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Water and Land Management and Agricultural Policy in Support of Food Security: The Amu Darya Delta in Uzbekistan

Ajsylu Safarova, Gulchekhra Khasankhanova

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Executive Summary

Like other deltas in the world, the delta of the Amu Darya river is a very dynamic natural system that reflects all the processes and developments that occur in a river basin. Water and terrestrial ecosystems of the Amu Darya delta and the Southern Aral Region provide valuable services derived from natural systems and maintain the welfare of the local population, who are strongly affected by the Aral Sea environmental disaster and land salinization, degradation, and desertification. The importance of the deltaic systems as an additional source of income and a buffer against economic hardships increased after the Aral Sea desiccation and social and economic transformations.

This case study contains an analytical review of the issues concerning the restoration of saline soils and agricultural policy in support of food security using the example of the Amu Darya delta in Uzbekistan. The studied area is located in the northern part of the delta between 42°30'N and 44°00'N in North Karakalpakstan (the Pre-Aral region) in Uzbekistan. It includes agricultural land (irrigated land, pastures, and lake systems), which make a major contribution to food security, as well as water ecosystems (wetlands) that provide valuable services derived from natural systems. Cultivated land and water ecosystems in the delta depend entirely on the river water flow and collector/drainage runoff and are extremely susceptible to reduced flow caused by climate change and the increase in the number of climate extremes.

This case study focuses on two stakeholder groups: (i) local stakeholders such as water users/consumers, agricultural producers, rural citizens' meetings, fishermen, dehkans (peasants) and other vulnerable groups; and (ii) national and regional stakeholders—for example, key government institutions, ministries and agencies, regional and district authorities (khokimiats), basin administrations of irrigation systems (BAIS) under the Ministry of Agriculture and Water Resources and their branches, and organizations responsible for the development and implementation of targeted programs, strategies, and environmental management plans.

This case study will demonstrate how the productivity of salt-affected irrigated lands can be improved and the services of water ecosystems in the Amu Darya delta in Uzbekistan can be sustained to support food security in the long term in the context of climate challenges. The following two food policy options are recommended [1]: (i) sustaining and maintaining food self-sufficiency and balances between food consumption and production by increasing production output to meet projected food shortages; and (ii) increasing production of food products in subsectors where Uzbekistan possesses a comparative advantage with the aim of substantially increasing of their export.

To achieve these targets, it is necessary to implement a range of interventions and measures aimed at further development of reforms and incentives in land and water use, mobilization of resources, and strengthening of institutional capacity along with the implementation of new forms and methods of planning, knowledge management, and awareness-raising among all stakeholders to disseminate innovations and replicate best agrotechnologies on a wider scale. These interventions should be extremely cautious; technically, economically, and environmentally acceptable; and socially relevant in order to achieve sustainable environmental and economic benefits and improve livelihood and food security.

Background

Through the efforts of the countries of the region and public, research, and international organizations—the Asian Development Bank (ADB), the German Agency for International Cooperation (GIZ), the Global Environment Facility (GEF), the United Nations Development Programme (UNDP), and the World Bank, among others [2], [3], [4]—the international community is aware of the Aral Sea environmental disaster and its grave consequences threatening life, health, and habitat.

The Amu Darya river is the largest river of the Aral Sea basin; it has an average annual flow of 78.5 cubic kilometers, or two-thirds of the total water resources in the basin. The Amu Darya is fed by glaciers and snow melt; it is 2,540 kilometers long if measured from the sources of its headstream, the Panj river, to the Aral Sea; it flows through the territory of Uzbekistan for more than 1,000 kilometers (Figure 1). The ancient irrigated oases of Samarkand, Bukhara, Khorezm, the Kashkadarya, and the Republic of Karakalpakstan, surrounded by the vast plain expanses of Kyzylkum and Karakum deserts, are located in this region [2].

The Amu Darya delta, as the end user of the river runoff, has been very severely affected by changes in the hydrographic regime, negative processes,

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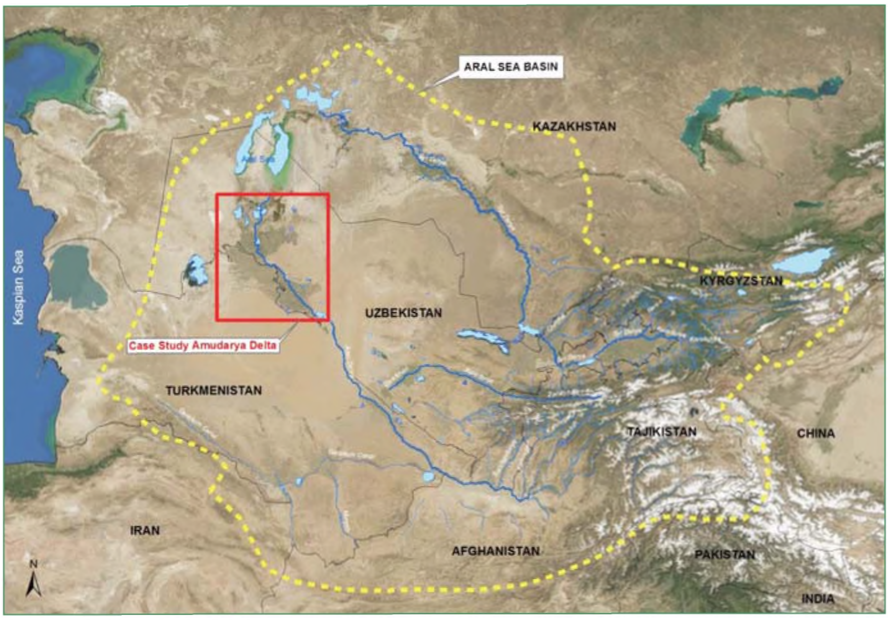

Figure 1. Aral Sea Basin: Location of the Case Study Region in the Amu Darya Delta

Source: NeWater 2009 [5].

and developments occurring in the river basin. The delta is located in the Turan plain of the desert area and occupies around 28,500 square kilometers, it extends for 400 kilometers and its maximum width is 250 kilometers. To the west the Amu Darya delta is bordered by the Usturt Plateau, to the northeast by an ancient riverbed network adjoining the Kyzylkum Desert, and to the north by the Aral Sea. The climate of the delta is semi-arid, with a mean annual precipitation of 80–120 millimeters. Evaporation is 1,200–1,600 millimeters per year, caused by high temperatures and strong winds in summer. The Khorezm oasis is located on the west riverbank of the Amu Darya, downstream from the Tyuyamuyun reservoir; the South Karakalpakstan zone, with 375,000 hectares of irrigated land, is located on the east riverbank. The northern part of the delta, between 42°30'N and 44°00'N, constitutes most of the former wetland areas and remaining semi-natural ecosystems. This is home to a distinctive system of lakes and floodplains with a total area of about 212,000 hectares, which creates a unique belt of water bodies along the former coastline of the Aral Sea.

