak cold chain coverage, limited grading and packing actors, and inconsistent compliance capacity for higher-value markets. Underdeveloped cold storage systems in KG are linked to post-harvest losses (including an approximate of 25% loss associated with lack of treatment and storage equipment such as refrigerators), increasing seasonality and reducing exporters' ability to wait for buyers. In UZ, a "poor and dilapidated cold chain storage system" is described as a major export barrier, with widespread reliance on low-protection storage and packaging practices (e.g., use of cardboards or bags) and reported post-harvest losses reaching 40% (Qureshi, 2022).

The following are major bottlenecks with regard to processing:

- **On-farm handling and temporary storage.** Evidence from TJ highlights largely manual post-harvest operations for onions (cleaning, trimming, drying, sorting, calibration, peeling and packaging). For tomatoes, quality and shelf-life constraints are closely tied to harvesting, sorting, packaging, and rapid cooling; where cooling is absent, deliveries to distant markets can arrive unsorted and overripe, driving losses and price reductions.
- **Aggregation, grading and packhouse functions.** Fragmented supply and long chains with multiple intermediaries constrain quality control and traceability, which are increasingly required by modern retail and export markets (World Bank, 2019). In parts of UZ, intermediary services (including storage and refrigerated transport) are largely unavailable or inaccessible for many farmers in surveyed areas, and intermediaries/processors are weakly integrated (Robalino et al., 2022).
- **Cold chain and storage.** Regional evidence emphasizes that insufficient and inefficient cold chain infrastructure is a major contributor to fruit and vegetable losses and undermines export competitiveness. UZ is cited as having insufficient storage capacity relative to output targets, with cold chain capacity well below demand, while KG and TJ are urged to stimulate investment (Qureshi, 2022; World Bank, 2019).
- **Processing and market access.** In TJ, tomatoes are strongly linked to processing (canning or tomato paste), but processors face constraints such as outdated technologies, irregular raw material supply, and weak contracting incentives for farmers. In KG, processing of horticultural produce is generally weak, with needs for investment, storage capacity, and skilled staff. These bottlenecks matter most for access to formal domestic retail and exports, where buyers require consistent volumes, documented compliance, and reliable cold-chain logistics. Without these, the produce is pushed into lower-value spot markets (World Bank, 2019).
- **Food safety, standards and labs.** Export upgrading is tied to standards and certification capacity and to laboratory and food safety improvements. Uzbekistan's WB-supported horticulture project explicitly links investments and training with improved product quality, strengthened standards/certification, and upgraded laboratories and research institutes to support diversification and food safety (World Bank, 2024).

4.3.5 Trade

Trade data for the years 2021 – 2023 show a clear asymmetry between the three target countries. UZ is a major exporter of both tomatoes and onions, while KG is structurally more import-dependent, and TJ appears import-dependent for tomatoes but a strong exporter of onions (see Table 30 and Table 31 below).

For tomatoes (fresh/chilled), KG recorded sizeable imports of around USD 11.9 million in 2023, while exports remained relatively small and volatile, peaking at USD 2.66 million in 2022 before dropping sharply

to USD 0.34 million in 2023. Exports are concentrated on Kazakhstan and Russia, indicating dependence on a narrow set of regional markets. Tajikistan's tomato trade is dominated by imports (rising to USD 1.87 million in 2023), with exports being negligible across all three years. In contrast, UZ exports large quantities of tomatoes (valued at USD 52–60 million/year), with Russia consistently being the main destination while Kazakhstan and KG are also key outlets (though Kazakhstan declined markedly in 2023).

For onions and shallots, KG shifted from near-balance to a clear export surplus in 2023, with imports and exports amounting to USD 2.24 million and 2.56 million, respectively. TJ is a consistent and sizeable exporter of onions/shallots, valued at USD 5.4–6.8 million/year, overwhelmingly to Kazakhstan, while imports have risen significantly but remain secondary. UZ onion exports grew strongly (USD 25.0 million to USD 63.7 million), with Kazakhstan being the largest export market; exports to Belarus and Afghanistan have also been expanded, suggesting both market diversification and rising regional competitiveness.

Table 30: Imports and exports of tomatoes (fresh or chilled) in the target countries, indicating major export partners (in USD)

		2021	2022	2023
Total imports Kyrgyz Republic:		18,690,105	11,651,945	11,991,644
Total exports Kyrgyz Republic:		642,068	2,656,260	339,221
Main countries exported to:	Kazakhstan	168,763	195,485	201,718
	Russian Federation	473,305	2,460,775	137,503
Total imports Tajikistan:		1,090,597	691,130	1,871,918
Total exports Tajikistan:		27	350	2,862
Main countries exported to:	Kazakhstan	N/A	350	2,862
	Afghanistan	27	N/A	N/A
Total imports Uzbekistan:		67,151	216,115	91,670
Total exports Uzbekistan:		59,860,735	57,819,299	52,240,466
Main countries exported to:	Russian Federation	28,585,650	37,132,575	37,848,759
	Kazakhstan	15,671,399	16,712,482	8,832,535
	Kyrgyz Republic	14,039,316	3,209,154	4,921,903

*Source: UN Comtrade, *Imports are CIF values, exports are FOB values; N/A = data not available.*

Table 31: Imports and exports of onions and shallots (fresh or chilled) in the target countries, indicating major export partners (in USD)

		2021	2022	2023
Total imports Kyrgyz Republic:		1,571,900	2,138,177	2,238,197
Total exports Kyrgyz Republic:		1,320,700	836,452	2,557,593
Main countries exported to:	Kazakhstan	183,514	178,354	245,581
	Russian Federation	1,046,444	390,906	216,640
Total imports Tajikistan:		2,180	171,666	696,810
Total exports Tajikistan:		5,431,319	6,769,087	6,096,077
Main countries exported to:	Kazakhstan	4,534,512	6,633,845	6,064,665
	Russian Federation	15,252	22,695	31,412
Total imports Uzbekistan:		2,712	1,204,893	2,100,689
Total exports Uzbekistan:		25,005,827	35,954,752	63,704,651
Main countries exported to:	Kazakhstan	14,237,784	13,144,818	11,744,428
	Afghanistan	255,037	1,915,431	853,581
	Belarus	294,727	1,173,298	2,188,556

*Source: UN Comtrade, *Imports are CIF values, exports are FOB values; N/A = data not available*

4.4 Enabling environment

Kyrgyz Republic

In KG, the policy context for open-field vegetables (onion, tomato, garlic) and greenhouse crops (tomato, strawberry) is increasingly influenced by deeper market integration and the practical requirements of meeting Eurasian Economic Union (EAEU)-linked quality and compliance conditions for trade. In practice, this means that production-side competitiveness (yield, season extension via greenhouses, input quality) increasingly

depends on whether producers and aggregators can comply with phytosanitary, food safety, and conformity assessment requirements that are embedded in national law and (for EAEU trade) in supranational technical regulations. Export readiness for perishables is therefore not only a logistics issue, but also an institutional one - requiring credible inspection, testing, and certification capacity (Ministry of Economy and Commerce of the Kyrgyz Republic, 2025). For open-field horticulture in Osh, JalalAbad and Batken, irrigation governance and collective management remain relevant enabling conditions.

