Eurasian Center
for Food
Security

Food security in Eurasia

Case studies

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Foreword

This volume presents outcomes of research projects (cases) implemented in several countries across the Eurasian region. The cases were part of an initiative designed to bring attention to some relevant food security issues in selected sectors of the agro-business industry, and produced with support from the World Bank and the Eurasian Center for Food Security (ECFS) of Moscow State University. Please note that the countries represented by these case studies (Armenia, the Kyrgyz Republic, Tajikistan, and Uzbekistan) feature a variety of landscapes, climates, and socio-cultural characteristics. The countries differ in terms of their soil and water endowments, which primarily impact agricultural production levels. However, as the research outcomes suggest, they also share a lot of common features that are generally characteristic of transition economies. These include, first, underdeveloped regulatory and legal frameworks for different farming industry sectors, dilapidated physical infrastructure and poor technology availability, a lack of the financial resources needed to upgrade the farming sector, and so on.

The published materials provide new data on the state of irrigated farming, animal farming, water use, and other relevant challenges. Among other things, in-depth research has looked at water use in the Ararat Valley basin (Armenia) and the Amu Darya delta (Uzbekistan), irrigation improvements and irrigation erosion, and animal farming promotion in the Kyrgyz Republic. The authors emphasize a variety of interests pursued by different stakeholders and stress the need for the government to address contradictory interests among producers by means of an effective regulatory framework. Outputs of the exercise are specific policy recommendations for all stakeholders in the sector regarding better production practices, higher standards of living, and environmental conservation.

The cases will serve both as the basis for further analysis and research in food security of the region and to raise awareness about these issues among decision-makers, farmers, and a broader academic and social community.

Sergei Shoba
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Introduction

Irrespective of political ideology, government policy and actions taken by other stakeholder groups are most likely to achieve their goals if based on relevant evidence. Design and implementation of government policies based on faulty or insufficient evidence is likely to result in disappointing outcomes and waste scarce resources. This publication has a dual purpose: (i) to illustrate how a case study approach can be applied to generate such evidence and strengthen university-level training in food policy, and (ii) to present empirical evidence of immediate utility to guide policy action to deal with selected food policy challenges in the Eurasia region.

Food security and nutrition are an outcome of (i) the food systems of which they are a part, (ii) the external factors—such as government policy—that influence the systems, and (iii) the behavior of the food systems' stakeholder groups. Food systems are complex, and public policy—as well as the behavior of a variety of interest or stakeholder groups—are critical for guiding those systems to fulfill society's goals. In fact, arriving at the goals to be pursued ("society's goals") is difficult, and the process is a function of the goals of the various interest groups. These groups include, but are not limited to, agents within the public sector and their relative power to influence decisions.

The design and implementation of appropriate government policy depend on a thorough understanding of the food system toward which it is aimed, how that system operates, and how it would respond to various government interventions.

Evidence-based decision-making is more likely to be successful in achieving stated goals than decision-making based solely on ideological reasons. Food policy research is an important source of the evidence needed for sound policy making. Methodologies available for such research may be divided into two groups: (i) double-blind randomized controlled trials (RCTs) and (ii) observational studies (OSs). The latter may consist of cohort studies and case studies. As the titles of these two methodologies imply, the former aims to test the effect of artificially introduced changes in variables of interest, controlling for the environment within which the trials take place and ensuring that neither the researchers nor the subjects under study are aware of which subjects receive the treatment and which are the controls, while the OS methodology is based on the observation of variables as they behave in their normal context or environment.

RCTs are the gold standard for generating scientific evidence because they aim to establish causation between the treatment and the outcome variables with acceptable error margins. They (i) involve randomization to ensure that groups receiving different treatments are similar, (ii) control and compare variables to study the impact of treatment by comparing treatment and control groups, (iii) design the trial such that neither the subjects nor the researchers know which subjects get the treatment and which are the control, and (iv) are able to replicate to verify the results. RCTs are used widely in health research. The weakness of RCTs is that the results are relevant only for the controlled environment or context in which they were undertaken. Except for small, usually insignificant projects, this weakness makes RCTs unsuited for generating the kind of evidence needed by policy makers to guide food policy. The evidence must be relevant to the environment or context within which food policy challenges are found and policy interventions directed, and not relevant only to an artificially controlled context. Furthermore, the randomization of policy interventions is usually impossible to manage and the difference between control and intervention is usually obvious, making the requirement for "double blindness" impossible to implement. One additional reason why RCTs are irrelevant for most policy interventions is the long impact pathway between the policy intervention and its impact on food security or nutrition—for example, the impact of policy interventions to improve water management in agriculture on human nutrition.

For the above reasons, OSs are the most common source of food policy–related evidence. In such studies, the variables of interest—say, the elements in a pathway from food policy to food security—are observed but not manipulated. The "treatment" is the natural variation in the population studied. Data for such studies may

be cross-sectional or longitudinal. One of the difficulties associated with OSs is the presence of confounding variables or variables that cannot be measured—that is, variables the effect of which renders them difficult to separate from the effect of the variable of interest. Appropriate epidemiological and econometric models are helpful in that regard. However, contrary to RCTs, which can produce causal relationships within certain statistically estimated margins, OSs can produce only associations.

RCTs can be carried out under strictly controlled conditions and therefore usually have high internal validity—that is, the results are likely to be true for the controlled conditions. However, precisely because the conditions are controlled, RCTs hide details that may be important for their interpretation and their external validity—that is, the validity of the results in a less controlled but more realistic environment may be low. Well-designed OSs, on the other hand, present results from the environment in which they are to be applied, and thus have a higher external validity. The external validity of cohort studies varies with the size and complexity of the cohort, while the external validity of well-designed case studies is likely to be limited to the subjects and/or the environment in which the case study is undertaken, although the validity of results may be extended to similar environments.

One of the limitations of cohort studies for policy advice is the time lag from the initiation of the study to the availability of the results to the policy maker. Good solid cohort studies, which involve primary data collection over a period of time, often take a couple of years to complete. Predicting the policy challenge for which the policy maker needs evidence two years into the future is difficult. Such cohort studies are critically important to maintain a relevant body of knowledge from which short-term policy studies, such as case studies, can draw the information needed for policy advice. Case studies are particularly useful for acquiring in-depth, policy-relevant evidence about how to deal with a particular, well-defined problem such as inappropriate water management associated with a particular watershed, or iron deficiency in a particular cohort of women. Such case studies can be completed in a short period of time and thus more likely to match the policy maker's needs. The case studies included in this publication are focused on such specific food security problems and the identification of policy options.

As illustrated by the seven case studies in this publication, each case study should identify the most important stakeholder groups relevant for the particular policy challenge being considered. Both public and private sector stakeholder groups and the subgroups within each, for example, should be included. The expected behavior of each of these groups and their expected response to policy options under consideration should be estimated. The relative power of each group should also be considered. For example, is the ministry of finance likely to have the final say on any policy suggestion made by the ministry of agriculture or health? How powerful is the farmers' union in influencing policy decisions? It is important to consider the behavior and expected response of each subgroup within the public sector, such as the subgroups within the ministry of finance and the ministry of agriculture. In addition to the for-profit private sector, the expected behavior of civil society organizations should be included in the analysis. The case studies are meant to complement cohort studies, including those where the cohort is a national or regional population, as well as RCTs where they are feasible.

The seven case studies included in this publication pursue a dual objective. The first is to strengthen the analytical capacity of students at Moscow State University and elsewhere to undertake policy-relevant research, including case studies, and to provide advice to policy makers with an emphasis on policy and other actions to improve food security in the Eurasia region[1]. The second objective is to generate policy-relevant evidence about seven high-priority constraints to improved food security and nutrition in the Eurasia region, to identify policy options to alleviate these constraints, to make recommendations about which option should be followed, and to suggest which stakeholder group(s) should design and implement the recommendations. Thus this publication should be of interest to policy advisers and analysts in the area of food and agricultural policy, particularly those concerned about food security and the sustainable management of natural resources in the Eurasia region, as well as to professors and others involved in the teaching of food and agricultural policy.

[1] A suggested methodology for university-level teaching of food and agricultural policy on the basis of case studies is found Appendix 1. The methodology has been developed by Cornell University and used at Cornell and many other universities during the last 10 years. A collection of case studies is available in open access on http://cip.cornell.edu/gfs

As illustrated by the seven case studies, the suggested format for each case study is that a brief analytical description of a specific food security challenge and the identification of the related policy issues and relevant stakeholder groups provides the foundation for a set of policy measures and other actions that may be considered by government and other relevant stakeholder groups and recommends actions to be taken. The expected impact on each of the stakeholder groups and their responses are analyzed in order to assess the feasibility and impact of each policy measure.

Two of the seven case studies were successfully used in training sessions at Moscow State University to illustrate their utility in university-level training in food policy analysis. The approach used in the two sessions is outlined in the *Appendix*. This approach has been used at Cornell University during the last 12 years and it is being used in a number of other universities in the United States and several developing countries. All annual evaluations by students at Cornell University, as well as final exams, have been very positive both in terms of students' enthusiasm for this very participatory, role-playing approach to learning and in terms of the achievement of learning objectives.

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Photo credit: The World Bank

Intensive Fish Farming as a Contributor to the Depletion of Underground and Surface Water Resources in the Ararat Valley

Tatiana Trifonova

Executive Summary

The Ararat Valley is situated at an altitude of 800–950 meters above sea level. It stretches from northwest to southeast for 120 kilometers, it is 10–30 kilometers wide, and is a significant groundwater reservoir. Since the old days, the Ararat Valley has been regarded as a breadbasket of Armenia, and today it remains a major agricultural region in the country. Its climate is favorable for the cultivation of various crops, ranging from horticultural crops (peach, apricot, apple, pear, prune, cherry orchards) to cereals and root crops.

Currently, in the Ararat Valley, land uses are linked with the enhanced development of fish farming, which requires artesian water in great amounts. Monitoring data show that groundwater storage has dropped by almost 60 percent while the artesian water withdrawal rate increased from 34.7 cubic meters per second (m3 per sec) to 80 m3 per sec. As a result of unsustainable management of the natural resources, the water level of the artesian basin has declined by 8–15 meters, and the groundwater level has gone down by more than 3 meters. This has brought about a number of adverse processes: the drainage of agricultural soils, increased irrigation depth, losses of soil organic matter, and so on. It should be noted that the artesian basin of the valley is the main and strategically important storage of potable water for the City of Yerevan as well; and the groundwater resources are a major regulating factor for irrigated agriculture and also for soil humidity conditions, which define soil fertility. The change in the soil moisture regime has led to soil aridization in some areas of the Ararat Valley (as of today, over 30 communities are left without water for irrigation), and emerging waterlogging in other areas, which are exposed to water discharges from fish ponds at lower altitudes.

Thus the Ararat Valley faces a broad range of interrelated environmental challenges; and the most serious of these arise from poor water management.

Such a conflicting situation brings together several stakeholders. The first is government entities, alarmed with the tangible threat of the depletion of the artesian basin, which is a strategically important source of potable water for almost half of the country. The second stakeholder is comprised of arable farmers in the Ararat Valley: they adhere to ancestral traditions of vegetable, fruit, and grain growing, but now they are losing their fields and orchards as a result of their draining and impaired fertility. The third stakeholder group consists of fish farmers: the valley alone harbors over 300 operating fish farms. This is a fairly successful and profitable sector. Owing to the high quality of the fish they produce, it is in great demand in the Russian Federation and other countries; therefore, about 20–30 percent of the output is exported abroad. It is quite natural that fish farmers are keen to expand their operations. The fourth stakeholder group is nature conservation organizations, warning that the entire ecosystem, generated by nature and man, is entering a stage of degradation in the Ararat Valley, and unless this process is stopped, desertification will deprive the country of its once-abundant breadbasket and food security stronghold.

How to arrest the process and attain sustainability? There seems to be no one clear-cut solution, but rather a broad range of coherent actions. First, it is necessary to: (i) cause the water withdrawal from the artesian basin to be drastically reduced, (ii) forbid (at least temporarily) the drawing of water from artesian wells that are not flowing any longer (as a result of dropped internal pressure); (iii) revise the quotas and rates of respective financial taxes payable by fish farmers; (iv) equip fish farms with water purification systems as soon as possible in order to introduce closed or semi-closed water consumption cycles; (v) retrofit or upgrade the interception and drainage systems to prevent waterlogging; (vi) consider an opportunity to use discharged water for irrigation purposes; (vii) introduce up-to-date water-saving drip irrigation practices in crop farming; (viii) forbid landowners to use their fields and orchards for purposes other than those for which they are designated to avoid rapid soil fertility losses; (ix) explore whether it would be appropriate to revive the Soviet practice of quite effective alternate uses of the same land areas for crop cultivation and fish ponds (two to three years for each use); cause nature conservation groups to consider the opportunity of giving the Ararat Valley ecosystem a status that would enable regulation of its land uses in a more purposeful and strict manner; and (x) advise the country's government to develop and adopt a targeted government program aimed at optimizing the environmental and economic situation in the Ararat Valley.

The main objective of this case study is to highlight the problem of the underground water storage decline in the Ararat artesian basin, arising chiefly from the intensified fish farming; and use the available information to propose and analyze possible policy and economic options of addressing the problem in a fully participatory manner, in order to ensure food security.

Background

Environmental Conditions in the Ararat Valley

The Ararat Valley stretches from northwest to southeast for 120 kilometers, it is 10–30 kilometers wide, and is a sink for solid and liquid matter, flowing from the Ararat slopes surrounding the valley.

The valley is located at an altitude of 800–950 meters above sea level (Figures 1 and 2).

The flatland part of the Ararat Valley has a typically semi-desert landscape with its specific semi-desert soils. Its soils range from hummocky sands and alkaline and saline soils to water-logged soils. A significant part of the valley is managed; this part has irrigated meadow brown soils. The non-managed part is covered with xerophilous and halophilous vegetation and Artemisia (sage), whereas irrigated meadow brown soils bear fruit orchards, vineyards, and various agricultural plantations. The piedmont steppe soils had developed from volcanic lavas and large sediments from the left tributaries of the Aras River. The piedmont river torrents have produced canyons 50 to 60 meters deep or deeper with steep slopes. At relatively low elevations, irrigated meadow brown soils occur intermittently with alkaline and saline soils, but the prevailing soils of this area are brown semi-desert soils and the area of transition to the steppe zone is dominated by chestnut soils and black earth. The soils are covered with grass vegetation [1].

The Ararat Valley climate is characterized by an exceptionally long duration of sunshine: on the average, it has up to 2,600 hours of sunshine per year. The longest sunshine duration (in hours per day) is in summertime. Seasonal variations in the atmospheric circulation are a strong contributor into the development of the climatic specifics in this area; they are accounted for by its highly continental climate with great annual and diurnal variations in air temperature and humidity. In the Ararat Valley, the difference between winter and summer temperatures may exceed 31oC (it may be –6°C to –7°C in winter and +25°C to +26°C in summer). The aridity of the area is explained primarily by the closed area of the valley.

In the South Caucasus, one of the most arid areas is the Ararat Valley, especially its flatland area where total annual precipitation may be as low as 200 to 300 millimeters.

Figure 1: The Ararat Valley (Source: T. A. Trifonova, July 2014)

Figure 2: An Image of the Ararat Valley from Space, from 1970 (Google Earth, 1970)

The moisture deficit is very acute here: soil humidity drops to 8 percent in mid-summer.

The heat is mitigated by cool air descending from the mountains as well as night cooling. Evenings and nights may be cool in the Ararat Valley, which adds to the diurnal fluctuations in air temperature and relative humidity.

The Ararat Valley ecosystem has a fairly sophisticated pattern of soil and vegetation cover: fertile long-irrigated soils coexist with white alkali-saline soils and water-logged areas in lower river plains.

The Ararat Valley is a major agricultural region of the country. In 2006, the World Bank completed a study that identifies key challenges that need to be addressed in order to sustain its high GDP growth rate, improve life standards, and integrate the environment into agriculture and forestry [2].

The climatic conditions are favorable for cultivating various crops, ranging from horticultural crops to cereals and root crops. Agriculture draws on irrigated land in the lowland and piedmont part of the area. About one-third of the agricultural output comes from the Armavir and Ararat Provinces, both located in the Ararat Valley.

Plant crop farming's key subsectors are the cultivation of grain crops, viticulture, fruit growing, and the production of vegetables and tobacco.

The cultivation area is 332,700,000 hectares; since 1990, it has decreased by 20 percent (then, it was 417,000 hectares). Grain crops account for the greatest share of Armenia's cultivation area (56 percent). The share of forage crops is 23 percent; potato, melons, and gourds account for 19 percent; with technical (non-food) crops accounting for slightly over 1 percent. Compared with the pre-reform period, the breakdown of cultivated areas by crop has drastically changed. The area of forage crops shrank fourfold (in 1990 they accounted for 58 percent of the cultivation area). The total cultivation area decreased primarily because of the reduction in the forage crop area while the areas producing other crops increased.

Cereals have become most prevalent in the Aragatsotn Province (in the upper part of the Ararat Valley), which accounts for about 15 percent of the total grain crop area in the country. Almost all of the winter grain crop area consists of wheat (97 percent), and the most prevalent spring crop is barley (79 percent). The combined share of wheat and barley is 93 percent of the total area of grain fields.

Viticulture is one of the oldest agricultural activities in Armenia. There are over 150 local grape varieties generated through "native" breeding over many centuries. Armenian vine-growing is concentrated on irrigated land areas in the Ararat Valley (Ararat and Armavir)—they are home to 70 percent of the total vineyard area and produce the highest-yield varieties. Wine-grapes to make strong wines and brandies as well as table grapes are cultivated here.

Fruit production is well developed throughout the country, but the Ararat Valley, both its lowland and foothill (Aragatsotn) area is the most significant region in this respect. Here, three provinces harbor over half of the fruit and berry orchards in the country. The valley is also very important because the yield of its orchards significantly surpasses the country's average; therefore its share of the gross output is always greater. Lowland areas produce thermophilic drupes (mainly peaches and apricots) and the foothills and mountains are occupied with more cold-resistant pomes (apple, pear, and quince orchards).

The average revenue from each orchard is over 1 million Armenian drams (AMD), which is equivalent to about US$2,000–2,500 per hectare.

Soil Fertility Losses and Soil Degradation

In the Ararat Valley, white alkali-saline soils are widely spread; their area encompasses 29,500 hectares, including 5,500 hectares cultivated in 1970–88. In the 1970s and 1980s, Armenia introduced and widely implemented an integrated approach to cultivation on alkali-saline soils: this was a method for integrated chemical amelioration, based on the use of industrial wastes—black sulfuric acid, iron sulfate, chlorohydric acid, distiller's solubles, activated natural ameliorants, contactless electromelioration, and so on. As a result of such chemical amelioration, white alkali-saline soils acquire certain agronomical properties of high value and offer optimal conditions for plant cultivation. In the course of the agricultural use of such soils, the biological production of plant biomass is growing, and qualitative and quantitative indicators of nutrient exchange between the soil and plants improve.

However, the efforts to use these soils were abandoned in the 1990s for a number of economic reasons. The earlier technology of chemical soil

amelioration is not cost-effective now because of its prohibitively high costs and lack of chemical ameliorants.

After the land privatization, the agricultural crop harvests significantly decreased because of the lack of needed amounts of fertilizers and their higher prices. Today farmers cannot afford to buy fertilizers in needed amounts, and reducing their harvests from cultivated crops. This has not only affected harvests of agricultural crops, but also caused secondary effects: plants draw from stocks of nutrients, accumulated over many centuries, the amount of organic matter decreases, and the soil structure is destroyed which ultimately leads to soil degradation [3].

Another factor contributing to desertification is erratic or nonexistent crop rotations. Small sizes of land parcels prevent farmers from having full-fledged crop rotations. The average area of privatized land per farm is 1.40 hectares—including 1.04 hectares of arable land, 0.12 hectares used in perennial plantings, and 0.24 hectares for haymaking.

Soil cover losses also result from irrigation that is not always well managed; new irrigation technology such as drip watering is applied in a very limited scale. One more desertification contributor is the abandonment of land cultivated earlier. Such soils tend to be rapidly overgrown with weeds, invasive aggressive species as a result of the lack of competition from native plants. This results not only in losses of cultivated soil, but also into weeded flora.

Impact of Waterlogging on Soil Degradation

To improve the status of irrigated land as well as to prevent waterlogging, the flooding of settlements, and the spread of malaria, drainage networks have been constructed since the 1950s. Their total length is 1,693.62 kilometers, including 1,064.12 kilometers of open networks and 629.5 kilometers of closed networks.

In 1991–97, to the situation's detriment, the network ceased to operate. In 1998, the operation of the drainage network was partially resumed. The public budget financed the cleaning of about one-third of the entire network on an annual basis, but in 2009 funding was reduced by 40 percent. Now only 14–15 percent of the network is cleaned every year, which would eventually lead to such adverse consequences as salinization, alkalization, and waterlogging. Currently the Ararat Valley is provided with 902.7 kilometers of open drainage networks with a total area of 25,000 hectares and 629.5 kilometers of closed drainage networks with a total area of 7,700 hectares.

Owing to the financing from the public budget made available in 1998–2014 and under the Millennium Challenges program in 2010–11, large-scale operations were completed to clean, maintain, and operate the drainage systems. This ultimately resulted in a reduction of waterlogged land (by 17,400 hectares); a reduction of land in poor condition (by 18.9 hectares); and a reduction of flooded land (by 49 hectares). However, these measures are not sufficient to cope with the situation.

In addition to the presence of alkali-saline soils in the Ararat Valley, since 2009 the confined groundwater level has been dropping in the Ararat Artesian Basin, closely linked to water withdrawal from 470 artesian wells of several hundred fish farms.

Fish Farming in the Ararat Valley

Armenia has vast experience in fish farming. As early as in the 1920s, trout-rearing farms started to operate in Lake Sevan to replenish fish resources. The next stage of fish farming development began in the 1970s when commercial operations were launched. Large fish farms were established to manage water resources and flooded areas of the Ararat Valley in a sustainable manner.

In the 1980s, the water surface area of the Armash and Sis fish ponds alone reached about 6,000 hectares and their annual commercial fish (primarily carp) output amounted to over 5,000 tonnes. In 1970–80, Armenia produced up to 7,500 tonnes of fish per year, including 5,000–6,000 tonnes of fish, reared by fish farms. It is noteworthy that fish farms were established on white alkali-saline soils, which required huge physical and financial resources. Studies show that fish farms sometimes had positive effects on physical and chemical soil properties: eventually, the positive processes of desalinization and dealkalinization were triggered.

Upon the disintegration of the USSR, fish farming experienced a drastic decline: for example, annual outputs of trout decreased almost 20 times—from 400 tonnes to 15–20 tonnes. The decline in fish harvests from fish farms was compensated for with increased harvests from lakes—in particular from Lake Sevan, which was exposed to the merciless overexploitation of fish resources.

The third stage of fish farming development started in the late 20th century and its key driver was the emerging new economic relations in the country.

At first, small fish farms were established; they were more competitive than larger ones. The most cost-efficient and competitive farms were those that used artesian flow water. Another important advantage was their gravity-fed supply of water to the ponds, with no need to spend electricity for pumping. Clearly it was very cost-efficient. The period since that time has seen an increase in the number of private fish farms, rearing fish in clean flow water and selling them for higher prices than state-owned fish enterprises that have higher production costs and lower selling prices. The fish product mix also changed. Carp farms completely disappeared. They were replaced with the 26 farms that reared primarily trout. Beginning in 1998, sturgeons have been produced in Armenia. These fish species require clean flow-through cool oxygen-rich water. For commercial purposes, successful efforts were made to rear Japanese carp (koi) and African loko because these fish species are distinguished by rapid growth, which makes it possible to reduce the duration of commercial fish rearing and, thus, to use water resources more efficiently. Today, fish farms rear the following fish species: two varieties of Sevan trout, Siberian sturgeon, Russian sturgeon, and white sturgeon (huso). It should be noted that the recent decade saw not only an increase in commercial fish outputs in the country, but also a broader fish product mix and an increase in the share of fish species that are expensive for the consumer. Currently, over 240 fish farms are registered in Armenia; about 75 percent of them operate in the Armavir and Ararat Provinces. To date, the Ararat Valley houses operating fish farms with a total water surface area of 3,033 hectares; almost 70 percent of them are found in Ararat Province and about 27 percent are in Armavir Province.

In 1996, the country's fish rearing output amounted to about 30–40 tonnes; by now it has increased 400 times—no other sector has been developing at such a rapid pace. Owing to the clean artesian water, the fish is very tasty and is in great demand in foreign markets. There is also a promising scope for the growth of its global market. Uncontrolled catches have been depleting fish resources in seas and oceans, and less than 75 percent of the global demand for fish products is actually met. For this reason, the fishery sector is significantly changing, shifting its emphasis toward aquaculture. Currently the country's commercial fish (mostly trout) harvest is about 14,000–15,000 tonnes per year. Owing to the high quality of Armenian fish, it is in high demand in the Russian Federation and other countries and about 20 to 30 percent of the output is exported.

Adverse Consequences of Groundwater Use

The development of fish farming brings about not only benefits, but also adverse environmental changes. For example, since 2009 the confined groundwater level of the Ararat artesian basin has been going down, and this process is caused by water withdrawal from almost 500 artesian wells by over 200 fish farms. Most farms use flow-through water. Both groundwater and artesian water levels have been rapidly going down.

Note: *Groundwater* means water present at small depths—from 3 meters to 10–20 meters beneath the surface. It occurs in relatively small layers at these depths on seat clays and is the main source of moisture for the soil and of water supply for wells. These groundwater layers are fed, primarily, from penetrating precipitation (that is, from above). It is this water that is used by local farmers for irrigation and drinking. If a great deal of water comes from above in the form of rain, the soil is strongly saturated with water, and this leads to soil deoxygenation, acidification, and waterlogging, impairing soil fertility. And, vice versa, if groundwater drops—for example, during dry periods—or if it is pumped, both the soils and the wells dry up.

Artesian water lies deep down at about 100 meters or more under the land's surface. As a rule, it comprises water basins, fed from underground sources. Artesian water is usually under pressure (confined); it flows out in some places and blows from drilled wells. Cessation of artesian water flowing means dropped pressure in the basin—that is, that the water level has fallen drastically. The Ararat artesian basin is the main source of potable water for almost half of Armenia, including the City of Yerevan.

The adverse impact of fish farming on the ecosystem may be outlined as shown in Figure 3 below.

Because of underground water use for fish farming in the Ararat Valley, in recent decades the groundwater level fell by 3–4 meters, and even by 5–6 meters in the central part of the valley where crop farming is most prevalent. The soil humidity therefore decreased, which, in its turn, increased the irrigation depth, regimens, and the amount

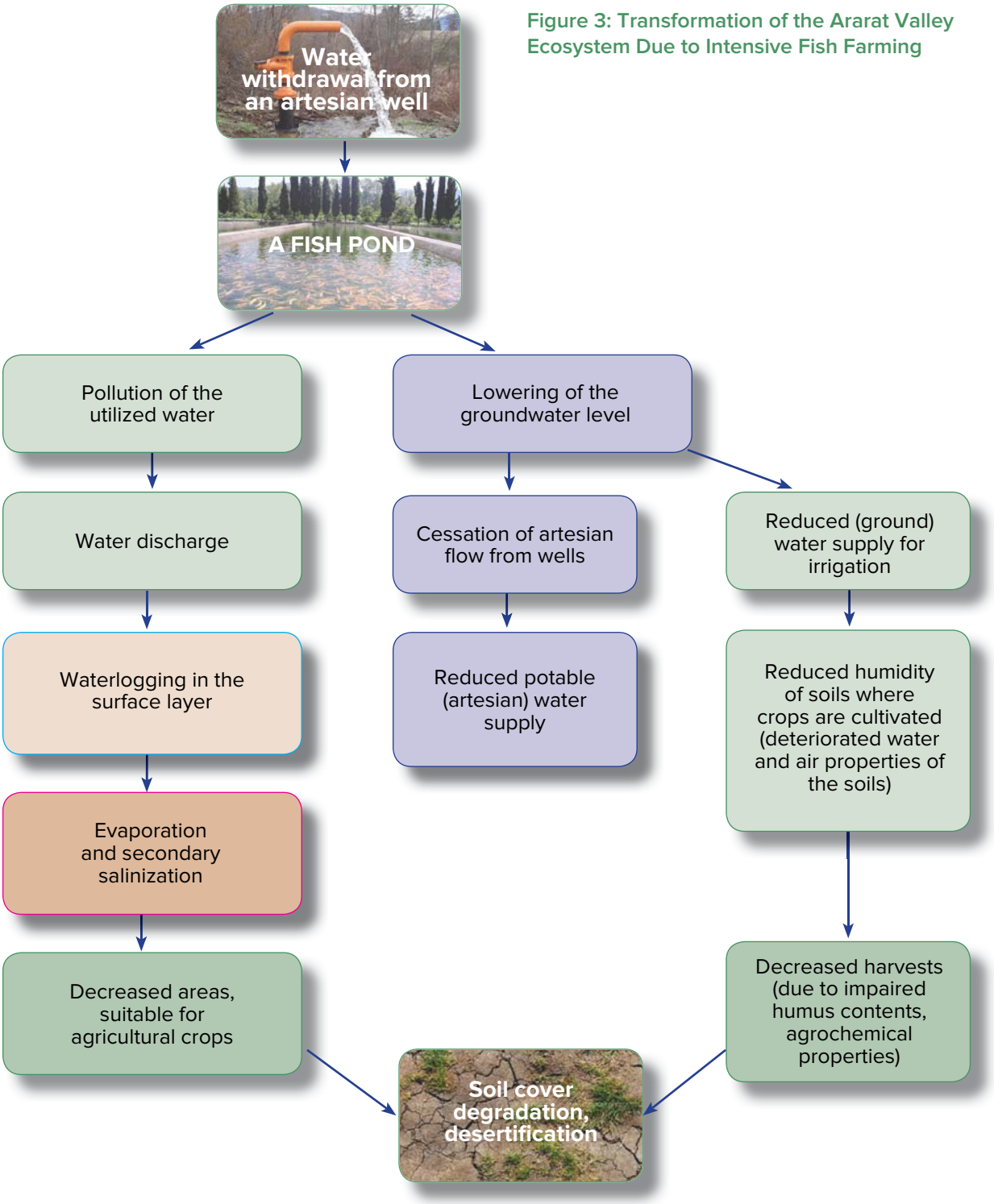


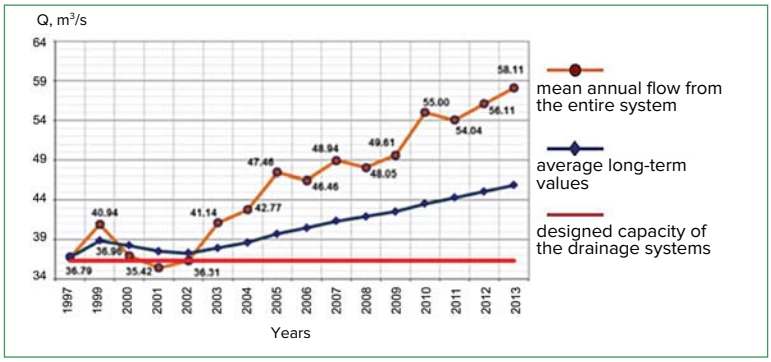
Figure 3: Transformation of the Ararat Valley Ecosystem Due to Intensive Fish Farming

of irrigation needed for agricultural land [4]. On the other hand, the wastewater from fish ponds is watering neighboring areas (Figure 4).

Water discharges cause local waterlogging instead of watering that spreads the water over fields evenly and in required amounts. Figure 5 shows how the amounts of discharged water keep growing (by year), while the designed capacity of the drainage network remains unchanged. This results in a reflux, excessive moisture in the soil surface, and waterlogging. It means that drains fail to perform their functions to control adverse processes of waterlogging.

Source: Google Earth, February 2016.
Note: The dark-brown spots show the processes of watering with the discharged water in neighboring areas.

Figure 4: A Space Image of Fish Farms in the Ararat Valley



Source: Cadaster of irrigated and drained land in Armenia, 2014 [5].

Figure 5: Discharge Water Flow from the Drainage Systems in the Ararat Valley, 1997–2013

According to statistics, since the year 2000, groundwater has been rising (from 2.0–2.3 meters under the surface to 1.2–1.5 meters in the lower southern part of the valley where major fish farms are based).