The Turan delta plain of the Amu Darya was the second largest after the Volga River's delta plain by its size, productivity, and biodiversity; it provided a large number of ecosystem services to the population and the area was a valuable habitat for many species [3]. Currently, the Amu Darya delta is one of the main ecosystems in crisis in the Aral Sea basin, where a catastrophic reduction in the river flow has become a dominant factor of natural habitat destabilization.

National Context

Uzbekistan is the second largest country in Central Asia in terms of its size and the largest country in terms of its population. The landscape of Uzbekistan is extremely diverse in terms of relief forms and includes plateaux, lowlands, and piedmont plains (70 percent) and mountain spurs and ridges (20 percent). Almost 80 percent of the country is occupied by deserts and semi-deserts, including the Kyzylkum, which is the largest desert in Central Asia.

Primary water resources in Uzbekistan include surface runoff from transboundary rivers such as the Amu Darya, the Syrdarya, their tributaries, and the Kashkadarya and Zarafshan rivers. Most Syrdarya water resources are formed in Tajikistan and its flow is formed in the Kyrgyz Republic. Currently the discharge of internal rivers in Uzbekistan is 11.5 cubic kilometers per year, the discharge of transboundary rivers is 42.0 cubic kilometers per year, and the country also has 9.43 cubic kilometers of "return" water and groundwater. The annual volume of water that is available to Uzbekistan, according to the interstate agreement signed by the heads of the Central Asian states, is 63.02 cubic kilometers [2], [6], [7]. Currently the available water limit for a year with a water flow probability (the natural river flow availability) of 90% does not exceed 59.2 cubic kilometers. Priority consumers of water resources (6 percent) are the utilities sector and the residential sector (drinking water), then comes the industry (2 percent), and agriculture (1 percent) as well as water users approved by a special resolution of the government, and so on. Irrigated agriculture

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that withdraws more than 84 percent of total water resources is the largest water user. In the future, water demand will continue to grow in order to maintain the food security of the rapidly growing population [2], [6], [8].

The land resources of Uzbekistan total approximately 447,400 square kilometers, including roughly 21.7 million hectares of agricultural land. Irrigated land, which is the most valuable type of land used for various purposes and the main asset of agricultural production, constitutes 4.3 million hectares—slightly more than 9 percent of the total land stock; rainfed farming land takes up 0.745 million hectares. Because of the dry continental climate, crop output is almost entirely dependent on irrigation and more than 95 percent of the cultivated area is irrigated cropland. Before achieving independence, cotton, which was cultivated on more than 60 percent of irrigated land, was the main crop in Uzbekistan. Currently the country's primary crops are cotton and grains grown on roughly 68 percent of cultivated land. The percentage share of cotton has gone down from 50 percent to 30 percent with the reallocation of land for grain crops, food crops, and fodder crops, which are vitally important for the population.

The population of the country totals more than 31 million people; half of them (49 percent) live in rural areas where irrigated agriculture is the main source of livelihood, material wealth, and employment. The number of people employed in the agricultural sector is 3,392,300, or 27.1 percent of the total economically active population. The percentage share of income for all citizens, on average, earned in agriculture is 35 to 60 percent; in rural areas it is about 70 percent [2].

Uzbekistan's ability to sustain the economic capacity of the land is limited to a great extent by the significant fragility and vulnerability of arid ecosystems to external shocks. Historically, the dry landscapes of the country have been susceptible to natural salinization of huge areas and are under increasing threat from drift sands, dust storms, and dry hot winds, whereas water deficit and its pollution exacerbate the situation even more [7]. Increased salinization of soils and water, wind- and water-induced erosion, grassland overgrazing, and deforestation are the most serious environmental issues that pose a threat to the country's ecosystems. Inadequate use of land resources—predominantly unsustainable agricultural activities, along with overgrazing and deforestation—are main reasons for agrosystem degradation and related diminished soil health.

In accordance with the Central Asian Countries Initiative for Land Management (CACILM) data [8], [9], currently around half of the irrigated land in the country is comprised of salt-affected soils. This is a major issue for the productivity of agriculture, especially in the Amu Darya downstream areas (up to 95 percent of land in the Republic of Karakalpakstan and Khorezm). Today, in 2016, the productive capacity of irrigated land, estimated in bonitet scores of soil diversity, has decreased by 3 scores, whereas the productive capacity of land in the Fergana and Namgan regions has decreased by 7–10 scores, causing reduction in crop yield and crop output per capita. Because of soil salinization, cotton crop yield has gone down by 20 to 30 percent on slightly saline soils, by 40 to 60 percent on medium saline soils, and by 80 percent and more on highly saline soils.

Irrigation and drainage are key factors in agriculture and essential elements for productivity, competitiveness, and environmental management. Despite a large-scale development of irrigation and drainage in the former USSR, up to 70 percent of irrigated land in the country has old systems of traditional irrigation and only around 1.3 million hectares have engineering systems, which are in urgent need of rehabilitation and reconstruction. High incidental costs are stipulated by the fact that around 1.4 million hectares of irrigated land are irrigated by pumps and electricity consumption may be as high as 8 billion kilowatt hours per year. Nearly 60 percent of the entire Ministry of Agriculture and Water Resources budget is spent on the electricity bill to pay for electricity used in pump irrigation and drainage. Most irrigation systems in Uzbekistan suffer from low-quality irrigation services, inadequate operation and maintenance, low productivity of agriculture, reduced revenues of the farms, and low-level or inadequate cost recovery. Annual loss from agricultural productivity is estimated at US$31 million [4], whereas economic loss caused by abandoning land because of its high salinization is estimated at US$12 million. Costs to rehabilitate the irrigation and drainage infrastructure, estimated by the World Bank [4] and the Environment Facility's Water Resources and Environment Management Project [6] vary from US$23 to US$31 billion. In accordance with the World Bank [4], total investment costs are around US$23 billion. The National Water and Environmental Management Plan [6] estimated the investment requirement for rehabilitation of the irrigation and drainage system and restoration of productivity of irrigated lands in the medium and long term at US$24.5 billion.

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Immediately after achieving independence in 1991, Uzbekistan encountered economic difficulties similar to those that arose in other Commonwealth of Independent States (CIS) countries: (i) loss of markets and subsidies from the former USSR; (ii) disruption of the trade and payment systems and economic links between CIS enterprises; (iii) hyperinflation and lower production; (iv) increase in the size of the low-income population; and (v) higher social and economic tensions [8].