Various laws and regulations in the target countries are aimed at increasing horticulture production, productivity, and exports, such as:

- i. New Water Code of the Kyrgyz Republic dated June 27, 2025: The recently published law improves bureaucratic efficiencies by designating specific state bodies to manage aspects of water use and protection. It separates the functions of the State institutions for water resources from those responsible for management infrastructure. It also aims to apply a basin-based approach for the management of water resources. The law is also expected to improve monitoring, transparency and accountability by applying new standards for issuing and operating permits for the use of surface and ground water.
- ii. Law of the Kyrgyz Republic of February 8, 2002 on Unions (Associations) of Water Users: This law enables Water Users Associations (WUAs) as non-commercial organizations for irrigation management (Kyrgyz Republic, 2013).
- iii. Law of the Kyrgyz Republic No. 38 of June 19, 1997, "On Seeds": See Section 1.4 (Enabling environment for Wheat subsection). For greenhouse tomato and strawberry, where producers often depend on imported hybrids/planting material, seed-sector rules interact with border controls and plant quarantine requirements; reforms have also been pursued to reduce unnecessary administrative steps for the import of seeds/planting material, as reflected in amendments referenced in official communications (Kyrgyz Republic, 2019).
- iv. Governmental Decree No. 576 validating the Regulation on Plant Quarantine Department of the Ministry of Agriculture, Food and Land Reclamation dated November 11, 2016, and Law of the Kyrgyz Republic dated November 12, 2025 No 254 "On Ensuring Food Safety in the Kyrgyz Republic": Both laws signal a compliance trajectory aligned to risk-based controls and traceability expectations (Ministry of Agriculture of the Kyrgyz Republic, 2026) While these regulations are not sector-specific, rather providing a framework for food products, they set the compliance floor for vegetable and berry value chains, including greenhouse produce, and shape the costs and incentives for aggregation (e.g., packhouses and traders needing consistent documentation and testing). This directly affects horticulture marketing, handling, and compliance costs for greenhouse and open-field produce.
- v. Law No. 70 of June 11, 2004, "On Cooperatives": See Section 1.4 (Enabling environment for Wheat subsection). For horticulture value chains, the law provides a general organizational vehicle for farmer aggregation, joint marketing, and service delivery.
- vi. Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 574, dated September 13, 2024, "On Approval of the Program for the Development of Trade and Logistics Centers in the Agro-Industrial Sector of the Kyrgyz Republic for 2024-2028".
- vii. Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 81, dated February 20, 2025, "On Approval of the Program for the Formation and Development of Growth Points in the Regions of the Kyrgyz Republic for 2025-2030".
- viii. Order of the Cabinet of Ministers of the Kyrgyz Republic No. 120, dated March 16, 2022, project "Lending to the Agro-Industrial Complex".
- ix. Order of the Cabinet of Ministers of the Kyrgyz Republic No. 416, dated May 29, 2025, on the approval of the project "Development of seed production and nurseries in the Kyrgyz Republic".

Tajikistan

Tajikistan's framework for vegetables and greenhouse crops is anchored less in explicit "horticulture policy" and more in how the state governs irrigation and natural resources, regulates plant quarantine and agrochemical use, and sets food safety requirements for market participation. For horticulture value chains in Sughd and Khatlon this translates into a policy environment where productivity gains (including greenhouse expansion) are closely linked to regulated access to irrigation and to compliance with mandatory phytosanitary and food safety rules for both domestic marketing and cross-border trade.

Other sector-relevant laws and acts include:

- i. Law No.672 December 29, 2010 "On food security": Regulates public relations in food safety, including requirements for imported products (documentation confirming safety) and the role of sanitary-epidemiological and veterinary examination (Republic of Tajikistan, 2022). For horticulture, the practical implication is that cold chains, packhouses, and aggregators need the ability to produce (or procure) documentation and testing evidence; otherwise, compliance becomes a bottleneck to scaling up trade in perishable commodities.
- ii. Law No. 355 of the Republic of Tajikistan, dated January 5, 2008 "On Seed Breeding": Establishes legal foundations for production/reproduction, processing, certification, marketing of

- seeds/seedlings/plants, as well as varietal registration and seed control; requires imported seed lots to undergo seed and phytosanitary control and links export seed lots to certification requirements (Republic of Tajikistan, 2024b).
- iii. Regulations on plant health and SPS: Tajikistan consolidated quarantine and plant protection into a single law that explicitly covers quarantine phytosanitary measures, state phytosanitary control, and the regulated circulation of plant protection products (pesticides and agrochemicals). This framework matters for horticulture because vegetables and greenhouse production are particularly sensitive to pest/disease pressure and pesticide residue risks; the law also clarifies that quarantine certification and phytosanitary certificates are within the mandate of the authorized state body—central to export readiness for fresh produce (Republic of Tajikistan, 2024a).
 - iv. Law No. 1289 of the Republic of Tajikistan, dated March 15, 2016 “On Dehkan (Farm) Economy”: Defines the legal status and operating rules for dehkan farms (registration, rights/obligations, ability to hold accounts, engage in economic activity including external economic activity as permitted), shaping producer formalization and aggregation pathways in horticulture regions (Republic of Tajikistan, 2016).
 - v. New Water Code of the Republic of Tjikistan, dated July 9, 2020: Regulates social relations related to the ownership, use, and management of water and water bodies and is aimed at the protection and rational use of water resources, as well as the legal protection of water users.
 - vi. Law No. 213 of the Republic of Tajikistan, dated November 21, 2006 “On Associations of Water Users”: Provides a dedicated legal basis for Water Users Associations as a vehicle for irrigation water distribution and management at local level and that is important for tertiary canal management, maintenance responsibilities, and the ability to improve water delivery reliability. This is relevant to horticulture intensification and irrigation modernization in Sughd and Khatlon (Republic of Tajikistan, 2006).

Uzbekistan

Over the past reform cycle, UZ has repositioned horticulture as an export-oriented growth subsector, supported by measures that streamline trade procedures and encourage investment along the value chain. In practice, this has included reforms that reduced direct state intervention in export operations and foreign currency management and aimed to speed up border and clearance procedures for perishable goods (e.g., “green corridors”). As a result, horticulture is often cited domestically as a positive example of reforms that can raise value added, employment, and export earnings (German Economic Team, 2021).

At the same time, the enabling environment still reflects key structural constraints linked to the legacy of central planning, including a dualistic farm structure: (i) smallholder dehkan farms (typically focused on horticulture and livestock) and (ii) larger farms (often oriented toward grains and cotton). The regulatory framework therefore has to serve very different producer types, ranging from household-based production to larger commercial farm enterprises (International Trade Administration, U.S. Department of Commerce, 2025).

Several public initiatives also seek to strengthen sector performance and compliance capacity. Notably, Agricultural Knowledge and Innovation Centers are planned for 2022–2026 in all regions, delivering more than 100 agricultural services through a “one-stop shop” model (including soil improvement, plant disease control, and seed selection). In parallel, the government is prioritizing modernization of irrigation and subsidizing adoption of water-saving technologies, reflecting the strategic importance of water efficiency for agriculture (International Trade Administration, U.S. Department of Commerce, 2025).

Some relevant regulatory acts for the horticulture sector include:

- i. Presidential Resolution No. PP-136 “On additional measures to increase export potential and develop the agricultural product processing chain”, issued April 2025: Sets targets for 2025–2027 related to storage, packaging, processing and export performance, including (among others): raising exports of fruits/vegetables and food products to USD 3.5 billion in 2025, expanding processing capacity and cold storage, and launching packaging investment projects.
- ii. Presidential Decree No. PP-4246, “On measures for further development of horticulture and greenhouse economy in the Republic of Uzbekistan”, issued 2019: This Decree established the Agency for the Development of Horticulture and Greenhouse Economy and set out core state-support functions (target programs, expansion of intensive orchards/greenhouses using resource-saving technologies, support for certification standards, cluster/cooperation development across the value chain, and investment attraction) (Tukhsinov, 2019).
- iii. Governmental Decree No. 481 (11 June 2019) – agency regulatory framework: This Governmental Decree validates regulatory legal acts governing the activities of the Horticulture and Greenhouse Development Agency under the Ministry of Agriculture, supporting a structured institutional framework for management and public support in the sub-sector.
- iv. Presidential Decree No. PP 4020 “Measures to create additional conditions for the development of greenhouse complexes”: The decree announced favourable investment conditions such as manufacturers’ tax incentives and exemption from customs fees for imports of construction materials.