An alarming situation is also looming over the artesian waters. According to the USAID assessment study of groundwater resources of the Ararat Valley (undertaken in 2013–14), during the period of 1983–2013, the underground artesian water area shrank by three times to 10,706 hectares; and the artesian water extraction rate increased from 34.7 cubic meters per second up to 80.0 cubic meters per second, primarily because of the growth in fish farming. This has disturbed the water balance. The Pan-Armenian Environmental Front reports that in 2013 alone, the extraction of water from the artesian

basin exceeded the admissible level 1.6 times. This level is 18 times as high as the water consumption in the City of Yerevan. In some locations of the Masis Municipality, the underground water level has dropped by 15 meters!

Thus, continued mismanagement of the water resources threatens to unleash the desertification processes in the Ararat Valley and to impair its fertility and harvests as well as to deplete its storage of potable water, which is also an important constituent of food security.

Policy Issues

In 2004, the Government of Armenia adopted a strategy aimed at introducing advanced technology in agriculture and developing research, education, and extension systems with due regard to interlinked challenges in agriculture and environmental management.

Fish breeding is of strategic importance for the country because fish farms could be established not only in the Ararat Valley, but also in piedmont and even mountainous areas, and especially in border villages where it may be deemed to be the only profitable sector in view of the rather limited feasibility of crop cultivation and cattle breeding. On the other hand, in Armenia—which has had its transportation routes disrupted since 1992—fish breeding addresses important issues of food security.

Policy questions and proposed answers:

1. How can the most enabling conditions for fish farming be created?

   It is necessary to explore opportunities to use available suitable water surfaces in full (not only in the Ararat Valley) because this would permit not only an increase of commercial fish outputs, but would also engage hundreds of households from mountainous and remote border communities in such operations.

2. How best can the profit-related interests of large and small entrepreneurs be accommodated?

   In future, Armenia can rear pond fish in great quantities. The challenge rests with another aspect: vested interests should not limit their focus only to the domestic market—there is simply no 'room' for their activities: eventually, the involvement of major investors would not meet their expectations but would only wipe out small and medium farmers to monopolize the market. At this point, it is important to enhance the role of government, which should monitor development processes, create enabling conditions for export, and guide producers toward cooperation and export. It is also necessary to address the issue of transporting the fish.

3. How can the increasing groundwater deficit be stopped?

   Today, the depletion of the underground water resources is the most important issue (perhaps this was not even foreseen 10 years ago). The first priority should be given to the following steps:

   - Introduce closed or semi-closed systems of water supply to fish ponds with at least 70 percent of the water to be repeatedly reused. A transition to the new system would require rather expensive new technology. Clearly some farms would not be able to afford such expenses. It would be advisable for the government to consider providing support for equipping fish farms with fish pond aerators, oxygenizing the water to make it possible to repeatedly reuse it.

   - Explore opportunities for cooperation between neighboring landowners and fish farmers so that fish farmers could supply their purified waste water to neighboring landowners for irrigation. Certainly supplying water to remote fields would entail high financial costs of water conduct and electricity.

4. Are controls and prohibitions necessary?

   It is the lack of control on the part of the country's authorities that has largely caused the currently alarming situation with water balance in the Ararat Valley. Most fish farmers have been practicing illegal, uncontrolled use of the water for a long time, and there has been no regular environmental monitoring or forecasts of the developing situation. Therefore it is currently necessary to assess the actual situation, undertake an environmental hydrological audit, and close or suspend the operations of some ponds and wells if emergency cases are detected.

Another option is to explore possibilities for converting fish farms to other agricultural uses. In this case, however, it would be necessary to develop recommendations for the fish farm owners on agricultural uses/operations/activities in which they could get engaged without a major detriment to their economic situation.

It is urgent to take measures because there are emerging conflicts between crop farmers and fish farmers. Urban dwellers are also raising alarm because they have already started to feel the deficit of potable water.

5. What arable farming policies should be adopted?

It is necessary to assess the situation in terms of flooding and soil drainage in different parts of area to identify their causes. It would be sensible to restore and expand existing drainage systems with a view to draining the soils and preventing secondary salinization. On the other hand, it is worthwhile recalling the project, financed by the World Bank in the 1990s, that was aimed at improving the profitability and sustainability of irrigated agriculture and creating basic opportunities to turn agriculture into a key source of employment. It would be quite appropriate to guide farms toward irrigated crop cultivation with the use of discharge water from fish farms.

Thus, in view of the current situation in the Ararat Valley, it is evident that degradation processes have become intensive there. To cope with them, it is necessary to implement agricultural policy reforms aimed at ensuring the sustainability of both the supply of agricultural products and the functioning of the whole ecosystem, including its water resources.

Stakeholder Groups

Dwellers of the Ararat Valley Engaged in Crop Cultivation

The average area of privatized land per farm/household is 1.4 hectares, including arable land (1.04 hectares), perennial plantings (0.12 hectares), and haymaking grounds (0.24 hectares).

During 1950–99, Armenian arable land shrank by 166,600 hectares, and the haymaking grounds and grazing land got reduced, respectively, by 15,600 hectares and 136,500 hectares. In contrast, perennial plantings increased by 28,800 hectares.

In the Ararat Province, farmers have to quit cultivating their land because they have no money for water, tillage, or seeding stock. According to local people, the price of tillage with the use of heavy machinery ranges from AMD 80,000 to AMD 100,000. They are forced to work for rich landowners for about AMD 3,000 per day. This issue is very 'acute' according to the opinion of those who participated in a roundtable, organized by EcoLur (an environmental nongovernmental organization) and hosted by the Ararat Aarhus Centre on April 5, 2012, as part of the *Make Your Voice Heard* project.

Pond fish farms are situated primarily on alkali-saline soils and practically have not contributed to the reduction of agricultural land areas, but they have driven the rise of the groundwater level around them and of waterlogging. The fish ponds discharge their water either simply into the soil or into the drainages that have ceased to perform their functions and turned into canals with high water levels and reflux, raising of the groundwater level in the southern part of the Ararat Valley, which results in such processes as salinization, alkalization, and waterlogging, but in many communities, both houses and facilities are also wet. On the other hand, in some places, the uncontrolled withdrawal of water for fish farms has lowered the groundwater level and, thus, led to soil drainage, especially in the habitable upper root layer, and to the need to increase the irrigation depth by 25 percent. Water pressure has decreased and farmers cannot obtain water on their own as they did earlier. For this reason, 31 communities are left without both irrigation and even potable water from flowing artesian wells. The Pan-Armenian Environmental Front predicts that, if the same water use scenario persists in the Ararat Valley, up to 400,000 people engaged in agriculture in the valley would lose their jobs and a new migration surge could be expected. So crop farmers need both land and water. It appears to be impossible to assess their attitude to fish farmers unambiguously.

Owners of Fish Farms

It is quite obvious that fish farming was very profitable until now. Using the high-quality water practically for free, fish farmers kept on increasing their outputs, often starting to rear more expensive fish species (trout, sturgeon) instead of cheaper fish. Euphorically, successful farmers were increasingly expanding their ponds, using cheap and sometimes free-of-charge water. Though fish farmers are aware of the emerged water balance crisis, they deem it unaffordable for many of them to introduce new

technology, which is rather expensive (its cost estimates range from €700,000 to €1.5 million). And, certainly, owners of fish farms are expected to resist new raised taxes if they are introduced.

The Ministry of Nature Conservation

Earlier, the Ministry of Nature Conservation (MNC) of the Republic of Armenia authorized the use of a total volume of 1.496 billion cubic meters of water by fish farms even though the renewable groundwater storage of the Ararat Valley is only 1.226 billion cubic meters [3]. As a result, 122 out of 638 artesian wells of the Ararat Valley have dried up, and 6,200 hectares practically faced the unavailability of water. To mend the situation, it was decided to increase the permissible volume for water released from Lake Sevan from 170 million cubic meters to 240 million cubic meters for five years [6]. In the meantime, the attempt to improve the situation by increasing the water released from Lake Sevan is not a fully positive decision. It is known that several years ago, the lowering of the Sevan water level caused many springs to dry up; hence, an increase in water released from Lake Sevan may indeed become very detrimental for underground water sources in a significant part of the country.

There are also public health concerns: the point is that fish ponds take pure artesian water and discharge polluted water. And since the Ararat underground basin is the main source of fresh water, in the near future this can lead to a deficit of potable water in Yerevan as well.

Nature conservation groups deem it necessary to reduce the underground water extraction and raise taxes on fish farms.

The Ministry of Agriculture

The Ministry of Agriculture is designated to cause food products to be supplied and to ensure their security. Key strategic documents are the Sustainable Agriculture Strategy (2004), the Poverty Reduction Strategy (2003), the Law on the Nature Conservation Frameworks (1991), the Land Code (2001), the National Plan of Desertification Control (2002), the Law on Agricultural Land Amelioration (2005), and the Technical Standards and Rules of Degraded Land Restoration and Classification (2006)[1].

Soil degradation (desertification) has become a serious challenge for the Ararat Valley. The ecosystem of this area has a sophisticated pattern, with its soils varying from brown long-cultivated soils to alkali-saline and waterlogged soils.

In the Ararat Valley, the changed water and thermal regimes of the soils account for the disturbance of the centuries-old equilibrium of the generation and destruction of organic matter that, in its turn, accelerated destructive processes, reduced the amount of humus in the soil by 0.5 percent–1.0 percent, caused its dispersal, deteriorated water's physical properties, and, ultimately, led to land degradation and lower yields of agricultural crops.

Regarding the use of fertile long-irrigated soils in the Ararat Valley, grain and fodder crops have been decreasing from year to year. On the one hand, their cultivation is partly profitable because these crops can give high revenues, but the infeasibility of their rotation results in soil depletion.

Clearly, the status and fertility of all the soils are directly dependent on the moisture regimens in the Ararat Valley; therefore restoring the water balance there is the most important goal for the Ministry of Agriculture because it is vital for food security in the country.

Research Community

Figure 3 is a generalized analytical picture of the current situation in the Ararat Valley (though in reality, it is much more complicated). As noted above, the valley is a complex ecosystem, generated by nature and man, with its relatively well established mode of functioning, evolved during many centuries of management. Now this mode is disturbed, and it has become evident that the entire ecosystem's environmental capacity has been significantly overused. The main mistake was transforming the area to make it perform functions that were alien to its nature as a desert/semi-desert geographic landscape. A similar mistake had been already made before, in the area between the Amu Darya and Syr Darya rivers with the Aral Sea.

Only scientists, focusing on such natural processes, can provide a comprehensive analysis of the situation and predict its development.

[1] All of these documents, available only in Armenian, can be found at http://minagro.am/

***Ashot Hoetsyan, a land degradation and desertification expert from the Ministry of Nature Conservation**, says: "The Ararat Valley situation is a particularly heart-breaking issue. The point is that it is the only more or less flat area (in comparison with other regions with their steep slopes—even with steepness of 5°–10°, the agricultural operations are difficult). The Shirak and Lori Plateaus are not a panacea either—their altitudes are too high (1,500–1,800 m above sea level). And the elevation of the Sevan basin is even higher—it reaches 1,900–2,000 m above sea level. That is why all our hope to supply agricultural products resides with the Ararat Valley, offering all needed conditions for agricultural development. But, alas, even here, desertification makes itself felt. This is not to say that fertile land of our breadbasket has degraded most of all. But! Sort of an Armenian 'desertification brand' is land salination. And of all places, the Ararat Valley is the only area, affected with it. Here, groundwater is very close to the surface and its evaporation is dispersing salts over ever vaster areas. No doubt, it benefits our salt producers. But it has tremendous adverse effects, especially as it is coupled with the predatory process of emptying the Ararat artesian basin. This refers to numerous pond fish farms, mercilessly consuming the ground water to meet their business needs. And in many cases, they do it without licenses. In the long run, the country is losing arable land for the benefit of someone's interests. And it is inevitably leading to impoverishment of farmers and further impairment of capacity to combat desertification." When asked about the area of land already lost for crop cultivation in the Ararat Valley, Ashot Hoetsyan said: "Nobody can give you exact data. But, in my opinion, in several decades, saline soils will cover over 30,000 ha in the Ararat Valley alone. To make you understand the seriousness of the situation, I shall say that in Armenia, the land area is 3 million ha and less than half of it is arable land! So, in 10–20 years, the Ararat Valley will lose its capacity to perform the agricultural function. As a matter of fact, when farmers are unable to handle difficult land, they tend to abandon such areas completely in search of better sources of income" (http://noev-kovcheg.ru/mag/2014-03/4349.html).*

Providers of Extension, Consultation, and Other Services

People need information and consultations about the advisability of taking up an occupation or engaging in a business, especially if there is a need to change it.

Policy Options

1. Develop a national integrated program aimed at optimizing the agricultural uses and sustainable development of the Ararat Valley ecosystem with due regard to the functional specifics of all its landscape components

It would be necessary to involve various specialists, including economists. A focus should be made on the groundwater status and changes in the Ararat artesian basin. These specialists should assess and estimate environmental capacity of the Ararat Valley.

2. Forbid granting new permits for water extraction from the Ararat artesian basin for fish farming

This would contain the depletion of artesian fresh water resources, and at the same time help to sustain the operation of fish farms—otherwise they would be gradually closed due to lack of water.

3. Conduct groundwater surveys to update the data to help address the issue of groundwater shortage in the basin and its surrounding areas

In view of the depletion of the usable groundwater storage in the Ararat artesian basin, it is necessary to conduct a retrospective analysis of changes in both underground and surface water storage, forecast the development of the situation, and organize detailed environmental monitoring in the basin.

4. Liquidate or conserve illegally used wells

The Government of Armenia should adopt a decision to take such measures as the liquidation and conservation of illegally used and abandoned deep wells. It is also necessary to introduce a valve operation mode for those wells where there are no valves and water is used inefficiently.

5. Introduce up-to-date water-saving technology of water use in fish farms

It is advisable to introduce semi-closed and closed systems of water supply to reduce the actual water consumption from 1,493 million cubic meters per year to 448 million cubic meters per year. It is estimated that to introduce new technology, fish farmers would have to invest €3 per 1 kilogram of produced fish; obviously, these are very expensive projects. Proceeding from the total number of fish farms in the Ararat Valley and their total production capacity, these investment needs of all the fish farms are estimated at about €23 million. It would be expedient on the part of the government to provide interest rate subsidies for loans to be borrowed from banks to implement such a program. Full-fledged implementation of such an important program should be preceded with a pilot project to identify all technical and economic issues. Since financial opportunities of fish farms vary, it is necessary to establish shorter periods for the introduction of new technology for large and medium-size farms and longer periods for small farms.

When selecting organizations to be supported, it is necessary to give preference to those organizations that would give firm guarantees of flawless operation of a semi-closed system of water supply, so that farms could have guarantees against financial losses.

6. Introduce economic levers for good natural resource management

Economic interventions are very important for water saving; and, in particular, they include rises in prices for water use and removal. Recent years saw a 10-fold increase in the price for water, used by fish farms: it has reached AMD 0.5 per m3, but overall, it has not led to significant water saving. Economic studies show that further growth of prices for both utilized and discharged water would increase the cost of fish production. With limited fish exports, it would have strong negative impact on farms. For this reason, it is necessary to find new production opportunities and markets, chiefly, foreign ones, alongside with the use of economic levers.

7. Use discharged water from fish farms for irrigation

A promising way to partially address the groundwater depletion in the Ararat Valley is to recirculate discharged water from fish farms to use it for irrigating fields. An analysis of such water shows that it is often suitable for irrigation although sometimes it should be purified. This practice would enable to reduce the consumption of water from those underground water sources that are designated for irrigation. However, this water is mostly found at lower levels and it is necessary to use pumps to extract to it. But this opportunity is limited because of the high costs of power (about AMD 50 per kilowatt hour). The issue could be addressed through:

a) constructing solar or wind power plants to use cheap power for water pumping;

b) receiving government subsidies to cover the costs of power; and

c) imposing obligations on farms to increase the area of their land parcels and introduce crop rotations.

8. Move fish farms from the Ararat Valley to higher altitudes

Another approach is to move fish farms from the Ararat Valley to higher altitudes. Recent years have seen specific steps in that direction. In particular, a caged fish farming program is ongoing in Lake Sevan and is expected to result into fish outputs of about 50,000 tonnes per year. However, it may be problematic because, in a colder climate, fish productivity is much lower and, hence, production cost would be higher. So this practice cannot be as competitive as fish farming in the Ararat Valley. In terms of fish rearing at higher altitudes in other regions of Armenia, it should be noted that though this trend is currently observed, there is a risk of contaminating rivers that are fairly clean in these regions and inflicting damage to the environment. To mitigate the risk, it is necessary to oblige owners to purify the water before discharging it back into the rivers, as is done in many other countries.

9. Resume the operation of the irrigation system

Currently, 24 communities have no irrigation water supply as a result of the lowering of the groundwater level. Their irrigation systems practically do not operate. The objective is to restore these systems and to have irrigation water supplied.

10. Promote local (focused) amelioration of white alkali-saline soils

It is necessary to promote focused amelioration of white alkali-saline soils. After chemical amelioration, these soils become fertile and may be used for perennial plantations. Due to the fact that most fish farms are located next to white alkali-saline soils, local reclamation of these soils by farm owners will lead to establishing fruit orchards and vineyards, which could be irrigated with water, discharged from the ponds. This would require modest efforts but could help to address both food supply needs and environmental protection objectives.

11. Promote collaboration of fish farmers and crop farmers

It is recommended to explore whether it would be appropriate to revive the Soviet practice of quite effective alternate uses of one and the same land area for crop cultivation and fish ponds. It is known that when water is removed from land upon completion of fish pond operation, the land has high yields during the first two or three years; later, its nutrient status deteriorates and it could be used for fish pond operation again for two years. In this case, not much artesian water is required. This problem is to be addressed by the Ministries jointly with respectively qualified experts.

12. Develop a system of environmental monitoring of the artesian basin and grant the Ararat Valley a Protection Area status

The Ministry of Nature Conservation has its Monitoring Centre, which monitors surface waters: rivers, lakes, and reservoirs. On the other hand, the Amelioration company (subordinated to the State Committee of Water Management under the Ministry of Agriculture of the Republic of Armenia) monitors ground and drainage waters. However, impact of water discharge from fish farms on surface waters has never been assessed. A full or partial nature conservation status of the valley would enable government agencies to legitimately restrict environmentally detrimental activities there.

13. Provide extension and consultation services

Extension/consultation service providers established under ministries, universities or institutions of higher education, and nongovernmental organizations possess respective databases, guidelines, information and relevant expertise. These organizations could help people to understand potential benefits and advisability of engaging in given economic activities.

Assignment

Drawing on an analysis of the current environmental situation in the Ararat Valley, resulting from the water balance disturbance due to intensive fish farming, your assignment is to appraise the potential effectiveness and feasibility of various policy options and propose adequate land use and fish farming measures to restore and stabilize the water balance.

It is recommended to use a SWOT analysis (a strategic planning method, consisting of the identification of various factors and their classification into the following four groups: Strengths, Weaknesses, Opportunities and Threats).

Policy Recommendations

For government entities (the Ministry of Agriculture, Ministry of Nature Conservation)

Objective: to stop the depletion of underground water resources. (*Stabilization and, if possible, restoration of the groundwater level are vital for both fish farmers and crop farmers as well as for sustainable water supply of this area and the City of Yerevan.*)

Action: To improve the situation, it is necessary, first of all, at the government level, to: (i) reform the system of fish farming in the Ararat Valley; (ii) undertake a thorough review of all existing fish farms, ranking the farms according to their environmental impact and impact on the water balance; (iii) close farms where wells have ceased to flow; (iv) introduce a recycling water supply for the fish ponds; (v) restrict rearing of fish species that require increased amounts of clean flow-through water; (vi) reform the system of

water use taxes; and (vii) support efforts to locate fish farms in mountainous areas.

Objective: to arrest the degradation of the Ararat Valley ecosystem.

Action: the Academy of Science together with the University and the Ministry of Nature Conservation should (i) develop a government-targeted program aimed at ensuring the sustainable development of the entire ecosystem of the Ararat Valley, and including detailed environmental monitoring; (ii) undertake an economic analysis and forecast the efficiency of land uses for purposes of supplying food products; and (iii) develop an environmental protection system and elaborate respective restrictive measures.

Objective: to resume active crop cultivation in the Ararat Valley, to recover its glory as the breadbasket of Armenia.

Action: (i) consider possibilities of cooperation between arable farms and fish farms; (ii) revise measures to provide farms with sufficient areas of land with recommendations on needed crop rotations to sustain natural fertility and yields; (iii) put in place a system of highly professional extension services and consultation support to be provided to farmers, farm managers and rural households, engaged in any agricultural activities and supplying food for their own subsistence and for sale.

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Photo credit: The World Bank

Rehabilitation of Saline Soils in Tajikistan: The Example of Saline Soils in Vakhsh Valley

Valery Demidov, Hukmatullo Akhmadov

Executive Summary

Over the past 25 years, since Tajikistan's independence, economic crisis and various social and natural disasters (the result of failure to carry out the bulk of reclamation activities) have led to secondary soil salinization in some areas. Secondary salinization results from anthropogenic impact on natural factors affecting the development of soils and landscape in general. It is caused by the intake of soluble salts that result from irrigation-related agrogenic contamination or from changes in the direction of natural processes. The immediate causes of salinization are improper irrigation, untimely clean-up of irrigation systems, irrigation erosion, and other factors. As a result, the groundwater level rises; its vaporization increases; and, consequently, an additional amount of salt is released into soil. Furthermore, an increasing land area affected by secondary soil salinization is being observed in the soils of Vakhsh Valley, which have been irrigated for a long time.

Currently Tajikistan is an agrarian country with about 60 percent of its population residing in rural areas. Agriculture is an important sector of the economy. As a result of economic reforms, about 20 percent of irrigated land has been transferred to private farmers' ownership (*dehkan* farms).

When saline soils are being developed, two periods are distinguished: the reclamation (transient) period and the operational (constant) period, which lasts as long as an irrigation system exists.

This study focuses on the development of recommendations and actions (using the example of the saline soils in the Vakhsh area) aimed at the restoration and the involvement of saline soils in agricultural land use and the dissemination of lessons learned from this experience to other territories.

The analysis of the modern condition of irrigated lands and the remediation of salted soils with the aim of increasing their productivity revealed the following issues that require decisions at different administrative levels: the reconstruction of infrastructure and economic and institutional reforms in irrigation; the increase in the operating cost of the cleaning, repair, and rehabilitation of existing irrigation and drainage-collector systems; the further deepening of land reform designed to transfer the selected dehkan land into private property or rent it on a long-term basis; the necessity of adopting measures for the mandatory transfer of responsibility for repair and maintenance of drainage and irrigation channels located on both state and farmers' land; the implementation of advanced agricultural techniques and salt-tolerant varieties of crops on saline lands and the observance of irrigation regimes; the resolution of questions of pricing policy for electricity (including the timing of its supply to consumers) and irrigation water, and so on.

To resolve these issues, the Government of Tajikistan and Parliament (*Majlisi Namoyandagon*) are expected to adopt legislative acts mandating state and local (*hukumats*) authorities to carry out reclamation works on both state and farmers' irrigated lands. Funding of soil desalinization reclamation is possible with the financial support of the National Bank of Tajikistan, nongovernmental organizations, local hukumats, dehkan farms, and private investors.

Your task is to present policy options that address the problem of the salinization of irrigated soils in the environment of changing market relations and to focus the solution to this problem on poverty reduction and the increased food security of the country.

Background

Irrigated agriculture is one of the most intensive types of farming established in desert, semi-desert, and arid zones as well as in areas lacking moisture during certain periods of the growing season. Irrigated lands deliver high and guaranteed yields from agricultural crops (wheat, rice, cotton, etc.) that are three to five times higher than yields from rainfed agriculture. Throughout the world, irrigated agriculture occupies about 18 percent of cultivated land, but its production is the same as that of rainfed agriculture [1]. According to various estimates, the irrigated land in the world totals about 250 million hectares.

As a result of the long-term use of the same land subject to excess watering, groundwater levels rise and the water-salt balance is disrupted. When passing through the soil, the water-salt content increases to 10.3 grams per liter, and once moisture evaporates, the salt stays. The irrigated lands of Central Asia evaporate up to 10,000 cubic meters of water per year per hectare; the process is accompanied by the accumulation of up to 20 tonnes of salts in the upper soil layer. For example, within 10 years of operation following the launch of a main irrigation channel, the area of highly saline and saline lands increases by 1 percent.

Historical Facts

As a mountainous and agricultural country, Tajikistan has limited land resources, although it is simultaneously rich in water and hydropower reserves (Figure 1).

Tajikistan's economy has evolved and developed mainly as a result of its agricultural sector, which is a key sector of the country's economy, representing 23.5 percent of GDP and employing 66.2 percent of the working population [2].

Crop production in inter-mountain valleys rich with water resources was launched in the Soviet era by expanding irrigation networks. As a result, irrigated land increased from 450,000 hectares in 1960 to 700,000 hectares in 1990; since 2010 it has remained at 745,000 hectares. The total land area in the country suitable for irrigation is 1.6 million hectares, of which currently (in 2015) 753,000 hectares have been developed. From 1930 to 2015, irrigated land in Tajikistan increased 5.2 times, while the population grew more than 8 times. Thus the specific area of irrigated land per capita has been gradually dropping, and now stands at 0.09 hectares per person.

Irrigation and Drainage Systems

The basis of the irrigation and drainage infrastructure is represented by large-scale systems built in the Soviet period, 1930–80. It is a complex infrastructure in terms of technical equipment and technology of service, and includes different types of water intake facilities as well as pumping stations of various types and capacity.

About 60 percent (452,000 hectares) of irrigated land in Tajikistan is irrigated by gravity-flow irrigation systems with waterworks built in the middle of the last century that are physically worn out by more than 50 percent. Many of these water intake facilities are built on non-regulated rivers, creating problems with the water intake each year. Part of the water intake is located in the territory of neighboring countries[1].

About 40 percent (301,000 hectares) of irrigated lands are located in areas with pumping stations and wells. However, because of the deterioration from long use of about a third of pumping equipment and pressure pipelines, and the high cost of electricity and its shortages in spring[2], actually about 262,000 hectares are irrigated by pumps[3]. Moreover, 5.2 percent of these lands are not irrigated.

The technical condition of the pressure pipelines of pumping stations along the total length of 298 kilometers is of serious concern. These pipelines

[1] For example, the Amu Darya river basin is shared by five countries: Tajikistan, Uzbekistan, Turkmenistan, Kazakhstan, and Afghanistan.

[2] In the Sughd Region, in March and April there is still a limited power supply regime in effect in accordance with an intergovernmental agreement with Uzbekistan, which is executed annually.

[3] The main areas of pumping irrigation are located in the Sughd Region, where in March through May there are electricity shortages. The power supply to pumping stations starts after mid-April or in May.

Figure 1: Map of Tajikistan

Source: State Committee on Investments and State Property Management of the Republic of Tajikistan [3].

have been in operation for over 40 years (some more than 50 years) and more than half of them need to be replaced. Socioeconomic consequences of a pumping irrigation area failure could be disastrous for residents, who will be threatened with becoming environmental refugees as a result of desertification. Addressing this problem will be more expensive than maintaining and operating existing pumping stations.

The irrigation water supplied by pumping stations is further hampered by regularly increased electricity prices and unstable supply. Because of the late delivery of electricity in spring or its early shut-off in autumn, in a crop rotation area of about 110,000 hectares[4], farmers are losing up to 30 percent of potential income from the cultivation of early vegetables and grains. For this reason, farmers are losing income on 38,000 hectares of land irrigated by electrified vertical wells.

Of the existing 1,823 drainage wells, about 74 percent are not working [5]. Unsatisfactory maintenance roads and communications systems make managing irrigation systems difficult.

Investment projects for the rehabilitation of water infrastructure totaling US$80.83 million, implemented since 2000, to some extent improved the technical condition of the irrigation systems in the areas where these projects were executed. With an average funding of US$250–450 per hectare, these projects, however, do not resolve all technical problems at the ground level. Upon their completion, only part of the problem has been fixed in the area of 108,000 hectares, which represents 14 percent of the country's total irrigated land [6].

Full elimination of saline soils and improvement of soil quality can add up to 20 percent of the gross harvest of cotton in the same area.

In some old irrigated areas, crop productivity increase is constrained by secondary salinization of soils associated with high saline groundwater, while newly developed areas are characterized by natural salinity and alkalinity of soils, resulting in an estimated loss (shortfall) of raw cotton production in the country of 100,000 tonnes each year. Therefore an improvement of irrigated lands represents the main growth potential for crops' productivity.
Prior to the start of the 1990s, the drainage system as a whole was supporting the normal operation of irrigated lands. The sharp decline in financing for the system's maintenance, along with the lack of an appropriate agro-technical approach to the use of saline land and violation of watering regimes led, by January 1, 2013, to the unsatisfactory ameliorative status of 56,076 hectares of the total irrigated area of 749,665 hectares in the country.

Vakhsh Valley: Lessons from the Saline Soils Study

With the establishment of the Vakhsh Soil-Reclamation Station (VSRS) in the mid-1930s, the study of salinity problems in Tajikistan gathered momentum. The research, guided by academician I. N. Antipov-Karataev, was conducted by VSRS staff, the Vakhsh hydrogeological party, and an expedition of the V. R. Williams Institute of Water Resource Engineers.

Actual water use on irrigated lands was studied in a detailed fashion for many years. A number of these studies were published in 1947 in the digest *The Soils of Vakhsh Valley and their Reclamation*[5].

The VSRS staff made recommendations regarding the drainage network in the valley (drains and collectors' depth, their location, length, etc.) that formed the basis of irrigation and land reclamation projects implemented in Vakhsh Valley [7]. These recommendations were subsequently used to carry out reclamation works in other areas of the Republic.

Implementing the VSRS recommendations, respective producers, within a very short time frame, successfully carried out the reclamation of a large part of the saline land in the valley. From 1945 to 1962, the area of saline soils in Vakhsh Valley decreased from 50 percent to 10 percent.

Along with development and research work, other aspects of salinity prevention and control were addressed, including soil and hydro operational, hydrogeological, agronomical, and other measures. Over the years, the research became complex and integrated, while evidence-based recommendations led to a negative water-salt balance in a number of irrigated areas (where the total water consumption exceeded water supply). Alongside the obvious positive results associated with the widespread use of reclamation in irrigated agriculture in the 1970s to 1980s, certain negative trends manifested themselves. An objective analysis of their causes is needed to understand the place and role of land reclamation in the national economy of the republic. One of the causes, of course, was a

[4] The data are from the Ministry of Agriculture of the Republic of Tajikistan, 2009 [4].

[5] This was the joint work of the Vakhsh Soil-Reclamation Station (VSRS), the Vakhsh soil-meliorative station, the Vakhsh hydrogeological party, and the V.R. Williams Institution of Water Resource Engineers.

large water intake, both general and specific, for irrigation systems that for many years exceeded the country's water intake limit of 11.3 billion cubic meters per year reaching 15,000–20,000 cubic meters per hectare and above. This situation had a number of causes.

Soil-reclamation science in the country has developed a large arsenal of tools and preventive measures in the fight against soil salinity and waterlogging. However, a number of these tools and measures were not properly tested, while others, as demonstrated later, were based on a faulty underlying concept. For example, in the development of new large plots of land, drainage was laid out at great depths and calculated assuming the full removal of salts from these plots of land and others.

Policy Issues

When developing an adequate policy aimed at solving the problems of irrigated agriculture, the rehabilitation of saline soils and ensuring the food security of the country must take into account the regional, soil, technical, financial, and political realities that emerged after independence.

Following the independence proclaimed in September 1991, the Government of Tajikistan continued to use some elements of the socialist system of centralized planning and management of the national economy. However, the transition to a market economy required a variety of reforms to be implemented in all areas of public management. In the process of this transition, all political and economic changes as a whole have an impact on agricultural production, including irrigated agriculture.

Irrigation and drainage were subject to significant investments in the Soviet era, but water management was not appropriate. Extremely extensive water use resulted in increased groundwater levels and therefore increased salinity, which in turn led to the deterioration of land quality. Often construction and maintenance were not thorough, resulting in the irrigation and drainage systems being in a poor state even before independence in 1991. After independence, the situation continued to decline. Maintenance had been repeatedly postponed, and many irrigation and drainage systems had further deteriorated.