In order to overcome these problems, the government adopted a phased transition to market relations based on principles of pragmatism and an active role of the state in reform implementation. Despite the results achieved, productivity in the agricultural sector is still substantially below its potential: a legacy of approaches and policy tools from the former centralized system of planned economy has not yet been eliminated and still impedes the sustainable development of agricultural production. A review of the main stages of the reforms, policy options, and measures to eliminate the impact of the former economic system is provided in the section on Policy Issues.

In the recent decade climate change and dangerous events (such as the severe drought in 2000–01) have begun occurring more frequently and have been causing instability of agricultural output, threatening the livelihood of the rural population. In accordance with the Uzhydromet forecast [8], [9], several synergy effects of climate change are expected in the future, with heat stress and increased water demand for agricultural crops in the context of water withdrawal limits having the most devastating consequences.

Continued growth of the population, reduced fertility of land and water resources, and higher water demand in the context of restricted access to water resources pose a threat to agricultural development. The situation in the agricultural sector is expected to deteriorate, which will put food security in jeopardy.

The Amu Darya Delta

The Republic of Karakalpakstan occupies 37 percent of the total area of Uzbekistan; approximately 5.5 percent of the total population lives in the republic, whereas its GDP is merely 2.4 percent of Uzbekistan's. Irrigated land accounts for 70 percent of land in Karakalpakstan; 54 percent of irrigated land has low-yield soils. This means that soil productivity is low—this region has the highest percentage of infertile soils in the entire country. The main economic activity in Karakalpakstan is agriculture; its share is 24.4 percent. Most labor (33 percent) is employed in agriculture. Grasslands, which make up the largest area, provide the primary source of fodder for sheep. The data on the current crop output and water needs per unit for agricultural crops in Khorezm and the Republic of Karakalpakstan, taking into account existing cropping patterns, are presented in Table 1.

Wetlands and Lake Systems in the Amu Darya Delta

The main source of irrigation of 400,000 hectares of land in North Karakalpakstan is the Amu Darya river flow and collector/drainage runoff. The Amu Darya runoff at the Kyzyljar site characterizes the water resource availability that is highly variable between years. In low-water years (when there is a 5 percent

Table 1. Existing Crop Production and Water Needs per Unit of Crop in Khorezm and the Republic of Karakalpakstan, 2014

	Water needs, cubic meters/ hectare	Crop				
		Cotton	Winter wheat	Rice	Vegetables, cucurbits, potatoes	Fruit, grapes
		Crop yield, tonnes/hectare				
Khorezm	14,939	2.6	4.9	2.9	28.6	12
Republic of Karakalpakstan	14,600	2.2	2.6	2.9	12.6	6.4
Average	14,776	2.4	3.7	2.9	21.1	10.4
		Total yield, 1,000 tonnes				
Khorezm	14,939	264	269	56.2	790	190,2
Republic of Karakalpakstan	14,600	220	169	27.9	304	40.8
Average	14,776	483.8	438.7	84.1	1,094.0	231.0

Source: Information and Analytical Bulletin for 2013 [10].

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probability of water flow) water practically does not reach the northern delta, but in high-water years (when there is a 95 percent probability of water flow) a flood can last for 2 to 3 months with a discharge of up to 2,000 cubic meters per second[1]. The region has no other sources of water.

Wetlands and lake systems in the northern Amu Darya delta are divided into three parts: the western, central, and eastern. Lake Sudoche and the Mashankul-Karadzhar lake system in the western zone; lakes or reservoirs Mezhdurechye, Rybachye, Muinak, and Domalak in the central part; and Dzhiltyrbas, Akpetki, and Abbas in the eastern section are the most important water bodies in the deltaic area. All lake systems and wetlands, especially in the western and eastern parts of the delta, are fully or partly depend on the volume and quality of runoff in the collector/drainage system (which includes the Main Lefbank Collector, the Usturt, the Collector Northern-1 and other collectors); their total mean discharge is 1.56 cubic kilometers per year.

Despite a single source of water supply, each lake system and wetland has its own distinctive features. The hydrochemical regime of wetlands is not stable and is fully dependent on the volume and quality of incoming flow. During dry years, especially the years of the severe drought (2000–01), around 85 percent of water bodies in the delta dried up. Endorheic lake systems were the most vulnerable to severe droughts, and during the drought water salinity in these lakes fluctuated within the range of 48–92 grams per liter, with the maximum value of up to 121 grams per liter observed in Lake Asushpa [3], [5].

A shortage of water, especially during severe droughts, destabilizes agricultural production in the Amu Darya delta. For example, the loss of grain crops in the Amu Darya delta (in Karakalpakstan and Khorezm) caused by the severe drought (2000–01) constituted 14 to 17 percent of total crop output, while loss of crops with a long growth period was estimated at 45 to 75 percent. Competition for water may have very severe consequences because of a fast-growing population and higher water demand. The main trade-off in water usage is water application for irrigation purposes in the southern delta (Uzbekistan and Turkmenistan) and the use of water to supply drinkable water and sustain fisheries in the delta lakes in the northern delta [5].

Efforts aimed at controlling drainage water runoff to improve the quality of water in the Amu Darya and Syrdarya basins are viewed as a top priority in National Salt and Water Management Plan [6]. The Drainage, Irrigation and Wetlands Improvement Project, which is an investment project of the World Bank (2005–09), implemented one of technical alternatives to improve the quality of water flow in the river by disposing of drainage effluent from South Karakalpakstan to the Aral Sea instead of the Amu Darya river; such technical alternatives were determined by the Drainage, Irrigation and Wetlands Improvement Project of Uzbekistan with assistance of the World Bank. The closure of the Beruni pumping station and the turning of the Beruni collector to reverse drainage runoff from the irrigated land of South Karakalpakstan were implemented in order to enhance gravity flow toward the Aral Sea. Project interventions have high benefits for water users and natural ecosystems in the Republic of Karakalpakstan and the Aral Sea. These activities are a specific contribution of the Government of Uzbekistan in implementing the bilateral agreement on the joint and sensible use of water resources of the Amu Darya signed with Turkmenistan on January 16, 1996. The next phase of the Drainage Project will eliminate discharges of collector/drainage waters from the Bukhara oasis and the Kashkadarya region by diverting them to desert depressions of the Kyzylkum [2], [11].

Activities aimed at creating landscape ecosystems in the Amu Darya delta were launched by the Aral Sea Water and Environmental Management Project of the GEF/World Bank (1998–2002); the component on "Restoration of Wetlands Surrounding Lake Sudoche" included the design and construction of the water-engineering system in the western Amu Darya delta to dispose of water to natural depressions. The Government of Uzbekistan initiated financing of the project to create water wetland areas in the Amu Darya delta (the feasibility study of phase I and the feasibility study of phase II). Currently, technical measures are being carried out in the central delta to rehabilitate water-engineering systems of the wetlands and the delta and to introduce technical control of environmental and flood flows of Amu Darya water and releases of collector/drainage waters [2].