Other sector-relevant regulatory acts include:

- v. Law of the Republic of Uzbekistan on Agricultural Cooperative (Shirkat) dated 30.04.1998 No. 600-I;
- vi. Law of the Republic of Uzbekistan on the Dehkan Economy dated 01.04.2021 No.ZRU680;
- vii. Law of the Republic of Uzbekistan on the Tomorka Economy dated 01.04.2021 No.ZRU-681;
- viii. Law of the Republic of Uzbekistan on Farming Economy dated 26.08.2004 No.ZRU662-II;
- ix. Law of the Republic of Uzbekistan on Organic Products dated 25.04.2022 No.ZRU-766;
- x. Law of the Republic of Uzbekistan on Breeding Achievements dated 28.9.2002 No. 395- II;
- xi. Decree of the President of the Republic of Uzbekistan on Additional Measures to Improve the Procedure for Leasing Agricultural Land dated 18.01.2024

4.5 Climate risk and impact

Horticulture in the target countries is exposed to climate risks dominated by rising temperatures and heat extremes, interacting with high irrigation dependence and variable water availability. In southern UZ (programme-relevant to Surkhandarya), available studies cited in IFAD's Horticultural Support Project (HSP) documentation expect the "average number of days with air temperature over 39°C [...] to reach a critical level for the currently growing crops," resulting in heat stress and decreased moisture levels during the vegetation period (IFAD, 2020). The same report characterizes Uzbekistan's climate as having dry, hot and long summers and estimates a national warming rate of 0.27°C per decade (IFAD, 2020). Consistent with this, IFPRI's crop-climate analysis highlights that Central Asia is projected to experience strong climate shocks, primarily through temperature changes, with large projected increases in the mean daily maximum temperature of the warmest month by 2050 across models for KG, TJ and UZ.

Data on likely farm-level impacts of these climate hazards on the exact focus crops of this proposal (open-field onion, tomato and garlic; greenhouse tomato and strawberry) are not available. However, evidence from the Fergana Valley on horticulture-adjacent systems indicates relevant impact pathways: as mentioned in Section 2.5 above, rising temperatures have led to delayed flowering of fruit crops, thus reducing yields and fruit quality, and prolonged heatwaves have also decreased fruit quality, alongside more frequent late frosts in March/early April that can eliminate harvests during flowering (Salokhiddinov et al., 2020a). While this evidence applies to fruit trees, it demonstrates how heat extremes and unstable spring conditions can drive yield instability and quality losses in temperature-sensitive horticultural production.

Water stress is a central risk amplifier. In the Surkhandarya context, the IFAD Horticultural Support Project documentation links low farm productivity to limited and unreliable access to irrigation water, and it characterizes irrigation and water management as highly climate-sensitive given the scale of agricultural water demand nationally (IFAD, 2020). At the broader regional level, much of Central Asia's irrigated agriculture depends on glacier- and snowmelt-fed river systems, and projected hydrological changes (including long-run glacier melt decline alongside more frequent drought and flood episodes) are expected to increase variability and uncertainty in irrigation supply (ADB, 2019, 2019).

Post-harvest and market risks compound climate impacts for perishable horticultural produce. IFAD reports major constraints in storage and processing capacity/technology in Uzbekistan's horticulture value chain, alongside high post-harvest loss rates, and notes that horticulture trade can be volatile in part due to weather conditions (IFAD, 2020). In such conditions, climate-driven fluctuations in volumes and quality are more likely to translate into higher physical losses, reduced saleable output, and greater income variability - especially for smaller producers with weaker access to storage, processing, and marketing services (IFAD, 2020)).

4.6 Climate-resilient technologies and adoption

4.6.1 Status quo regarding the adoption of climate-resilient horticulture production

Kyrgyz Republic

Climate resilient horticulture practices in KG have been introduced gradually as a consequence of ongoing structural changes in Kyrgyz agriculture, and through projects as part of development assistance initiatives. The government has introduced programmes to develop horticulture that have resulted in a shift towards more profitable and climate resilient vegetables and fruits (Derkenbaeva et al., 2024).

In terms of international support for the horticulture sector, documented climate-resilient or "best technology" promotion has occurred mainly through project-supported demonstration and training, rather than through quantified mainstream adoption at scale. For example, a FAO technical cooperation project emphasized capacity development and demonstration of technologies relevant to climate resilience (such as IPM and soil and water-saving technologies) but its core implementation sites for nurseries and demonstration plots were in Chui and Issyk-Kul oblasts, not in Osh/Jalal-Abad/Batken (FAO, 2025b).

In the south of the country, enabling policy dialogue and stakeholder engagement is evidenced through regional round tables organized under the same FAO project, including events in Osh city for stakeholders from Osh and Batken and in Jalal-Abad oblast, indicating structured platforms to discuss constraints and recommendations for horticulture development.

In terms of concrete technologies, drip irrigation does exist but is not widespread. Only few farmers use drip irrigation where they receive canal water; rather, drip irrigation is used almost exclusively on unproductive, rainfed land where vegetable cultivation would otherwise be impossible, suggesting that capital-intensive water-saving irrigation is for the time being concentrated among farmers facing severe water access constraints or with higher investment capacity.

Irrigation reliability issues in Batken likely reinforce both the need for and constraints to adoption. Field observations from Batken show that irrigation water inflow has become unpredictable (high runoff in early spring but less water in summer when demand is highest) and that landslides/mudslides damage and clogs already deteriorated irrigation infrastructure, affecting water supply and quality (UNDP, 2022). Furthermore, while available water resources could be sufficient with proper planning and functioning infrastructure, in practice there is an acute shortage in July–August, and irrigation infrastructure remains inefficient in many places despite donor support; willingness/ability to pay does not match the requirements for adequate maintenance (UNDP, 2022).

Regarding an enabling environment for the adoption of climate-resilient horticulture, KG has an established advisory-service infrastructure supported by donor programming. The Rural Advisory Services (RAS) network operates nationally through independent foundations, including in Batken, Jalal-Abad and Osh, supporting rural people by providing know-how and linking farmers to relevant market actors (Microfinance Centre, 2011b). Agrolead and TES Centre are other key non-governmental extension services playing a role in promoting climate-resilient horticulture. In addition, multiple donor projects (e.g. Helvetas/ICCO, GIZ, USAID) have historically supported agriculture value chains and advisory/training services, including in the southern oblasts (Microfinance Centre, 2011b). Complementing advisory services, the World Bank's Resilient Agri-food Clusters Development Project concept includes a horticulture cluster intended to support producers and processors (notably in Jalal-Abad). The project identified a need for training and capacity building to promote climate resilient technologies, along with investments that can include pest and disease control and food safety improvements, and post-harvest facilities such as washing, grading, packing, pre-cooling, and cold storage (Syed, 2022). This supports the assessment that, while the adoption of climate-smart practices is currently not widespread, their use is being promoted through structured cluster investments and capacity-building activities.

Tajikistan

Across TJ, climate-resilient techniques have been introduced and promoted through donor-supported projects, but scaling remains limited. This is true not only for horticulture, but for the overall adoption landscape in which horticulture technologies are being promoted.

For horticulture/vegetables specifically, there is evidence that (unheated) greenhouses for cucumbers and other vegetables are profitable under proper management, implying that such protected cultivation systems do currently exist and are economically relevant for smallholders with very small areas (example given: 0.04 ha) (USAID, 2022).

Regarding an enabling environment for the adoption of climate-resilient horticulture, the World Bank "Strengthening Resilience of the Agriculture Sector Project" (SRASP) explicitly targets the enabling of investments in agri-logistical centers (ALCs) for horticulture value chains, noting that horticulture produce quantity/quality remains low and that cold storage, sorting, grading, and processing infrastructure is "still rudimentary," contributing to short, seasonal supply. The supported investments are aimed at reducing losses and improving market access conditions for horticulture (World Bank, 2022).