In 2006, the Government of Tajikistan carried out the first agricultural reform that dissolved state and collective farms and divided them into dehkan (private) farms. At that time, all debts of agricultural enterprises to suppliers of electricity and water were written off. By then, the market prices for the agricultural produce started to stabilize. It was expected that smaller dehkan farms that replaced collective and state farms would be motivated to develop agriculture more rapidly. However, after nearly a decade, the reform failed to produce the desired results. For various reasons (mostly administrative) most of the private farmers have not become land owners. Only a small portion of dehkan farms became profitable. Meanwhile, the experience of individual farmers who were more successful prompted the authorities to expand land reform.

Unfortunately, land privatization was not accompanied by reforms that transferred responsibility for drainage and irrigation canals, which had previously been the responsibility of collective and state farms. Following the privatization of agriculture and the subsequent reform of collective farms, little has been done to create a new physical and institutional infrastructure suitable for small private farms. As a result, dehkan farms almost entirely lack capacity and financial incentives to use water resources sustainably and reduce the unit cost of irrigation.

The agricultural irrigation subsector plays an important role in providing the population with food and creating jobs in rural areas. This subsector has faced a number of challenges, including the deterioration of existing irrigation and drainage infrastructure, expanded land areas that are unsatisfactory in terms of amelioration, the withdrawal of irrigated arable land from agricultural use, the erosion of irrigated land, the breakdown of pumping stations, insufficient machinery, and a lack of normal water metering among other problems.

As of January 1, 2015, about 33,500 hectares in the country were withdrawn from agricultural use, including 16,800 hectares of irrigated arable land, as well as 31,000 hectares of wastelands similarly withdrawn. Furthermore, 49,000 hectares of irrigated lands are in a poor ameliorative condition. The efficiency of the country's irrigation systems is often only 40 to 50 percent [8].

These problems that limit farmers' access to the required water supply have a negative impact on agricultural production yields. One solution to these problems is the reconstruction of infrastructure and implementation of economic and institutional reforms in land reclamation.

Since 2000, production mechanisms, land ownership and economic relations between producers, suppliers, and direct consumers have radically changed. Following land reform, agricultural

products are produced by private companies; these products are sold based on free market principles. Yet irrigation and drainage services are far from based on market principles. In order to establish such a system, it is necessary to improve the existing legislation.

Cotton is the main crop in Tajikistan. However, low prices combined with low profit have made this industry unprofitable, resulting in lower production and a debt crisis in the cotton sector.

Salinization of 16 percent of irrigated land has contributed to this problem. For example, according to Ministry of Melioration and Water Resources estimates, salinization and inefficient drainage infrastructure reduce cotton production by 100,000 tonnes per year [9].

Tajikistan is challenged by a complex, capital-intensive long-term goal of developing all lands suitable for irrigation, restoring saline soils, and rehabilitating and improving the technical level of irrigation and drainage systems. It would make sense to implement these tasks in the following order:

1. carry out short-, medium- , and long-term programs with measures aimed at raising the efficiency of inter-farm and on-farm irrigation systems;

2. improve techniques and modernize irrigation technology;

3. carry out substantial land leveling and complex reconstruction of irrigated lands;

4. execute desalinization of saline soils by washing them out with irrigation water;

5. implement biomeliorative saline lands with the use of phytomeliorants (alfalfa, sweet clover, licorice root, sugar beet, corn, sweet sorghum);

6. recover and reconstruct drainage-collection networks; and

7. gradually reclaim land for irrigation.

In order to make these improvements, it will be necessary to:

- seek opportunities to expand the area of gravity irrigation;

- ensure normative operation and maintenance of irrigation and drainage systems subject to state support (government funding), charges for water supply, and other sources;

- ensure the reasonable, sustainable use of water through improved soil agro-landscaping, reclamation and hydro-zoning, research-based irrigation scheduling, advanced water-saving technologies, and improved land reclamation, which is of great economic, environmental, and ecological significance and is addressing issues of food security; and

- resolve the debt problem and establish a system of state support for farmers in order to increase their farms' profitability and increase their contribution to irrigation, collector-drainage systems, and water saving.

The introduction of universal water metering, staff training, the preparation and implementation of water management plans—the transition to hydrographic management and shaping public opinion and interest—these are the main organizational objectives in the area of irrigated agriculture.

There are the following limitations to achieving these objectives:

- the lack of current inventory: since 1990, no inventory of the irrigation and drainage systems has been made;

- the high degree of depreciation of fixed assets of irrigation and collector-drainage network;

- the lack of financial resources;

- low water tariffs for consumers;

- inflation, increased tariffs for electricity, energy, and other resources;

- the lack of government regulatory documents regarding the reform process and the lack of state support, although allowed by the Water Code;

- complexities in providing water organizations with land for conducting land reclamation;

- low investment attractiveness of irrigation and drainage; and

- the lack of incentive mechanism for water conservation, among others.

Stakeholder Groups

In addressing issues of food security of Tajikistan, in particular those of agriculture and irrigated agriculture, the key role belongs to the government, which is the main shareholder approving decisions and laws at the state level.

The government approves regulations for ministries and state committees, determines the structure of their central bodies, and is responsible for their coordination and inter-agency cooperation.

A very important role in the enforcement of land legislation is played by regional and district committees, which report directly to the umbrella organization and, jointly with local governments (hukumats) are actively involved in the implementation of land policies on the ground.

There are three groups of stakeholders in land management. The **first group** performs controlling functions, the **second** one includes land users, and the **third** one consists of intermediaries.

Controlling Government Organizations

The first group includes state committees, ministries, research and design institutions—that is, state supervision and implementation organizations.

State control over the use and protection of lands is carried out by the authorized state agency of regulation of land relations and its local agencies and by the authorized state agency of Tajikistan. Land protection involves a system of legal, economic, and other measures aimed at protection for the use of lands, soil conservation, and the prevention of their degradation, and to prevent unreasonable seizure of the most valuable lands from agricultural turnover, as well as to restore and improve soil fertility.

The State Committee on Land Management and Geodesy of Tajikistan is the central body of the executive authority responsible for the development and implementation of a unified state policy in the area of state land survey work; land cadaster; topographic, geodesic, aerospace, and cartographic works; and state registration of immovable property and titles.

The Agency for Amelioration and Irrigation is responsible for the development and operation of irrigation canals, water reservoirs and associated equipment, land reclamation and irrigation of new areas, distribution of water among agricultural customers and collection of payments therefrom, and promotion of coherent technology policy. It also sets the rules and limits on water intake by users, monitors the effectiveness of water use, and provides water consumption data.

The Ministry of Agriculture is responsible for the development and implementation of a unified state agricultural policy. Its most important tasks are its obligations to monitor the import, export, production, processing, or storage of agricultural produce, waste, and equipment in order to ensure the quality of final products and environmental safety in general. It cannot impose administrative sanctions on violators of environmental legislation. The Ministry of Agriculture operates in close collaboration with other ministries and departments, local executive authorities (hukumats), the Academy of Sciences of the Republic of Tajikistan, the Tajik Academy of Agricultural Sciences, and other organizations, institutions, and enterprises.

The interaction between the government's Agency for Melioration and Irrigation and the Ministry of Agriculture is very poor, despite the fact that 85 percent of the water is used for irrigation.

Local administrations or local *Majlis* (councils of people's deputies), according to the Law on *Local Self-Government and Local Economy*, are elected by direct vote in towns and villages. Local councils are authorized to coordinate the protection of environment and the use of resources by enterprises within their jurisdiction. They may suspend the activities of an enterprise that fails to have its plans approved in the prescribed manner.

Hukumats (local executive authorities) implement environmental laws and other regulations. Their chairmen are appointed by the president of Tajikistan and approved by the Majlis.

Local councils may grant or withdraw land plots and monitor their reasonable and sustainable use, register titles or land use rights, and establish water use rules, including water consumption by households, farms, and others.

Land Users

The second group is composed of dehkan and seed farms, owners of presidential land[6], tenants, and owners of private plots.

[6] *Presidential land* is made up of fertile sites from former collective and state farms that have been distributed by the presidential decree in 1995 and 1997 to the citizens for the organization of private farms. Presidential land is reserved for rural *jamaat* (local government bodies), and are exempt from all taxes except land tax. These areas are intended for agricultural production but not for the construction and cultivation of gardens.

Land users in Tajikistan are juridical and physical persons. Juridical and physical persons can be primary or secondary land users. Primary land users are juridical and physical persons using the land in perpetuity, for fixed-term or lifetime inheritable use. Secondary land users are juridical and physical persons using land plots according to the terms of a lease.

Land users are obliged to:

- ensure the land is used in accordance with the purpose and conditions of its provision;
- effectively use all the available land, and use environmental production technology, to prevent the deterioration of the environmental situation in the territory as a result of economic activities;
- pay land taxes or rent in a timely manner;
- not violate the rights of other land users; and
- provide to the relevant authorities established by the country's laws timely data on the status and use of lands.

Nongovernmental Organizations and Communities

The third group consists of local nongovernmental organizations and communities.

Analysis of the different population groups that (i) increase land salinity and those that (ii) are directly impacted by its effects shows that these two groups are closely related to each other; a population group can both cause salinity and simultaneously be impacted by it. Schematically, this relationship is represented in Figure 2.

The entire range of groups that generate the processes of salinization and are affected by those processes can be divided into four levels: regional, district, local, and individual. Each of them includes areas defined by land users.

Depending on causal factors and the impact of soil salinity, these groups can be divided into two categories: a group of people causing the salinity of soils and groups of people directly affected by soil salinity. Depending on the effect of salinity on the population, all irrigated areas are divided into land that has been irrigated for a long time, old irrigated, irrigated land, and newly irrigated land.

The following groups of people who are not part of those listed above should also be highlighted:

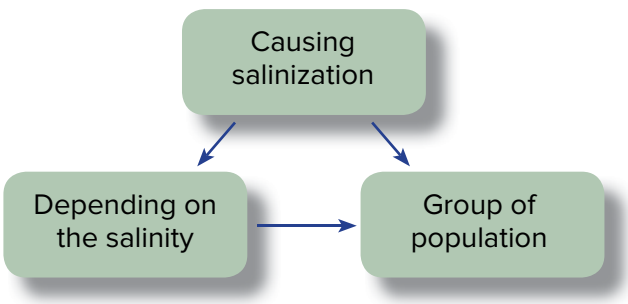
Members of dehkan farms. Most of these people are directly dependent on the degree of soil salinity, soil natural fertility, watering method and techniques, and other agro-technical measures aimed at increasing land productivity. Of all categories of farmers most affected by soil salinity are the farmers of the irrigated land of the Vakhsh Valley.

Members of households. This group, in the same manner as members of dehkan farms, depends on soil's physical and chemical properties. Depending on where the land is located, these households should be divided into two groups: those in irrigated areas and those in rainfed areas, because the number of potential factors affecting erosion processes in rainfed areas is greater than it is in irrigated areas.

Individual land users. This group is closely related to land salinization. Sometimes several categories of soil salinity can be detected within the same area. The main development factor is anthropogenic and natural.

Among all the stakeholders listed above, the most interested are farmers and rural population, who account for 72 percent of the total population and for whom agriculture is the key source of livelihood.

Figure 2: Relationship between Population Groups Involved in the Salinization Process



Source: Akhmadov and Khodjaev 2013 [10].

Policy Options

The key strategic objective in the area of agriculture is enhancing the self-sufficiency of the country in food and gradually increasing its export potential by cultivating profitable and exportable processed crops. At the same time, necessary measures should be taken to ensure that, by 2025, the country's population will be provided with food and agricultural raw materials in quantities no less than those required by food security standards in Tajikistan [11]. An important factor contributing to the success of this policy is the ability to obtain sustainable yields

of crops on irrigated lands after the restoration of saline soils. There are several potential options for the development of irrigation.

Statistical analysis showed that the security of grain, meat, milk, and fruit available to the population of Tajikistan was behind consumer standards by 25 to 73 percent. The availability of other foodstuff (potatoes, vegetables, and melons) already exceeds the established international standards. A 10-fold increase in fodder crop production is required to develop the animal husbandry industry and to ensure an adequate level of meat consumption, which is currently low. To fully meet the food needs of the population, by 2025 the irrigated area should reach 922,000 hectares, or about 0.10 hectares per person. At the same time, the level of crop yield should approximate maximum levels (3 tonnes per hectare for grain, 10 tonnes per hectare for fodder, 30 tonnes per hectare for potatoes, 50 tonnes per hectare for vegetables and melons, and 20 tonnes per hectare for fruits and berries).

There are several options for the development of irrigation.

1. Maintain the Existing Pace of Land Development

Given the current pace, by 2025 the irrigated land in the country will total 780,110 hectares with an average 11,500–12,000 hectares added each five-year period. At this rate of land development, per capita area will decrease by 23.29 percent, from 0.105 to 0.081 hectares.

The current pace of land development for irrigation is possible only through the involvement of new land in mountainous areas or through newly desalinized saline soils and soil that is improved through secondary salinization in lowland areas.

2. Keep the per Capita Irrigated Area (Approximately 0.1 Hectares per Person) at the Current Level

By 2025, to maintain the per capita irrigated area at 0.1 hectares per person will require bringing the total irrigated land area to 965,000 hectares by developing an additional 65,000 to 85,000 hectares every five years.

The implementation of this option is possible by carrying out major works to improve secondary salinization of soil and to regulate the operation of collector-drainage networks.

3. Guarantee Food Security in Tajikistan

This requires the sensible use of land resources, especially arable land (including land usable as a result of soil desalinization), including saline soils, so as to produce two or three harvests in one field; norms of fertilizer quantity, technology, and irrigation; and so on. On desalinized soils, after the first harvest, it is necessary to plant a second crop (rice).

After political stability was achieved in 1996–97, a large number of reforms were launched in Tajikistan. Macroeconomic stabilization was, perhaps, the most successful and was an essential precondition for other reforms and investments. Such stabilization laid the foundation for land management as well, though not sufficiently—especially in a small landlocked country such as Tajikistan, where new regional barriers and foreign trade in agricultural produce have significant implications for land use. One of the export crops is cotton grown in Tajikistan, with its controversial impact on the distribution of saline land.

Land reform was the main objective of government efforts aimed at enhancing land productivity. Its goal was to transform the old collectivized agriculture consisting of about 500 large collective farms into a more responsive and efficient sector by creating new forms of farming supported through the right to lease land. By 2016, the number of such farms totaled about 160,000, of which 140,000 were individual dehkan farms, while another 20,000 were collective farms (different from old collective farms). Formally, to a large extent reform has been carried out. However, a deeper analysis reveals a number of unresolved issues, superficial changes, and weaknesses or the absence of several features that incentivize caring about the land (lease terms, adequate legal protections, transferability, etc.).

It should be noted that Tajikistan excludes individual ownership of land, which is an accepted fact and not questioned by land users. This practice weakens the impact of reform. In general, land management policy has been correct although incomplete and shallow, with weak links to implementation. Incompleteness also refers to the management of saline and unproductive lands. In the future, these two neglected aspects (individual ownership of land and management of saline lands) may play an important role in the development of agriculture in the valley. The transition from a planned to market-based agriculture has been relatively difficult for Tajikistan. The government's intervention in the cultivation of cotton is visible.

A complex set of issues is related to irrigation and the policy of maintaining low fees for irrigation. This indirectly promotes the expansion of irrigated agriculture in high-value or environmentally sensitive areas, potentially negating other forms of land use that are more socially beneficial[7].

Technical support to the organizations managing land resources continues to be distorted. Methods of farming reminiscent of Soviet collective farms continue to dominate. Research institutions and technology are slow to reorient to new methods of production and management approaches that take into account altered expenditure related to resources and supply, and modified decision-making. For a long time, since independence, the majority of research institutions have failed to adjust. This situation is slowly beginning to change because the newest initiatives are donor-funded. Although much of the funding is regional, there has been some progress even in this area.

Responding to the Challenges Faced by Irrigated Agriculture

Approximately one-third of the existing irrigation systems (a total of 240,000 hectares) rely on pumping water into gravity distribution systems. About 75,000 hectares of land lift water up to 150 meters with pumps. These highly energy consuming systems are in poor condition. Abandoning these systems would endanger the livelihood of a large share of the rural population. It would also threaten irrigation reform. Approximately 60,000 hectares are irrigated with wells. By most standards, the fact that only 17 percent have full irrigation efficiency (transportation losses combined with losses by farms) is very low. The drainage network covers about 350,000 hectares, or half of the total irrigated area. At the beginning of the decade, about 50 to 80 percent of the drainage network was in poor condition and in need of repair. The main causes of waterlogging and secondary salinity are the lack of a drainage system or poor farm management. Even traditional opponents of "water consumption" are beginning to understand the difference between the abundant water coming from the mountains and a sustainable supply of water to the fields, which entails a significant loss of water and higher costs.

The land reform process being undertaken in Tajikistan is complex and faced with implementation problems. Nevertheless, this reform represents the biggest and only hope for sustainable land management. Legislative reforms should be mainly aimed at improving land use rights and, ideally, full land ownership (with safeguards against abuse, ownership concentration, and exceptions). The guaranteed right to lease includes a plurality of elements (legal, supporting the right kind of property, effective land management, etc.), all of which should be present in order to really guarantee the lease.

Lack of land ownership and existing restrictions on land transfer remain a major obstacle to investment in land productivity improvement. The rapid adoption of new land-related laws is not conducive to clarifying this situation. The intended beneficiaries—members of former collective and state farms—remain poorly informed about important aspects of land reform and their rights and responsibilities in the new environment. Hukumats continue to be interested in influencing the production-related decisions of "their" farmers, thus undermining their managerial autonomy. There are cases of unfair initial distribution of previously jointly managed land. Continued lack of farm credit for any subsector except cotton (which itself is in deep crisis) and a general lack of credit management experience reinforce the reluctance of many new land users to make investments. If a weakened farm support system and various product transportation problems are combined with investment constraints, the costs of improved land productivity become enormous.

Planning and management of land use continue to be addressed at the national level; this is an important plus. The peculiarities of the land reform are reflected in the National Poverty Reduction Strategy (NPRS) and the Poverty Reduction Strategy Paper (PRSP). Land salinization is the main challenge in the Government Program of Economic Development to 2015 [6].

Obviously, the best known form of land degradation associated with irrigation is secondary salinization caused by poorly managed irrigation that leads to overwatering, gradual elevation of groundwater levels, and increased salinity. Soil erosion caused by irrigation represents another problem. Uncalculated irrigation leads to soil being washed out. Among the main technical causes of irrigation erosion are poor initial layout and poor technical land preparation, siltation of irrigation canals and drainage collectors, inadequate quantity of water, and applied methods of field irrigation. The extent of salinization associated with irrigation has increased with the use of the irrigation system.

Unreliable irrigation water supply in a country where more than 40 percent of all irrigation supply is ensured by pumps is the main immediate problem, with its underlying complex issue of how to restore,

[7] For example, the gradual transition from pump irrigation to improved global irrigation or the improvement of saline land.

maintain, and manage the pumping system that was developed in a different time and for a different production system. Indirectly there are also problems associated with the assessment of the electricity supply for pumping stations.

Integrated resource management is currently applied only to selected communities and areas where the physical configuration (i.e., a valley) and social organization facilitate an integrated vision of resource use, and where active supporters of this vision (international nongovernmental organizations or a number of bilateral donors) provide financial and technical support.

Therefore, the role of the Ministry of Agriculture should evolve from managing to providing assistance to producers in the private and household sectors. Its regulatory functions should be limited to the key aspects of the public interest. In working with farming communities, the Ministry of Agriculture should focus more on consultative approaches.

In irrigated land management, the Ministry of Agriculture and the Agency for Melioration and Irrigation should abandon the policy of "irrigation at any cost" while focusing on the social profitability of irrigation, and should assess various methods of irrigation. It is necessary to amend the legislation to permit collateralization of the right to land use. The Agency for Melioration and Irrigation's potential should be strengthened in financial management, legal issues, water management, investment planning, and cost recovery procedures. It is necessary, in every way possible, to promote mechanisms of voluntary transfer of land ownership to areas that are subjected to salinization and swamping.

In agricultural finance it is necessary to promote savings, loans, and credit systems, thus allowing a transition from the traditional model of cotton credit intermediaries to direct lending. It is necessary to amend legislation to stimulate the establishment of credit unions and microfinance organizations.

Sustainable land management policy—particularly regarding the sustainable use of saline soils—should be more closely linked to government funding. Appropriate measures should be taken to facilitate budget formulation and preparation and the implementation of measures to control land-based territories on the basis of projects and programs that require close interagency coordination. This integration should take place at both central and local levels, and it should be preceded by the strengthening of local capacities and the establishment of consultative mechanisms. The present stage of agricultural reform in Tajikistan should promote the transition from large to small units.

The problem facing mountainous areas that require pumping water to a higher level and a related subsidy policy are worth thinking of as an opportunity to partially reorient the land use from pump-irrigated areas in higher elevations to crops that need far less water and thus reduce waterlogging and salinity. It is necessary to seek alternative agricultural and non-agricultural land use in those areas where irrigation is not economically viable.

Land management research in Tajikistan should be applied rather than theoretical in nature and serve new dehkan clientele. Research should focus on areas such as soil fertility, land development, and reclamation methods, with an emphasis on economic sustainability and the efficiency of investments as well as on land and water protection methods through decentralization. It is necessary to provide maximum opportunities to introduce the results of the best applied research in arid zones, relying on the recommendations of the International Center for Agricultural Research in Dry Areas and the International Crops Research Institute for the Semi-Arid Tropics.

All investments in sustainable land management in Tajikistan should be supported through mutual departmental consent and be integrated in this sense. Currently the process of policy formulation within each ministry is rather weak. As a result, public spending is disproportionate and managed mainly through inertia and the old habits of regulatory budgeting. The departments that are administratively most involved with sustainable land management are hampered by their perceived status as "ordinary" administrators rather than masters of the situation (for example, the Ministry of Agriculture and the Agency for Melioration and Irrigation); their work style and priorities have been inherited from the priority-setting in the central planned economy. Another deficiency separating policy and funding is the narrow definition of land improvement that has long been regarded in Tajikistan as synonymous with the Ministry of Melioration and Water Resources activities and with irrigated land, as if land can be improved only through irrigation.

The place of sustainable land management in cross-sectoral documents is evolving. Sustainable land management is reflected respectively in the PRSP (although it is not highlighted there as a separate budget category); however, it is not presented as a separate issue in the Plan and the Program of Socio-Economic Development (SEDP). The PRSP and

SEDP remain largely on the sidelines. The existence of two guiding documents parallel to the budget makes combining politics with the budget process more difficult. Currently the budget includes the Centralized Public Investment Program (CPIP) and is complemented by the Public Investment Program (PIP). Between them (each accounts for about 3 to 4 percent of GDP), CPIP and PIP finance virtually all new public investment; previously disbursed funds were mainly provided by donors. Currently PIP is not directly included in the budget. CPIP is part of the current budget process, but its funding priorities are in conflict with those of the PRSP.

The solution to the existing problems of irrigated areas should fully tap the potential of land reform in order to increase land productivity and reduce the overwhelming dependence on one or a limited number of crops (for example, cotton).

Water Price

The transition to more sustainable agriculture in valleys requires a recognition of the real cost of water and energy and of the idea that the water supplied to a field is a precious resource that should be used accordingly. Between half and two-thirds of the irrigated land in Tajikistan (depending on the forecast of future crop prices) would not be sustainable if the water were priced at its potential cost.

In 1996, after the Tajikistan Presidential Decree "On the Introduction of Fees for Services of Water Delivery from State Irrigation and Watering Systems" and the reform of agriculture, the share of public financing available for the maintenance of irrigation systems was gradually reduced because of the state's financial difficulties after independence. Currently the share of state finance is less than 20 percent, and the rest of the financing expense (80 percent) comes out of the water supply fees. Every year, in November and February, the water consumer must provide advance payment of 40 percent of the fee to the water supplier for the preparation of irrigation systems for the irrigation season. Then, in the second half of the irrigation season, the balance (60 percent) is paid out gradually, as water is provided. However, this requirement is not met by the consumers, who do not pay the balance; this lack of funding leads to further deterioration of the technical condition of the irrigation systems and structures. In fact, the overall level of payment received from the water consumers ranges from 32 to 66 percent.

The problem of unsustainable water use is primarily caused by the fact that the existing irrigation systems were designed and built for the water supply and drainage of large collective farms. Many of these systems cover several villages. Following the privatization of agriculture and the subsequent collapse of these farms, little has been done to create new a physical and institutional infrastructure suitable for small private farms. Many new households do not own hydraulic valves and water meters, and they are not able to adjust the time and amount of water used. Payment is at a fixed rate for the use of water without regard to the volume consumed. As a result, farms do not have enough opportunities or incentives to promote the sensible use of water resources or to decrease the unit costs of irrigation[8].

In order to reduce poverty in Tajikistan, a transition from agriculture with a high cost of irrigation to another type of agriculture and land and water use is necessary. The introduction of new technologies of irrigation (drip, subsurface, sprinkler irrigation) saves water by two- to threefold. Such reform should lead to decreased use of water-intensive crops and improved water use efficiency with environmental benefits (less waterlogging, salinization, and soil erosion) as an important economic advantage. However, limited resources and the lack of a production base do not yet allow development in this direction. Perhaps deliberate steps that would accelerate this change are needed, rather than expecting these adjustments to occur through market mechanisms. Creating self-supporting advisory services in the area of advanced irrigation methods and lease-related issues could be an important factor facilitating this transition.

The organization and management systems for primary and secondary irrigation networks should be further decentralized. It is necessary to promote and establish water user associations. Technical assistance should be provided to water management agencies to improve water use and groundwater monitoring, as well as to improve soil fertility and land reclamation techniques.

The most difficult aspect that needs to be addressed is faced by a few regions that are currently engaged in irrigation pumping, where continued farming is minimally effective and economically unprofitable. These areas are subsidized by the cost savings that is a consequence of using the improved water supply to other areas that are mostly enjoying gravity irrigation.

[8] For example, water consumption per 1 hectare is, on average, 10,000 cubic meters. The cost of 1 cubic meter of irrigated water is 0.047 Tajik somoni. Therefore, 10,000 cubic meters of water = 472.44 somoni or US$60.1 (at the July 2016 exchange rate of US$1 = 7.86 somoni).

Land resources–related research is only now beginning to show signs of modest recovery after a decade of decline. In general, land management in Tajikistan still suffers from the continued mechanisms of interaction between technical, scientific, and administrative bodies that were established to serve collectivized land use. The aim, therefore, is not to restore the previous scope and breadth of research, but rather to redirect it to the current and emerging priorities. The research should take into account different levels and structure of land- and water-use units and be more focused on management.

In order to resolve this issue, the Government of Tajikistan and Parliament (*Majlisi Namoyandagon*) are expected to adopt legislative acts mandating state and local authorities (hukumats) to carry out reclamation work on both state and farmers' irrigated lands. Funding soil desalinization reclamation is possible with the financial support of the National Bank of Tajikistan, nongovernmental organizations, local hukumats, dehkan farms, and private investors.

Assignment

Your task is to present policy options to address the problem of salinization of irrigated soils in the environment of changing market relations and focus the solution to this problem on poverty reduction and increased food security of the country. Evaluate the presented policy options from the perspective of each stakeholder group.

Policy Recommendations

Problems of irrigated agriculture and food security can be solved by carrying out the following priority activities:

1. Establish the sensible, sustainable use of land resources, especially irrigated lands, including saline soils, with two or three yields from each field, including those with saline soil, and using norms of fertilizers, machinery and irrigation norms, and so on.

2. Keep up the current pace of land development for irrigation, which is possible only through the involvement of new lands in mountainous areas or the new desalinization of saline soils, and improve the condition of soils that have undergone secondary salinization in lowland areas.

3. Carry out large-scale works to improve and regulate the operation of collector and drainage networks.

4. Convert part of the irrigated land in rainfed agriculture to crops that are less demanding for irrigation and/or introduce new irrigation technologies (drip, subsurface, sprinkler irrigation).

5. Introduce differentiated tariffs for water depending on natural and climatic zones, gravity water supply, water lifting machine, and so on.

6. Form a clear payment mechanism between water suppliers and water consumers that takes into account the seasonal nature of the work, as well as individual parts of irrigation systems.

7. Address 100 percent of the level of payment for water services and electricity; this is possible with a realistic assessment of the paying capacity of users and the corresponding economic justification of tariffs.

Improvement of water resources management system could have several levels:

- *The first level is national*, and includes the parliament, government, ministries, and departments empowered to manage and regulate the use of water resources. The Ministry of Melioration and Water Resources of Tajikistan plays a key role, since it is a specially authorized state agency concerned with the regulation of use and protection of water resources for irrigation and with issuing permits for special water use in this sphere of activity.

- *The second level is the level of the water basin*, and should include the basin water organizations (management) created by the main river basins.

- *The third level* is the management of large channels, which needs to take place through a centralized administration system because they are the primary channels from which water is supplied to the irrigation fields.

- *The fourth is the grassroots level*, where water management is carried out directly within the enterprises of various patterns of ownership and water users' associations.

Financing for irrigated agriculture can come from:

- funds collected from water consumers,
- means derived from the budget of the Republic;
- means derived from local budgets;
- foreign investment; and
- other sources not prohibited by legislation.

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Abbreviations

CPIP	Centralized Public Investment Program
GDP	gross domestic product
NPRS	National Poverty Reduction Strategy
PIP	Public Investment Program
PRSP	Poverty Reduction Strategy Paper
SEDP	Program of Socio-Economic Development
TAAS	Tajik Academy of Agricultural Sciences
VSRS	Vakhsh Soil-Reclamation Station

Photo credit: The World Bank

Suggested Actions to Reduce Irrigation Erosion in the Kyrgyz Republic

Nadira Mavlyanova, Kubanichbek Kulov, Payaziddin Jooshov

Executive Summary

Intensive development of virgin lands in Central Asia in the 20th century was driven by the continuous growth of the population, a demand for higher agricultural output, and a need to develop amelioration technologies. In the Kyrgyz Republic, where mountain systems occupy more than 90 percent of the area, most agricultural lands are located in piedmont and mountainous areas with rugged terrain. That is why the most dangerous types of degradation, from the environmental and economic point of view, are water erosion and irrigation-induced erosion on irrigated lands. In the Kyrgyz Republic 700,000 out of 1 million hectares are affected by irrigation-induced erosion, which leads to a reduction in crop yields on eroded soils by 20 to 60 percent and, as a consequence, an increase in the poverty rate to 70 percent of the rural population. Fertile land is a national asset of the country that is a prerequisite for its food security.

The aim of this case study is to define key causes of irrigation-induced erosion in the Kyrgyz Republic and offer various approaches and technologies for the sensible use of irrigated lands to decision makers. To this end, the case study:

- reviews causes for irrigation-induced erosion in the Kyrgyz Republic and identifies key factors contributing to this process;
- analyzes laws and resolutions adopted by the Government of the Kyrgyz Republic from 1991 to 2016 to reduce land degradation;
- identifies stakeholder groups such as government authorities, research and education institutes, local authorities, and farms;
- and proposes specific recommendations for each stakeholder group so that decisions are made at their own level to preserve soil fertility and increase their crop yield.

For the Government of the Kyrgyz Republic, conservation of soil fertility is a key policy target, which is confirmed by the adoption of numerous laws and national programs on food security of the country since 1991. However, detailed analysis of the current situation in the Republic, which shows how issues of irrigation-induced erosion are addressed today, demonstrates that these laws and programs do not work. This is mainly because of the lack of an integrated approach to resolving this issue—which is why small financial funds allocated for this purpose do not result in major achievements. Responsibility for the enforcement of the government's adopted laws and resolutions and its finances is allocated among several ministries and agencies. There is no link between programs and action plans implemented by different ministries and agencies in terms of substance and implementation timelines. In the Soviet Union (until 1991) this was the responsibility of the State Planning Committee of the Kyrgyz Republic, which relied on thorough research of specific issues. Today programs are prepared using a "silo" approach: scientific validity and the environmental security of programs implemented in parallel in one region or area are not analyzed, which is why the effect expected by decision makers is not achieved. Executive agencies responsible for environmental protection do not have sufficient human resources that would have good knowledge of existing issues related to land degradation, its causes, and modern technologies for land improvement. They only acknowledge that the quality of environment has been deteriorating.