These projects determined environmentally important wetlands and floodplains in the Amu Darya delta that urgently need to be restored, and where possible to expand them or increase their elevation and develop a long-term water

[1] The phrase 95 percent probability of river water flow refers to five dry years during a 100-year period; and 5 percent probability of river water flow refers to 95 dry years during a 100-year period.

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management policy for the creation of wetlands and restoration of the delta. In 2009, NeWater (New Approaches to Adaptive Water Management under Uncertainties), which is a research project funded by the European Union within its 6th framework program, helped improve existing methods and develop new approaches to introduce integrated water management and sustain the delta ecosystem services while taking the complexity of river basins and uncertainties of climate and socioeconomic changes into account.

Policy Issues

Food security is based on the availability of adequate quantities of good-quality food supplied via domestic production or imports.

Climatic characteristics of Uzbekistan (its clear-cut continentality, aridity, and many hot and sunny days) are stipulated by the country's location in the center of a vast continent far from oceans. In terms of solar radiation, from May to October Uzbekistan surpasses the Mediterranean and California. Agroclimatic conditions in Uzbekistan support the development of horticulture, and few other regions in the world have similar conditions [2].

Since independence, food security has been at the top of the Uzbekistan development agenda, and basic principles of food policy were developed as early as the beginning of the 1990s. The supply of adequate quantities of food was achieved partly by restructuring agricultural production and making considerable investments in modern agricultural technologies. The government undertook revolutionary measures to implement economic reforms in order to introduce market relations and develop private ownership in the rural areas.

The population of the country continues to grow and, based on various estimates, will exceed 33 million as early as 2025. Population growth will push up demand for food, which will require a corresponding increase in food production (see http://unstats.un.org/unsd/demographic/products/dyb/dybcensusdata.htm).

Reforms in Agriculture

Analysis of available overviews has singled out roughly three periods of economic growth in the country [8], [13]: the years of depression (1991–95), the years of development (1996–2003), and the years of economic growth (starting in 2004). In 1986–1990, average GDP growth dropped from 5.7 percent to 2.2 percent. In 1996 the economic situation in Uzbekistan stabilized and growth was steadily positive. Starting in 2004, the economy of the country grew even faster. During 2004–11 annual GDP growth was 8.1 percent on average.

Regarding the effectiveness of structural changes in agriculture, four transformational stages that followed progressively may be singled out [12].

The first stage (1991–95) is associated with the creation of conditions for the transition from a planned economy to a market economy. Before independence was declared, practically all commercial production of main agricultural output had been concentrated in state-owned farms (*sovkhozes*) and collective farms (kolhkozes); in reality, there were no big differences between them and they were subjected to state monopoly in planning and implementing agricultural programs aimed at the large-scale development of virgin lands for their irrigation and the cultivation of cotton. After independence, Uzbekistan inherited problems such as land administration and management authorities that had been created to satisfy the needs of the former system.

Despite the agricultural reforms and institutional transformations, the impact of the administrative and command system in farming, which is a legacy of Soviet times, has remained a major constraint impeding sustainable management of agricultural production. The state order for cotton and wheat—two main crops occupying approximately 68 percent of arable land—hindered stable crop rotation and diversification and reduced soil fertility. Since land "ownership" was possible only as a leasehold, farmers had few incentives for making long-term investments in improving the soil, increasing its productivity, and implementing resource efficiency measures. Fixed state prices (which are below market prices) for cotton and grains reduced farmers' income and restricted their ability to invest in the operation and maintenance of the on-farm infrastructure, new crop management practices, and modern agricultural machinery [13], [10].

To support and provide incentives for agriculture development, the government used a combination of production taxes (direct and indirect taxes through purchasing prices below market prices) and subsidizing the means of production, including water, fuel and lubricants, loans, crop protection chemicals and fertilizers, and machinery leasing. Administrative control over land use, state investments in the

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agricultural infrastructure and extension services, and so on were widely applied as well.

At the second stage (1996–2003), profound progressive changes in agriculture and the entire agroindustry became a top priority. This period saw deeper market transformations, development of the legal framework, and adoption of main laws such as the *Land Code of the Republic of Uzbekistan* (Law No. 602-I, dated April 30, 1998); *On Agricultural Cooperatives (shirkats)* (Law No. 600-I, dated April 30, 1998); *On Farming* (Law No. 602-I, dated April 30, 1998); and *On Dehkan Farms* (Law No. 604-I, dated April 30, 1998). Each of these documents set forth a legal framework for the establishment and operation of entirely new entities in agriculture. New principles in land relations, such as the transfer of land as long-term leases to farms for up to 50 years and to dehkan farms for lifelong use, were introduced.

In March 2003 a Presidential Decree (UP-3226, dated March 24, 2003) created the basis for the development of private farming. This decree reduced state control in agriculture substantially, providing more freedom to farmers in the selection of crops and reducing quotas of cotton and wheat purchased by the government at fixed prices, as well as helping introduce market principles in supplies of agricultural produce and sales of output. Furthermore, changes in the official exchange rate (which became close to the commercial rate) in September 2001 led to a substantial increase in purchasing prices and reduced payments made by the agricultural sector to the budget.

However, efforts to shift to a market economy achieved only partial success. State-owned enterprises were supported through targeted loans and/or loans guaranteed by the government and the system of multiple exchange rates, and these enterprises used resources obtained through the state purchase system for cotton and wheat, low prices for energy resources, and state monopoly on gold mining. The government relied on sectorwide development and import substitution, and sought ways to achieve wheat self-sufficiency by applying methods from the Soviet times, such as state planning, currency exchange controls, monopoly in domestic and foreign trade, various other restrictions in trade, targeted loans, and large state capital investments.

The third stage (2004–07) was aimed at protecting producers' rights and restructuring low profit and unprofitable large agricultural enterprises (*shirkats*) as well as transforming them into private farms and extension services. One of the major issues for low-profit agricultural producers was a lack of farms working for the market. Backyard allotments and dehkan lands of low-income households are not meant to produce output for the market, and almost their entire output is consumed by the household. The main reason for the slow development of market relations was the small size of holdings, which did not allow farmers to create specialized farms and enter the market [13].

During **the fourth stage** (2008–12) the size of land plots used by farms was optimized and the basis for sustainable economic activity was created. After optimization the number of farms dropped by more than 147,000 and amounted to 66,100 farms, whereas the average size of the cultivated area per single farm increased from 26 to 44 hectares. The country entered **the next stage** in 2012 after approval of the Presidential Decree (No. UP-478, dated October 22, 2012), *On Measures on Further Improvement of Farming Organization and Development in Uzbekistan*, which increased economic independence and financial viability of farms, provided incentives for farmers, and so on.