Advisory systems are another essential prerequisite to the adoption of climate-resilient technologies and practices, particularly in the horticulture sector which is knowledge intensive. In this regard, Tajikistan's digital agriculture ecosystem is still nascent, with only a few major players providing digital services for agriculture, including Sarob Cooperative (farmer advisory focus) and the Neksigol group (multiple ag-tech products), alongside an agricultural producers' association developing a farmer app (USAID, 2022).

Uzbekistan

In general, farmers in UZ do use advanced technologies, such as drip irrigation, plastic tunnels, and greenhouses, thus enhancing yields and adapting produce to market demand (Larson et al., 2015). The adoption of sustainable, climate-smart technologies is increasing among larger farms, including the use of efficient irrigation systems and renewable energy technologies, with an observed shift from flood irrigation to drip irrigation systems (World Bank, 2024). However, these technologies remain too costly for a large share of smallholders. Some projects active in the sector report that some planned service-delivery and enabling outputs were not or only partially achieved (e.g., IPM programs), which suggests unevenness in the strength of advisory/knowledge systems even within a major national program (World Bank, 2024).

4.6.2 Potential and barriers preventing the adoption of climate-resilient horticulture production

The adoption constraints outlined below are mainly of a systemic nature rather than being commodity or horticulture specific. Hence, these constraints affect the adoption of climate resilient technologies and practices in a broad range of crops, including tomatoes, onions, garlic, and strawberries. Where constraints are of particular relevance to the horticulture sector this is highlighted in the text.

Kyrgyz Republic

The main barriers preventing the large-scale adoption of climate-resilient horticulture production among smallholder farmers include:

- **Technical aspects**
A recurring constraint is limited access to appropriate technologies and inputs for smallholders. The FAO horticulture project background notes that smallholders often struggle with limited access to quality inputs and appropriate technologies and face constraints in technical knowledge (FAO, 2025b). Separately, there is a widespread reliance on obsolete equipment inherited from the Soviet period, with limited impact of existing leasing efforts relative to need.
- **Extension services**
Horticulture is knowledge intensive (production, irrigation practices, plant care, post-harvest handling), and insufficient farmer know-how can translate into lower quality and marketability (Qureshi, 2022). Private advisory centers are effective intermediaries and knowledge providers, yet their outreach is generally too limited to be nationally significant. There is no public extension service.
- **Access to finance**
Access to finance for upgrading production and post-harvest systems is constrained by collateral and affordability issues. Harvesting and processing infrastructure require large investments; yet, borrowing is limited by collateral constraints, highlighting the importance of guarantee mechanisms to improve access to finance. More broadly, access to financial resources remains limited for many producers due to collateral requirements, complicated borrowing procedures, and limited financial literacy (Derkenbaeva et al., 2024).
- **Water efficiency**
Water-saving irrigation is a key adaptation strategy, particularly in arid areas such as Batken (Derkenbaeva et al., 2024).
- **Inputs**
The availability of quality seeds and seedlings is an important gap across the agriculture sector. In this sense, the FAO project explicitly prioritized improved availability and use of quality planting material, establishment of nurseries, and strengthening nursery managers' capacity to supply locally adapted climate resilient materials (FAO, 2025b). With respect to horticulture, this is particularly relevant for strawberry planting material and greenhouse vegetable seedlings.
- **Post-harvesting**
The horticulture sector is affected by significant post-harvest infrastructure gaps; underdeveloped cold storage is leading to substantial post-harvest losses and seasonality in supply (Qureshi, 2022). Constraints around packaging and processing infrastructure are additional barriers affecting the sector.

The following actions are important to address the existing challenges in the horticulture sector:

- Demonstration plots and structured training to disseminate IPM, soil and water-saving technologies, and improved production methods (FAO, 2025b).
- Strengthening and scaling regional advisory/extension capacity, such as RAS and other advisory organizations which currently have only limited outreach.
- Targeted investments in production technologies, cold storage and post-harvest handling, repeatedly identified as binding constraints for horticulture competitiveness and loss reduction.

Tajikistan

In Tajikistan, the following barriers have been identified for the dissemination of climate-resilient horticulture production among smallholder farmers

- **Technical barriers**
Key technical barriers in TJ include limited availability of quality seeds and planting materials, weak practical agronomic skills, and poor understanding of soil restoration and moisture management technologies. These issues are of high relevance in open-field and greenhouse based vegetable production that depends on quality seeds and seedlings and effective nutrient management and pest/disease control. Furthermore, Tajikistan's agriculture is highly dependent on irrigation, which is considered a structural technical constraint affecting the feasibility and affordability of intensified, climate-resilient horticulture practices (USAID, 2022).

- **Knowledge**
Lacking awareness and knowledge and advisory gaps are key constraints to the widespread adoption of climate resilient practices. Farmers are also hesitant about introducing new practices due to (perceived) risks and lack of successful local examples. There is broad evidence that smallholders rarely adopt new methods unless they are visually and practically demonstrated and endorsed by local experts. Lack of adequate extension services and low penetration of digital tools to supplement extension are a persistent constraint (USAID, 2022).
- **Access to finance**
Similar finance barriers apply to smallholder farmers in TJ as to those in KG, as described above.
- **Water**
The adoption of water-efficient irrigation technologies is constrained by the generally low efficiency of existing irrigation networks, entailing high water losses during supply and distribution.
- **Input systems**
Input constraints include limited availability and affordability of quality seeds/planting materials and other inputs in view of general agricultural input price increases. For horticulture in particular, such input system weaknesses can directly hinder shifts toward more resilient varieties, better seedlings, and improved crop protection practices.
- **Post-harvesting**
Similar to KG, post-harvest gaps are a major factor affecting the productivity and profitability of Tajikistan's horticulture value chains. Cold storage, sorting, grading, and processing infrastructure is still rudimentary, making supply short and highly seasonal and contributing to food and nutrition insecurity (World Bank, 2022). At the same time this weakens incentives and farmers' ability to invest in upgraded production, because quality premiums are not reliably captured by producers without adequate post-harvest infrastructure and logistics (World Bank, 2022).

In terms of the opportunities to address these existing challenges, the following have been identified:

- Targeted support through attractive financing mechanisms for the introduction of climate-resilient production practices and technologies among smallholder farmers.
- Demonstration-led dissemination and farmer learning platforms. As elaborated in Section 2.6.2 above, tailored educational materials and the establishment of demonstration plots and farmer field schools across agro-ecological zones are recommended, as well as targeted investments on key technologies such as drip irrigation and drought-resistant seeds. USAID's evidence on smallholders' adoption behavior reinforces the importance of visual/practical demonstrations supported by trusted local expertise (USAID, 2022).
- Reducing losses and improving returns via agri-logistics investments. Improved access to cold storage and handling services can increase the payoff to investing in improved and climate-resilient production practices by reducing perishability-related losses and improving market access (World Bank, 2022).

Uzbekistan

In Uzbekistan, important barriers have been identified for the dissemination of climate-resilient horticulture production among smallholder farmers

- **Knowledge**
Key knowledge barriers lie in shortfalls in efficient irrigation, IPM-related outputs and other knowledge, suggesting persistent gaps in extension/knowledge services needed for the adoption of more knowledge-intensive resilience packages (World Bank, 2024).
- **Access to finance**
Limited access to finance is a central barrier. Uzbekistan's financial sector has historically offered limited support to agriculture, with high collateral demands, high interest rates, and a lack of tailored products, with loans often short-term and unsuitable for the sector's seasonal needs (World Bank, 2024). To enable larger investments in the horticulture sector (e.g. for greenhouses or cold storage) longer-tenor finance is critical for farmers/SMEs to manage cashflows and investments (ADB, 2025).
- **Post-harvesting constraints**
In large parts, the horticulture value chain is characterized by a rudimentary marketing and transportation infrastructure, limited and technologically poor storage and processing capacity, and high levels of post-harvest losses (ADB, 2018). Apart from infrastructure deficits, another important gap concerns training of value chain actors on proper post-harvest handling of perishable horticulture produce (World Bank, 2024).