It is proposed that a single coordinator—that is, the Ministry of Environmental Protection and Sustainable Development—be set up on the basis of the existing State Agency of Environmental Protection of the Kyrgyz Republic that, in close cooperation with research institutions and local authorities, will study ongoing natural processes, conduct monitoring, offer recommendations, supervise their implementation and provide funding at the local level. Decisions made by this ministry must be based on research conducted by research and educational institutes, because such institutes:

- have multi-year databases and relevant methodologies, and are able to evaluate ongoing processes of land degradation and propose rational technologies for land irrigation and cultivation; and
- have the capacity to define land and water management policy, including integrated policy, in contrast to public officials and parliamentarians who work in their offices and who are often replaced, and when they are removed from their positions, persons responsible for authoritative disastrous decisions cannot be found.

Farmers have to improve their agrarian education and apply recommended land irrigation and cultivation technologies to preserve land fertility.

Numerous reports of international programs, concepts, and laws adopted by the government are based on research conducted 30 to 40 years ago or have been borrowed from other countries where natural and climatic, geological and geographical, and social and economic conditions are absolutely different. For example, the last quantitative evaluation of the land erosion rate in the Kyrgyz Republic was conducted in the 1980s. Today, without having scientifically validated information about the conditions of irrigated lands, it is not possible to develop activities aimed at preserving land fertility. A principally new unified system of agricultural land monitoring needs to be put in place with the use of geographic information system (GIS) technologies, which can provide reliable information on land conditions in real time and can help conduct studies on quantitative evaluation of erosion hazards.

Background

Artificial land irrigation that was used to sustain high crop yields developed intensively in the 20th century. In 2009, the year for which Food and Agriculture Organization (FAO) data are available, 261.2 million hectares of land were under irrigation worldwide. Irrigation can offer crop yields that are two to four times greater than is possible with rainfed farming, and irrigated areas provide 40 percent of the world's food from approximately 20 percent of its agricultural land [1]. By the early 20th century, land resources in Central Asia were a little more than 2.0 million hectares [2]. A need to increase agricultural output boosted the intensive development of virgin land in the 1930s. At that time the present irrigation system was put into effect; this was followed in the 1960s by the active development of irrigated farming in the Kyrgyz Republic. In 1937 the At-Bashy irrigation system was built in the Chui Region; the Western Big Chui Canal was built in 1945, and the area under irrigation began to expand quickly; when the Southern Big Chui Canal and the Orto-Tokoy Storage Reservoir were constructed, the irrigated land expanded substantially.

Today, the overall area of the Republic is 19,995,100 hectares, with the cultivated area comprising only 10,670,600 hectares (Table 1) [3].

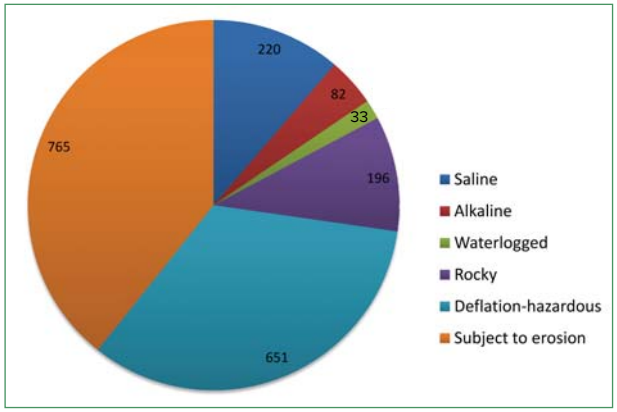
Human activities intensify natural processes and result in changes in the landscape such as deterioration of the soil and drastic reduction in its quality. Because of human activities, the Kyrgyz Republic has now the following types of soils: saline soils, alkaline soils, waterlogged soils, stony soils, soils prone to deflation, and soils susceptible to water erosion (Figure 1) [3]. Starting in 1985, the area occupied by degraded soils in the Kyrgyz Republic has grown substantially (estimates vary from 50 percent to 80 percent of agricultural land is degraded); a comprehensive monitoring of land was conducted last in 1990 [4]. The magnitude of the issue is highlighted by the fact that the Institute of Water Management at the Academy of Sciences [6], which studies dangerous processes caused by artificial irrigation in the Kyrgyz Republic, was established as early as 1957. With the annual increase in the size of population, the area of irrigated land per capita has been decreasing; in 2015 this indicator was 0.17 hectares per capita [4]. To supply food to the population in sufficient quantities, the government should consider the improvement of soil productivity as a top priority.

Table 1. Agricultural Farmland in the Kyrgyz Republic

Agricultural land	Area (1,000 hectares)	Percent of total area
Tilled land	1,259.3	6.3
Perennial plantings	41.6	6.3
Fallow land	21.8	0.2
Hayfields	169.1	0.1
Pastures	9,178.8	0.8
TOTAL	10,670.6	45.9

Source: National Framework for Sustainable Land Management Programme, Bishkek 2006 [3].

Figure 1. Types of Degraded Soil (1,000 hectares)



Source: Estimates of N.Mavlyanova, K.Kulov, P.Jooshov

Figure 1 shows that soils subject to water erosion are the most widespread, with around 765,000 hectares being affected—this is 70 percent of irrigated lands. Irrigation-induced erosion—a type of water soil erosion—has become a dangerous process for the territory of the Kyrgyz Republic. It is a mountainous country and, because of its natural and climatic conditions, most irrigated land is located on hillsides; for this reason from 10 to 150 cubic meters per hectare of fertile topsoil are washed away during a single season [5]. Water leakage from irrigation canals and the uncontrolled discharge of irrigation water along the perimeter of intensively irrigated fields lead to gully formation.

Irrigation-induced erosion is caused by such factors as failure to comply with irrigation regimes and irrigation technologies, a lack of necessary hydro-technical constructions in the irrigation and drainage systems, a lack of crop rotation, failure to fulfill requirements for crop growing, and the absence of optimal fall plowing and fertilizers. Irrigation-induced erosion in the Kyrgyz Republic is primarily due to the following factors:

- **Climate** impacts overland flow and runoff directly and indirectly. Direct impact is caused by precipitation—its intensity and duration as well as the season; indirect impact is made by air humidity, wind, and so on [5], [6], [9].

- **Terrain** in the Kyrgyz Republic is varied and rugged. The Republic is located at an altitude between 500 and 7,439 meters above sea level. Nearly 90 percent of the country's area is located at an altitude of 1,500 meters above sea level and is dominated by the Tian Shan and the Pamir Alai mountains that lie in parallel rugged mountain ranges [5]. Slope intervenes in erosion in terms of its gradient, length, and shape. When crops are irrigated on land where the slope exceeds 0.005, there is a danger of topsoil being washed away [6]. In the Kyrgyz Republic, slopes greater than 20° account for 62 percent, while slopes of less than 10° account for not more than 18 to 20 percent.

- **Geology's** contribution to erosion is determined by the physical and mechanical properties of soils and subsoil. The irrigated lands in the Kyrgyz Republic are covered by loess deposits. Topsoil formed on loess is characterized by high productivity. However, loess has high water permeability and collapses in wet soil conditions [7]. For a long time the climate in the piedmont areas of the Kyrgyz Republic was dry and maintained a natural balance. Tillage and artificial irrigation disrupted the water regime of these soils that, in the past, had been exposed only to natural rainfall.

- **Soils** in the Kyrgyz Republic have varied topsoil cover in a wide range of natural and climatic zones from dry subtropic areas and semi-deserts to dry steppes and cold high mountains according to altitudinal zonation. Depending on the type of terrain and climatic conditions, the following main soil groups and subgroups are singled out: gray soils (sierozem), chestnut soils, and black earth (chernozem soils). Soils with high in humus and silty particles have a great amount of water-stable soil aggregates, while soils with a low amount of such components have poor aggregation. In terms of reduction in soil loss tolerance, gray soils show color ranging from dark-colored to typical to light-colored. In addition to the content of water-stable structural aggregates, the soil erosion tolerance of gray soils depends on the erosive velocity of runoff. It has been established experimentally that the velocity of runoff on typical gray soil is 6.7 centimeters per second, whereas on light-colored gray soil the velocity is 5.2 centimeters per second [7].

- **Vegetation** protects topsoil from water erosion, reduces the velocity of overland flow and runoff, and increases the ability of irrigated lands to permit water to pass through the soil. Regarding anti-erosion effect, all grasses can be divided into three main groups: perennial grasses that protect soil from being washed away; cereal crops that shield soil but to a substantially smaller degree; and shallow-rooted industrial crops with a low soil protection effect (potato, maize,

vegetables, and higher profit garden crops that the rural population has to grow to supplement the household budget).

- **Anthropogenic activities** are related to improper management of agricultural landscapes and wasteful use of irrigated lands. A high rate of detachment and transport of soil particles occurs where there is failure to comply with anti-erosion treatment methods, water-saving irrigation technologies, and irrational cropping plans.

Erosion washes or blows away the most fertile soil layer, wasting the time that is needed for soil to form in natural conditions. In natural settings it takes from 100 to 300 years for one centimeter of fertile topsoil to be formed. The humus content of fertile topsoil dropped from 2.5 percent in 1992 to 1.0–1.5 percent in 2012. If humus is lost at this rate, 40 years from now the most fertile topsoil will have disappeared [8]. It is not possible to accelerate the process of building up topsoil by introducing excessive amounts of fertilizes because soil can absorb only a certain amount of fertilizers.

The mechanics of irrigation-induced erosion has three phases: detachment of soil when soil is washed from the upper end of the field; washout of soil from the field at the mid-slope; and accumulation of soil onto the lower field reaches [9]. Topsoil washed away by water is deposited at the lower reaches of the furrow or is washed away further down slope. Foreign researchers have reported that yield in the upper end of the furrow may be 25 percent lower than in the lower end, where washed-away soil is deposited [10]: 75 percent of southern Idaho's furrow-irrigated fields had lost, on average, 38 centimeters of soil from the upper ends of the furrows, whereas the topsoil thickness of the lower ends had increased two- to fourfold as a result of deposition [11].

In the Kyrgyz Republic studies aimed at developing integrated technologies for soil conservation and water erosion control in piedmont agricultural land were conducted in the Chui Region, which is the most densely populated region with developed industry and agriculture. The susceptibility of 143,000 hectares of hillside farmland to heavy irrigation-induced soil erosion is a real challenge here. Such erosion is the result of the existing improper system of irrigation, through which between 20 and 60 tonnes of productive topsoil are lost per hectare during each irrigation application, and rills and gullies are formed [8].

To streamline erosion control activities, studies were conducted in Kenenbay pilot farms and the Instructional Farm of Agrarian University (Kyrgyz National Agrarian University) located in the piedmont and plain area of the Sokuluk District. Field experiments examined different aspects of irrigation application, such as the size of the irrigation stream in the furrow, the depth of the irrigation furrow, the impact of slotting on the velocity of the furrow stream, the size of additional moisture reserve, and the quality of soil moisture. Optimal values of these variables were determined. In 2014, in order to evaluate the erosion hazard and plan soil conservation activities, a system for developing a GIS-based database on the types and extent of degradation of soils cultivated by farmers was devised by the Kyrgyz National Agrarian University together with the Republic's Soil and Agrochemical Station in the Research Institute of Irrigation.

The studies demonstrated that high crop yields on irrigated land could be achieved through sensible water flow in the furrow; optimal practices of irrigation along the slope that is the least prone to erosion; reduction in the quantities of excessive discharge of irrigation water; proper organization of field works; enhancement of efficiency of used fertilizers; and fertilizer irrigation events and the application of chemical ameliorants, chemical pesticides, and herbicides to kill weeds and pests. To substantiate the efficiency of these agricultural practices, field experiments were carried out for two years (first in the Moscow District and then in the Sokuluk District). These activities have an immediate effect on increase of the crop yield and its quality by applying liquid mineral fertilizers and combining the irrigation technology and efficient technical means of water metering.

Policy Issues

The Government of the Kyrgyz Republic understands that the agricultural strategy of the Republic must include a system of laws, economic measures, and policies aimed at ensuring the food security of the country through local production, creating good living standards, and providing favorable business conditions for the rural population. Starting in 1991, agricultural policy in the Kyrgyz Republic has gone through several challenging stages; a lot of laws, resolutions, and concepts have been approved in order to improve agricultural land management. Between 1990 and 1996 collective and state farms were broken up and replaced predominantly by

small agricultural cooperatives and large private peasant farms. In accordance with the Regulation *On Procedures for Determining the Share of Citizens in Land and Issuing of Land Certificates* approved in 1994, all land belonging to former collective and state farms as well as other agricultural enterprises was to be divided into land shares and provided to individuals to be used for agricultural purposes. As a result, 53 percent of the Kyrgyz population received land shares for private ownership and more than 330,000 smallholder farms were created (Table 2). In the past, 60 percent of agricultural output was produced by state farms; in 2011 this share dropped to 3.9 percent, with the share of private farmers going up to 55 percent. Presently, 70 percent of arable land is privately owned [12].

A substantial number of the former on-farm irrigation canals of collective and state farms became part of the inter-farm network. Farmers had to maintain, rehabilitate, and operate irrigation networks themselves. There was a need to create new entities and, pursuant to the Resolution of the Kyrgyz Government *On Water User Associations in Rural Areas*, water user associations (WUAs) were set up in 1997 to regulate water relations between district water management authorities and water users (farmers) [13].

In 1996 the Ministry of the Water Sector and the Ministry of Agriculture were consolidated and the Ministry of the Water Sector became part of the Ministry of Agriculture, Water Sector and Food Processing Industry. A number of laws on agricultural policy were adopted at that time. In 1999 the government issued the Kyrgyz Government Resolution *On Monitoring of Agricultural Lands in the Kyrgyz Republic* (to enforce the resolution, the Republic's Soil Chemical Laboratory updated the map of arable lands, though only partially, because of a shortage of finance). The government also adopted the *Land Code of the Kyrgyz Republic*, and the *Law On Individual Smallholder (Peasant) Farms* that set forth rights and obligations of farms. Article 6 of the Law [14] states, for example, that "…a peasant farm shall use cropland efficiently for the purpose it has been allocated, improve soil productivity, apply modern technologies of agricultural production, prevent deterioration of the environmental situation caused by its activities, undertake a set of measures on land conservation set forth in the legislation of the Kyrgyz Republic." The *Law On Agricultural Land Management* was passed in 2001.

The Presidential Decree issued in 2004, *On New Guidelines and Measures of Land and Agrarian Reform* [15], states that for the first time in many centuries of its history the Kyrgyz population received land for private ownership. In order to complete the land and agrarian reforms efficiently and in a timely fashion, 10 priorities of land and agrarian reforms—including the development of agricultural science, extension and marketing services, and improvement of water and pasture resources—were defined in accordance with the *Comprehensive Framework of the Kyrgyz Republic Development for the Period Up to 2010*. In the same year, the *Concept for Agricultural Policy in the Kyrgyz Republic Up to 2010* was approved. This Concept looks into the issue of food security, highlights the issue of land degradation, and states that around 100,000 hectares have already been removed from cultivation. Depletion of nutrients in soil exceeds nutrients being put back in soil fourfold. All this leads to reduction in crop yields and natural disasters.

Special attention was paid to water consumption and, based on the Resolution of the Kyrgyz Government, all irrigation systems were transferred from rural authorities and district water management authorities to the balance sheet of the WUAs. Subsequently, the consolidation of the WUAs began and unions of

Table 2. Distribution of Land in the Kyrgyz Republic by Type of Farms

Land users	Number	Total land (1,000 hectares)	Farmland
1. Farms	331,058	219.0	218.1
2. Collective farms	509	484.3	481.0
3. Collective smallholder (peasant) farms	93	594.2	466.3
4. Agricultural cooperatives	374	943.2	347.3
5. Joint stock companies	42	89.7	68.2
6. State farms	64	330.0	229.5
7. Other land users	–	4,507.2	2,790.3

Source: Kyrgyzstan in Figures, the National Statistical Committee of the Kyrgyz Republic, Bishkek: 2011 – 344 p. [12].
Note: — = not available.

the WUAs, which took the management of irrigation systems into their own hands, were gradually set up locally, while the Water Code of the Kyrgyz Republic was approved in 2005 to carry out reforms and regulate organizational and legal issues of water management at the legislative level [16].

The government supported the development of the agri-food sector through the funds of the Republic and local budgets, and in 2009 it approved the *Law On Development of the Agricultural Sector in the Kyrgyz Republic*. One of its main development guidelines was defined as "…the conducting of activities to preserve, restore and reproduce fertility of agricultural lands as well as activities to prevent soil degradation processes." No targeted funds were allocated to finance these activities from the state budget; however, thanks to donor support, it became possible to develop the Central Asian Countries Initiative for Land Management (CACILM) Program, which includes such components as research, information systems on land monitoring, and knowledge management. The second stage of this program implementation began in 2015. In the same year, the country approved the *Concept of Food Security of the Kyrgyz Republic for 2009–2019*; as stated in the Concept, in the past 15 years the country did not conduct a consistent food policy; therefore, comprehensive agricultural policy needs to be developed, investment priorities should be set, and food infrastructure should be developed. "Support of activities aimed at improving soil productivity" is defined as one of key objectives of state agri-food policy. The Law *On Conservation of Soil Fertility of Agricultural Lands* passed in 2012 stresses the priority of sensible cultivation and conservation of soil as a major component of providing food security in the risky hillside agriculture settings. This law governs relations regarding soil conservation, productivity, preservation of quality, and protection against degradation and other adverse processes related to the ownership, use, and disposal of agricultural lands. In 2014, in order to combat desertification, the government approved the National Action Plan and the Implementation Framework to revitalize the UN CCD activities in the Kyrgyz Republic for 2015–2020 [5].

Assessment of losses caused by land degradation. Currently there are no reliable and structured data on comprehensive estimates of economic costs associated with land degradation. That is why the consultants whose task was to develop the Integrated Financial System (IFS) for the National Action Plan to Combat Desertification in the Kyrgyz Republic [19] prepared a rough estimate of economic loss from the degradation of arable lands and grasslands. Economic costs associated with land degradation vary between 6.3 percent and 7.6 percent of GDP, which is the difference between revenues and expenditures. By way of illustration, annual loss from land degradation is represented as economic and social goods. For example, loss in wheat production from land degradation is estimated at more than 1 million tonnes of wheat or more than 600,000 tonnes of flour; similarly, economic loss from land degradation is estimated at around 7 percent of the country's population not receiving a subsistence wage.

Social losses from land degradation include, among other things, deterioration of the population's health; poverty, because reduction in agricultural land area leads to lower income of the rural population; migration, because deteriorated land quality and changes in the land structure make agriculture unprofitable and cause large-scale exodus of rural inhabitants, who become either internal or external migrants.

As the data from the CACILM project demonstrate, because of reduced soil fertility and failure to follow crop management practices, staple crop yield declined on average by 50 percent. Therefore, in accordance with rough estimates, it costs the country's economy around 8 billion soms or about US$2 billion annually in lost GDP (Table 3) [20].

In recent years around 100,000 hectares of arable land has remained unused every year; mostly these areas are overgrown with reeds and land with salinized soils, waterlogged soils, and rocky land. In accordance with the data from the Ministry of Agriculture, Water Sector and Food Processing Industry, all these factors cost farmers around 2 billion soms, or US$50 million annually in foregone revenues [20].

After the *Law On Soils* was approved in 2012, the Ecological Technical Inspectorate was set up under the Government of the Kyrgyz Republic; this entity inspected land only to identify significant land damage. Land was not inspected to identify such processes as soil salinization or loss of humus. Decisions are made based on general and populist information not validated by research, which is confirmed by the fact that the Institute of Irrigation, which conducts all research on water erosion in the Kyrgyz Republic, has never been approached with a request to provide data on the analysis of irrigation-

Table 3. Losses from Land Degradation and Underuse in the Kyrgyz Republic

Area	Degraded	Losses from degradation	Source of the data
Total ≈ 20 million			
Agricultural lands: 10.4 million hectares		Total: US$250 million annually	
• arable land: 1.2 million hectares	60% (0.7 million hectares)	US$100 million annually Land taken out of cultivation: 100,000 hectares, with a loss of 2 billion soms (US$50 million) Crop yield reduced by 50% on 0.7 million hectares, with a loss of 8 billion soms (US$200 million)	Ministry of Agriculture and Water Sector
• grassland: 9.2 million hectares	40% (3.6 million hectares)	US$100 million in foregone revenues. More carbon emissions and more severe climate change	World Bank
• forest land: 3.3 million hectares	Forested area: 4.2% compared with 6% in 1930	Stronger wind erosion and more carbon emissions	

Source: Kulov 2009 [20].

induced erosion. Decisions made by the government are not linked to the databases on soil conditions in various regions of the country.

The overview of the laws and resolutions clearly demonstrates that the Government of the Kyrgyz Republic has been undertaking activities to ensure food security. As the focus of this case study is the development of activities to reduce damage caused by irrigation-induced erosion, we will review the efficiency of the government's efforts undertaken to address this issue. The performed analysis of laws, a lack of statistical data or any other information on noticeable improvement of grass stand on pastures, improvement of fertility of irrigated lands, and trees planted in water protection zones help us conclude that the issue of land degradation and continued land desertification has not been addressed. The following reasons may be identified:

- A lack of an integrated approach to addressing this issue illustrates that there is no single coordination body in the country. Responsibility for measures adopted by the government is allocated among various ministries and agencies, and there is no link or consistency between programs and action plans of various ministries, agencies, and local authorities.
- Finances for adopted programs are allocated among several ministries and agencies and only a small portion of funds reaches local implementing agencies, which is not sufficient to undertake any measures to control degradation of agricultural lands.
- There is a shortage of professional human resources in the government who would have knowledge of existing issues of land degradation, their causes, and modern technologies of land improvement. This leads to a situation where programs are developed in silos and without scientific validation.
- So far there has been no unified cadaster valuation of agricultural land taking into account ongoing degradation processes. Productive fertility of land has not been determined and all available information on this issue is based on rough estimates produced by studies conducted in 1980s. Without understanding the causes of the issue and without an evaluation of actual magnitude of the process unfolding in the country, it is not possible to undertake efficient measures.

It is necessary to create a single coordination center for the Government of the Kyrgyz Republic, which will identify issues, develop scientifically substantiated programs, and convey allocated finances directly to the entities and people who are involved in tackling this issue, make investments in the irrigation infrastructure of irrigated lands economically beneficial, and provide finance support to farmers, because the profit in this case will be much higher than the costs incurred.

Stakeholder Groups

Intensive use of fertile lands and grasslands to grow agricultural crops and livestock products caused land degradation. Land degradation under the impact of human activities leads to desertification of lands and, along with other factors, impacts the ecosystem in Central Asia. The aftereffect of such degradation may be disastrous for people living in such areas [17].

During the Soviet period, when the irrigation infrastructure was being put in place and irrigated areas were expanding, soil conservation and erosion control were very high on the policy agenda and enormous funds and material resources were allocated by the state to address this issue, with the emphasis placed on highly productive land cultivation. However, when the agrarian reform was being implemented in 1991–2001 and the land was privatized, the erosion issues in the Kyrgyz Republic got worse [5]. That is why stakeholders who can make decisions with the aim of reducing land degradation include government authorities, research and education institutes, local authorities, and farmers.

Government Authorities

The Government of the Kyrgyz Republic demonstrates an interest in soil conservation and improvement of soil productivity. When a new government is formed, many resolutions and laws are passed. Taking into account changing natural and social conditions, these laws are amended from time to time. For example, in recent years around 40 amendments have been introduced in the *Land Code* alone.

The Ministry of Agriculture and Melioration is directly interested in obtaining new technologies of sensible use of irrigated lands. This ministry administers most functions regarding water management through the Department of Water Management. It directly manages irrigated agriculture. The government intends to reserve the right to own and manage all strategic facilities such as dams, water storages, hydro-electric power stations, main canals, and so on. At the same time it plans to privatize water management systems by corporatizing companies that will be created. The State Agency of Environmental Protection can also use results of this study in its activities.

Research and Education Institutions

Research undertaken to reduce damage caused by land degradation and scientific and practical technologies developed on its basis improve the awareness of decision makers. Research and educational institutions such as the Kyrgyz National Agrarian University, which has a network of agricultural colleges across the Republic; the Kyrgyz Research Institute of Farming and Soil Studies; the Kyrgyz Research Institute of Irrigation; the Kyrgyz-Russian Slavic University; and the Republican Soil and Agrochemical Station (RSAS) of the Kyrgyzgiprosem (the State Design Institute of Land Management) are also interested in the results of this project, which provides a scientific and analytical overview of irrigation-induced erosion, summarizes laws and resolutions of the government on food security adopted from 1991 to the present, and gives recommendations for the sensible cultivation of irrigated lands. The results of this project may be used in developing educational programs for a course on land degradation for students of agrarian colleges and universities.

Local Authorities

These authorities are the Ministry of Local Governments, the Regional Public Administrations (7), District Public Administrations (44), Aiyl Okmotus (450), Water User Associations (there are around 500 WUAs in the Republic), and Rural Extension and Advisory Services (around 20). Breaking up former collective and state farms and transferring lands to smallholder land users led to the liquidation of specialized services such as a chief agronomist, a chief hydrotechnologist, a zoo-technician, an economist, and so on. Previously these services consisted of experienced specialists with university backgrounds. They provided necessary information and advice (instructions) on advanced, scientific organization and production technology to production personnel of the farms.

Smallholders (Peasants) and Farms

The main stakeholder group consists of smallholder (peasant) farms and farms as a group, since around 200,000 farms are located in the piedmont areas of the Kyrgyz Republic. The changes over time in the number of farms in the Kyrgyz Republic between 1991 and 2014 are provided in Table 4 [18]. Today farmers find themselves detached from scientific achievements and advanced production experience. Many such farmers are poorly adapted to independent, highly efficient agricultural production, especially in irrigated lands. When farms and peasant smallholdings were organized in the Kyrgyz Republic, allotments per each member of the household ranged from 20 to 35 ares (a metric unit equal to 100 square meters). Low-quality land (Class III and Class IV land) was distributed first. Because of a shortage of machinery in the farms, the lack of fertilizers and herbicides, the failure to follow crop management practices, and the lack of crop rotation, land become overgrown with weeds and the quality of agricultural land continues to deteriorate. These problems have resulted in a substantial crop yield decline. For example, in former large farms, the wheat yield used to range from 60 centners per hectare and the barley yield from 50 to 55 centners per hectare. Now the wheat yield is 25 to 30 centners per hectare, whereas the barley yield is 20 centners per hectare. The farmers believe that if the situation does not change, the wheat yield will be reduced to 10 centners per hectare and the barley yield will be reduced to 5 centners per hectare. Dissemination of knowledge about safe, sound technologies of irrigated land cultivation among farmers under this project helps reduce damage caused by irrigation-induced erosion and enhance crop yields. Local extension services that would train farmers locally, building on the efficient results of applied research, can be readily accepted by land users if they are accompanied by specific and clear recommendations on improvement of irrigated land quality.

Policy Options

Sustainable food security is based on fertility and productivity of agricultural land. Land and water are the basis for food production, and care about their preservation and the sensible use of land is the most important stage in the food chain.

Irrigation-induced erosion is one of many issues facing the rural areas, along with soil salinization; the rise of the groundwater level, which causes partial flooding; grasslands degradation; faulty crop rotation; corruptive transformation of land, and so on. In the Kyrgyz Republic all these issues are interrelated. That is why irrigation management and the control of irrigation-induced erosion should be tackled within the integrated land, water, and bioresource management process [5].

1.Coordination of Management of Integrated Improvement of Irrigated Lands

Today the country does not have a single state body that can coordinate all efforts aimed at improving

Table 4. Farmer Organizations in the Kyrgyz Republic, 1991–2014

Year	Collective farms	State farms	Independent farms	Private collective farms	Private cooperative farms	Joint stock companies	Total
1991	195	323	4,567	—	—	—	5,085
1995	37	49	23,180	227	608	74	24,175
2000	—	61	7,1163	236	292	45	71,797
2001	—	59	8,4692	212	463	43	85,469
2002	—	94	25,1526	63	624	39	252,346
2003	—	68	255,882	124	772	75	256,921
2004	—	68	259,701	200	832	79	260,880
2005	—	—	296,299	—	—	—	296,299
2014	—	—	321,800	135	424	3454	326,700

Note: — = not available.

the condition of agricultural land. For example, in a specific ecosystem in a certain region, such as a river basin—which is the most typical ecosystem for mountainous Kyrgyz Republic (the Republic has more than 25,000 rivers and an associated number of river basins)—the natural resources of the ecosystem are managed by several ministries and local authorities.

Heads of the Ministry of Agriculture and Melioration focus mostly on the production of agricultural output, and the ministers have only short-term targets in their plans—such as measures aimed at increasing crop yields, which allows them to retain their seats for a year or two (from 1991 to 2016 the ministry had 18 ministers). For this reason, the ministers deal with the issues of land degradation only partially, because most of the time they are busy with disaster response measures rather than preventing ecological damage. The capacity and financial possibilities of the chief environmental agency of the country, which is the State Agency of Environmental Protection, are very low. The agency is not able to control specific environmental issues such as soil erosion, preservation of the natural potential of catchment areas and water protection zones, and so on. It appears that no one is responsible for land degradation at the state level.

Besides, the ministry and the agency are unable to raise the issue of long-term sustainable development because, organizationally, they do not have research centers that study upcoming trends. Because of the lack of agreement, soil fertility, which is the national wealth of the Kyrgyz Republic, may be lost forever.

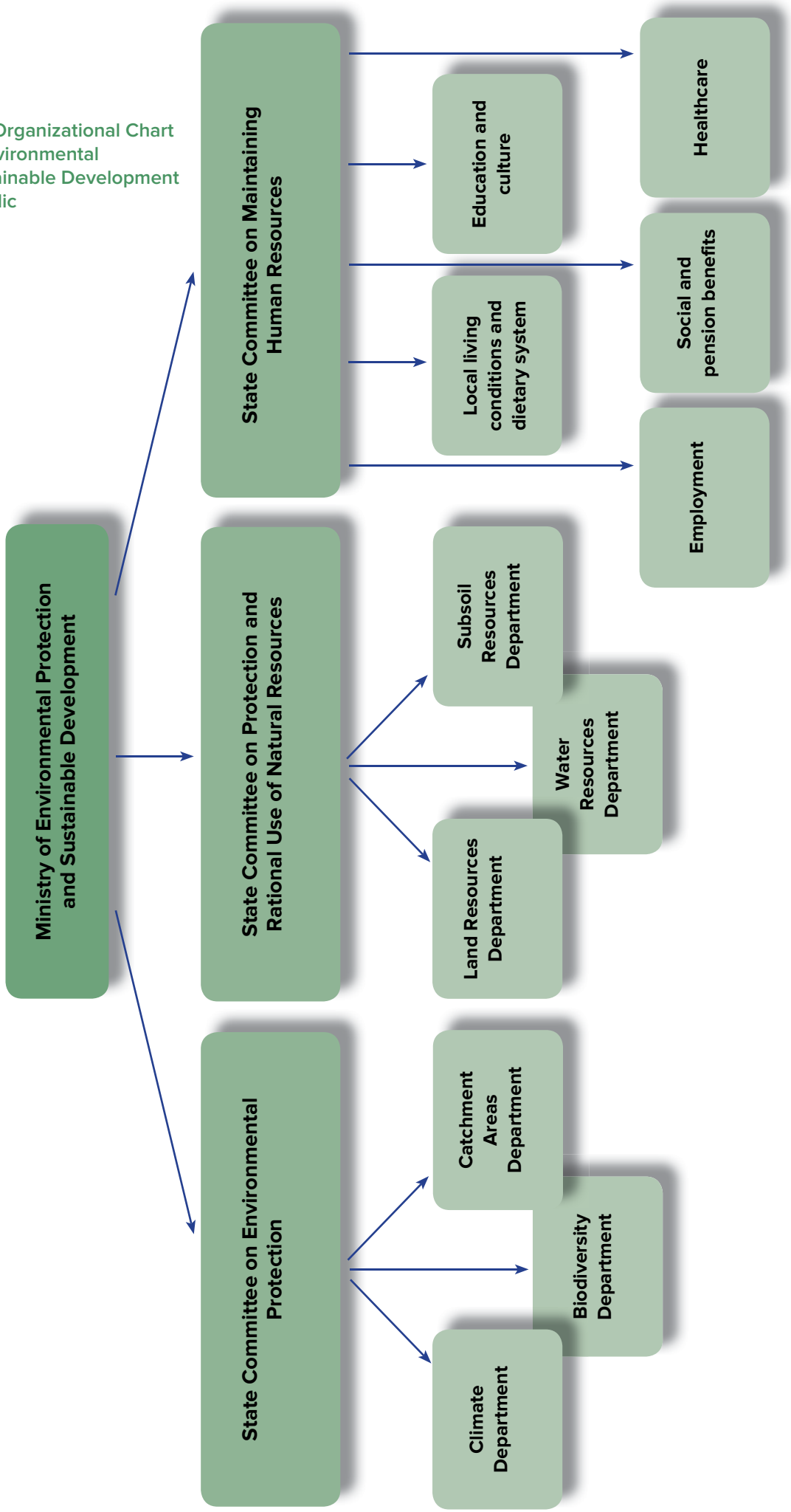
At the same time, it is the Agency of Environmental Protection that has more chance of becoming a coordinator of the integrated approach as, because of its functions, it must always take a longer view, look into the future, and aim to preserve the habitat. The government does not spur the directors of the agency to meet specified targets, as is the case with the ministers of agriculture, and the heads of the agency work in their position for four to five years. This agency needs to be restructured, reinforced by finances and research centers, and the Ministry of Environmental Protection and Sustainable Development needs to be created on its basis. The Republic of Kyrgyz has now a chance to do this. A new parliament and a new president will be elected in the forthcoming elections in 2017. Given the global trends of sustainable development and the green economy, the status of the chief environmental agency of the country may be enhanced and its budget may be increased.