The creation of the private sector—private farms and dehkan farms—has become the main benefit of the reforms. Today 87 percent of agricultural lands are leased by farms. The remaining agricultural lands are privately owned by 4.7 million dehkan farms with the right of lifelong use and the right to inherit. Dehkan farms produce 64 percent of gross crop output.

Irrigation and Drainage

The most important legal document in the system of water management is the *Law On Water and Water Use*, signed by the President of Uzbekistan on May 6, 1993; other documents were adopted as well. The Strategic Study of the Irrigation and Drainage Sector for the short term and medium term was developed with support of the World Bank [4]. This includes two stages: "Consolidation and Emergency Actions" and "Rehabilitation and Modernization"; each stage is a combination of investments, institutional transformations, and strategic reforms. The reforms in the water sector stipulated the principle of the organization of water management along the basin by replacing province water management organizations with basin administrations of irrigation systems (BAIS) set up along hydrological boundaries instead of administrative boundaries of the provinces. It also established water user associations (WUAs) and the Central Water Administration, which coordinates the operation of the entire water use system in the

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country. WUAs, which are a new and vital form of non-state institution set up to manage and maintain on-farm systems, are equally important. Currently, 1,487 WUAs are operational in the country; they provide services to 3,747,900 hectares and have 63,775 members. However, based on assessments [5], [16], success in establishing viable and sustainable WUAs remains intangible.

Reforms in the irrigated farming structure also created a new challenge for irrigation and drainage (I&D). Responsibilities were divided: the government was made responsible for operation and maintenance of the inter-farm and main I&D network, whereas responsibility for the on-farm I&D systems was delegated to new private farmers.

To address all these issues, the President of Uzbekistan issued a decree in 2007 (Decree No. UP-3932, dated October 29, 2007), *On Measures for Drastic Improvement of the Land Reclamation System*, which defined agriculture as a top priority area for economic development and set up a coordination body—the National Irrigated Land Reclamation Fund. The government also adopted the State Program for Irrigated Land Reclamation in Uzbekistan for 2008–2012. More than US$100 million was allocated for technical measures every year. Construction and rehabilitation works on 677,900 kilometers of collectors were completed; 11,200 kilometers of inter-farm and on-farm network, 340,100 kilometers of the looped collector/drainage network, and 720 wells of vertical drainage were rehabilitated in 2012. The program helped provide farmers with equipment and machinery for land reclamation. The works carried out led to a substantial reduction in soil waterlogging and salinization and also improved land conditions on more than 740,000 hectares.

Today the country has been undertaking many efforts to diversify agricultural production on irrigated lands, shift to crops that are not sensitive to water shortages, and introduce restricted access to water [13]. A recently adopted *Resolution of the President of Uzbekistan* (No. PP-2460, dated December 29, 2015) sets the task of developing horticulture by implementing intensive technologies and drip irrigation, and expanding areas for orchards, vineyards, and horticulture crops.

Because of the measures adopted to reduce water demand, water withdrawal went down from 64.5 cubic kilometers per year in 1980 to 52.0 cubic kilometers per year in 2006–09 (by 19 percent), while water needs to irrigate one hectare of land decreased from 22,400 to 12,200 cubic meters per hectare (by 46 percent). In the future it is planned to reduce cotton production by 350,000 tonnes in phases, and reallocate low-profit lands for farming vegetables, cucurbit crops, potatoes, and orchids.
The Ministry of Agriculture and Water Resources estimates that over the past 10 years, with the support of international financial organizations, more than US$1.0 billion were invested in rehabilitating irrigation and drainage systems and modernizing water facilities and pumping stations [14], [15]. These large-scale technical measures and institutional interventions resulted in significant improvements of water use efficiency at various levels, improvement of technical conditions of hydrological facilities, better management and higher savings of irrigation water, and so on.

Issues of Agricultural Output Consumption and Demand

Reforms and better production relations in the rural areas have led to an increase in crop and livestock output. From 1991 to 1998 gross wheat harvest increased more than sixfold through the expansion of cultivated areas and the speedy increase in yields supported by public investments. By the end of 1990s Uzbekistan achieved grain self-sufficiency that has been maintained ever since. In 10 years, the percentage share of imports in domestic consumption decreased from 80 to 5 percent, whereas the country has been exporting grains since 2001. The country has achieved self-sufficiency in most other food products (Table 2).

In recent years meat consumption per capita has increased by 1.3 times, milk and dairy product consumption has increased by 1.6 times, potato consumption has gone up by 1.7 times, vegetable consumption has increased more than twofold, and consumption of fruit increased almost fourfold. However, nutrition security of the population has not yet been achieved [16]. The calorie intake of an average citizen of the country has shifted toward bread and ground corn products, while consumption of fruit, vegetables, meat, eggs, and, especially, fish and fish products is below average global indicators. Needs in meat and dairy products for a balanced diet are not met by domestic production despite the increase in livestock output observed in recent decades.

Continued demographic growth has been pushing up demand for food products. To meet the increasing demand of the population for food products in

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Table 2. Livestock Output Indicators

	1995	1998	2000	2003	2004	2005	2006	2010	2013
Meat (1,000 tonnes)	508.7	475.8	501.8	561.3	592.2	632.6	679.4	855	1,787.5[a]
per capita (kg)	21.7	19.4	19.9	21.8	22.9	24	25.5	30.8	
Milk (1,000 tonnes)	3,665.4	3,494.9	3,632.5	4,031.1	4,280.5	4,554.9	4,855.6	6,169.0	7,884.7[a]
per capita (kg)	156.3	142.2	144.1	156.8	164.5	173.1	182.1	222.4	
Eggs (million)	1,231.8	1,164.6	1,254.4	1,632.4	1,860.3	1,966.2	2,128.1	3,061.2	4,379.1[a]
per capita	52.5	47.4	49.7	63.5	71.5	74.7	79.8	110.4	

Source: UNDP/CER 2013 [13].
Note: [a] Data are from the Information and Analytical Bulletin for 2013 [10].

the medium and long term, output will have to be increased and production structure will have to be changed. If the current output and cropping pattern of cultivated areas remain unchanged, food demand forecast by 2025 will be as follows (see Table 3).

An analysis of the forecasts demonstrates that the increase in food demand by 2025 will lead to a deficit of grains at 26.88 percent, deficit of meat at 92.5 percent, deficit of milk at 69.52 percent, and deficit of vegetable oil at 92.55 percent, and so on.