Nevertheless, horticulture is a key sector in the country, including in the target regions, and there are a number of opportunities to mitigate these barriers:

- Credit lines paired with technical assistance and training to enable investment of smallholders in water-saving irrigation, greenhouse facilities, and improved production and handling practices (World Bank, 2024).
- Training of extension services on climate-resilient practices and technologies in horticulture, including inputs, water-efficiency, soil fertility etc.
- Agro-logistic centers / cold storage and processing infrastructure to reduce post-harvest losses, consolidate services (including certification and market advisory), and strengthen incentives for farmers and SMEs to invest in higher-quality, more resilient production (ADB, 2018).

4.6.3 Proposed climate-resilient technology

Key strategies to enhance climate resilience in the horticulture sector encompass the development and use of climate resilient planting material, the implementation of efficient water management techniques, and the application of improved and protective agronomic practices (Jain et al., 2024). To address the climate risks affecting vegetable and berry cultivation as outlined in Section 5 above, the programme will therefore support the following technologies and practices through investments and technical assistance:

- **Use of climate resilient seeds and seedlings:** the programme will support the use of seeds and seedlings of high-yielding varieties for vegetable crops. Testing such varieties for their drought and heat tolerance by local agricultural extension organizations will be supported and those with the best climate-resilience characteristics will be recommended to target farmers. Special emphasis will be placed on climate-adapted rootstocks that enhance tolerance to water scarcity, high summer temperatures (often exceeding 40°C), winter frost events, and increasing soil salinity - conditions typical for many parts of Central Asia. In vegetable production, grafted seedlings on stress-tolerant rootstocks and hybrids bred for climate variability will be encouraged, drawing on recent breeding advances within Central Asia and internationally (Kapur, 2013). This approach will strengthen crop productivity and stability under increasingly erratic climatic conditions.
- **Use of drip irrigation:** the establishment of drip irrigation is a key strategy for enhancing the climate resilience of high-value crops, such as fruit trees (EDB, 2023). Compared to traditional irrigation methods, the use of drip irrigation leads to water savings of 40-70% while having the potential to increase yields by 25-100% (Pushparaj & Punithkumar, 2024). Water will be supplied via water harvesting infrastructure (such as appropriate-scale reservoirs) or by installing tubewells for groundwater based irrigation, depending on local conditions. Drip irrigation systems must be equipped with suitable filters to prevent pipe blockages due to sandy water. The integration of fertigation systems is an option; drip irrigation can cut the use of mineral fertilizers and pesticides by 21—33%, at the same time preventing nutrient leaching and subsoil water pollution (EDB, 2023) (Pushparaj & Punithkumar, 2024).
- **Improved plant nutrition:** in horticulture production, an issue of concern is the typically imbalanced use of fertilizers, which tends to be heavily biased towards nitrogen (i.e. urea application) while the application of phosphorus and potassium is largely neglected. Hence, training farmers on proper usage of mineral fertilizers would likely lead to significant productivity increases in the horticulture sector, thus further enhancing the sector's resilience against climate change conditions, while reducing GHG emissions, nutrient loss and eutrophication of water bodies.
- **Use of insect-proof nets/shade nets:** The use of shade nets has been adopted by a few farmers in the programme target region to protect tomatoes from extremely high temperatures and sunburn. The programme will support shade nets in specific areas. Their use can also significantly contribute to **Integrated Pest Management (IPM)**, by physically protecting vegetable fields against certain pests which are expected to proliferate under progressing climate change conditions (FAO, 2025a). In particular, it will be tested whether shade nets are effective in preventing infestation of tomatoes with the pest *Tuta absoluta* which is an increasing problem in the programme target area.

The programme will provide **financial support** through matching grants to help make climate resilient seeds/seedlings, drip irrigation and fertigation equipment, trellises and horticultural netting available and accessible to smallholder farmers. **Technical assistance** will encompass the training of farmers on improved crop management practices, encompassing irrigation, plant nutrition (including fertigation) and plant protection.

Due to differences in current cultivation practices and market conditions, the proposed programme intervention packages vary across the three target countries. Table 32 provides an overview of the respective target crops, BAU management characteristics, and improved practices to be supported by the programme.

Table 32: Overview of proposed programme intervention packages in vegetable and berry production

Crop	Kyrgyz Republic	Tajikistan	Uzbekistan
Onion	• Improved seeds	• Improved seeds	• Improved seeds

(open-field)	- Capacity building on improved plant nutrition and IPM - No change in irrigation (furrow irrigation; drip irrigation is being explored, but, due to insufficient data, it is not yet included in the intervention package)*	- Capacity building on improved plant nutrition and IPM - Change from furrow to drip irrigation	- Capacity building on improved plant nutrition and IPM - Change from furrow to drip irrigation
Tomato (open-field)	Main season production: - Improved seedlings - Capacity building on improved plant nutrition and IPM - Change from furrow to drip irrigation Early production (in low-lying areas): - Improved seedlings - Capacity building on improved plant nutrition and IPM - Drip irrigation - Trellises - Shade nets	- Improved seedlings - Capacity building on improved plant nutrition and IPM - Change from furrow to drip irrigation	- Improved seedlings - Capacity building on improved plant nutrition and IPM - Change from furrow to drip irrigation
Tomato (green-house)	-	- Improved seedlings - Capacity building on improved plant nutrition and IPM - Improved plant protection - Change from manual irrigation to drip irrigation	- Improved seedlings - Capacity building on improved plant nutrition and IPM - Improved plant protection - No change in irrigation (drip irrigation)
Garlic (open-field)	-	-	- Capacity building on improved plant nutrition and IPM - Change from furrow to drip irrigation
Strawberry (green-house)	-	- Improved seedlings - Capacity building on improved plant nutrition and IPM - No change in irrigation (drip irrigation)	- Higher seedling density - Capacity building on improved plant nutrition and IPM - Improved plant protection - No change in irrigation (drip irrigation) - Use of hydroponic mats

*New data on drip irrigation in onion production will be available from TES Centre after the 2026 harvest; if results are favorable, drip irrigation will be added to the intervention package

5. Non-timber forest products

5.1 Relevance

Based on stakeholder consultations, national priorities, socio-economic aspects and climate change impacts, two non-timber forest product (NTFP) value chains have been selected: walnuts and pistachio. Importantly, this analysis only includes data and information for walnuts and pistachios from natural forests or forest plantations, i.e. tree plantations established with the primary purpose of reforestation or afforestation and not for production. Walnuts and pistachios produced in orchards have not been included.

Another important aspect to consider is that walnut and pistachio forests support the production of a wide range of other NTFPs, including medicinal herbs, mushrooms, wild fruits and berries, and honey. Most of these products are produced on a family basis and little data exist on volumes and trade. Their production is irregular due to natural cycles and specific annual climate conditions, and markets are therefore typically opportunistic, with buyers sometimes greatly varying from one year to another. Although these NTFPs are not included in the analysis, the proposed programme measures are designed to also increase their production.

Walnut

The walnut-fruit forests in Jalal-Abad and Osh regions in the Kyrgyz Republic (annual production from 1,000 to 3,900 MT, with estimations up to 6,500 MT for an average year (FAO, 2023b; Swoboda, 2019). Walnut

forests contribute to the livelihood of over 10,000 people in rural areas, involved in collection, primary processing and trade (*ibid.*). These forests are also recognized as a biodiversity hotspot, home to the original varieties of several nut and fruit species, including walnuts, plums and several species of wild apple (Orozumbekov et al., 2014). These forests are publicly owned, and forest plots are leased out to local forest tenants for walnut collection. Tree felling is prohibited unless under very specific conditions. Despite these protection measures, these forests are rapidly degrading, mainly from insufficient natural regeneration that is prevented by intense livestock grazing and intensive walnut (seed) collection. Climate change impacts are already visible on walnut production. Early flowering combined with late frosts on the one hand, and hot spell in summer contribute to decreasing tree productivity (Tyrgotov et al., 2024).