To win elections, new parliamentarians and the new president need fresh ideas and interesting proposals to present to the country's population, which is already aware of global issues of climate change, anticipates disasters for people and animals, and expects the leadership of the country to undertake responsible steps. To pursue sustainable development of the Kyrgyz Republic and support food security, it is necessary to offer new scientific solutions and justify the need to strengthen the Agency of Environmental Protection structurally and financially. All this gives the government a chance to include in the mandate of the new Ministry of Environmental Protection responsibilities for issues that have previously been forgotten. These include issues such as water erosion, forest melioration (to stop wind erosion), preservation of water protection belts (for more than 25,000 rivers in the country), strict compliance with soil protection technologies in crop growing, and harsh measures to suppress violations, as well as the inclusion of relevant research centers in the organizational chart of the ministry and the assignment of complex tasks to them. Then the country will go through a restructuring toward sustainable green development, and the population will see the efforts made by politicians to preserve the environment, the flora, and fauna of the country for future generations. New areas of research and investments will appear.

Hence, in order to identify optimal mechanisms for natural resource management, and with sustainable development principles in mind, the creation of the Ministry of Environmental Protection and Sustainable Development is proposed on the basis of the State Agency of Environmental Protection. Organizationally, the ministry will be composed of relevant state committees, each of which will have research centers on environmental protection, protection of natural resources, and maintenance of human resources (Figure 2).

The country has all elements put in place to set up such a ministry: regarding land conservation, activities are being undertaken by the Ministry of Agriculture under the National Action Plan to Combat Desertification for 2015–2020; the Ministry of Agriculture has already launched several projects. Funds are being allocated for Sustainable Land Management from the state budget.

Figure 2. Proposed Organizational Chart of the Ministry of Environmental Protection and Sustainable Development of the Kyrgyz Republic



2. Policy Decisions for Reducing Damage from Irrigation-Induced Erosion

The following policy decisions are being proposed:

- To keep the priority of developing traditional hillside livestock grazing (which not only provides food security in terms of supply of livestock products, but also is beneficial economically because of the export of ecologically clean products) high on the policy agenda. The task requires the percentage share of fodder perennial plants in the crops to be increased (up to 30–50 percent against the current 10–20 percent). This policy will contribute to soil conservation because perennial plants reduce the possibility of soil detachment, hold soil particles in place effectively, and enrich soil with nutrients.

- To sign international treaties and agreements for the purpose of national soil policy implementation, prepare and launch projects on capacity building of local bodies of power and services on sustainable land and water management at the level of farmers' fields (regional and district authorities on agricultural policy, WUAs, agricultural cooperatives, etc.), and adopt a policy toward incorporating anti-erosion technologies in investment projects that are developed.

- To provide financial support for research about soil conservation, taking into account the risks of hillside agriculture and livestock; monitor soil fertility by making records in the land cadaster; and assign the task of supervision of the activities conducted by the Land and Water Inspectorates to research institutions, which developed science-based requirements for the use of land and water resources.

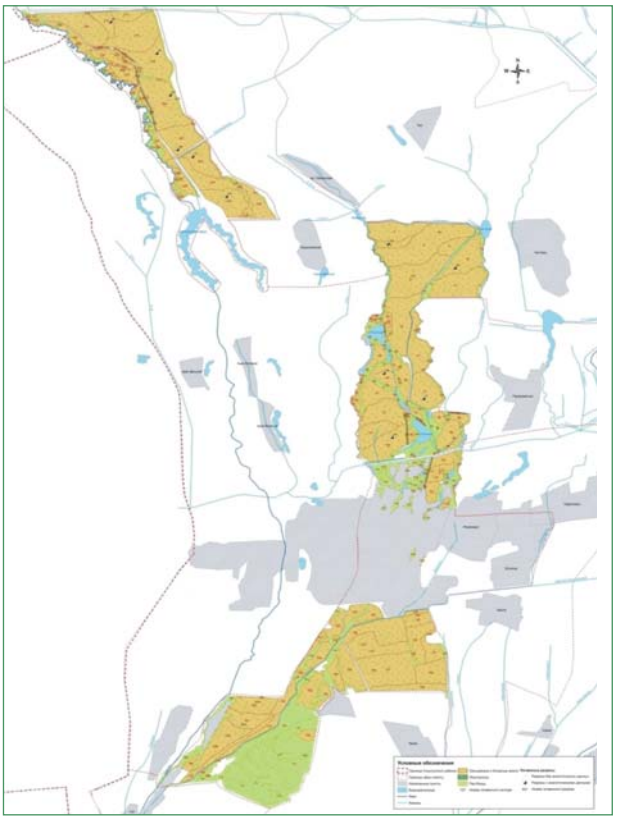
- To include the position of the Agronomist in the staff of village administrations and provide financing for this program. Currently village administrations have only the position of the Specialist on Land Use, who primarily deals with surveying the boundaries of the farms and construction sites.

- To rehabilitate on-farm irrigation systems in the piedmont agricultural lands with the use of contour irrigation, sprinkler irrigation, drip irrigation, and micro-sprinkler irrigation. In those farming units where the configuration and the irrigation system cannot be changed, it is advisable that farmers be trained in compliance with the required depth of irrigation and minimum stream sizes in furrows.

- To evaluate land degradation and organize the monitoring of agricultural land conditions for 350 rural areas of the Kyrgyz Republic, prepare digital maps of soil susceptibility to various types of degradation using the GIS of the database of agricultural land degradation, which can generate technical solutions (developed by the Kyrgyz Research Institute of Irrigation; see Figure 3 [18]).

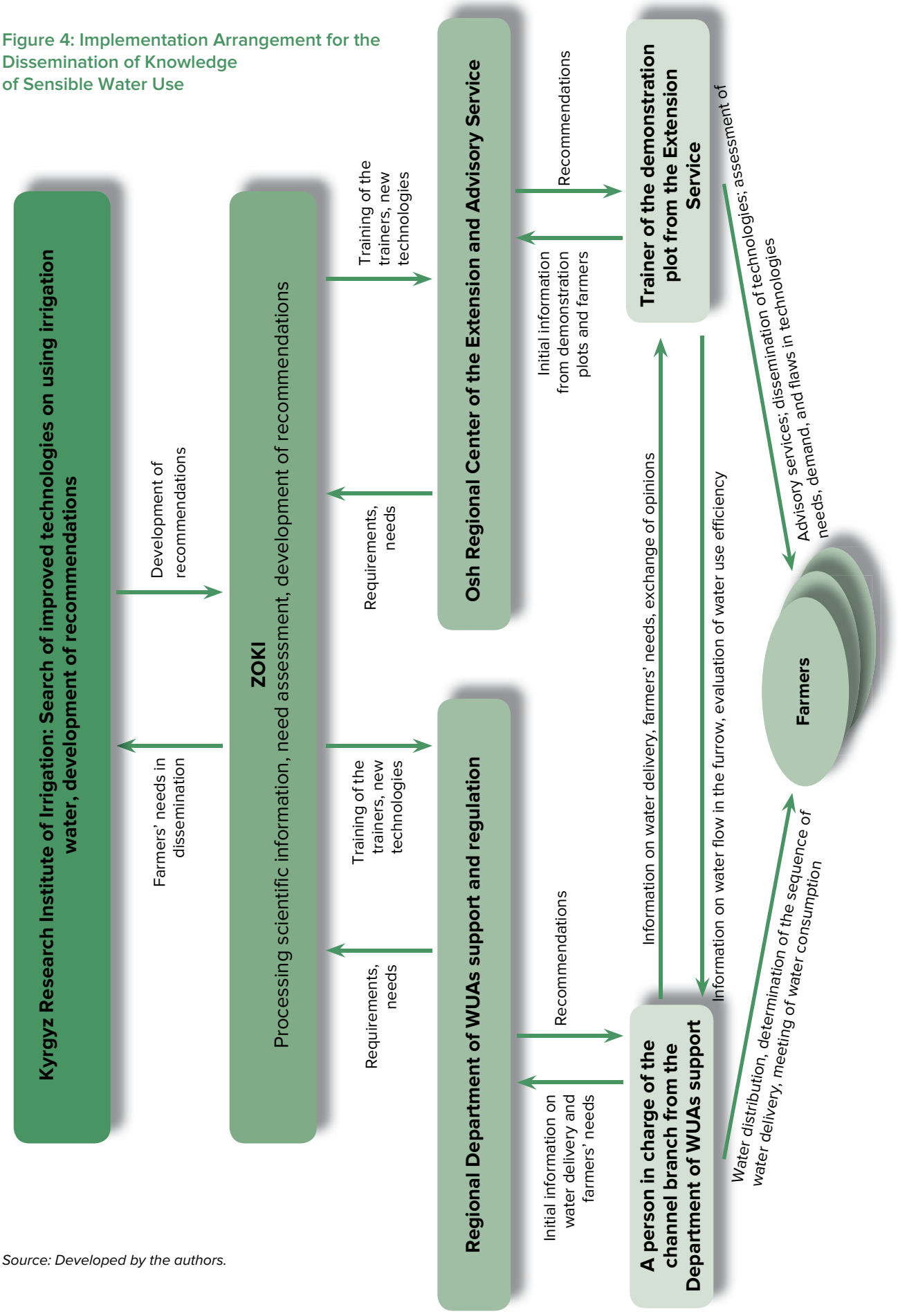
- To develop local extension and advisory services; disseminate best practices on anti-erosion irrigation technology; and introduce a special course on irrigation-induced erosion in universities and technical vocational schools: Kyrgyz Agrarian University; Kyrgyz Slavonic University; Osh Technological University, and so on (Figure 4).

Figure 3. A Fragment of the GIS Map on Soil Erosion in the Sokuluk District of the Chui Region



Source: Gerashchenko LP Evaluation of soil erosion hazard maps in the GIS (scientific report), Kyrgyz Irrigation Research Institute 2014 [18].

Figure 4: Implementation Arrangement for the Dissemination of Knowledge of Sensible Water Use



Source: Developed by the authors.

3. Technologies for Reducing Land Degradation

A set of erosion control activities is developed to conserve soils and enhance their fertility and productivity, taking into account the gradients of the slopes, the intensity of erosive processes, and soil and climatic conditions. Large-scale implementation of erosion control measures will help increase crop yields by 20 to 30 percent, save irrigation water consumption by 10 to 20 percent, and reduce erosive processes [5].

The most efficient way to combat irrigation-induced erosion is crop rotation that includes perennial legume crops and legume-grass mixtures. On the slopes less than 5° the common rotation includes two to three pasture crop fields; if the gradient is 5–10°, three pasture crop fields with more grain crops are used; grass-cereal crop rotation is common for fields with slopes greater than 10°.

The planned system of crop fertilization enhances soil fertility, increases crop yield by 1.3 to 1.5 times, and improves the development and growth of the areal part and the root system of plants, which protect soils against impact of erosive processes. A key role is played by organic fertilizers because they help conserve humus in the soil. A standard quantity of organic fertilizers on eroded lands and washed-off soils should be increased by 1.5 to 2 times relative to usual recommendations for regular soil.

Irrigation technology encompasses the selection of the most efficient methods and technologies and is an important consideration for soil fertility conservation. As experiments of the Kyrgyz Research Institute of Agriculture demonstrate, when the velocity of water flow in the furrow increases from 0.3–0.5 to 0.7–1.0 liters per second, on the slopes with a gradient of 0.03–0.04, fine-grained soil is washed away four to five times faster than it is from the original soil, which leads to the depletion of humus, nitrogen, and other nutrients in the tilth soil by 1.5–2 times. In this case, potato yield is reduced by 46 to 79 centners per hectare, whereas maize yield is decreased by 33 to 60 centers per hectare [21]. For this reason, in order to prevent and reduce soil detachment on such fields during furrow irritation, stream sizes should be 0.20–0.25 liters per second, and when the water enters the lower reaches of the furrow, the stream size should be decreased by 1.5 times to continue irrigation until the required amount of water soaks into the soil.

Attention should be paid to irrigation methods. For example, the pulse drip irrigation method is based on the use of the soil's physical property—soil swells when wetted—which helps regulate the velocity of soil moistening along the depth and the length of the furrow or the strip. The application of pulse watering reduces soil washout from the field on average by 40 to 60 percent.

Contour irrigation of the land provides protection of soils against water erosion and should start, first and foremost, with contour amelioration of the irrigated land, when water-retaining furrow dikes and diversion ridging are installed along the field borders running across the slope. Permanent structures mark the borders. Contour irrigation of the land is a dominant factor for all farms, as it determines the location of all other technological and amelioration elements and crop management practices used to treat soils and retain soil moisture.

Drip irrigation enables farmers to deliver irrigation water, mineral nutrients, and minor plant nutrients slowly in doses; increase crop yield; achieve savings of irrigation water; and combat irrigation-induced soil erosion, waterlogging, and salinization. When drip irrigation was applied to stone fruit crops on stony pebble soils of the Issyk-Kul Region, irrigation-induced soil erosion was reduced by 20 percent and the apricot yield was 180 centers per hectare, which is four times higher than the crop yield on furrow irrigated lands [22]. Irrigation-induced erosion was also reduced on medium loam highly permeable soils in the Batken Region, which contributed to increase in grape yield by 2.7 times compared to furrow irrigation [23], [24].

Soil treatment techniques are needed. Soil treatment and all crop management practices of seeding must also be aimed to prevent soil washout and eliminate losses of fine-grain earth and depletion of nutrients caused by erosion. The experiments conducted by the Department of Fruit-farming and Viniculture in the Kyrgyz Research Institute of Farming have demonstrated that, in a vineyard with rows planted parallel up and down the slope, 12.0 tonnes of soil were lost on average per hectare; if rows were planted across the slope, 6.5 tonnes of soil were lost per hectare, while in case of contour alignment of the rows, the loss was 2.4 tonnes per hectare. For field crops on 5° sloping fields, deep tillage across the slope is practiced with the use of treatments such as ridging, subsoiling, and contour soil treatment. On slopes greater than 10°, seeds

should be planted across the slope with strips 20–30 meters wide. In-row tillage leaves undisturbed soil between the rows. Terracing is also used on steep slopes.

The studies conducted by the Kyrgyz Research and Technological Institute of Pastures and Fodder have demonstrated that tandem disc harrowing to a depth of 10–12 centimeters is the most efficient soil treatment method for slopes with the 3–15° slopes. In this case, some plant residue is left on the soil surface and washout of soil in spring is reduced. Pastures on the hill slopes exceeding 8° are tilled in strips, alternating tilled strips with untilled strips 15–25 meters wide. When planted perennial grasses overgrow and form grassy turf, the alternate strips are seeded. On the grasslands improved by fertilization, underseeding of grass, and other activities, surface runoff is reduced by 60–70 percent while losses of fine-grain earth are reduced by 2.5 to 3.5 times.

Soil should be plowed and harrowed when the moisture content is not less than 65 percent of its minimum moisture holding capacity, or 12 to 18 percent of its density. To achieve the maximum effect, fall-plowing should be done right after the forecrop is harvested because heavy spring precipitation will not allow the farmers to do quality field work before early to mid-May. The method of soil harrowing is selected depending on its mechanical properties. In the first year of cultivation, after surface treatment with 40–60 tonnes of organic fertilizer per hectare and 80 percent of the estimated amount of phosphorous fertilizer and the entire amount of potassium fertilizer, if possible, primary tillage is performed with a double-cut three- or four-furrow plow to incorporate manure into the root zone of the soil. The soil is broken up and turned over the surface to a depth of not less than 25–30 centimeters while the subsoiler breaks up and loosens soil to the depth of 40 centimeters. Such tillage is done every two years. In late autumn dry or surface-frozen soil (November, early December), dry or surface-frozen topsoil undergoes soil slotting to a depth of 45 centimeters by soil ripper/mole plow. In the years between deep tillage, light and similar soils (sand clay, light loams) are plowed with a blade cultivator to a depth of 15–17 centimeters or with a soil ripper to a depth of 20 centimeters across the slope, leaving some crop residue on the soil surface, with subsequent soil slotting to a depth of up to 45 centimeters. Hillside lands treated using the described crop management practice possess enhanced erosion tolerance as transport of precipitation and melt water down the slope is reduced because of better soil capacity to absorb water and larger moisture accumulation in the 0.80 soil layer.

Application of fertilizers and soil amendments through an irrigation system is called *fertigation* (from English words *fertilizer* and *irrigation*), and because of its integrated impact on soil processes, irrigation technology is now called fertilizing irrigation. Water has a direct impact on solubility of solid macro- and micro-nutrients found in soil and fertilizers and also influences the entire soil fauna during aerobic and anaerobic processes.

4. Organization of Extension Service, Development of Educational Policy

Education. Despite the overall high literacy rate of the Kyrgyz population, rural entrepreneurs lack knowledge of specific issues of agribusiness organization and development, especially agricultural production technology. The established system of education and training in agriculture needs to be adjusted to follow the new structure of production in this sector and the changed market demand for specialists. Modern enterprises need not only specialist-technicians but also managers, marketing specialists, financial managers, and consultants. The main link in the training and retraining of farmers is in the rural vocational and technical lyceum schools. Curricula must be revised to meet real requirements and demands of farms to the maximum extent possible. To this end, a pilot Helvetas project aimed at training farmers in the Naryn Region on the basis of vocational schools and lyceums should be rolled out across the entire Republic[1].

It is recommended that a special course on irrigation-induced erosion be included in the training programs in universities and technical schools (such as Kyrgyz Agrarian University, Kyrgyz Slavonic University, Osh Technological University, etc.).

Research. Basic research and some priority applied research should continue to be financed by the government. The main task in this respect is to move toward a competitive allocation of funds for such research. Integration of agricultural science of the Republic into the global scientific process will become an important element for its development. Competition would incentivize the development of agribusiness and would support applied research while the ongoing expansion of the agri-food sector would increase potential financing of research

[1] Information about the HELVETAS Swiss Intercooperation project is available at www.kyrgyzstan.helvetas.org

institutions [25]. As a follow-up to the second stage of the CACILM project, it is planned that an Interagency Scientific and Technical Committee will be organized under the National Coordination Council on implementation of the UN Convention to Combat Desertification. It is planned that a number of projects will be developed and studies conducted within the CACILM project [26].

Extension and advisory services: Dissemination of best practices. Under the conditions of a market economy, the rural extension and advisory service with its local branches must continue providing full assistence to rural entreprenours, helping them address all issues of small and medium enterprise development in rural areas and disseminating knowledge among heads of the companies in such areas as marketing, management, and technical and financial analysis of their operations (Figure 4). In the future, the rural extension and advisory service should become a financially sustainable organization [27], [28].

It would be right to note here that the *Law On Smallholding (Farming)*, adopted back in 1999, which sets forth rights and responsibilities of farms, places huge responsibility for soil preservation onto peasants without providing them with financial, extension, or advisory services. Only in the last two or three years have subsidized loans (at a 10 percent interest rate) been allocated for amounts up to 3 to 4 billion soms (US$40 to 60 million) for one to three years to produce agricultural output (www.minfin.kg), but extension and advisory services are available for not more than 30 percent of the farmers.

Assignment

Having analyzed the effects of irrigation-induced erosion in the Kyrgyz Republic, suggest efficient technologies of irrigated land use and provide recommendations for relevant stakeholders and policymakers.

Policy Recommendations

This case study proposes the following recommendations for stakeholders:

Government Authorities: To create the Ministry of Environmental Protection and Sustainable Development of the Kyrgyz Republic, which will be an authorized body of the government with a mandate to coordinate and supervise actions of all organizations that deal with land degradation issue at various levels.

To create a research center at this ministry in order to use expert capacity in developing the technical policy of this ministry, and to advise and provide technical supervision of activities carried out by various ecological inspectorates.

To maintain the priority of upland pasture livestock; provide financing for research on soil conservation and implement developed technologies; support extension and advisory services on sensible anti-erosion treatment of soil provided to farmers; and adopt a resolution on the rehabilitation of on-farm irrigation systems in piedmont lands with the use of contour irrigation, sprinkler irrigation, drip irrigation and micro-sprinkler irrigation. Furthermore, to include the position of the Agronomist in the staff of village administrations and provide financing for this program.

Research and Education Institutions: To intensify and upscale participation in policy issues and processes, and provide information to the government on the methods aimed to reduce soil degradation; develop research on improving conditions of irrigated lands; cooperate with foreign experts in this area; create a single digital GIS-based map of the irrigation-induced erosion hazard in the Kyrgyz Republic with an extended and open database; improve awareness of the land degradation issue and methods for its solution among the population; create demonstration irrigated units on hillside lands with the use of drip irrigation, sprinkler irrigation, contour irrigation, plastic tubes; and introduce a special course on irrigation-induced erosion in universities and vocational schools of the country.

Local Authorities: To organize civil society control over compliance with standards, quality regulations, soil fertility (together with the Land, Water Inspectorates and Ecological Services); to provide information to citizens on current soil conditions and soil conservation activities on a daily basis; to undertake harsher prosecution measures, including confiscation of the land plot from the owner, for damage caused to soils.

Farmers: Individual farmers should be aware of their responsibility for conserving land and water for future generations and the state; improve their agricultural education; apply recommended technologies for land conservation and treatment and use of water resources; and actively participate in the implementation of programs for sustainable soil management and improvement of their fertility.

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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

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,

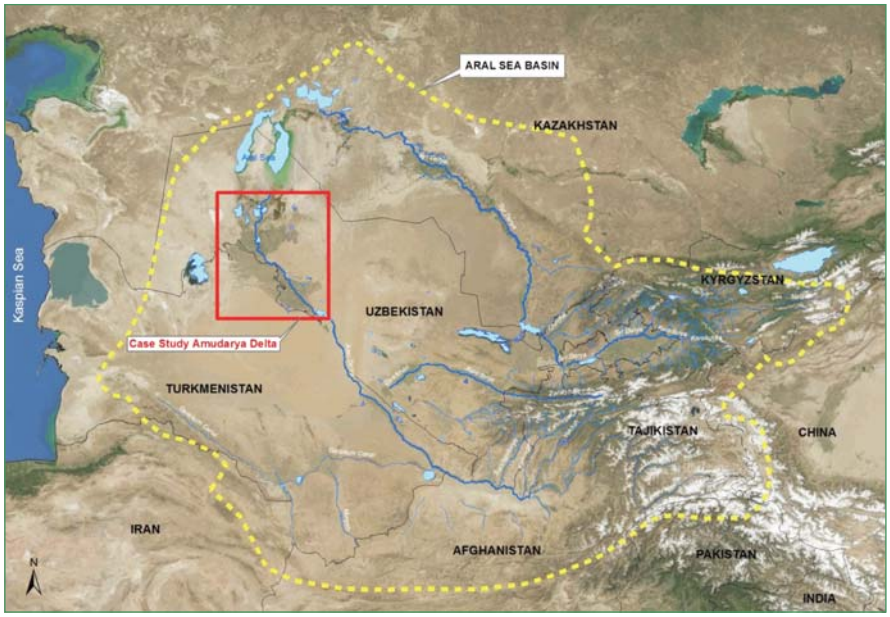

Figure 1. Aral Sea Basin: Location of the Case Study Region in the Amu Darya Delta

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

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.

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].

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].

[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.

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

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

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

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

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,

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].

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

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

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

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.

Additional Readings

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Sustainable Development of Agro-Industrial Sector and Food Security of the Kyrgyz Republic in the Process of Integration into the Eurasian Economic Union

Ekaterina Yakubovich, Zalina Yenikeyeva

Executive Summary

The integration of the Kyrgyz Republic into the Eurasian Economic Union (EAEU) will permit the country to most optimally combine the diversity of natural, economic, intellectual, and other resources into a single system. However, within the framework of the EAEU, the food security of the country depends mostly on ensuring the conditions for effective functioning of the agro-industrial complex, effective implementation of its potential to optimize the volume of production of competitive agricultural products and food necessary to meet the needs of the population and processing industry, and reduction of dependence on food imports.

This study aims to identify the key food security issues of the Kyrgyz Republic in the process of its integration into the EAEU. To this end, the study identifies key changes in the agro-industrial complex and reveals the interests of potential stakeholders (the political elite, business, actors in the agricultural production sector, population, etc.) in strengthening food security. To improve food security of the Kyrgyz Republic in the process of its integration into the EAEU incorporating the best interests of all stakeholders, the following policy options were offered: (i) to create a system of procurement depot complexes; (ii) to expand the transportation systems and replace the vehicle fleet; (iii) to reform veterinary and phytosanitary systems; (iv) to support the food security atlas; (v) to actively participate in the Scaling Up Nutrition (SUN) Movement; and (vi) to strengthen the social protection system to reduce poverty in rural areas.

The food security situation in the country was forecasted based on current trends and factors as well as proposed recommendations, which were prepared during this case study. In making decisions, the Government of the Kyrgyz Republic must take into account the interests of all stakeholders in an optimal manner and, at the same time, must understand that integration into the EAEU does not deprive political elites of their independence in making management decisions. All proposed policy options will help develop the agro-industrial complex of the country and strengthen its food security; however, it is expected that the most productive options include creating a system of procurement depot complexes; reforming the veterinary and phytosanitary systems; developing the transportation system; and strengthening the social protection system to reduce property in rural areas. Implementation of these policy options will help agricultural producers of the country enter the common agricultural market as well as help the government improve quality of the agricultural output, reduce dependence on imports, increase exports, reduce social tensions, and supply quality food products to the population of the country.

Background

Overview of the Agro-Industrial Complex of the Kyrgyz Republic

The agro-industrial complex is one of the most important sectors of the Kyrgyz Republic economy. It accounts for 15 percent of GDP and employs more than 30 percent of the workforce.

According to the official data of the National Statistical Committee of the Kyrgyz Republic, in 2010–15 the average annual production growth rate remained at 0.5 percent. The structure of the country's agriculture is dominated by crop production (51 percent of the gross output value) and livestock (47 percent); the share of other subsectors (services, forestry, fisheries) does not exceed 2 percent (Figures 1 and 2).

Cultivated crops include mostly wheat, barley, potatoes, vegetables and fruits, fodder and technical crops (cotton, tobacco, sugar beets). The main subsectors of livestock breeding are dairy and beef cattle, sheep and goats, horses, and poultry.

Peasant farms (60.2 percent) and privately owned small landholdings of the population (35.7 percent) manufacturing products partly for sale and partly for private consumption form the basis of agriculture in the Kyrgyz Republic. In 2010–14, the share of state and collective farms in the total gross output of agricultural production remained virtually unchanged; in 2014 it accounted for about 2 percent (Table 1).

Overview of Food Security of the Kyrgyz Republic

The *food security* of the Kyrgyz Republic refers to the physical availability of food in sufficient quantity, access to this food by households (food produced by households, as well as that acquired through purchase, gift and other sources), and the consumption of food in a quantity required to meet nutritional needs [1].

Food and nutrition security are believed to be achieved if there is adequate food (in terms of quantity, quality, security, and socio-cultural

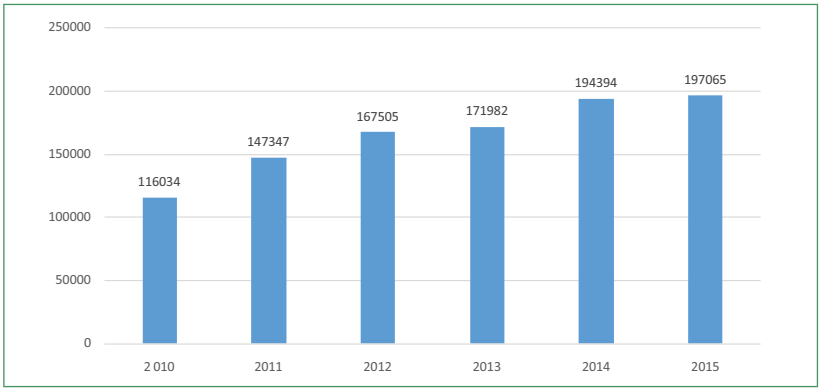

Figure 1. Gross Agricultural Output
(Kyrgyz soms, million)

Data source: Kyrgyz National Statistics Committee data.

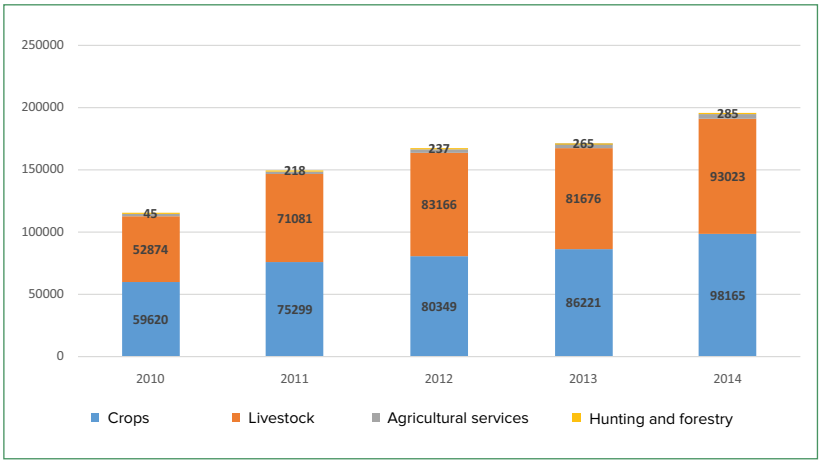

Figure 2. Gross Output by Sector: Agriculture, Forestry, and Fisheries
(Kyrgyz soms, million)

Data source: Kyrgyz National Statistics Committee data.

Table 1. Number of Agricultural Farms by Sector

	2010	2011	2012	2013	2014
Agricultural farms (as of the end of the year), number	332,170	345,113	357,227	383,436	384,871
including:					
State farms	64	65	60	56	40
Collective farms	509	556	525	497	513
Peasant farms (individual farms) and individual entrepreneurs	331,059	344,492	356,642	382,883	384,318
Subsidiary farms of state, collective organizations, and enterprises	538	538	538	538	538

Data source: Kyrgyz National Statistics Committee data.

acceptability) that is accessible and satisfactorily consumed and digested by all individuals at all times to ensure an active and healthy life.

In accordance with the *Law On Food Security in the Kyrgyz Republic*, physiological dietary norms are taken to mean scientifically substantiated and legislatively approved nutrient and energy intake standards, which ensure that the needs of healthy people in terms of the necessary nutrients and energy intake are fully met [2]. Approved physiological norms are shown in Table 2 [3].

As shown in Table 3, a comparison of the availability of basic food products on the domestic food market of the Republic by product description, taking into account carry-overs and average physiological norms, with the availability of products produced domestically makes evident the difference between the quantities of a specific product consumed by the population and the quantities of the product grown in the Kyrgyz Republic. For example, domestic consumption of bread products in 2015 amounted to 177.5 percent, while 108.9 percent of bread products were produced inside the country. Analyzing the results finds that, out of nine food security products, the Kyrgyz Republic is fully self-sufficient only in three: potatoes, milk, and vegetables (Table 3). Other products were imported from other countries. As Figure 3 shows, the percentage share of imported food products is still substantially higher than that of the exported goods.

From 2010 to 2015, the export of agricultural and food products remained consistently at 12 to 14 percent of the total export of goods; the share of imports of agricultural products ranged from 15 to 18 percent of the total imports. In value terms, exports remained at the same level, while imports demonstrated a growth trend caused by the increase in U.S. currency value. The Kyrgyz export structure is dominated by the following agricultural products: vegetables, nuts, fruits, beans, and milk. Its import structure is dominated by certain types of agricultural products and readymade food products: meat, wheat, vegetable oil, readymade food products (sugar, chocolate, and confectionery), and alcoholic and nonalcoholic beverages.