Table 3. Forecast of Food Product Structure and Consumption

Food group	Per capita consumption, kilograms/year		Demand increase taking into account population growth, percent		Difference between the supply increase and demand increase, percent	
	2015	2025	2015	2025	2015	2025
Grains (wheat, rice, barley, maize)	203.6	204.4	17.8	34.5	2.2	–26.9
Meat (beef, mutton, goat meat, poultry, pork)	35.5	54.8	28.2	125.1	1.8	–92.5
Milk	186.8	239.1	36.7	99.0	–6.7	–69.5
Eggs	5.6	8.4	31.0	121.6	4.0	
Vegetables	265.1	292	29.1	61.7	–4.1	–24.4
Potato	39.0	52.6	21.4	112.5	–1.4	
Vegetable oils (cotton, soya, sunflower)	14.3	20.1	18.8	112.6	–14.0	–92.6
Sugar	9.0	17.9	17.6	195.0	7.4	–30.0
Fruit	82.7	82.1	29.1	76.8	0.9	–31.0
Fish and fish products	1.8	20.4	26.8	1,393.1	33.2	–56.0

Source: UNDP 2015 [16].

In order to address water use issues, urgent measures and actions to find alternative sources of water are needed. Quite obvious examples include the re-use of collector and drainage waters, resource efficiency, the diversification and intensification of agriculture, and a wise approach to water management. The overarching task is to develop an acceptable plan of action and measures that meet both social needs in agricultural food products and the need to preserve and protect agrosystem services from the degradation and exhaustion of resources.

Stakeholder Groups

Stakeholders can be divided into three groups: governmental entities at regional and national levels; smaller, subnational entities that include communities and individuals; and groups that are active at the local level.

Regional and National Levels

The International Fund for Saving the Aral Sea (IFAS), the Interstate Sustainable Development Commission (ISDC), and the Interstate Commission for Water Coordination (ISWC) set up at the IFAS have been in operation at the interstate level since 1993 [2].

Until recently *The Agreement on Cooperation on Joint Management, Use and Protection of Water Resources from Interstate Sources*, signed by the leaders of five Central Asian countries in February 1992, has been the legal framework for joint management and allocation of water among the Aral Sea basin water users.

Water management at the state level in Uzbekistan is carried out by the Cabinet of Ministers and the Water Management Department of the Ministry of Agriculture and Water Resources. A number of ministries and institutions have been assigned the task of carrying out environmental measures and inspections, and have been made responsible for various sectors: these include the Ministry of Agriculture and Water Resources; the State Committee on Environmental Protection; the Ministry of Health; the State Committee on Land Resources, Geodesy, Cartography and State Cadaster of the Republic of Uzbekistan; the Uzbekistan Hydrometeorological Service (Uzhydromet), and so on. These ministries and agencies are responsible for supporting the sustainability of the public administration system and developing and implementing special programs, strategies, and action plans on environmental protection and environmental management.

Subnational Level

Diversity of agricultural production and environmental activities increases the number of beneficiaries at all regional levels.

A great number of beneficiaries associated with land and water use operate at the subnational level. Such beneficiaries include urban and rural communities as social units, including agricultural enterprises, family farms, individual farmers, upstream and downstream farms, and private housing. Each beneficiary pursues his/her own interests in ensuring efficient land and environmental management.

Main stakeholders at the regional and district levels are: (i) regional and district khokimiats (authorities), basin administrations of irrigation systems (BAIS), irrigation system authorities; (ii) regional agricultural and water authorities and their branches, including special services responsible for monitoring soil salinization and waterlogging, amelioration conditions of irrigated lands, and control of the volumes and quality of water intake and drainage runoff, and so on; (iii) companies that operate amelioration and water facilities; and (iv) research institutes, nongovernmental organizations, educational institutions, and so on.

Various functional units of the Ministry of Agriculture and Water Resources, the State Committee for Environmental Protection, and local governments are engaged in the operation, protection, and use of the natural resources of local water bodies in the Amu Darya delta. This stakeholder group also includes hunters and fishing farms, administrations of irrigation systems, the BAIS, the Uzbek Agency *Uzkommunkhizmat*, and so on. There are also other stakeholders such as sanitary and epidemiological stations, centers of labor, and employment and social protection of population (job centers).

Local Level

There are quite a number of stakeholder groups at the local level, namely: (i) agricultural producers and their associations; (ii) farmers' councils and citizens' self-governing bodies; (iii) nongovernmental organizations; and (iv) the population whose income depends on agricultural production. These groups include farms (*shirkats* in the grasslands areas), their members, owners of backyard allotments, private farmers, industrial enterprises, commercial enterprises, and urban and rural residents. The interests of these stakeholders overlap: for example,

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private farmers have backyard allotments, and an urban resident may be hired by a water supply organization.

Changes in the environment have affected the agricultural sector, undermining the well-being and food security of all population groups, including fishermen, farmers, agricultural producers in the downstream areas, and agricultural producers specializing in specific crops. Bodies of local government—that is, *makankeneses* (local committees), *beys* (informal leaders), women's organizations, fishery *kolkhozes*, district administrations, citizens' self-governing bodies, agricultural cooperatives, and so on—play an important role and have responsibilities in planning, decision-making, and implementation of local activities in the Amu Darya delta [17].

Policy Options

Today Uzbekistan is facing serious problems concerning future demand for water to meet needs of the rapidly growing population in food and ensure food security in the country.

The section on Policy Issues clearly demonstrates that, despite the achieved results, it will be a real challenge to sustain the existing balance between food demand and supply in the future because a number of new threats and challenges. For example, demographic trends such as the growth of the population and its changing age structure, as well as issues related to the deficit of water resources, degradation of cultivated lands, soil salinity, climate challenges, and drought risks will affect food production and consumption in the medium and long term.

This case study is based on two food policy options developed by the UNDP in the course of preparing *Uzbekistan towards* 2030 [1], [16]. These are aimed at meeting the demand of the population for food products in the medium and long term (Table 4).

Required changes in crop yields and cultivated areas under Option 1 are illustrated in Table 5.

The analysis demonstrates that, to meet expected shortages of grains by 2025, the grain crop yield must go up to 5.5 tonnes per hectare by 2025, whereas the cultivated areas for growing grains must be expanded to 1,500,000 hectares. Similarly, average yield of vegetables must be increased by 47 percent, and the cultivated area for growing vegetables must be expanded by 20 percent, and so on [16].

Option 2 stipulates: (i) reduction of the cultivation of grains by 42,000 hectares on rainfed land and use of this land for cultivating fruit; and (ii) reduction of cotton on low-yield land by 60,000 hectares in favor of vegetable crops.

Table 4. Two Food Policy Options for Meeting Demand

Option	Description
1	Sustaining and maintaining food self-sufficiency and balances between food consumption and production by increasing production output to meet projected food shortages (see Table 3)
2	Increasing production of food products in subsectors where Uzbekistan possesses a comparative advantage with the aim of substantially increasing their export

Source: UNDP/CER 2013 [13].