The walnut forests of Tajikistan and Uzbekistan do not span over significant areas and contribute to the livelihoods of only a few communities located in their vicinity.

Pistachio

Pistachio forests grow on dry hills in Jalal-Abad (Kyrgyz Republic), Khatlon (Tajikistan) and Surkhandarya (Uzbekistan) regions. Pistachio collection and sale is an important source of income for the population in areas that are, otherwise, dominated by livestock production (GIZ/Unique, 2023; Kaiypovich Kenzhebaev et al., 2023). These forests are under several threats, including low regeneration rates and climate change impacts⁷.

5.2 Production volumes and key production areas

Walnut

Based on the statistics available, Table 33 summarizes the area covered by natural walnut forests, walnut production and yields. Apart from providing statistics at national level, the table includes data for the provinces that make up the two intervention areas, i.e. (i) the 'Fergana Valley' (FV) which encompasses provinces in all three target countries (shaded in light blue) and (ii) 'Khatlon & Surkhandarya' (KS), two bordering provinces in Tajikistan and Uzbekistan. Due to missing data, totals for FV and KS areas cannot be provide

Table 33: Walnut production statistics for the target countries and intervention areas

Country/province	Area covered by natural walnut forests (ha)	Walnut production (MT)	Average walnut yield (kg/ha)
Total Kyrgyz Republic (KG)	45,0008	3,565	4,507
Jalal-Abad (KG)	31,100	1,610	5,439
Osh (KG)	5,094	997	6,042
Total Tajikistan (TJ)	N/A	99	N/A
Khatlon (TJ)	10,000	122	N/A
Sughd (TJ)	0	0	N/A
Total Uzbekistan (UZ)	1,450	N/A	N/A
Andijan (UZ)	0	0	0
Fergana (UZ)	0	0	0
Namangan (UZ)	0	0	0
Surkhandarya (UZ)	N/A	N/A	N/A

Fergana Valley **Khatlon/Surkhandarya**

Source: Various national and provincial agricultural statistics; N/A = not available

Pistachio

Based on the statistics available, Table 34 summarizes the area covered by natural pistachio forests and pistachio production.

Table 34: Pistachio production statistics for the target countries and intervention areas

Country/province	Area covered by natural pistachio forests (ha)	Pistachio production (MT)
Total Kyrgyz Republic (KG)	34,403	52
Jalal-Abad (KG)	N/A	N/A
Osh (KG)	0	0
Total Tajikistan (TJ)	81,520	66
Khatlon (TJ)	81,520	66
Sughd (TJ)	0	0

⁷ State Forest Agency of Tajikistan, personal communication

⁸ The exact territory of the walnut-fruit forests in Kyrgyzstan is unclear – as per various sources it may be around 36000 (when summing up the areas reported by individual State Forestry Enterprises) or 45000 ha (B. I. Venglovsky on the basis of various sources from the Soviet era). A reason for the difference could be the definition of which density of tree cover is needed to count an area as forest.

Total Uzbekistan (UZ)	30,000	N/A
Andijan (UZ)	N/A	N/A
Fergana (UZ)	N/A	N/A
Namangan (UZ)	N/A	N/A
Surkhandarya (UZ)	N/A	N/A

Fergana Valley Khatlon/Surkhandarya

Source: Various national and provincial agricultural statistics; N/A = not available

5.3 Description of the value chain

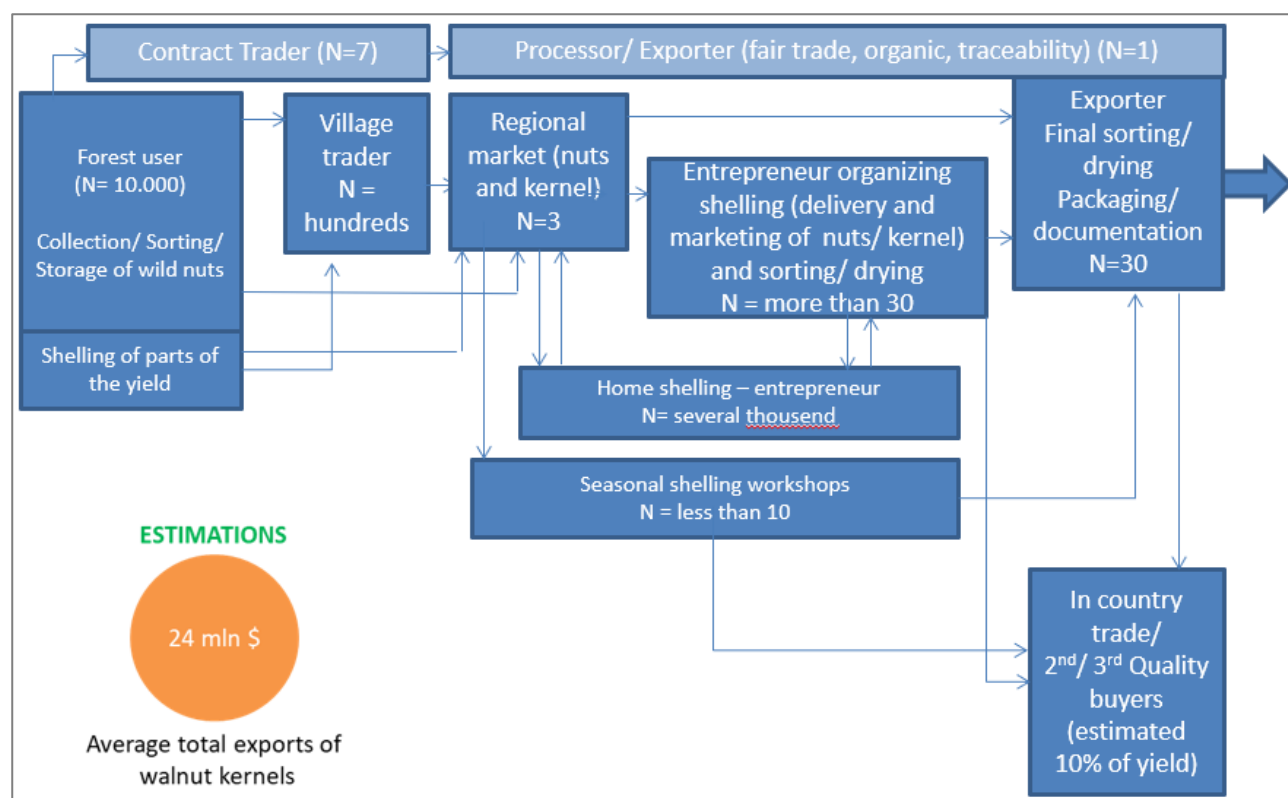
5.3.1 Physical and legal entities involved in the value chain

Stakeholders in the walnut and pistachio NTFP value chain can be categorized into five groups:

- Entities at national and regional levels, Association of Walnut Growers and Foresters in KG, National Association of Dehkan (Farmer) farms in TJ;
- Cooperatives;
- Forest users (see 'Production' below).
- Private sector actors, such as input providers (see 'Inputs' below) and intermediaries/enterprises engaged in the purchase, transportation, processing, packaging and marketing of walnut and pistachio products; and
- Consumers, i.e. the entire rural and urban population who has access to walnut and pistachio products.

The figure below provides an overview of the walnut value chain in the Kyrgyz Republic.

Figure 2: Structure of the walnut value chain in the Kyrgyz Republic



Source: Swoboda, 2019

5.3.2 Inputs

Walnut seedlings for use in forest plantations are produced domestically. There are ongoing efforts by some state forest enterprises in the Kyrgyz Republic to improve the quality of planting material through grafting, using locally selected, productive and climate-resilient trees. Seedling prices vary depending on the age of the seedling and whether it is grafted or not, with an average price of KGS 300 per seedling.