Table 2. Physiological Dietary Norms set for the Population of the Kyrgyz Republic

Food products	Physiological dietary norms of food intake per capita		
	kg/day	kg/month	kg/year
Bread products (bread, macaroni products, flour, grits, legumes) in grain equivalent	0.32	9.61	115.34
Potatoes	0.27	8.21	98.55
Vegetables and vine crops	0.32	9.52	114.25
Fruits and berries	0.34	10.31	123.74
Sugar and confectionery	0.07	2.13	25.55
Vegetable oil	0.03	0.76	9.13
Meat and meat products (in meat equivalent)	0.17	5.11	61.30
Fish and fish products	0.03	0.76	9.10
Milk and dairy products (in milk equivalent)	0.56	16.67	200.00
Eggs, number	0.51	15.21	182.50

Source: http://faolex.fao.org/docs/texts/kyr104425.doc

Table 3. Availability of Basic Foodstuffs on the Domestic Food Market of the Kyrgyz Republic (Percent)

	2010	2011	2012	2013	2014	2015
Availability of basic foodstuffs at the domestic food market of the Kyrgyz Republic, including carry-overs / carried forward balances and in accordance with average physiological norms						
Bread and bakery products	281.3	145.3	139.3	153.7	147.9	177.5
Potatoes	248.6	161.3	152.8	154.0	182.8	256.0
Milk	113.2	112.0	112	112.0	135.1	117.2
Meat	85.2	77.8	75.0	71.2	87.4	68.5
Vegetables	178.8	131.4	146.3	139.1	174.1	184.8
Vegetable oil	194.6	90.2	98.8	112.3	140.2	145.7
Sugar	70.6	66.1	63.7	72.0	73.7	87.2
Poultry eggs	43.7	43.6	42.6	43.1	56.9	50.7
Fruits and berries	23.8	25.7	24.0	27.6	33.0	36.9
Produced domestically						
Bread and bakery products	147.2	88.9	59.1	89.0	72.2	108.9
Potatoes	248.4	161.1	152.7	154.0	182.5	255.8
Milk	113.2	112.0	112	112.0	135.1	116.7
Meat	59.1	56.8	56.9	56.1	68.7	56.5
Vegetables	178.4	130.8	146.1	139.0	172.2	182.8
Vegetable oil	58.4	34.2	27.9	27.3	31.6	70.5
Sugar	10.1	12.2	9.4	17.3	16.3	38.5
Poultry eggs	38.6	38.5	40.3	40.0	49.7	47.7
Fruits and berries	18.2	21.7	21.6	23.2	28.5	31.2

Data source: Kyrgyz National Statistics Committee data.

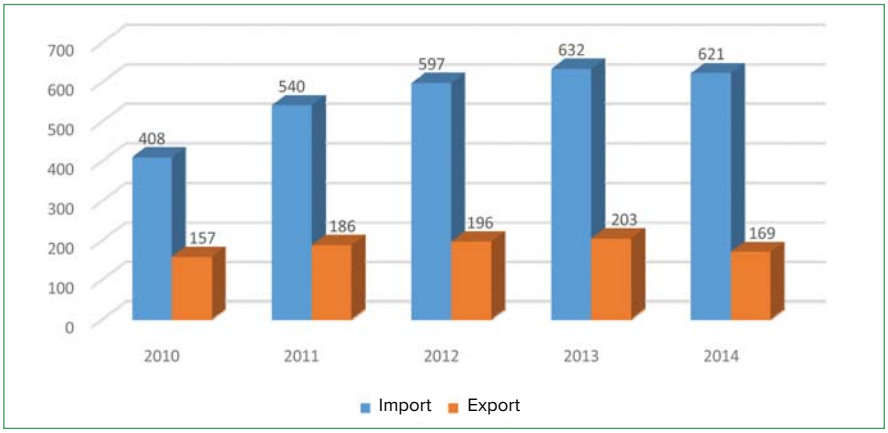

Figure 3. Dynamics of Trade in Food Products (US$, millions)

Data source: Kyrgyz National Statistics Committee data.

In 2010–15 the Kyrgyz Republic faced factors that had a negative impact on agricultural production:

- Agricultural production decreased as a consequence of an acute shortage of fuel, oil, and lubricants, which followed political events in the country (the revolution in 2010 resulted in the change of government) and the temporary closure of the border with Kazakhstan and Uzbekistan, causing a lack of diesel fuel at many petrol stations, especially in the mountainous regions of the country.

- Agricultural production was also affected by abnormally hot weather during the grain-filling period (wheat and barley). In addition, in some years these regions experienced heavy rains, mudslides, and frosts in mid-May, which affected the indicators of gross agricultural crop output.

The increase in gross agricultural output in January–December 2015, when the Republic became a full member of the Eurasian Economic Union, was caused primarily by the increased production of grain, vegetables, and potatoes, as well as livestock production. This was recorded in all regions other than Batken Region and the city of Bishkek. Grain production grew as a result of a significant increase in wheat and barley yields. For example, if in 2014 the average wheat yield was 16.9 centners per hectare (at net weight), in 2015 it was 23.7 centners per hectare. Respectively, the barley yield was 12.7 centners per hectare in 2014 compared with 21.3 centners per hectare in 2015.

Main Policies Implemented in Kyrgyz Republic in Agro-Industry and Food Security

Export-Import Policy and the Development of the Agrifood Trade

Agrifood trade plays an important role in the economy of the country. The main markets for the *export* of agricultural products from the Kyrgyz Republic include the Russian Federation (cotton, tobacco), Kazakhstan (vegetables, dairy products, fruits), and Turkey (beans).

Imported products are supplied mainly from Russia (vegetable oil, chocolate, confectionery, cigarettes, and fertilizers), Kazakhstan (wheat and wheat flour, vegetable oil, soft drinks, cigarettes), China (fruit, meat), Western Europe (sugar, processed food), and Ukraine (poultry, chocolate, confectionery). The geographical and commodity structure of exports and imports remained fairly stable.

The Kyrgyz Republic's accession to the EAEU in 2015 is the most important change in public policy that has occurred in recent years. The change in the Kyrgyz som exchange rate against the national currencies of the countries, which are its major trade partners, made a substantial impact on the Kyrgyz Republic's foreign trade. In accordance with the overview of agri-food trade policy in the former USSR countries (2014–2015) conducted by the Food and Agriculture Organization of the United Nations, as of the end of 2015, the som appreciated against the Russian ruble and the Kazakhstani tenge and weakened against the U.S. dollar and the Chinese yuan. As a result of these exchange rate changes, the price competitiveness of Kyrgyz goods dropped in major export markets. Conditions have become more favorable for imports from Russia and Kazakhstan. At the same time, imports from China, the European Union, and the countries with the exchange rate pegged to the U.S. dollar became more expensive.

In addition, the economic recession in 2014–15 in Russia and the somewhat slower growth rates of Kazakhstan's economy had a negative impact on the Kyrgyz Republic's exports. Economic sanctions imposed by Russia against the European Union and some other countries that banned the import of agricultural products and foodstuffs from these countries created niches in the Russian market and, consequently, additional opportunities for increased agrifood exports from the Kyrgyz Republic to Russia. As this overview shows, the Kyrgyz Republic so far has failed to take this opportunity to increase exports and establish itself in the Russian and Kazakhstani markets. The main reason for this failure is that the quality of Kyrgyz products often does not meet the requirements and technical standards established by the Eurasian Economic Union, which considerably limits the potential for the export boost [4].

In 2014–15, the economic policy of the Kyrgyz Republic government as a whole, and with respect to the import of agricultural products in particular, was focused mainly on EAEU pre-accession measures. Otherwise the country's economic policy has undergone limited changes. The bulk of the agrifood trade was made with the countries that are party to the Commonwealth of Independent States free trade zone agreement (CIS FTZ) with a zero import tariff rate. An important exception, as noted above, was a temporary (but repeatedly renewable) import duty on wheat flour, the rate of which in recent years

was 3 soms per kilogram (about US$0.06 dollar per kilogram, or about 20 percent of ad valorem equivalent). When crossing the Kyrgyz Republic's customs border, all products—including those originating from the countries that are party to the CIS FTZ—were subject to 12 percent value added tax (VAT). Trade with other countries was carried out at the rates of the most-favored nation (MFN) tariff in accordance with the customs tariff of the Kyrgyz Republic, which was not particularly high compared with international standards. In this case too there has been one significant exception: certain goods (in particular, beef and poultry) imported by individuals were not subject to VAT (in a so-called simplified procedure). This procedure is mostly applied to imports from China. The Kyrgyz Republic almost never resorts to quotas for agricultural product imports (there are quantitative restrictions on the import of alcoholic beverages from the countries outside the World Trade Organization), nor does it actively use sanitary and phytosanitary measures and other non-tariff measures [4].

In March 2015, the Government of the Kyrgyz Republic approved the Action Plan for Developing Exports of the Kyrgyz Republic for 2015–2017 that singles out as a priority all the traditional agrifood export products (dairy products, fresh and processed vegetables, fruits and nuts, wool and animal skins, and cotton) as well as meat products and bottled water. In the Republic, breeding beef cattle is one of the main subsectors of agriculture and is a traditional activity of the country's rural population, although the export of meat products from the country is virtually nonexistent now because of an unfavorable veterinary situation [4].

In accordance with the overview conducted by the Food and Agriculture Organization of the United Nations, all activities of the Action Plan for Developing Exports of the Kyrgyz Republic Export for 2015–2017 are focused on four areas:

1. **Access to trade information and export promotion**: The Action Plan is expected to carry out marketing and other studies, strengthen the capacity of trade support institutions (including the Agribusiness Competitiveness Center), assist the private sector in organizing and participating in exhibitions and fairs, and create and develop national and sectoral brands.

2. **Trade facilitation**: Measures included to ensure the country's accession to the EAEU are seen as a major opportunity to increase exports to the countries that are members of this association. Another set of measures in this area involves reducing time and expenditures needed to implement export procedures by introducing a "single window" mechanism for foreign trade throughout the country and improving business processes in this area. The most resource-intensive trade facilitation measures aim at improving logistics and infrastructure.

3. **Support and development of quality infrastructure**: Activities in this area are of great importance for the promotion of the Kyrgyz Republic's agrifood products because their nonconformity with technical specifications of the importing countries is one of the most significant barriers to their export. Implementation of the Action Plan for the accession of the Kyrgyz Republic to the EAEU is planned in the field of technical regulation and application of sanitary, phytosanitary and veterinary measures. In addition, implementation of measures aimed at improving quality infrastructure are planned; these measures include increased budget funding and the creation of private laboratories and service organizations (especially in the area of veterinary medicine), training of entrepreneurs in the use of the techniques of the HACCP system of food safety management, adherence to international safety standards, and others.

4. **Access to finance**: The Action Plan is intended to improve exporters' access to financial resources. Interest rates on loans are high for a period of one to two years, and scarce resources for long-term loans is one of the most serious obstacles resulting in the low competitiveness of agricultural producers in the Kyrgyz Republic. The Action Plan is expected to include exporters as a priority category in credit support programs aimed at small and medium-sized businesses that are implemented with the support of international development organizations and the state budget. In addition, the task is set to properly arrange for VAT reimbursement to export companies, the issue that could not be resolved for many years [4].

Bilateral and multilateral trade agreements are enumerated below:

- The Treaty on the Accession of the Kyrgyz Republic to the Treaty on the Eurasian Economic Union of May 29, 2014, signed on December 23, 2014.

- The Protocol amending the Treaty on the Eurasian Economic Union of May 29, 2014, and selected international treaties included in the law of the Eurasian Economic Union in connection with the accession of the Kyrgyz Republic to the Treaty on the Eurasian Economic Union of May 29, 2014, signed on May 8, 2015.

- The Protocol on the conditions and transitional provisions related to the implementation by the Kyrgyz Republic of the Treaty on the Eurasian Economic Union of May 29, 2014, selected international treaties included in the law of the Eurasian Economic Union, and acts by the organs of the Eurasian Economic Union in connection with the accession of the Kyrgyz Republic to the Treaty on the Eurasian Economic Union of May 29, 2014, signed on May 8, 2015.

Enforcement of these documents entailed many amendments in various areas of legislation, regulation, and administration. Key changes related to foreign trade of agricultural and food products can be divided into the following groups: (i) import regulations, (ii) customs and tax administration, and (iii) technical regulations and sanitary and phytosanitary measures [4].

1. Import regulations: Presently no substantial changes from the country's accession to the EAEU have been observed in the Kyrgyz Republic. However, fewer imported goods from Turkey and China for the benefit of EAEU partners, such as Kazakhstan and Russia, are expected after the transition period. Besides, higher duties for some types of imported products may lead to an increase in prices for consumers. But, because of the devaluation of national currencies in Russia and Kazakhstan, Kyrgyz goods have lost their competitiveness on these markets and, as a consequence, the import of products from these countries has increased.

The Kyrgyz Republic joined the Common Customs Tariff (CCT) of the EAEU, which implies a full renunciation of the previously existing national customs tariff and, in particular, of the simplified regime for individuals that served as the main channel of cheap imports from China and some other countries. This means a significant increase of customs duties on the import of agricultural products from the countries with the MFN status (i.e., all countries except CIS members and Vietnam). It may be noted that a significant increase of import duties and taxes on agricultural products is expected as a result of the abolition of the simplified regime with very low rates and a general rates increase during the transition from a national customs tariff to the CCT EAEU [4].

2. Customs and tax administration: The Kyrgyz Republic has begun to implement the EAEU Customs Code and is currently reorganizing its customs administration in line with the organization's rules. The Kyrgyz Republic borders with China, Tajikistan, and Uzbekistan represent EAEU external customs borders through which goods are released for free circulation throughout the Union. The border between Kazakhstan and the Kyrgyz Republic is now an internal border within EAEU and therefore no longer a customs border—hence the customs services of both countries have ceased their activities (and even their presence) along this border. Import duties charged by the State Customs Service of the Kyrgyz Republic now accumulate to a common EAEU fund. Under Article 8 of the above-mentioned Treaty on the Accession, the Kyrgyz Republic will receive 1.9 percent of the total duties collected by all the EAEU member states. At the time of the negotiations it was expected that this would signify a significant increase in revenues to the state budget compared to the customs duties collected before joining the EAEU. However, because of the drop, in 2015, of imports to Russia and other EAEU countries by 20 to 40 percent, the Kyrgyz Republic's government revenue increase from this source turned out to be negligible. In view of the cessation of customs control with respect to the trade with the countries that are EAEU members, responsibility for administration of the VAT on the import from these countries has transferred from the State Customs Service to the State Tax Service of the Kyrgyz Republic (STS). When importing from the EAEU, taxpayers are no longer required to pay VAT at the border, generating certain risks of tax evasion. In order to minimize these risks, STS has recently introduced an accounting system for goods crossing the Kyrgyz-Kazakh border [4].

3. Technical regulations and sanitary and phytosanitary measures: The Kyrgyz Republic should fully join the system of technical regulation and sanitary, veterinary, and sanitary and phytosanitary quarantine control adopted within the EAEU. This involves implementing a set of measures to harmonize legislation, modernize and expand the range of existing laboratories and their accreditation with EAEU authorized structures, train all market participants, and so on. Because of the technical complexities of adjusting to all these changes, the Kyrgyz Republic was granted a deferral on accession

to many of the existing EAEU technical regulations for a period of 6 to 48 months; for the majority of food and food safety regulations the deferral was provided for 24 months [4].

Policy on State Support of Agriculture

In accordance with the overview of agri-food trade policy in the former USSR countries (2014–15) conducted by the Food and Agriculture Organization of the United Nations, agricultural support measures implemented in the Kyrgyz Republic include budgetary programs of a general service provision nature: the financing of plants and animals protection offices; the procurement of agricultural chemicals and veterinary drugs; support for plant breeding and livestock breeding; the development of agricultural mechanization, pasture monitoring, maintenance, and irrigation infrastructure; the provision of soft commodity loans to agricultural producers for inputs such as seeds, fuel, lubricants, and other logistical resources.

A significant part of these measures is implemented as part of the Public Investment Program that incorporates international development agencies' projects. A relatively new program of support for agricultural producers is the project called Agricultural Financing 3, which was approved by the government in March 2015 and implemented using proceeds from the government budget. Similar projects had been previously implemented in 2013–14. In 2015–16, a total of 330 million Kyrgyz soms (about US$5 million) was provided to finance interest rates on subsidized loans to agricultural producers, who obtained access to loans from the Kyrgyz Republic's commercial banks with an interest rate of 9 or 10 percent per annum for 24 months and a six- or nine-month grace period. These loans are not attached to specific products or agricultural subsectors. Lending (from banks and micro-credit organizations exceeding 2 billion soms in 2014) to the agricultural sector has substantially increased. However, the lending amount remains low relative to the agricultural sector's share in GDP or the percentage of people employed in this sector. Access to "long" loans is limited because of high interest rates [4].

Stakeholder Groups

It is feasible to ensure the Kyrgyz Republic's food security during its integration into the EAEU by achieving the maximal balance of interests of the most interested groups (political elites, actors in agriculture, population), the activities of which affect the development of agriculture and food security.

Government

One of the key stakeholders interested in the improved efficiency of the agricultural sector and the country's strengthened food security is the Government of the Kyrgyz Republic, represented by the political elite and domestic bureaucracy. The process of the Kyrgyz Republic's integration into the EAEU is hampered by the interests of the government's political elites; agencies are deprived, to a certain extent, of the sovereign independence and of monopolies seeking to limit competition (this issue is related to personal political interests of representatives of the authorities, who will now have to make decisions in conformity with EAEU requirements and standards). Therefore it is necessary to identify the political elites' motives in order to sharply accelerate the integration process. Triggered by its membership in the EAEU, the transition to world prices for energy and other raw materials necessary for the functioning of the most important agro-industrial complex sectors may potentially cool down the relations between the Kyrgyz Republic and the EAEU, in turn affecting the pace of the integration process.

Making decisions on the management of the agricultural sector development and food security, the political elite of the country must, first and foremost, take into account the interests of the population, agricultural producers, and other actors of agricultural production. Furthermore, decisions must be made in accordance with the EAEU legal framework. The elite should understand that pursuing national interests does not run counter to EAEU objectives and does not deprive the leadership of the country of independence in decision-making. It means only that now that the country has become a member of the EAEU, its agricultural sector operates in new conditions, and, indeed, the wise use of existing opportunities will only strengthen the economic potential of the country. The pursuit of common interests through the implementation of joint development projects related to agribusiness production together with the ally states, as well as the implementation of agreed agricultural policy, is thought to help shape new perceptions of the political elite of the Kyrgyz Republic and incentivize the leadership of the country to accelerate integration with the EAEU.

Actors in Agricultural Production

In order to ensure food security in the context of the Kyrgyz Republic's integration into the EAEU, the state should abandon its dependent status as the donor of natural resources to agriculture. In this regard, the role of various agribusiness entities (agricultural organizations, farms, processing plants) will be strengthened, because their contribution will be conducive to strengthening the country's food security once intra-relationships are restored along the entire chain of production cycle—from agricultural production to processing and the production of finished products. It is in the interests of various agribusiness entities that this should be the major focus of their efforts.

The actors in the Kyrgyz agro-industrial complex are objectively interested in strengthening integration and developing economic relations with partners from EAEU member states. The development of the processing sectors of the country's agro-industrial complex whose products are usually not competitive in foreign markets is feasible only provided the common agricultural market is integrated. This would ensure the survival and development of the agricultural sector, which is one of the most important in the national economy and is critically dependent on the CIS markets.

Agricultural companies and farmers must also get access to the common agricultural market. However, first it will be necessary to carry out substantial work to bring the quality of their products in line with EAEU requirements.

The Kyrgyz Republic's agro-industrial complex remains in a state of crisis, and there is the potential for a further drop in production. At the same time, the domestic conditions for its development are extremely limited, while the available capacity is clearly insufficient for modernizing and increasing competitiveness. Accelerated integration into the EAEU opens access to new markets; it also ensures improved trade terms and increased turnover, enabling the agro-industrial complex to launch large-scale joint projects in the field of agriculture, thus giving a powerful impetus to enhanced food security.

Population

With regard to the population's interests in strengthened food security, the most important thing is to increase the share of high-quality food in the food market. In addition, agro-industrial complex development will reduce unemployment and improve overall living standards. The policy aimed at boosting the population's incomes is driven, among other things, by the need to preserve the country's skilled workforce. The conditions for the free movement of skilled labor from the Kyrgyz Republic set forth within the EAEU lead to a situation where these workers create value added for a foreign, albeit allied, country. Part of the funds earned by Kyrgyz citizens working in Russia is repatriated, but the bulk of the value added that is created by them stays in Russia. The loss of this value added creates problems for the Kyrgyz Republic's budgeting, as well as for financing major public expenditures—including those aimed at agro-industrial complex development. Implementation of the projects intended to develop the agro-industrial complex will help create new jobs and will reduce both the unemployment rate and the outflow of the working-age population to neighboring countries.

Policy Options

The analysis made of the current situation in the agricultural sector and food security of the Kyrgyz Republic and the review of the stakeholders' interests and motivation has enabled the development of several options for political transition in the country.

1. Create a System of Procurement Depot Complexes

According to Nikita Mendkovich—an expert on the Russian Council on International Affairs—the Kyrgyz Republic could take its agricultural niche within the Eurasian Economic Union [5]. For example, the Republic enjoys a comparative advantage in tobacco, beans, and cotton production compared to other EAEU member states. However, there are a number of issues that, once resolved, will allow the Kyrgyz Republic to benefit from the situation.

The main problem is the fragmentation of agricultural production in the Kyrgyz Republic. According to Mendkovich, a sufficiently large part of the market is not consolidated into large holdings, and business suffers from a shortage of land, poor logistics, and intermediation. As an example, he cites the production of white beans in Talas, which face problems of access to external markets because manufacturers are dependent on intermediaries who lower purchase prices and in turn are dependent on Turkish companies, which

provide goods transportation services. At the same time, it is worth noting that this is not too reliable a channel, because Turkey itself is a bean exporter to the post-Soviet region and, thus, a competitor to Talas' manufacturers. As a result of these problems, for example, in 2013 a significant share of Kyrgyz beans, despite their large yield, failed to reach the Russian and Kazakhstan markets.

In some southern regions of the Kyrgyz Republic, a weak transport system leads to intermediaries' ability to dictate terms. Their influence is so strong that the purchase price for the product and regional market price differ by an order of magnitude. As a result, farmers are deprived of profits and working capital needed for production modernization and expansion.

The implementation of the idea of establishing procurement depot complexes through a public-private partnership would contribute to the centralized procurement of any agricultural products (meat, milk, vegetables, fruits, etc.) and would enhance their subsequent supply to foreign markets. Operators of such centers would purchase from local producers at a fair price, and at the same time they would cooperate with wholesale customers throughout the country, as well as with other markets primarily located in EAEU member states. A price that would be fair for everybody must be set, regulated, and monitored by the State Agency of Anti-Monopoly Regulation under the Government of the Kyrgyz Republic, whose main task is to protect and develop competition to support the efficient operation of markets of works, goods, and services [6].

The activities carried out by the operators of the procurement depots should be also supervised and monitored by the government to avoid collusion with agricultural producers and/or wholesale consumers. In exchange, the government may provide some subsidies, benefits, or support needed to put in place the necessary equipment. Such complexes are rather expensive, as they entail both government financing and investments by other interested market participants (international organizations, business community) and involve the procurement of expensive equipment. However, all market participants would benefit from having these depots established: producers would sell their products at a reasonable price, allowing them to modernize production; consumers would be able to buy products at affordable prices; the state would thus ensure increased food security, among other things, for low-income families who would be able to get more vitamins and improve their nutrition.

2. Expand Transport Systems and Replace the Vehicle Fleet

The transport systems in the Kyrgyz Republic are poorly developed. The main transportation vehicles are trucks that are costly both in terms of product transportation and the use of fuels and lubricants. Discussions about the importance of the railway transportation system within the Republic have been going on for a long time. A developed and branched railway network would help reduce transportation and logistics costs and attract more investment projects to various sectors of economy, including agriculture. However, all these ideas remain on paper, because no budget money is allocated for their implementation.

Expanding the transportation systems and replacing the vehicle fleet means a set of long-term and costly activities, but, if implemented, these improvements would benefit other sectors besides the agricultural sector. During the establishment and expansion of the transport systems, workers would be hired, thus reducing unemployment, and a convenient transportation system would enable an increase of the export of agricultural products and foodstuffs, as well as other types of goods produced in the Kyrgyz Republic.

3. Reform the Veterinary and Phytosanitary System

Diseases of livestock and a lack of effective veterinary services are important obstacles limiting the development of the livestock sector. In addition to negatively impacting livestock productivity, diseases of domestic animals also jeopardize public health and limit the export potential of the country. There also exist serious concerns regarding the quality of food.

Failure to comply with EAEU requirements for agricultural output reduces the country's export potential substantially.

The measures aimed at reforming veterinary and phytosanitary safety as part of EAEU accession have not yet been integrated into the state budget.

According to the reports of a parliamentary delegation, during a trip to the Issyk-Kul Region it was ascertained that the state of veterinary medicine in the Kyrgyz Republic was poor [7]. A set of measures aimed at achieving veterinary improvements would simultaneously result in high costs for the state;

however, these measures would provide the country with meat and substantially reduce dependence on import.

The private sector would have to take extensive measures to train staff and improve the technology used to ensure compliance with EAEU technical regulations and problem-free passage of the sanitary, veterinary, and phytosanitary control systems. This would require both time and investment.

The Government of the Kyrgyz Republic should ensure the establishment of sanitary and phytosanitary laboratories authorized to issue certificates for agricultural products to be exported to the EAEU in accordance with its requirements and regulations.

The modernization of laboratories and their accreditation, along with improvements to sanitary, veterinary, and phytosanitary control systems, would allow certificates of conformity, declarations of conformity adopted by product manufacturers, and unified EAEU forms of veterinary and phytosanitary certificates issued by the relevant authorities of the Kyrgyz Republic listed in the EAEU single register to be recognized throughout the territory of the EAEU.

It would also be necessary to ensure the development of the research potential of the agricultural science and support to promising areas of research.

4. Support for the Food Security Atlas

The UN World Food Programme (WFP) and the Ministry of Agriculture and Land Reclamation of the Kyrgyz Republic developed the first edition of the *Atlas of Food Security*. The atlas is a new tool for mapping food security in the country. It is a series of thematic maps on food security based on existing data and indicators, and includes 30 thematic maps on the four pillars of food security (availability, access, utilization, and stability). All maps are presented with a description of the inequalities between the regions/districts and a comparison with other maps in the atlas. The first part of the atlas focuses on the production of wheat, potatoes, and vegetables. The second part includes the nine crops that shape the food security of the Kyrgyz Republic. For example, wheat is a major product in the diet of the majority of the Kyrgyz population. Daily, an average person receives about 1,076 calories from wheat, representing 38 percent of daily energy needs. This crop represents 47 percent of the total domestic cereal production [8].

One of the maps represents the average wheat production over three years (2012–14) by district. The map reveals data on wheat production in the Sokuluk, Jayil, Issyk-Ata, and Moscow Districts of the Chui Region (Oblast)[1]; Uzgen and the Kara-Suu District of the Osh Region; and the Tyup District of Issyk-Kul Region, which together account for more than half of the wheat production in the country.

At the same time, according to official statistical data, wheat production in the highly productive districts of the Chui Region (Sokuluk, Jayil, Issyk-Ata, Moscow, and Panfilov Districts) fell sharply in 2013 and 2014.

The importance of this atlas is emphasized and prioritized by the Ministry of Agriculture, Food Industry and Land Reclamation.

5. Participate Actively in the SUN Movement

As the Ministry of Agriculture, Food Industry and Land Reclamation is guided by the Program of Food Security and Nutrition in the Kyrgyz Republic, which has been approved by a Resolution of the Kyrgyz government dated September 4, 2015, the ministry stresses the importance of the Kyrgyz Republic's participation in the Scaling Up Nutrition (SUN) Movement established in 2010 by a range of stakeholders concerned with the lack of progress toward reducing hunger and malnutrition and achieving food and nutrition security for all [9]. The *Road Map for Scaling-Up Nutrition* (SUN) published in 2010 states "Nutrition security can be achieved when secure access to an appropriately nutritious diet is coupled with a sanitary environment, adequate health services and care, to ensure a healthy and active life for all household members."

The program of food security and nutrition in the Kyrgyz Republic for 2015–17 cites the results of a sample household survey of energy consumption (per capita kilocalories per day) in 2012 and the first half of 2013 for those households that have a positive balance compared to the minimum consumption standard, with the exception of the population of Batken Region, where the energy value of food has a negative energy balance. Inadequate consumption of protein and fat per capita per day is noted in almost all regions with the exception of the population with the highest income [10].

[1] Region has the same meaning as oblast in this case study.

Unbalanced nutrition during fetal development and infancy is one of the causes of stunted growth and intellectual development, high morbidity, mortality, and occurrence of chronic diseases in adults: cardiovascular diseases, certain types of cancers, diabetes, anemia, and other diseases.

The participation of the Kyrgyz Republic in the SUN Movement is an additional measure aimed at improving nutrition and eliminating vitamin deficiency in the country.

6. Strengthen the Social Protection System to Reduce Poverty in Rural Areas

Social support policy should be coordinated with food security programs. In order to improve social protection systems, consultations are provided on issues of policy, capacity development, and the promotion of sustainable and equitable rural development, poverty reduction, food security, and nutrition.

Special attention should be paid to strengthening the institutional and professional capacity for the development of the agricultural sector at all levels (from farms to research institutions). Investments in agricultural education, social protection, and an expanded list of services, along with greater cooperation between farmers, would help address a number of challenges. Primarily, this would address the general goal of accelerated development in rural areas, including productivity growth of existing enterprises, increased incomes and reduced poverty of the population, and the creation of new businesses and new jobs for the unemployed population outside the farms, thus ensuring productivity gains by these farms.

Assignment

The assignment is to identify and analyze the changes in the agro-industrial complex of the Kyrgyz Republic in connection with the country's integration into the Eurasian Economic Union (EAEU). In addition, suggest policy actions that would strengthen food security and ensure that relevant stakeholders' interests are met.

Policy Recommendations

This case study has identified key challenges in development of the agro-industrial complex and food security of the Kyrgyz Republic during the process of its integration into the EAEU.

The analysis of statistical data over the studied period (2010–15) demonstrated that, despite increased agricultural output (mostly as a consequence of the increased production of potatoes, wheat, and vegetables), the country is not able to provide home-produced food products to its population; that is why the percentage of imported food is still high. At the same time, failure to comply with EAEU standards and requirements substantially reduces the volume of exported agricultural output produced in the country.

After the country joined the EAEU, state support of the agro-industrial complex changed significantly. Currently a number of budget programs aimed at supporting agricultural producers by providing them with commodity loans of seeds and lubricants/fuel, developing the mechanization of agriculture, and maintaining and developing irrigation infrastructure, among others, are being implemented.

Regarding implementation of export-import policy toward agricultural products, after the country joined the EAEU, more drastic changes occurred in such areas as import regulation, customs and tax administration, and technical regulation.

However, the measures being undertaken are not sufficient. The agro-industrial complex of the Kyrgyz Republic is still in crisis and the country's dependence on imported food is high.

In order to ensure steady and sustainable development of the agro-industrial complex and strengthen the food security of the country, new policy decisions that would strike the right balance between the interests of the most important stakeholders—for example, political elites, agricultural producers, and the population—need to be worked out in the process of integration in the EAEU.

Based on this premise, this case study has developed and offered options for political changes aimed at facilitating the development of the country's agro-industrial complex and strengthen food security. *Forecasts of changes in the situation that would take place if the proposed policy options were implemented help recommend the most productive and efficient options—namely, creating a system of procurement depot complexes; reforming the veterinary and phytosanitary systems; expanding the transportation systems and replacing the vehicle fleet*. It is important to note that comprehensive implementation of the recommended policy options will have a positive impact on agro-industrial complex development, help create conditions for increasing the output of competitive agricultural products of high quality, improve the situation with supplies of food to the population of the country, reduce dependence on imports, and increase export volumes. Moreover, it is expected that the implementation of the proposed policy options would lead to more jobs in agriculture and lower the unemployment rate, which would help reduce social tensions in the country.