Table 5: Required Changes in Crop Yields and Cultivated Areas to Meet Projected Food Deficits by 2025 (Option 1)

Food group	Difference between demand and supply, 1,000 tonnes	Yield, tonnes/hectare		Cultivated areas, 1,000 hectares	
		2012	2025	2012	2025
Grains	–1,542.5	4.2	5.5	1,472.3	1,500.0
Vegetables	–1,650.0	30.0	44.0	162.8	195.5
Fruit	–400.4	10.0	16.0	244.3	269.3

Source: UNDP/CER 2013 [13].

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Option 2 would increase the average yield of fruit from 10 to 20 tonnes per hectare and the average yield of vegetables from 30 to 48 tonnes per hectare by 2025, while implementing intensive methods of horticulture. Total production of fruit and vegetables would increase by 2.3 and 2.2 times, respectively, by 2025, while total economic gains for the economy from these activities would amount to US$3,398,200 (for fruit) and US$1,384,200 (for vegetables) in 2010–12 prices and 36,000 and 97,600 jobs would be created in these subsectors, respectively. A small deficit of grain products (5 percent of total consumption) that would be generated by the reduction of grain cultivation could be covered by import of grain products [13].

When implementing Option 2, it is important to provide the relevant capacity and quality of products in order to increase exported volumes of fruit and vegetables. From the point of view of the further diversification of food production, in addition to conventional crops, it is appropriate to consider prospects of growing unconventional crops (e.g., pistachios). For instance, according to the results of pilot projects [18], cultivating pistachios in the piedmont rainfed lands is 50 times as profitable as cultivating wheat on these lands, whereas cattle grazing for the entire period accounts for merely 4.5 percent of the profit of cultivating pistachios during the same period.

Efficient implementation of these food policy options and the supply of adequate quantities of food in the Amu Darya delta require policy options in the following areas, described in this section.

1. Further Reforms in the System of Land and Water Use and Investments in the Amelioration of Saline Soils

This policy measure is necessary because continued degradation of soil fertility and a trend of secondary salinization of irrigated lands are posing a serious threat to agriculture in the Amu Darya delta and to the entire country. Measures to promote efficient use of water and land resources, formalized in resolutions of the government, stipulate modernization and improvement of the I&D infrastructure and increase in incentives and stricter supervision and control of the activities carried out by relevant organizations, as well as adequate and timely financing. In 2016 repairs and rehabilitation works were carried out in the collector/drainage systems and facilities, and other land reclamation activities were undertaken in the irrigated lands of the Republic of Karakalpakstan and Khorezm on 77,600 hectares. The cost of these works and activities is 53,828 million soms.

However, the existing institutional, legal, and policy framework should be reinforced to mainstream practices of integrated water and land management, and to provide incentives, especially to farmers, so that they use available water and land resources in a more efficient and productive manner.

Climate change will aggravate the aforesaid negative events, and moisture stress and high temperatures will reduce the productivity of soils. These processes will be accompanied by progressive secondary salinization of agricultural lands. That is why it is very important to create an enabling environment by improving the legislative framework, planning system, management, and investments to enhance the fertility of soils affected by salinization and improve the quality of output.

The option of intensive methods of land and water use for the medium and long term, approved under Vision-2030 [1], stipulates mobilization of resources for efficient use of available water and land resources, modernization of the irrigation infrastructure, development of alternative sources of water, and intensification of agriculture in order to sustain food security and consumption balances as well as to increase in internal and local inputs of the WUAs and farms (repairs and maintenance of the on-farm network, pumping stations, monitoring), and environmental funds at subnational and district levels [13], [16].

As a result of these measures and considerable investments, the water table level would drop, the area with secondary salinization of soils would be reduced, and land productivity would be restored. Implementation of intensive methods of horticulture and a good amelioration state of land can increase the average yield of fruit from 10 to 20 tonnes per hectare and the average yield of vegetables from 30 to 48 tonnes per hectare during 2012–25.

2. Institutional Capacity Building and Developing New Forms and Methods of Management, Monitoring, and Supervision

After approval of interstate agreements on water management signed by the independent Central Asian countries in 1992, the Amu Darya delta became an independent water user. The interstate agreement guarantees controlled releases of

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3.2 cubic kilometers per year (100 cubic meters per second) to the delta to maintain quality water standards and releases of 2.0 cubic kilometers per year for environmental and fishery needs. The Interstate Commission for Water Coordination has approved higher quantities of water releases to the Amu Darya delta from 5.2 to 10 cubic kilometers per year depending on the dryness of the year [2], [5], [19]. However, current water allocation practice does not meet these environmental requirements.

The analysis indicates that in a low-water year 2,851–2,967 million cubic meters are released into the delta after all irrigation intakes, which is two times below controlled releases needed to improve water quality downstream. Technical interventions of water redistribution through engineering measures to control environmental flows and flood flows of the Amu Darya and to release collector/drainage waters cannot guarantee management of water ecosystems in the Amu Darya delta because the current system of management and monitoring of the deltaic water ecosystems remains unsatisfactory and requirements are met only during the lifecycle of projects and research programs.

Therefore, an integrated water and land management approach needs to be applied to achieve sustainable links and consistency in land and water use and to protect ecosystems within the catchment area. It is necessary to make decisions and undertake measures to strengthen the existing institutional framework and develop new forms and methods of management, monitoring, and control. To achieve these objectives, there is a need to launch an *Integrated Program on Climate Resilient Water Management in North Karakalpakstan* that would provide for flexible management of water and land resources in the irrigated areas and would integrate environmental releases into the system of water management and allocation to improve the quality of services provided by lake systems and wetlands and preserve biodiversity in the Amu Darya delta.

3. Scaling Up Sustainable Land and Water Management of Salt-Affected Landscapes

As noted earlier, the objectives of the government policy are to expand innovations and sustainable land management (SLM) technologies, mitigate droughts, and adapt climate resilience methods in agriculture management, including such measures as reducing cultivation of hydrophilic crops (e.g., replacing rice with winter wheat, reducing cultivation of cotton in favor of food crops, etc.) and introducing drought-resistant varieties and crops. In the near term, it is planned to reduce the cultivation of cotton on 170,500 hectares in phases in favor of food crops—for example, vegetables, cucurbit crops, and potatoes. In this case, cotton cultivation areas in the Republic of Karakalpakstan and Khorezm will be reduced by 7 to 10 percent on average.

The recent transition to horticulture crops has turned out to be useful because such crops are less thirsty than cotton. Some studies contain the following data on water footprints per tonne of crops in Uzbekistan [20], [21]: cotton needs roughly 4,426 cubic meters; wheat 2,068 cubic meters; grapes on average 2,400 cubic meters; apples roughly 820 cubic meters. Given that more than 90 percent of cultivated land in the Amu Darya delta is irrigated, and 95 percent of irrigated land is susceptible to salinization, in order to expand the land available for the cultivation of vegetable and cucurbit crops, land currently used to grow other crops needs to be reallocated in favor of vegetables and cucurbits.