The production of **pistachio seedlings** follows a similar path to that of walnut, with seedlings being produced locally and efforts being made to improve the productivity and resistance of seedlings through grafting. The latter is particularly developed in Tajikistan and Uzbekistan.

Table 35 indicates the sources of inputs for walnut and pistachio production.

Table 35: Sources of inputs for walnuts and pistachio production in the target countries

Type of input	Kyrgyz Republic	Tajikistan	Uzbekistan
Seeds	Seeds collected mainly from state forest enterprises (walnuts and pistachio).		
Seedlings	Seedlings mainly produced by state forest enterprises, with emerging private tree nurseries offering grafted seedlings (walnuts and pistachio).		

5.3.3 Production

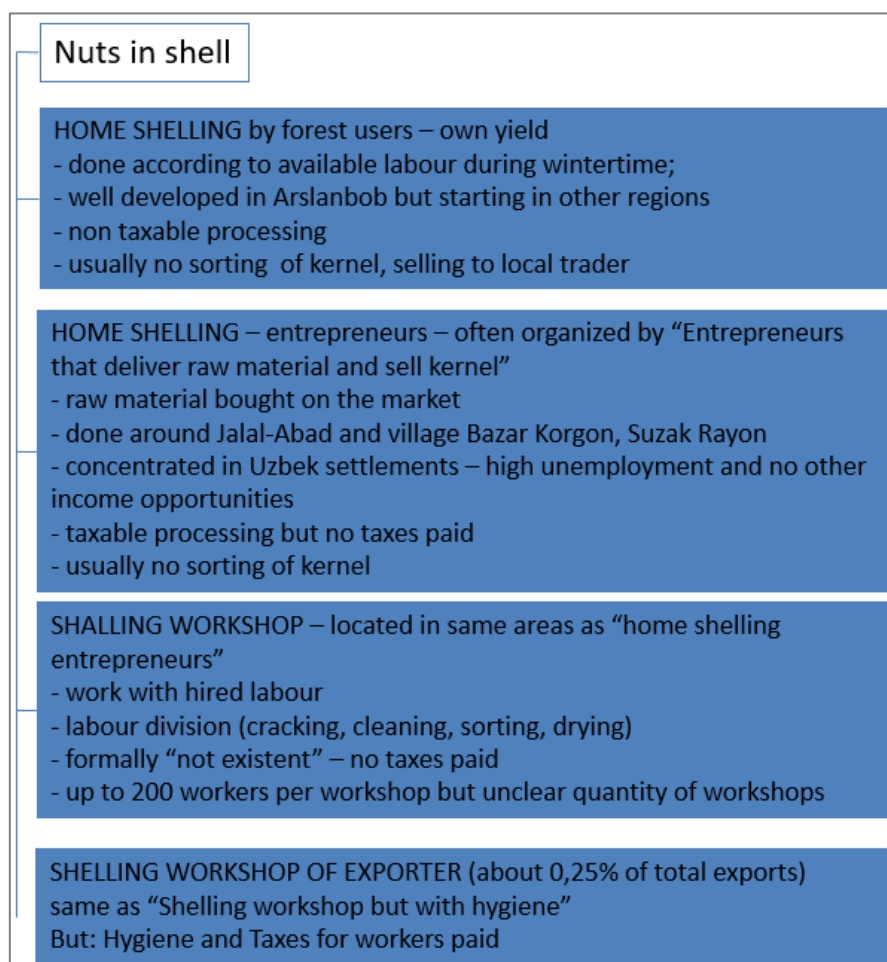
In all three target countries, farmers and poor to wealthier households, who are mostly small producers, occupy the main place in the total mass of **walnut and pistachio collection**. The collection of walnuts and pistachio is only possible after a formal agreement has been signed between the forest tenant and the local state forest enterprises. These agreements determine the territory or the trees where collection is permitted. Walnuts mostly grow in mountainous and sub-mountainous regions. In the Kyrgyz Republic, most **walnuts** and **pistachios** are harvested in Jalal-Abad region and a smaller quantity of walnuts in Osh region. In Uzbekistan, pistachios are collected in limited quantity in the Fergana valley and more extensively in Surkhandarya region. In Tajikistan, pistachio production is particularly widespread in Khatlon region.

5.3.4 Processing/storage

In all three target countries, walnut and pistachio are not deeply processed.

Walnut collectors either sell walnuts in-shell on the market or shell them throughout the winter and sell them as in-shell walnuts. Walnuts sold in-shell on the market are shelled further, mainly by individual women, and in some cases in specialized facilities operated by exporters. Figure 3 below provides an overview of the different streams of walnut shelling.

Figure 3: Overview of processing in the walnut value chain



Source: Swoboda, 2019

Walnut storage is an issue in mountainous areas where rainfall is frequent during the harvest season. Inadequate drying of in-shell nuts immediately after harvest and of kernels after shelling can lead to rotting, mold fungi and an increase in aflatoxin levels, which are toxic to humans.

In addition to drying, the poor hygienic conditions under which most walnuts are shelled have a negative impact on quality, with enterobacteria regularly reported.

Table 36: Adequacy of storage facilities for walnuts in the target countries

Criteria	Kyrgyz Republic	Tajikistan	Uzbekistan
Storage capacity (1 = clearly insufficient; 2 = slightly insufficient; 3 = just sufficient; 4 = fully sufficient)	2	1	2
Storage quality in terms of infrastructure and service (1 = large storage losses; 2 = moderate storage losses; 3 = minor storage losses; 4 = fully adequate storage quality)	2	1	2

Note: assessment based on expert judgment by the consultant team; the national-level scores also apply to the provinces in the intervention areas.

Pistachios

After harvesting, forest users and state forest enterprises most often sell their pistachios in bulk to intermediaries. Forest users who have storage facilities and a vehicle sell their pistachios either to retailers in the local market or directly to the end consumer in local or regional markets. Pistachios always undergo minimal processing, at least drying and sometimes roasting. There are also a few companies carrying out pistachio shelling. Quality issues due to moisture do not affect pistachio, which are growing in areas that are generally dry.

5.3.5 Trading

Import and export values of (raw) walnuts are presented in Table 37. While exports are sizeable in the case of KG, the value of walnut imports is 2 to 3 times higher. Similarly, KG exports processed walnut products in significant amounts, which are yet exceeded by respective imports (Table 37). Given that the domestic demand in the Kyrgyz Republic is low, these figures need to be handled carefully as the import of nuts is not a sizeable phenomenon in the country. Misclassification in custom declaration, or import and re-export of Chinese walnuts might explain part of this inconsistency. The export of processed walnut products is also significant in the case of UZ, but it is mainly related to walnut produced in orchard plantations which are not part of the analysis. Such exports are very limited in TJ.