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The Dairy Sector of Armenia: Relationships among Supply Chain Members

Irina Poleshkina, Elbis Peplozyan

Executive Summary

Agriculture plays a special role in transition economies, in both economic and social terms. The sector produces a major portion of the country's GDP and not only provides food but often serves as the only source of income for a large part of the population.

For the Armenian government, the key objectives of dairy sector development are to attain the country's full self-sufficiency in dairy products, make them more competitive in foreign markets, protect local suppliers' rights, and ensure that rural incomes are compatible with urban income levels. But, according to data of 2015, the milk self-sufficiency of Armenia remains low (62.7 percent) and processors continue to underprice farm-gate milk.

In Armenia, the insufficiency of milk output is accounted for, primarily, by the uncompetitive standing of raw milk producers in the chain of added value. Most of these producers (99.2 percent) are individual farms with an average livestock population of 1 animal. For this reason, the margin is distributed among farmers, processors, and traders disproportionately relative to their inputs; incomes of local people go down; milk supplies for commercial processing is decreased; processing capacities are underutilized; and the performance of the dairy sector as a whole is impaired.

To make milk producers more competitive, several policy options are proposed: the introduction of a mechanism for regulating price relations among milk producers and processors; the use of incentives such as direct payments to producers to encourage them to reduce the seasonality of milk supply to processors; the establishment of marketing and milk processing cooperatives; the establishment of large commercial milk producers; and the delivery of training programs for farmers.

The key stakeholders in the dairy sector of Armenia are government bodies, farmers, milk processors, retailers, and dairy product consumers (rural and urban populations).

Your task is to develop recommendations for decision makers to help them select the best government regulation policies in the dairy sector, taking a balanced approach to the interests of all supply chain participants; and to identify the economic, social, and food implications of such policies.

Background

Armenia is a small mountainous country located in the South Caucasus with a total area of 29,743 square kilometers (Figure 1); Armenia borders with Azerbaijan and self-proclaimed Nagorno-Karabakh Republic, Georgia, Turkey, and the Islamic Republic of Iran. Foreign trade is actively pursued only with Georgia and the Islamic Republic of Iran.

The country's landlocked position and huge variation in elevation define its climate, with hot summers and cold to moderate winters.

Figure 1. Armenia and Neighboring Countries

Source: http://www.mapnall.com/

Agricultural land comprises about 67 percent of the country's territory. The area of tilled land in Armenia has been shrinking every year (see Table 1).

Administratively Armenia is split into 10 marzes (regions): marz Aragatsotn, Ararat, Armavir, Vayotz Dzor, Geharkunik, Kotayk, Lori, Suynik, Tavush, and Shirak, along with the city of Erevan, which has a special administrative status as the country's capital. Erevan is the largest city, with a population of 1,071,500.

Armenia is a member of the Council of Europe, the Eurasian Economic Community, and the World Trade Organization.

As of the beginning of 2015, the population of Armenia was 3,010,600, of whom 64 percent resided in rural areas.

Agriculture is an important sector of the Armenian economy: based on 2015 data, it accounts for 20.5 percent of the GDP with crop production taking up 59 percent and animal husbandry 41 percent. The dairy sector produces 2.56 percent of the GDP. Agriculture employs about 36 percent of the country's population, but this share has been shrinking as a result of inadequate profitability of the business [1].

Self-sufficiency in staple agricultural products in Armenia in 2014 was 60 percent in caloric equivalent. The lowest self-sufficiency level is observed for poultry and pork, wheat and milk (see Table 2). Food self-sufficiency of a country is understood as reliable (sustained) and sufficient (according to respective dietary standards) supply of the country's population with food which is produced domestically and independently of imports, and adequate availability of inputs for agroindustry.

The State of the Dairy Sector in Armenia

Dairy farming holds a special place in agricultural production. According to 2015 data, the availability of domestically produced milk (that is, Armenia's self-sufficiency in milk) per capita per annum is 196.1 kilograms, which is 38.7 percent lower than the recommended human nutrition norm. The per capita milk consumption, including imported milk, is 240.1 kilograms per annum with import considered; this is 25.0 percent lower than the recommended standard (320 kilograms per capita per year) (Table 3).

Armenia is number two among the Eurasian Economic Union members in terms of the share of imported dairy products in gross consumption (18.3 percent), trailing the Russian Federation where the share of dairy imports is 30 percent; according to

Table 1. Land Resources of Armenia

Land resources of Armenia, 1,000 hectares	1995	2010	2011	2012	2013	2014	Area increase / reduction (%)
Total area	2,974.3	2,974.3	2,974.3	2,974.3	2,974.3	2,974.3	0.0
Agricultural land	1,391.4	2,100.9	2,076.9	2,052.4	2,051.0	2,049.4	47.29
Including							
Tilled land	483.5	448.5	449.2	448.4	448.2	447.5	-7.45
Perennial plantings	74.7	32.9	33.0	33.4	33.3	33.7	-54.89
Hayfields	138.9	127.1	128.3	121.6	121.8	121.7	-12.38
Pastures	693.5	1,104.3	1,067.2	1,056.3	1,055.3	1054.2	52.01
Other	0.8	388.1	399.3	392.7	392.4	392.3	48,937.5

Source: The National Statistical Service of Armenia [1].

Table 2. Domestic Outputs of Key Agricultural Products in Armenia, 2014–15

Agricultural product	Total output (1,000 tonnes)		Per capita consumption (kilograms per annum)		Share of domestically produced outputs in the total supply (%)	
	2014	2015	2014	2015	2014	2015
Wheat	338.2	383.7	150.3	153.4	48.7	50.9
Potato	733.2	764.5	47.9	69.7	101.1	101.7
Vegetables	1,200.4	1,318.3	384.2	226.4	99.1	100.0
Fruit except grapes	291.0	493.1	97.7	116.5	93.8	102.0
Grapes	261.3	309.2	4.7	4.7	101.9	101.2
Beef	59.0	63.6	22.9	24.3	87.9	92.3
Pork	16.2	17.5	10.2	10.7	54.2	57.8
Lamb and goat meat	9.1	9.8	3.0	3.2	103.4	107.7
Poultry	8.4	9.5	14.5	15.5	20.0	21.8
Milk	700.4	728.6	260.7	257.7	81.5	93.0
Eggs	35.3	36.3	11.4	12.2	97.2	99.5

Source: The National Statistical Service of Armenia [1].

the Armenian government's food security strategy, it would be expedient if this share of consumption could be covered, instead, by domestically produced products.

In 1991, after the breakup of the Soviet Union, agricultural land, fixed assets, and livestock were privatized in Armenia. Instead of large collective farms and state-owned farms, 332,900 small farms appeared. At that time, vertical links in the production and marketing of milk and dairy products were severed, and they took a long time to restore.

Those developments resulted in a high prevalence and low consolidation of small milk producers, which makes them somewhat dependent on

Table 3. Annual Balance of Milk in Armenia and Self-Sufficiency Levels

Indicator	2012	2013	2014	2015
Opening balance, 1,000 tonnes	59.8	60.1	85.9	75.1
Domestic production, 1,000 tonnes	618.2	657.0	700.4	728.6
Used as animal feed, 1,000 tonnes	61.8	65.7	77.0	80.1
Losses, 1,000 tonnes	8.6	8.6	9.7	8.9
Exports, 1,000 tonnes	9.0	17.8	20.8	77.6
Closing balance, 1,000 tonnes	60.1	85.9	75.1	46.8
Self-sufficiency in milk, 1,000 tonnes	538.5	539.1	603.7	590.3
Self-sufficiency level relative to the nutritional standard, %	57.0	57.0	64.0	62.7
Self-sufficiency in milk per capita per year, kilograms	178.2	178.1	200.1	196.1
Imports, 1,000 tonnes	134.8	133.6	151.9	132.6
Consumption, including imported products, 1,000 tonnes	673.3	672.7	755.6	722.9
Share of imports in milk consumption, %	20.0	19.9	20.1	18.3
Total consumption per capita per year, including imported products, kilograms	222.8	222.2	250.4	240.1

Source: The National Statistical Service of Armenia [1].

large processors that are more competitive in the market. The imbalance in the competitive positions of dairy market participants causes disproportional distribution of margin among producers, processors, and traders; higher transportation and transaction costs; and, ultimately, lower cost-effectiveness for the entire sector and for milk producers in particular.

In order to analyze the dairy market in Armenia it is necessary to study the entire supply chain, identify the market position and interests of all stakeholders, and understand the extent to which the government can influence the processes in the sector. The number of links in the dairy chain may vary depending on the number of intermediaries, while the number of operations and processes needed to obtain a certain dairy product is fairly constant. Supply chain efficiency is defined by the optimal allocation of all necessary processes that create added value among participants.

The value chain for dairy products includes five key stages: (i) milk production and storage, (ii) raw milk collection and delivery for processing, (iii) milk processing and production of dairy products, (iv) transportation of final products to the places of sale, and (v) sale of dairy products to consumers (see Appendix A).

The retail price for finished dairy products is determined by the cost of production, transaction and logistics costs defined in the course of establishing contractual relations, and the cost of the movement of goods between production stages along the value chain.

According to the sector competition level assessment technique suggested by Michael Porter, a sector's appeal is defined by the five "horizontal" and "vertical" competition forces. The horizontal competition forces include the rivalry within the existing players, the threat of new entry, and the threat of substitution. The vertical competition forces include the bargaining power of suppliers and the bargaining power of buyers. A sector is appealing if it offers sufficient profitability for all players; it is not when competitive forces reduce profitability for at least one group of players [2].

In Armenia, the demand for milk is higher than its domestic supply, judging by the large share of imported dairy products in the Armenian market. The high degree of rivalry in the raw milk market is observed in six of Armenia's marzes: Aragatsotn (producing 644.3 kilograms per capita per year), Gegarkunik (551.9 kilograms), Lori (377.2 kilograms), Shirak (448.5 kilograms), Syunik (495.0 kilograms), and Vayotz Dzor (496.1 kilograms; see Figure 2). Since the milk outputs of other marzes are not sufficient to meet the nutritional standards for its consumption, the problem could be resolved through encouraging cross-regional exchange.

Wide variations between different marzes in terms of own-production milk availability are explained by natural and climatic conditions that define availability of usable pastures and the possibility of producing succulent fodder. The productivity of cattle in Armenia is low (see Table 4) as a result of [3], [4]:

- the dry climate and the need for irrigation;

Table 4. Cattle Population, Volume of Milk Production, and Average Productivity of Cattle

Indicator	2010	2011	2012	2013	2014	2015
Cattle population (1,000 head)	**273.9**	**272.6**	**283.3**	**303.3**	**309.6**	**313.9**
Commercial organizations	2.4	2.5	2.6	2.2	2.7	2.7
Individual farms	271.5	270.1	280.7	301.1	306.9	311.2
Milk production (1,000 tonnes)	**600.9**	**601.5**	**618.2**	**657.0**	**700.4**	**728.6**
Commercial organizations	3.4	3.6	3.5	4.1	5.3	6.3
Individual farms	597.5	597.9	614.7	652.9	695.1	722.3
Average annual milk yield per cow (kilograms)	**2 193.8**	**2,206.5**	**2,182.1**	**2,166.2**	**2,262.3**	**2,321.1**
Commercial organizations	1,416.6	1,440.0	1,346.1	1,863.6	1,962.9	2,333.3
Individual farms	2,200.0	2,213.6	2,189.8	2,168.3	2,264.9	2,321.1

**NSSA [1]*

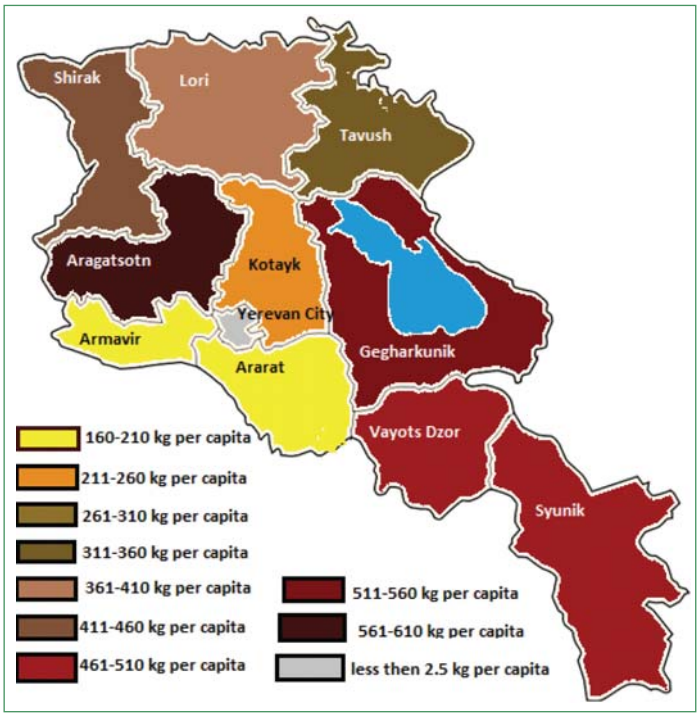


Figure 2: The Volume of Milk Produced in the Regions of Armenia per Capita, 2014

Source: Developed by I.Poleshkina and E.Peplozyan; data from www.armstat.am.

- the low genetic potential of animals and the lack of modern technologies to breed high-yielding young cattle;
- poor pasture load management system, which results in exhausting pastures near settlements;
- the less nutritious winter diet;
- high animal morbidity; and
- the lack of experience with commercial milk production.

Individual farms tend to satisfy their own needs for milk, preferring to sell milk they process on their own. Surplus milk goes to commercial processing. As a result, only 63.1 percent of milk goes to commercial processing; individual farms process and sell 22.8 percent of gross milk volume, and the remaining 14.1 percent is consumed by producers' households (see Figure 3).

According to the Ministry of Agriculture of Armenia, there are 61 milk-processing organizations in the country with a total productive capacity of 490,000 tonnes of milk per annum; they produce

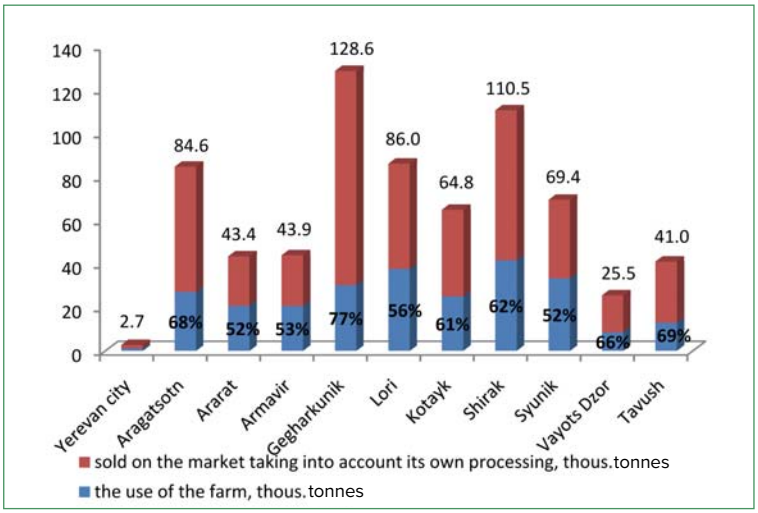


Figure 3. Levels of Milk Marketability, by Marz

Source: Developed by I.Poleshkina and E.Peplozyan.

dairy products on a commercial basis all year round. Furthermore, there are many small cheese-making factories [5] (Table 5). The average capacity utilization rate of these factories is 30–40 percent because many processors use obsolete equipment and barely manage to recover their maintenance and operation costs. At the same time, 80 percent of dairy products are produced by 10 major milk processors, actually using about 85 percent of their capacity.

The operation of small producers is characterized by high seasonality; thus, milk for processing comes mostly during the summer, while the milk supply in winter all but ceases. Therefore milk processors start to compete for raw milk suppliers (see Figure 4).

Underutilization of capacity results in a loss of profit due to the inadequate use of economies of scale, which in turn prevents processors from increasing farm-gate price. This makes the delivery of milk for processing unprofitable and forces farmers to produce dairy products on their own; such products do not always meet sanitary and hygienic standards. Farmers are unable to sell their milk at acceptable prices; this prevents the increase of the dairy livestock population and thus constrains the development of the milk processing industry.

The threat of new entries into the domestic dairy market is low because of low cost recovery in dairy husbandry and the lack of foreign investment. The threat of new entries into the foreign market is present if the diary market has unused capacity. At the same time, the majority of the Armenian population prefers to consume domestic dairy products with a short shelf life.

There is no threat of substitution since the local population tends to consume traditional dairy products made from natural raw milk.

The impact of "vertical" competition forces is manifested in the bargaining power of suppliers. It comes in the form of price pressures from energy suppliers and the high volatility of fodder prices, which affects the cost of milk production.

The bargaining power of buyers is defined by the influence of three players: processors, wholesalers and retailers, and dairy product consumers. At each stage milk can be both raw material for the subsequent stage of the logistics chain and the final product.

The monopolistic position of processors results in retail prices that undermine the sector's development.

Table 5. Volume of Dairy Product Production in Armenia

Product	2012	2013	2014	2015
Cheese, tonnes	17,658	17,375.4	18,317.3	18,592.5
Milk, dairy products (processed) including processing at farms (except internal consumption), tonnes	319,800	362,700	430,000	447,900
Ice cream, 1,000 liters	3,628.6	4,265.1	6,345.0	9,639.5

Source: The National Statistical Service of Armenia [1].

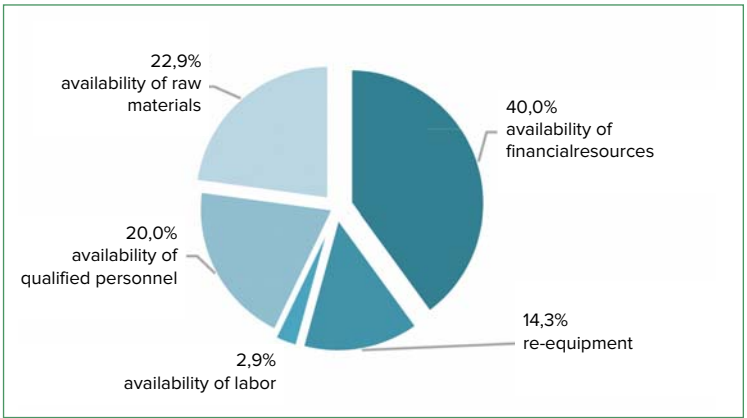


Figure 4. Constraints to Milk Processors' Development

Source: Ministry of Agriculture of the Republic of Armenia 2014.

Table 6. Retail Price Composition in the Dairy Market in Armenia, 2015

Period	Average sale price in Armenia (dram/liter)			Share of each market participant in the pasteurized milk sale price (3.2 % fat content) (%)		
	Raw milk by farmers	Pasteurized milk (3.2% fat content) by processors	Pasteurized milk (3.2% fat content) by trade organizations (consumer price)	Farmers	Processors	Retailers
January	181	335	418	43.3	36.8	19.9
February	177	334	417	42.4	37.6	19.9
March	175	332	416	42.1	37.7	20.2
April	166	325	411	40.4	38.7	20.9
May	150	323	410	36.6	42.2	21.2
June	136	322	409	33.3	45.5	21.3
July	131	321	408	32.1	46.6	21.3
August	130	320	407	31.9	46.7	21.4
September	135	319	406	33.3	45.3	21.4
October	140	320	407	34.4	44.2	21.4
November	151	324	409	36.9	42.3	20.8
December	146	325	410	35.6	43.7	20.7

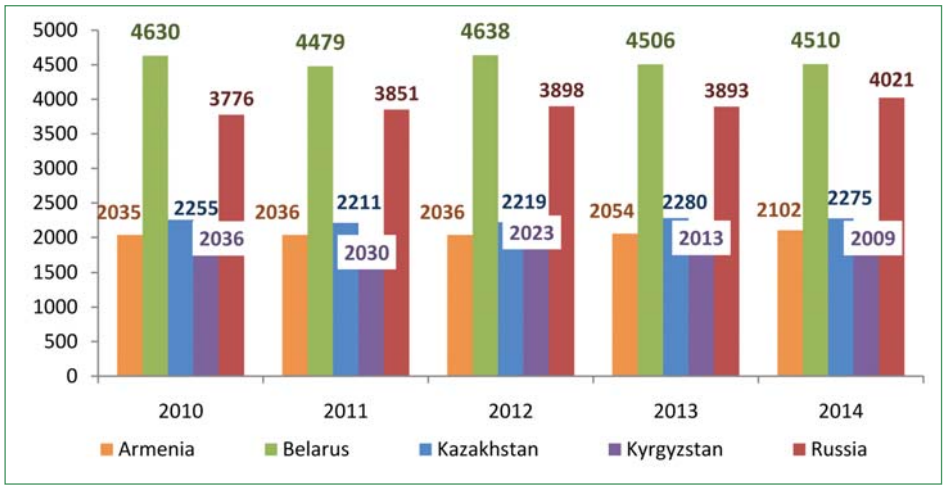
Source: Calculations of I.Poleshkina and E.Peplozyan.

According to experts, the optimal composition would be when 50 percent of retail price reflects the farm-gate price of milk, 30 percent reflects the sale price of processors, and 20 percent reflects the share of retail trade [6]. When this composition is not achieved, producing milk becomes unprofitable, and instead of extended reproduction and new upgraded farms a declining cattle population is observed. Compare this to the following: in the United Kingdom, the share of farmers in the sale price of pasteurized milk is 56 percent; in Germany, it is 46 percent [7], [8]. The retail price composition of the Armenian dairy market is presented in Table 6.

Policy Issues

The overwhelming majority of cattle worldwide (68.3 percent) have productivity below the world average level—of 2,319 kilograms per cow per year. Productivity of cattle in Armenia is the lowest among member countries of the Eurasian Economic Union (see Figure 5).

In this context, government regulation should be regarded as a way to mitigate dairy market failures and set up conditions for successful development



Source: Armenia and the Customs Union: Evaluation of the Integration Economic Impacts, 2013 [9]

Figure 5. Milk Yields per Cow in Eurasian Economic Union Members, All Farm Types (kilograms)

of the sector. Government regulation of the dairy market is objectively needed in view of the fact that producers, processors, and traders inherently have unequal power in the market because of the specific characteristics of milk as an asset. The leading milk-producing countries provide many examples of government regulation used to encourage dairy sector development. For instance, in the Netherlands the government focused on establishing cooperatives; in Canada, on setting up a market for dairy products and regulating farm-gate prices at each stage of the production chain [10]; in the European Union, on maintaining high domestic prices for dairy products by using quotas to constrain milk supply [11], [12]. Over the course of more than 80 years, the United States has experimented with many regulation tools, including government support of raw milk producers and regulating raw milk prices [13].

The sector's development can be spurred only if normal profitability is achieved, thus allowing extended reproduction. The profitability of milk producers is determined not only by the production efficiency but also by the relations established along the supply chain all the way to the end consumer.

The key challenges for the Armenian dairy sector that need to be addressed by the government are as follows:

1. low productivity of cattle—its causes are outlined in the previous section;

2. poor milk quality, since farmers do not employ state-of-the-art milking, collection, and cooling technologies;

3. small-scale milk production with high seasonality and low marketability that prevents full and even utilization of processing capacity during the year;

4. an unfair distribution of margin between the dairy chain participants, with an obvious advantage for processors—their share of the retail sale price is 42.3 percent; and

5. an underdeveloped market infrastructure—a sound market infrastructure is required to build long-term vertical links between the dairy chain participants with minimal transportation and logistics costs.

The above constraints result in inadequate self-sufficiency for Armenia in dairy products. In concurrence with this, 100 percent self-sufficiency of Armenia in milk is a high-priority objective for the government—a priority that is reflected in the Food Security Concept for Ensuring Food Security of the Republic of Armenia. Insufficient milk output is compensated for with imported powder milk and those dairy products that have not been traditionally produced in Armenia. The imported products allow foreign companies to consolidate their positions in the Armenian domestic market. The situation is aggravated by Armenia's joining the Customs Union of the Eurasian Economic Union.

The state policy in agriculture in Armenia is implemented by the Ministry of Agriculture. It comprises the Licensing Center, the State Inspection of Agricultural Machinery, the State Service of Food Safety, and the State Committee on Water Industry. The ministry disseminates knowledge through a network of regional agriculture support centers that provide extension services to farmers.

The Government of Armenia is aware of the grave situation in the dairy sector, and is implementing a series of programs to address the challenges. Implementation of the Animal Husbandry Development Program for 2007–2015 was completed in 2015. This program aimed to improve selective breeding of cattle, support farms, enhance the productivity of farm animals, and preserve the genetic material of the locally selected breed Brown Caucasian with average yield of 4,000–5,000 kilograms of milk per year. Under the program, 2,067 bred heifers of the Holstein and Simmental breeds were brought to Armenia; they were provided at cost to cattle farms on the installment plan for four years. The amortization schedule calls for the repayment of 10 percent of the cost in year 1, 20 percent in year 2, 30 percent in year 3, and the remaining 40 percent in year 4.

In order to encourage fodder production, the country is carrying out the Program to Promote Production of Barley, Alfalfa and Sainfoin in Armenia for 2016. Under this program, farms with more than 0.3 hectares of land are eligible to obtain seeds at a subsidized price.

The Farm Animals Vaccination Program intends to reduce animal morbidity in Armenia. The program uses public funds to perform prevention for eight infectious animal diseases and diagnostics for two annually; this helps to maintain a stable sanitary and epidemiological situation.

A program of subsidized agricultural loans aims to promote industry technology upgrades: each farm

can obtain a loan of 3 million drams for two years at 14 percent per annum. The state subsidized 4 percent of the interest rate prior to 2015, and 6 percent after 2015.

A special place in animal husbandry development belongs to the Community Agricultural Resource Management and Competitiveness Project implemented by the Ministry of Agriculture with the support from the World Bank in 2015–2020. The project aims to support livestock farms by improving roads to remote pastures, improving irrigation and rehabilitating degraded pastures, building capacity for milk collection and processing, improving veterinary and breeding services, and other activities. At its initial stage, the project was implemented in six out of ten marzes (Aragatsotn, Lori, Shirak, Tavush, Gegharkunik, and Syunik). The activities are mainly financed by the government; farmers cover only 20 percent of the cost of agricultural machinery purchased and 5 percent of other costs. The productivity of livestock in participating communities has grown 20 to 25 percent, and at the same time the livestock population and incomes of livestock farms increased.

All government-sponsored programs aiming to support the dairy sector provide direct subsidies to farmers and targeted financial support to meet intra-farm needs. Such measures do not immediately result in larger farms and greater marketability of milk. Besides, they disregard price relations between dairy chain participants. Therefore some financing intended for the livestock sector is redistributed to processors through underpriced farm-gate raw milk prices.

The Government of Armenia has opted for a hands-off trade policy in the dairy sector, and does not interfere with market interactions between the players. There are no quantitative restrictions in Armenia with respect to the export and import of dairy products. Imported products are subject to ad valorem duties of 0 and 10 percent[1]. Zero customs duties apply to imported food ingredients, and the rate of 10 percent applies to final products. Such policy encourages import of ingredients and domestic production of goods that could be later exported [9]. There are no export duties on agricultural produce in Armenia. Armenia's foreign trade policy is rather liberal, which is characteristic of majority of developing countries. This policy ensures growth in cheese exports and a relatively stable situation with regard to dairy products import (see Table 7).

Prices of domestic dairy products in Armenia are higher than in the Customs Union member countries [9]. On the one hand, Armenia has no protection against imports; on the other hand, people have low purchasing power. In addition, market integration and transport infrastructure are underdeveloped, which constrains a further increase in dairy imports.

In Armenia, average dairy products tariffs are 5.64 percent lower than the Unified Customs Tariff used by the Customs Union. Therefore, in order to protect local milk and dairy products producers, the government has to reconsider its import policy. Higher customs duties will help to reduce budget deficit and redirect trade flows; however, if this is to be achieved, domestic milk production volumes must increase.

The total cash transfers to agriculture are very low in Armenia: according to 2015 data, they account for about 1.4 percent of the country's gross agricultural output. Only 1.1 percent of the public budget was

[1] Ad valorem duties are set as percentages of the customs value of the goods imported.

Table 7. Export versus Import of Dairy Products in Armenia

Product	2012	2013	2014	2015
		Export, tonnes		
Cheese	903.6	1,541.1	1,542.4	9,114.7
		Import, tonnes		
Milk (all kinds)	3,066.5	3,095.2	4,455.6	4,343.6
Butter	4,907.4	4,749.0	5,262.3	4,419.7
Cheese	1,056.2	1,243.7	1,187.9	1,118.4

Source: The National Statistical Service of Armenia [1].

spent to support agriculture although this sector generates 20.5 percent of the GDP, with the dairy subsector contributing 2.56 percent of the agricultural share of the GDP.

The above government regulation measures are obviously insufficient; this is evidenced by the huge volume of milk and dairy products entering the market informally. The informal dairy chains appear because of the price pressures that processors put on milk suppliers—their relations are free from any state regulation. Therefore the key challenge for the government in Armenia at present is to identify the best mechanisms that would help regulate market relations between dairy chain participants. There are good reasons that the dairy market in the majority of developed countries is the most heavily regulated.

Stakeholder Groups

The Government

The key stakeholder in the dairy sector development in Armenia is the government; achieving food security is a strategic objective, and this is set forth in the *Law On Ensuring Food Security of 2002* [14], the National Security Strategy of the Republic of Armenia, and the Concept for Ensuring Food Security of the Republic of Armenia. Measures to reach the objective are specified in the *Strategy for Sustainable Development of Agriculture of the Republic of Armenia for 2014–2025* [15], which was amended when the country joined the Eurasian Economic Union. The responsibility for the implementation of this strategy rests with the Ministry of Agriculture. Financing of the program is approved by the Ministry of Finance, which keeps reducing the amount of money made available for the dairy sector. The main goals of the strategy are to reach the milk production volumes necessary to ensure food security (100 percent self-sufficiency in milk); to boost the competitiveness of domestic dairy products in the international market; to uphold the rights of local producers; and to assist rural communities in mountainous and piedmont areas that specialize in domestic livestock breeding. Table 8 shows the targets for the dairy sector established in the Strategy for Sustainable Development of Agriculture of the Republic of Armenia.

Farmers

Another stakeholder group is farmers producing milk and dairy products. Armenia has close to 170,000 such farms, and they are responsible for 99.2 percent of gross milk output; commercial organizations account for less than 1 percent of output (see Table 9) [16]. The predominance of small producers in the dairy sector is typical for developing countries, but their share in Armenia is indeed huge.

Table 8. Targets for the Dairy Sector

Indicators	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Milk output, 1,000 tonnes	721.8	759.3	800.3	838.3	883.0	924.6	968.4	1,013.5	1,057.0	1100.8
Cattle population, 1,000 head	325.9	330.7	335.3	339.6	343.7	347.1	350.7	354.1	357.4	360.6
Average annual milk yield per cow, kilograms	2,250	2,330	2,420	2,500	2,600	2,690	2,790	2,890	2,985	3,080

Source: Strategy for Sustainable Development of Agriculture of the Republic of Armenia for 2014–2025 [15].

Table 9. Size of Livestock Farms in Armenia

Indicator	Over 100 head	70–99 head	15–69 head	7–14 head	Up to 7 head	Total
Number of dairy farms (%)	49 (0.03%)	505 (0.29%)	1,971 (1.13%)	4,057 (2.34%)	167,134 (96.21%)	173,716 (100%)

Source: Dries et al. 2014 [16].

Milk sales comprise the main source of income and food for the majority of small farms, as milk provides a relatively quick return on investment for small farms. Farmers are mostly interested in getting normal income from milk sales that would allow them to fully cover the cost of its production and realize a profit. The majority of farmers are unable to scale up milk production because they lack the needed labor force because of the migration of young people from rural areas. For this reason, in order to scale up milk production, they need resources to automate production processes. The average cattle population per farm in Armenia is one animal. Extremely small output per farm makes farmers dependent on price policies pursued by processors and deprives them of any voice in policy and decision-making.

Milk Processors

The next group of stakeholders is represented by milk processors. They are mostly interested in securing a stable supply of high-quality milk throughout the year so that they can fully utilize their capacity. Since processors have the strongest competitive position in the Armenian dairy market, they absorb the main share of the dairy chain margin, thus reducing farmers' incomes and dampening the impact of public support provided to farmers. The milk processors would like to set up large operations for commercial milk production.