These estimates have shown that, by changing varieties of cultivated crops and optimizing the cropping pattern, food production on irrigated land in Karakalpakstan and Khorezm can be increased without using additional water resources. The example assumes that the cultivation of hydrophilic crops will be reduced (cotton by 10 percent and rice by 5 percent) whereas the land used for potatoes, horticulture crops, orchards, and vineyards will be expanded. By introducing intensive methods of horticulture and orchard farming, the average yield of vegetables is expected to increase from 21 to 27.4 tonnes per hectare, and the average yield of fruit and grapes will increase from 10.4 tonnes to 16.6 tonnes per hectare by 2025. Total economic gains for the economy from these changes will amount to US$766,300,000 (horticulture crops and potatoes) and US$1,384,200 (orchards and vineyards).

Substantial gains in the overall chain of benefits are expected from restoring and sustaining services derived from lake systems and wetlands—for example, fish, game, muskrat, fodder crops—in the Amu Darya delta (the area is to expand up to 234,000 hectares).

The World Bank estimates demonstrate that the presence of strong research institutes is a driver for achieving substantial increase in crop yields in the fruit and vegetable subsectors and the orchard and viniculture subsectors [22]. Studies related to research of fruit trees, vineyards, and wine

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production processes are led by the R. R. Shreder Uzbek Research Institute. Studies of horticultural and field agricultural crops, including cucurbit crops and potatoes, are led by the Uzbek Research Institute of Vegetable and Cucurbit Crops and Potatoes.

At the same time, to achieve a reliable potential increase in food products, it is necessary to support the entire chain—that is, *purchase and storage, distribution, processing, and sales of agricultural output*. Given the need to store additional volumes and maintain a line of food products, significant scaling up of refrigeration capacity and processing of foodstuffs is needed.

The creation of *an efficient system of sales, marketing, and distribution* of the output with expansion of trade in food shops and large supermarkets will substantially reduce costs, facilitate interaction between farmers and distributers, and contribute to food safety by putting in place an adequate control of food on sale.

4. Creating Incentives for the Introduction of Modern Agrotechnologies to Increase Yields in Plant Production and Productivity in Livestock Farming

Despite numerous pilot initiatives that demonstrate efficient practices in agriculture and management natural resources, there is no state policy or fiscal incentives for large-scale measures. Therefore, there is a need to develop a system of incentives to promote and replicate best technologies and practices of sustainable land and water resources management.

The country has adapted quite a sufficient number of technologies and approaches to sustainable land management [2], [8], [9], [15]. It is advisable that piloted SLM cost-efficient technologies and practices should be implemented on a large scale. The most important SLM practices are as follows:

- *Efficient use of water and water saving* tasks are addressed by strengthening the WUAs' role in improving on-farm allocation and use of water (leaching, drip irrigation, water metering and supervision) and so on.

- *Soil laser-leveling of irrigated fields* is achieved by introducing the soil laser-leveling system under pilot projects of the UNDP/GEF Small Grant Programs; reducing mechanization costs by 14 percent, labor costs by 23 percent, irrigation costs (electricity, pumps) by 27 percent, water use by 30 percent; and increasing the yield (of wheat) by 400 kilograms per hectare.

- *Deep tillage* of soil (60–70 centimeters) makes an efficient impact as it improves the structure and microstructure of soil profile as well as water and physical properties of soil, especially hard-to-ameliorate soils and saline soils. Deep tillage helps reduce costs of irrigation water by 10 to 15 percent and enhance the yield of crops by 20 to 30 percent.

- *Silvicultural reclamation* as an alternative way to rehabilitate saline and degraded (marginal) cultivated lands and the technology of alternative land use may contribute substantially to an improvement of the environment through bio-amelioration of saline and degraded sections of irrigated land under cultivation. Planting salt-resistant plants on degraded land generates financial benefits by providing firewood and construction timber, edible berries, mulch and other products, and leaf fodder for domesticated animals. Along with economic benefits, farmers will obtain indirect benefits from dropped water table levels, restored degraded lands, and enhanced fertility. The variety and magnitude of benefits from saline land afforestation were demonstrated under the ZEF/UNESCO Project [23]. The net present value for seven years included potential revenues from trade in forest products as well as potential payments for CO2 fixation under the Clean Development Mechanism (CDM). Depending on the wood species, the net present value varied from 415 to almost 3,934 euros per hectare [2].

- *Development and introduction of more efficient local plant species and animal breeds* are better adapted to harsh natural and climatic conditions in Uzbekistan.

- *Integration of research in national strategies and agriculture development plans* will help adapt to climate change and achieve large-scale dissemination of SLM practices.

5. Raising the Awareness of Stakeholders

Paradoxically, a country for which agriculture is such an important sector does not have a systematic extension service provided to its over 100,000

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agricultural and pastoral farms [24]. Furthermore, the extension services that do exist tend to favor larger farms rather than subsistence dehkan farms. Finally, extension advice does not currently take a climate change adaptation perspective. Therefore, the development of extension services and innovation dissemination services to raise awareness and improve access of the population to SLM best practices will help improve productivity of land and water use and agricultural output.

Assignment

Your assignment is to work out policy recommendations for expanding the cultivation of food crops on irrigated lands and sustaining the services of lake systems and wetlands in the Amu Darya delta in the context of climate change as defined in this case study.

Policy Recommendations

To meet the population's demand for food in the medium and long term, the following food policy options have been proposed: (i) sustaining and maintaining food self-sufficiency and balances between food consumption and production by increasing production output to meet projected food shortages; and (ii) increasing the production of food products in subsectors where Uzbekistan possesses a comparative advantage with the aim of *substantially increasing of their export.*

Both policy options for the country are inseparable: most people earn their livelihood from land, and agriculture contributes a large percentage of the country's GDP. To achieve these targets, it is necessary to implement a range of interventions and measures aimed at further developing reforms and incentives in land and water use; mobilize resources; and strengthen institutional capacity along with implementing new forms and methods of planning, knowledge management, and raising awareness among all stakeholders to disseminate innovations and replicate best agrotechnologies on a wider scale. These interventions should be extremely cautious; technically, economically, and environmentally acceptable; and socially relevant in order to achieve sustainable environmental and economic benefits and improve livelihood and food security.

Given the forecasts of a growing population, changes in demographic patterns, and higher income that will increase the food burden on agricultural producers substantially, the task of sustaining food security in the long term will require new and more sophisticated policies and tools.

In this context, to achieve expected results concerning sustainable increase in food production and improvement of agricultural and ecological services in the Amu Darya delta, it is recommended that all five policy measures recommended in the section on Policy Options should be implemented.

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Additional Readings

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