Table 37: Imports and exports of (raw) walnuts in the target countries (in USD)*

	2021	2022	2023
Total imports Kyrgyz Republic:	8,037,309	9,429,343	20,297,376
Total exports Kyrgyz Republic:	1,503,796	3,493,195	10,000,468
Main countries exported to:	Russian Federation	1,102,646	2,182,116
	Uzbekistan	-	763,593
	Turkmenistan	128,317	389,272
Total imports Tajikistan:	18,504	N/A	N/A
Total exports Tajikistan:	12,133	20,320	N/A
Main countries exported to:	Kazakhstan	12,091	19,570
	United Arab Emirates	-	750
Total imports Uzbekistan:	211,242	921,819	5,597,362
Total exports Uzbekistan:	265,831	157,568	935,137
Main countries exported to:	Russian Federation	6,999	6,495
	Iraq	-	163,650
	Turkmenistan	241,509	121,188

Source: UN Comtrade; *Imports are CIF values, exports are FOB values; N/A = data not available

Table 38: Imports and exports of processed walnuts in the target countries (in USD)*

	2021	2022	2023
Total imports Kyrgyz Republic:	6,379,883	11,275,835	24,579,190

Total exports Kyrgyz Republic:		4,524,378	8,760,615	12,461,704
Main countries exported to:	Russian Federation	1,758,135	566,250	7,517,802
	Georgia	714,590	1,083,660	1,973,980
	Türkiye	666,015	2,388,716	222,743
Total imports Tajikistan:		N/A	8,760	N/A
Total exports Tajikistan:		180,397	310,651	N/A
Main countries exported to:	Kazakhstan	143,878	211,458	
	Russian Federation	22,573	56,233	
	Belarus	-	42,960	
Total imports Uzbekistan:		N/A	150,408	1,401,490
Total exports Uzbekistan:		11,929,359	11,027,233	13,437,248
Main countries exported to:	Russian Federation	677,884	2,858,327	1,829,405
	Azerbaijan	1,035,971	949,628	1,632,857
	Türkiye	2,323,619	158,071	5,627,782

Source: UN Comtrade; *Imports are CIF values; exports are FOB values; N/A = data not available

5.4 Enabling environment

Kyrgyz Republic

- i. Resolution of the Government of the Kyrgyz Republic dated June 2, 2014 No. 293 "PROGRAM for the development of nut crops in the Kyrgyz Republic until 2025": The program, developed under the Concept of Development of the Forestry Sector of the Kyrgyz Republic, aims to improve existing nut plantations, establish high-yield nut plantations, enhance food security, and boost exports of environmentally friendly nut products. It focuses on increasing forest cover, mitigating climate change effects, and implementing "green economy" priorities by introducing modern agricultural technologies, grafting methods, and valuable nut crop varieties. By 2025, the program plans to establish 7,800 hectares of nut plantations, improve 13,350 hectares of existing plantations, and produce 1.7 million high-quality seedlings, leading to a projected annual walnut production of 2,500 MT. Funding sources include the republican budget, local governments, forest and land users, and international grants, with a total budget of 173.9 million soms. The program also promotes sustainable forest management, investment in the forestry sector, development of nut product processing workshops, and increased economic contributions from forestry while reducing poverty in forested areas.

Uzbekistan

- i. Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 674 dated 21.12.2023 "On measures to improve lease relations in the use of land plots of the State Forest Fund": as per the resolution, unused forest fund land plots can be leased through the "E-auction" platform, with a "zero" rental rate for five years starting January 1, 2024, for establishing nut orchards such as pistachio, almond, and walnut plantations. These land plots are available for lease for a period ranging from three to forty-nine years, with specific allocations including 1 to 20 hectares for nut orchards and 0.01 to 2 hectares for beekeeping. Illegal logging and livestock grazing are strictly prohibited on leased forest land to ensure environmental preservation. The initiative aims to promote sustainable land use, encourage nut production, and support beekeeping activities in forested areas. By offering incentives and structured lease terms, the program fosters agricultural development while maintaining ecological balance.

5.5 Climate risk and impact

Walnut

Walnut trees are affected by climate change which direct implications on their productivity. Warm spells in spring tend to trigger early flowering which puts the trees at risk of being affected by late frost events that are frequent in the mountain areas where walnut forests are located. Hot spell and extended droughts in summer contribute to decreasing tree productivity, as trees drop non-mature nuts as a ways to limit their water consumption (Tyrgotov et al., 2024). The impact is particularly high on trees growing at lower altitudes within the walnut's distribution range, around 1,000–1,200 metres above sea level.

Pistachio

Despite being drought resistant, pistachio forests are affected by the increased occurrence of prolonged droughts and of extreme temperatures in summer. These phenomena that are becoming more frequent have

direct implications on tree productivity. Dust storms are also becoming more frequent and have a major desiccating effects on trees, leading to the loss of immature pistachios in summer.

5.6 Climate-resilient technologies and adoption

5.6.1 Proposed climate-resilient technology

By definition, NTFP value chains differ greatly from agricultural value chains. There are limited options to influence production, as these products originate from natural or semi-natural ecosystems that are subject to various biological and climate-related influences, which can result in any production level, from zero to exceptional harvest volumes. Only by restoring and expanding these ecosystems and by managing them in a sustainable and climate-resilient manner can production levels be expected to increase in the mid to long term. Additional efficiency gains can also be achieved by improving post-production conditions which remains largely family-based and below standards.

In this context, the programme will provide three types of support to help NTFP value chains become more climate-resilient and productive:

Forest restoration and expansion

The programme will support, through investment grants, the restoration of existing walnut and pistachio forests and their expansion through afforestation on degraded open land. This will enable to increase the productivity of walnut and pistachio forests in the long-term through enhanced natural generation. The resilience of these forests to climate change, in particular to droughts, as well as to pests, will be improved by restoring and increasing the density of the understorey's trees, bushes and plants. This, in turn, will increase the production of other NTFPs which mainly originate from species of the understorey, including wild fruits (e.g., apples), berries (e.g., wild plums, dogrose), forest mushrooms (e.g., morels) and medicinal plants. New plantations on degraded land following mixed designs (e.g., walnut/fruit) will also increase walnut, pistachio and other NTFP's production in the longer term. Participatory forest management plans involving state forest enterprises and the surrounding communities will determine the selection of specific actions that benefit from investment grants. They will also serve as a means to more actively involve local communities in climate-resilient forest management and forest development, alongside SFE staff. Table 39 below provides an overview of the possible eligible investments for forest restoration and reforestation activities.

Table 39: List of indicative investments for forest restoration, afforestation and reforestation of degraded open land

General objective	Items and categories of items eligible for programme funding	Rationale
Forest restoration	Fencing material	- Protect areas under restoration from livestock grazing and other physical disturbance - Channel livestock movement through forest areas - Enable self-seeding and natural regeneration
	Seedlings	- Additional planting in most degraded areas - Planting of locally selected climate-resilient seedlings
	Labor (planting costs and others)	Labor costs for restoring large areas with limited local community involvement are possible (e.g., juniper forests)
	Construction material for water points	- Channel livestock movement away from forest areas - Avoid livestock roaming in forests
Afforestation/reforestation on degraded open land	Small machinery for use in tree nurseries	Increase the production capacity of tree nurseries
	Equipment for tree nurseries	Improve seedling quality and survival potential through, e.g., a well-developed root system and hardening
	Tree seeds	Multiplication of locally selected high productivity and climate-resilient trees
	Seedlings	Plantation of indigenous tree species for which seedlings are not available
	Equipment and construction material for efficient water retention and distribution	Improvement of the survival rate of tree plantations
	Fencing material	Protection from livestock grazing

	Labor (planting costs and others)	• Labor costs for tree planting and second-year re-planting
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Capacity improvement for sustainable and climate-resilience forest management, and for NTFP processing

The programme will provide technical assistance to staff of the local state forest enterprises and to the forest users having a contractual relationship with the SFE. Table 40 below outlines a preliminary list of topics and skills which will be included in the programme's capacity development interventions.

Table 40: Preliminary list of topics for capacity development in forest management

Key fields for capacity development	Specific topics
Climate information for forestry and how to use it	• Main climate hazards in forestry • Use historical climate information in forest management planning • What exposure, sensitivity, and adaptive capacity mean in practice for forest conservation, forest management, and the productivity of NTFPs • Translating risk into forest management priorities
Participatory forest management planning	• Planning of participatory restoration and climate change adaptation interventions
Forest management and forest restoration techniques and interventions	• Planting techniques for afforestation and reforestation • Seed and seedling production from local species • Selection of local climate resilient tree species • Support and management of natural regeneration • Efficient protection from grazing • Efficient irrigation • Integrated pest management • Livestock management within and near forest areas • Interactions with other land use systems • Non-timber forest product value chains: sustainable collection and processing

NTFP value chain investments

The programme will provide support to MSMEs in the sector via the matching grant mechanism that will be established. Key measures/technologies that have been preliminary identified as eligible to receive programme support include improved drying, processing and storage technologies.

6. References

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