Retailers

Dairy product retailers want to be able to offer the full range of fresh products demanded by the local population. The products need to be delivered to stores at an acceptable price that would allow the retailers to set desirable mark-ups and still benefit from effective demand. The worst-case scenario for retailers would entail losses due to shortages of dairy products: in this case they lose not only revenues but their loyal customers as well. Any disruption in the dairy chain triggers a shortage of dairy products. Retailers in Armenia do not possess excessive bargaining power, which can be seen from the normal distribution of the margin in their favor.

Consumers (Rural and Urban Population)

The last link in the dairy chain is represented by dairy product consumers. They comprise two groups: urban and rural. The groups differ in terms of their income levels and consumer preferences.

The rural population prefers to buy milk and dairy products through informal channels; such products as a rule are processed in-house, since there is no mark-up for delivery, processing, and packaging. The majority of informal transactions represent barter trade [17], [18]. These consumers prioritize milk price over the degree of processing or dairy products variety.

Urban residents have higher incomes and generate actual effective demand for a wide range of dairy products produced by processors as well as those imported to Armenia. They are interested in having high-quality dairy products available at affordable prices, with government bodies expected to perform quality control.

Policy Options

The dairy sector plays a prominent role in the Armenian economy in terms of generating income for the rural population and ensuring food security for the nation. It is one of the most challenging in terms of balancing stakeholders' interests. Milk as an asset possesses some very special properties that determine the nature of competition and interactions among the dairy chain components. It is a highly perishable good that demands special treatment to be done very quickly; it is also a strictly standardized asset that puts special demands on the production, collection, cooling, and transportation technologies that affect its quality. The demand for milk does not coincide with its production peak, and this has pricing implications. The hands-off approach in dealing with the dairy market pursued by the Government of Armenia undermines the effectiveness of public support to milk producers and does not help the sector develop in a sustainable manner. A set of policy measures is proposed to stabilize the situation in the Armenian dairy sector.

1. Set a farm-gate price floor based on the quality of milk delivered for processing

Farmers are the most disadvantaged group of Armenian dairy market participants, yet they produce ingredients for the entire dairy chain. Milk production volumes can be increased only if fair milk pricing is guaranteed. The above analysis of margin distribution suggests that most of the margin is captured by processors. A more balanced profit distribution can be achieved only by bolstering the competitive position of the farmers through scaled-

up production. However, in the near term, and given low profitability, significant public financing would be needed to achieve this. In this context the best option would be to introduce a floor for farm-gate milk price that would be calculated on the basis of the cost of production and would ensure normal profit for expanded reproduction (15 percent profitability). Thus, the farm-gate price floor would be cost-based and determined separately for each marz, taking into account the effective demand and current economic situation in the country. In this case, guaranteed prices should be paid contingent on maintaining an even supply of milk to processors throughout the year to encourage farmers and producers to lower the seasonality of their operation.

The beauty of this arrangement is that no public support or subsidies to milk producers are required. Normal profits are ensured by the fair distribution of the margin among players; a similar system operates in Canada [19], [20] and, to some extent, in the United States. The experience of Canada suggests that such arrangements cause higher retail sale prices; thus the cash transfer from consumers to producers occurs directly via market mechanisms and not through the budget system, which makes it more transparent. The use of such a mechanism must be accompanied with an aggressive import restriction policy because high domestic prices would make local producers less competitive than foreign ones.

This approach would benefit farmers but it would reduce profits for processors and cause higher prices of dairy products, which would affect the rural population most strongly; it would be a bit less painful for the urban population owing to its higher incomes.

2. Encourage milk supply to processing plants

One alternative to a farm-gate price floor could be direct payments to farmers per liter of milk delivered for processing contingent on maintaining even supply of milk to processors throughout the year. Volumes of milk supplied to processors would be calculated on the basis of signed contracts. This would help to increase farmers' incomes, milk marketability at farms, and capacity utilization rate, and therefore would improve processors' profitability. This would be the best option in the eyes of the processors. However, dishonest processors may be tempted to subtract the amount of such payment from the farm-gate price. Yet processors would like to increase their capacity utilization rate.

For the government this would mean a higher burden for the budget, and would not help ensure a fair redistribution of the margin in the dairy chain. On the other hand, this would increase tax revenues collected from processors thanks to a greater production volume of dairy products and putting more milk into formal circulation.

This measure would partially affect the rural population since the supply of less expensive dairy products sold informally would drop.

3. Set up and develop marketing and milk processing cooperatives

There are virtually no large commercial milk producers in Armenia. A lot of farms sell raw milk on their own without any long-term guarantees or obligations, and often with no contract with the processor. Vertical integration in the dairy market requires an enlarged initial component in the supply chain; this can be achieved by setting up marketing cooperatives that would bring together small producers. Collecting milk from many small farmers results in higher transportation costs and lower overall milk quality—since it is impossible to control each and every supplier—and a lack of feedback between processors and farmers.

Agricultural cooperation in the dairy sector is a strategic area in the Armenian agrarian policy, but no effective mechanisms that would encourage establishment of cooperatives have been implemented yet. Besides, until the end of 2015 there had been no law On Agricultural Cooperatives [21] in Armenia that would define the principles and legal framework for agricultural cooperatives activity. Up to that time the activity of farmers' associations had been regulated by the Law On Consumer Cooperatives that was passed back in 1993; that law defined cooperatives as not-for-profit organizations with a membership of at least 30 individuals [22].

Between 1992 and 2005, the Marketing Assistance Program was implemented in Armenia with the assistance from the U.S. Department of Agriculture; the program aimed to establish cooperatives (co-ops) in the dairy sector. Upon its completion, however, many of the newly established co-ops split up or became inactive. The key problem regarding co-op development in Armenia is a lack of trust in collective ownership. According to a survey of the new co-op members, only 39.5 percent believed that co-ops would help increase their incomes; 28.4 percent considered themselves owners of the co-

ops, and 28.2 percent realized their right to control the co-ops' activity. However, the survey revealed that co-op membership motivates farmers to invest more in the development of their farms. Thus, 42 percent of the surveyed co-op members invested in modernization of cattle stalls; 39 percent increased their livestock population; and 20 percent increased livestock population, upgraded cattle stalls, and procured new equipment [23].

The experience of Israel, where co-ops produce some 80 percent of the country's agricultural output, confirms that co-ops should be built on a philosophy, government policy, and effective production processes. The Government of Israel invests heavily in the development of co-ops and positions them as the main marketing channel for agricultural produce. Co-ops in the Israeli dairy sector have allowed an increase in milk production volumes and strengthened the farmers' voice and their market positions [24].

A two-pronged approach should be pursued to set up co-ops in the Armenian dairy sector, given its specific development patterns. The first approach would be to identify raw milk purchase areas used by large milk processors based on reasonable milk transportation costs, and to set up marketing co-ops in those areas. This would help to dramatically improve marketability for the co-op members and encourage them to increase their dairy livestock population. Studies done in Armenia demonstrate that the more milk farmers produce, the greater the share of such milk sold to the market [25]. Farmers specialize in milk production, and they prefer to get a higher income from milk sales and buy finished dairy products. A higher profitability for co-op members would be achieved thanks to the consolidation of milk lots sold to the market and thanks also to quality control; co-ops would be able to enter into long-term contracts with processors on better terms. But a mandatory condition of financing such marketing co-op programs should be the even supply of milk to processors throughout the year.

The second approach would be to establish cheese-making co-ops in the areas that are outside of the purchase areas used by active processors and are fairly remote: production sites located far from the markets make the transportation of fresh milk unprofitable. The best option for the areas outside the purchase areas would be to produce cheese and bring it to sales venues (to cities or for export). This would help farmers to significantly increase their revenues from sales of processed dairy products. Arrangements for the establishment of a milk-processing co-op require a detailed business plan and a feasibility study. A lot of money is needed to procure milk processing equipment. The number of co-op members, as well as their capacity to supply milk for processing and possible purchases of milk from outside suppliers, must be defined precisely in order to set the processing capacity of the co-op. The demand for dairy products, possible sales volumes for each marketing channel, and optimal assortment and quantity must be identified. Production technology based on the local raw milk properties should also be developed.

The key support mechanisms for marketing and processing co-ops should be targeted grant financing to procure equipment as well as scientific and technical advice provided throughout the project implementation. The U.S. experience suggests that technical assistance to farmers often produces a greater development impact than financing. Eligibility for grant financing would be provided if a certain annual volume of milk is guaranteed to be processed or delivered for processing. Currently the only support for co-ops comes as interest rate subsidy of 6 percent.

The number of founding members would be determined by the number of those willing to join and the co-op's need for cash to buy transportation, milk cooling, and quality control equipment. To build an effective cooperative, special attention should be given to the establishment procedure. Since co-ops are based on voluntary membership, only future members should make the decisions to set up a co-op and participate in its creation. The government, financial institutions, and farmers associations may inform farmers and provide training and advice, but may not initiate the procedure—this should come only from those wishing to set up a co-op. Large farms that have sufficient livestock population, land, and equipment to produce fodder would function as facilitators during this process (see Appendix B).

The government would use cost-benefit analysis to evaluate the effectiveness of such support measures. Costs include the financing of investment projects to set up marketing and processing co-oops; benefits come as tax revenues from the co-op members and milk processors, based on increased output of dairy products.

Milk processors would find this measure especially appealing because it would help increase the purchases of raw milk; marketing cooperatives

would do milk collection, cooling, and transportation. Having larger suppliers would allow the introduction of a system to manage their own supply chains. The introduction of such a system would ensure the balanced and concerted development of its participants, help develop a uniform strategy, and gain competitive advantage in two areas:

1. Better satisfaction of dairy products consumers' demands thanks to: the establishment of close feedback with milk suppliers; the management of new product development as a result of changes in raw milk production technologies; the faster movement of products with a short shelf life within the distribution network; and the joint creation by all the participants of an efficient, uninterrupted cold chain, allowing for maintaining desired temperatures at each stage of the supply chain.

2. Reduction of the total costs for all the supply chain participants thanks to: alignment and optimization of technology and logistics processes; minimized transportation and transaction costs; fewer intermediaries; reallocation of logistics functions among the supply chain participants; the management of return flows that help reduce losses caused by the short shelf life of dairy products; a reduced number of activities that do not create value; and lower risks of unfair collaboration.

All cooperative ventures would allow farmers to strengthen their bargaining power and policy influence, increase revenues from milk sales, and invest additional resources to scale up their production.

The rural population would have somewhat less access to cheaper dairy products sold on informal markets.

4. Invest in establishing large commercial milk producers

One alternative to enlarging the primary segment of the milk supply chain (the milk producers) would be to establish large agricultural farms for commercial milk production. This would be economically sound since the cost of milk production there would be significantly lower than at small farms thanks to the economies of scale, the introduction of intensive technologies, automation, and so on. The experience of developed economies suggests that the trend in the dairy sector has been to have fewer farms and more animals per farm. However, given the budget deficit in Armenia, the implementation of such projects is impossible in the short run—on average, it takes about 15 years for a large farm to pay back its loans. Besides, large dairy farms would crowd out a lot of family-held farms, which would affect the incomes of the rural population. Thus, considering the fiscal capacity of the government and social interests of the rural population, a gradual farm size increase thanks to higher profitability caused by fair margin distribution would seem a better idea.

5. Establish a farmer education program to introduce intensive technologies for milk production, cheese-making, and the establishment and operation of marketing and processing cooperatives

A majority of Armenia's rural residents involved in milk production lack the specialized knowledge that allows the application of scientific approaches to production. Therefore one important public support measure would be to design, together with milk processors, a set of training programs dealing with the implementation of standardized milk production technology that duly recognizes area-specific climatic conditions. This would help produce milk with the pre-defined biological properties required for some dairy products. Such programs would be delivered by regional agriculture support centers. Furthermore, a program on cheese-making is needed; participation in the program would serve as eligibility criteria when obtaining grant financing to set up cheese-making cooperatives. Another education program should deal with the establishment and operation of marketing and processing co-ops based on the recent *Law On Agricultural Cooperatives* [21] and best international experience. The program should cover legal, market operation, contracting, and sound management issues.

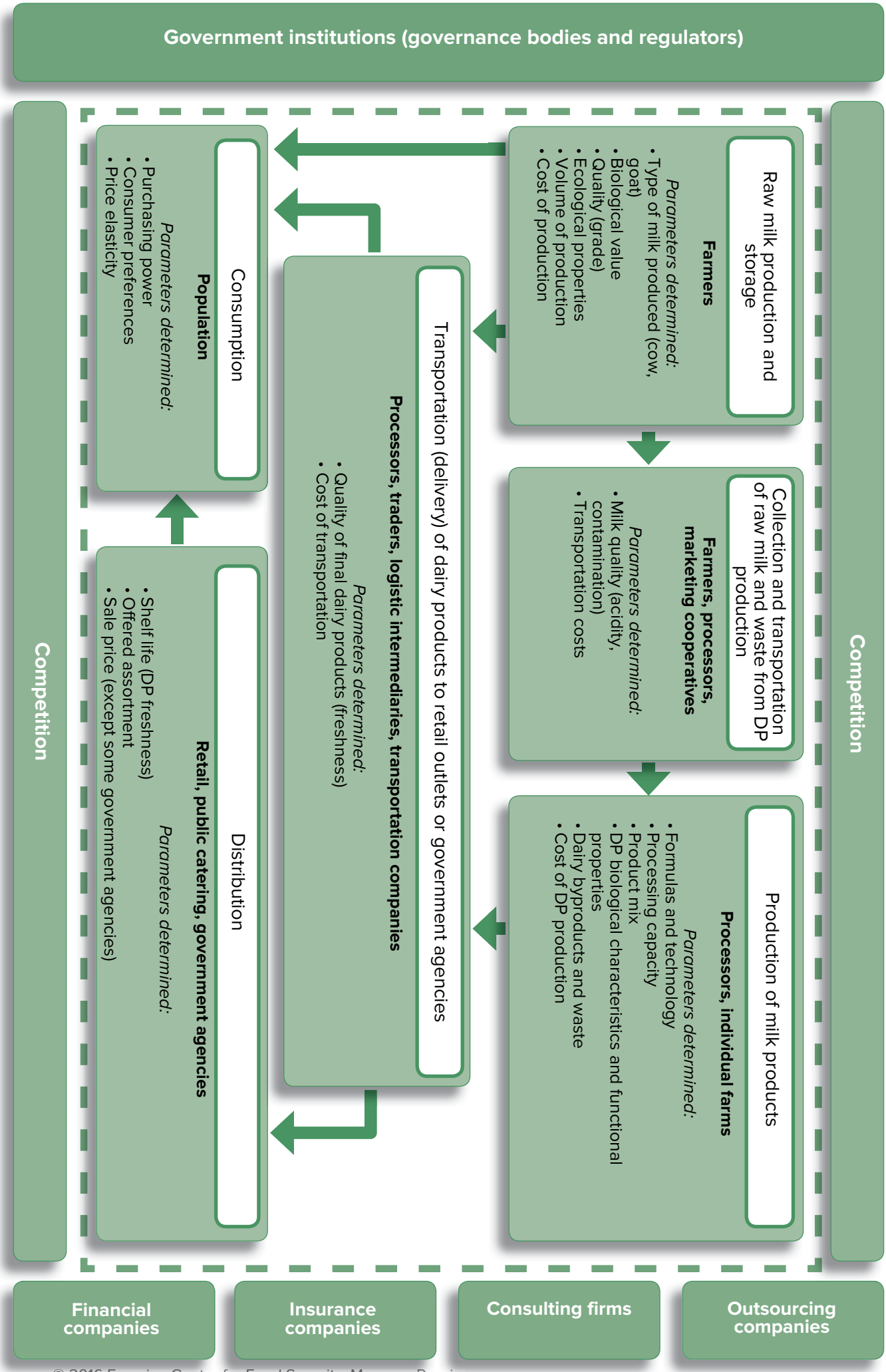
Assignment

Your task is to develop recommendations for decision makers to help them select the best government regulation policies in the dairy sector, taking a balanced approach to the interests of all supply chain participants, and to identify the economic, social, and food implications of such policies.

Policy Recommendations

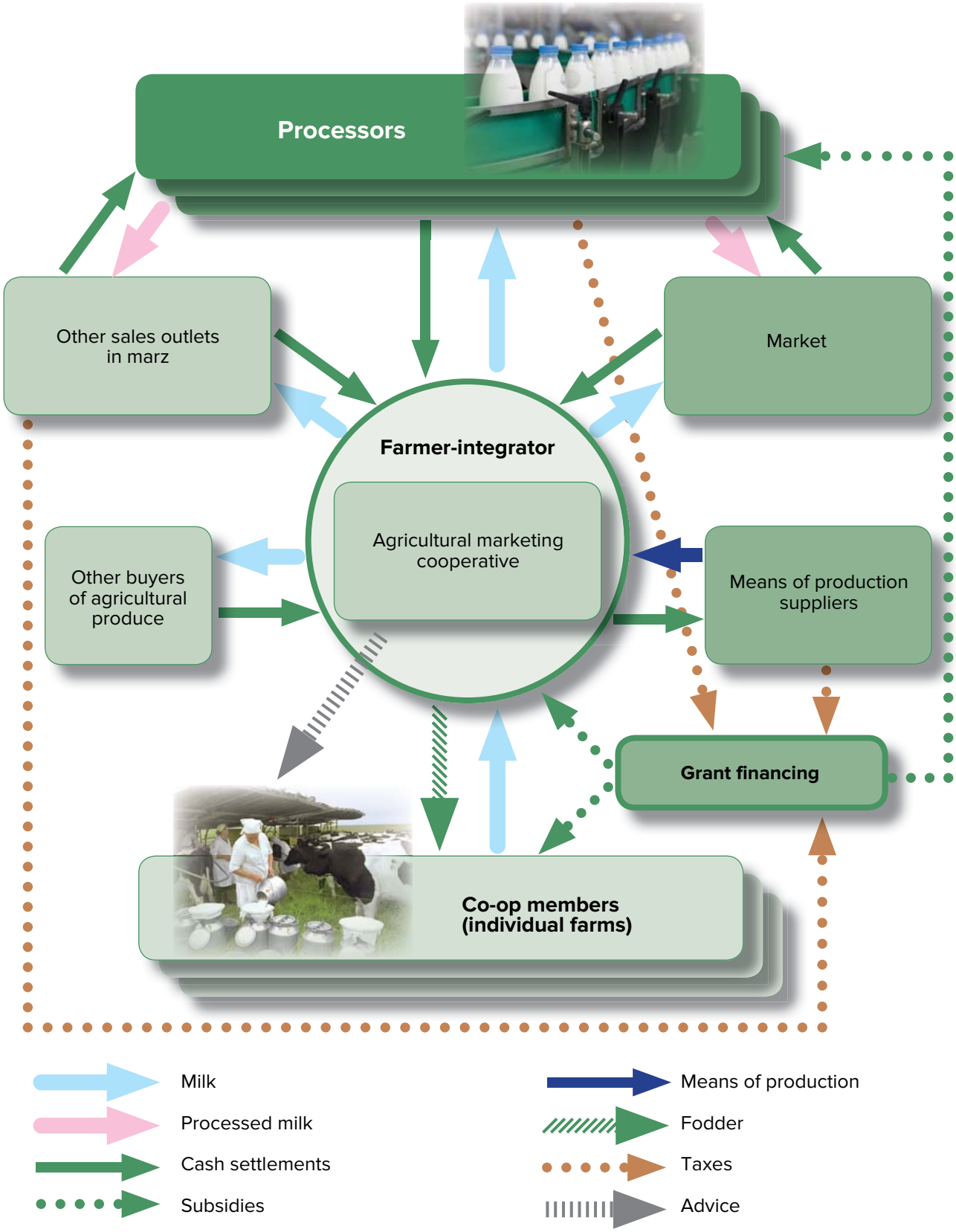
Based on the proposed set of government regulation measures for the Armenian dairy sector, a combined support program can be developed that would help create a balanced dairy chain with due consideration of all stakeholders' interests. Such a program should envisage the establishment and development of marketing and processing co-ops as well as incentives to supply milk for processing. Money for the milk supplied for processing or the milk processed by co-ops can be provided directly to new co-ops in advance—as a lump sum upon approval of the project to set up a co-op, and based on the expected annual milk collection or processing volumes. These resources, together with grant financing, would be used to purchase equipment and establish co-ops. Mandatory eligibility criteria for the establishment grant would be participation in an established program designed together with processors and successfully passing an examination.

A farm-gate floor price of milk supplied for processing is the most effective tool for establishing fair relationships within the dairy chain, but processors would be reluctant to embrace it. Therefore such a floor price could be introduced in stages. Initially a public-private partnership arrangement could be employed to upgrade processing facilities conditional on guaranteeing a farm-gate price floor when purchasing raw milk from farmers. Then an in-depth analysis of margin distribution within the chain would be completed, and gradually such conditions would be expanded to the entire sector. This measure would have to be accompanied by heavier restrictions on dairy product imports to Armenia because the farm-gate floor price would trigger an increase in retail dairy prices.



Source: Developed by I.Poleshkina and E.Peplozyan.

Appendix B: Operation of an Agricultural Marketing Cooperative



Source: Developed by I.Poleshkina and E.Peplozyan.

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Development Issues in the Traditional Livestock Sector of the Kyrgyz Republic

Ivan Nefedjev, Aida Bolotbekova

Executive Summary

The Kyrgyz Republic is a country in Central Asia with an area of 199.9 square kilometers and a population of 6 million. More than three-quarters of the territory is covered by mountains. The share of agriculture in GDP is 14.7 percent. Livestock production is one of the leading sectors of Kyrgyz agriculture. The share of livestock products in the total volume of agricultural gross output was 47.6 percent in 2014 [1].

As a result of historical, cultural, and geographical factors, for centuries Kyrgyz farmers practiced a nomadic type of livestock farming with three kinds of pastures: near-village pastures (usually used during the winter and located close to the villages in the valleys), intensively used pastures (used during spring and autumn, located at the foot of the mountains), and nomadic or distant pastures (for summer grazing in the highlands).

The Kyrgyz Republic is a mountainous country with a rather fragile natural environment. Nomadic livestock production is one of the few options available for reclaiming desert and mountain landscapes. The stability of this interaction depends on many factors: the traditions of livestock farming, public policy, government development strategies and livestock legislation, market conditions and access to information, the institutional environment, and the effects of climate change, among others [2].

At present, the grazing situation varies for different livestock owners. There are nomads who drive their herds to summer pastures (nomadic type), and there are small farmers (who make up the bulk of the country's farmers) who use only near-village pastures all year round for various reasons. This imbalance causes pasture degradation that has a direct impact on livestock nutrition. The other stakeholder groups are state authorities of the Kyrgyz Republic; organizations representing the interests of farmers; donors and organizations with interests in the region and in neighboring states. All of these stakeholders have different interests, mechanisms, and power for changing the situation.

The pressure from intense grazing, especially in near-village pastures, is several times higher than recommended. This naturally leads to lower productivity—since 1990 the productivity of near-village pastures decreased threefold, from 300 to 100 kilograms per hectare [3]. On the other hand, remote pastures are often degraded because of lack of use (for example, they become overgrown with weeds, which are not suitable for feeding cattle). Access to distant pastures is limited because of problems with the infrastructure, financial difficulties, legal restrictions, and so on.

This study is devoted to the analysis of possible changes that could be made at the local and national level to improve Kyrgyz nomad livestock farming. Policy recommendations—such as integrating databases that monitor pasture conditions; broadening the pasture committees so that they include all groups of pasture users; supporting farmers who have a small number of cattle; investigating the experience of neighboring countries; and reconstructing infrastructure—are suggested.

Background

In the Kyrgyz Republic, the tradition of nomadic livestock farming has been formed over many centuries. The development of animal husbandry in the country began about 8,000 years ago with the domestication of yaks, sheep, goats, and horses [4]. Most of the pastures could be used only for a short time period each year because of the low level of rainfall and other weather conditions, so the cattle was continuously moved from place to place to adapt to seasonal changes in pasture vegetation [5].

A number of specific features characterize environmental zones that are predominantly suited to nomadic farming. These zones are characterized by their arid climate, continentality, the low productivity of forage vegetation, lack of rainfall, high solar radiation, variable climatic conditions, recurrent droughts, limited water and soil resources, high predisposition of soil erosion and desertification, among other factors. The nomadic pastoral economy under such conditions is often the dominant or the only possible way to use these ecosystems [6].

These features have determined the need for vast territories of pastures that require periodic migrations in search of suitable grazing areas. Minimum pasture resources during the year were 5 to 7 hectares per sheep in the steppes and 12 to 24 hectares per sheep in the desert and semi-desert [7]. A sedentary lifestyle is usually not effective in arid ecosystems, even in an industrial society. Therefore the transition from a nomadic to sedentary lifestyle for farmers in arid ecosystems has repeatedly led to the degradation of millions of hectares [6], and thus is not effective.

One of the features of nomadic livestock breeding is the special structure of the herd, which has a high proportion of small animals like sheep and goats (up to 90 percent of the herd). According to historical records, in Kazakh agriculture the share of ordinary cattle (cows, bulls, and calves) used to be 12.3 percent [6]. In Mongolia the share of cattle in the herd structure did not exceed 14 percent [8]; for Buryats it was 16 percent [9][1]; in Tuva, 14.6 percent [10][2].

Nomadic grazing farming is highly adaptable to the environment. Thanks to the sensible use of local plant resources, Kyrgyz farmers managed to avoid degrading pastures from trampling or allowing them to get overgrown from lack of use.

Because the local people have lived in the same region for decades, they had a very precise idea of the feeding capacity of local pastures, nearby water sources, and the most favorable time to use a particular area.

Before the Kyrgyz Republic became part of the Soviet Union, the land used for extensive nomadic livestock farming did not have clearly defined boundaries [11]. Most pastures in the region, depending on the climatic conditions, are suitable for only a short period of time. Animals are constantly moved from place to place to use the seasonal growth of vegetation in the lowlands and the highlands, and to get access to water. Although the boundaries of land were not clearly defined and everything was resolved at the local level without a common set of laws, overgrazing was not an issue for a long time [12]. This system used a particular pasture rotation, where grazing on each individual pasture occurred only every third or fifth year [13].

When the Kyrgyz Republic became part of the USSR, this well-established system that had been used for centuries collapsed and the traditional animal husbandry skills were quickly lost. People in rural areas were educated for their new jobs in the newly forming agricultural system, but without a comprehensive knowledge of the local nomadic traditions. So the pastures were owned by the collective and state farms, and the policy was aimed at maximizing the number of livestock. Other features of the Soviet system were that the winter feedstuff was supplied from other regions of the USSR and livestock movement and pasture rotation was controlled from the center [3]. Intensive economic growth in the Soviet period contributed to a significant improvement in economic performance but also led to significant environmental issues. However, it should be noted that the plowing of virgin lands (often former pastures) was done in the Kyrgyz Republic less intensively than in many other regions of the Soviet Union. Therefore degradation of Kyrgyz ecosystems was significantly lower than, for example, in Kazakhstan [6].

In the USSR the following system of driving the herds was formed: from lowland winter pastures the cattle were taken to the plains in the early spring; then in late spring the cattle were moved to hill pastures, and in summer they were taken to the highland pastures [13]. Spring pastures were at some distance from the main settlements. Animals grazed there starting from the period when grass and plants appeared until the plants were mature, when the pasture productivity decreased. Then the animals were driven to the highland alpine and sub-alpine meadows, where they fed on young grass until mid-autumn. These pastures were called *summer pastures*, remote or *jailoo* pastures. Then, in late autumn, the animals were moved back to the lowlands closer to the village. To maintain the animals in good condition during the winter months, farmers used different kinds of additional forage—hay, grain, and so on.

Plans for pasture management have been developed on the basis of forage pasture productivity, calculated on the base of an analysis of 80 major species of plants in Kyrgyz pastures. Despite the scientific approach, pasture productivity in the period from 1960 to 1990 decreased by 36 to 67 percent, depending on the type of use. The negative consequences were that in an area of 50,000 square kilometers, woody and inedible plants started growing, and 5,400 square kilometers have become unsuitable for grazing [14].

After the collapse of the USSR, the distribution and marketing systems for agriculture products were ruined. Along with a decrease in the world prices for wool, among other reasons, this led to a sharp decrease in the number of livestock in the Kyrgyz Republic [3]. Since 1991 the number of collective farms has been reduced, and now 96.5 percent of the cattle are in private households [15].

[1] Buryats are the local people of Buryatya, a region in Russia located east of Baikal Lake.
[2] Tuva is the region in Russia's South Siberia, bordering on the northwest part of Mongolia.

The Current State of Livestock Management and Legislation

About 64 percent of the Kyrgyz Republic's population (3.5 million people) live in rural areas [16]. Agriculture is their main source of income [3]. For these people, breeding and livestock is a key factor in ensuring financial status [17]. In recent years there has been evidence of an increasing number of cattle because local people see the ability to save income only in this kind of activity [3].

Until 2009 the pasture management system was three-tiered, run by an aiylokmotu (rural council) that had no information about the boundaries of pastures, the location of infrastructure, the capacity of pastures, or other characteristics necessary to manage this resource. The system was opaque, control was missing, and farmers used only near-village pastures because renting them was the easiest, although often the formal contract for that rental was not even concluded [12].

Pastures (unlike other real estate) in the Kyrgyz Republic cannot be privately owned because of their public importance [17]. Decisions establishing the boundaries of pastures are made at the level of the Government of the Kyrgyz Republic, which indicates the high importance of this issue for the Kyrgyz authorities [18].

The new law concerning pasture management was accepted by local residents with appreciation for several reasons: prior to implementation the rural population was consulted and it increased their interest in the new law; the new legislation is based on the local tradition of nomadic farming [19].

The new law created a new structure—the pasture (zhayyt) committee—which is the executive body for administrating pastures. The committee develops and implements plans for pasture use, monitors pastures, issues grazing tickets and use permits for other purposes, establishes and collects payments, and manages revenues. When making decisions, the members of the pasture committee must also take into account the federal government's plans for environmental protection [20].

Pasture tickets (that grant the right to use the pastures) are issued after payment is made to the pasture committee. The amount of payment is calculated annually for each pasture system and for every type of agricultural practice, and then approved by the local authority. The fee depends on the type of livestock being grazed on the pasture. Taxes go to the government budget, and the rest of the fee (no less than one-third of the total) is divided between the local budget and pasture improvement [20]. The authorized state body assesses and controls the preservation of the natural state of pastures. Violators are liable for criminal and administrative prosecution [20].

Despite the significant positive changes in the law, there are still some drawbacks. For example, all the "other activities" that take place on pastures (collecting wild plants, hunting, beekeeping, etc.) are combined and the fee for each of these activities is, by default, the same.

The Condition of the Pastures

About 20 percent of the population of the Kyrgyz Republic work in the Russian Federation and Kazakhstan [21]. Typically, remittances are used to buy cattle, because this is the main channel for investment in rural areas. In this case, animals serve as an investment fund, which increases thanks to natural reproduction.

Most pasture farmers are trying to maximize their income by increasing the size of their herd without caring about the state of pastures. According to official statistics, the number of livestock animals is growing [5]. Most farmers, especially those with a small number of cattle, use only near-village intensive pastures, so many remote pastures are not used intensively enough or not used at all [3].

The near-village pastures frequently exhibit deteriorating grass; turf destruction; soil erosion; and a growing number of grazing paths, gullies, and ravines. Furthermore, certain types of plants are disappearing and there is also evidence of changing dominant plant communities. In the remote pastures, yields and fodder reserves are decreasing, and researchers are noticing the growth of weedy inedible, harmful and poisonous plants, or an increase in shrubs with thorns. According to the State Design Institute Kyrgyzgipromzem, about 25 percent of pastures are moderately or severely degraded [17].

The degradation process is advancing, and in some areas of the Kyrgyz Republic it has become irreversible. Irreversible consequences can be prevented only by taking appropriate measures that require large financial investments. The increase in

the number of livestock, along with the deterioration of natural grassland, has led to an excessive load on the pastures. As of 2010, the pressure from intense grazing exceeds the norm by 1.5 to 2 times [22]. In some village pastures (especially in the southern regions) the pressure exceeds the norm by 3 to 4 times [17]. Since the separation of the Kyrgyz Republic from the Soviet Union in 1991, the productivity of village pastures decreased threefold, dropping from 300 to 100 kilograms per hectare [3].

Policy Issues

The current Kyrgyz farmer faces a number of problems:

Loss of Continuity and Organization

The lack of continuity and loss of the organizational skills of nomadic farming has introduced multiple problematic issues. Over the course of the past 25 years, since 1991, farmers have worked by trial and error, and it is too early to speak about the revival of the traditions of the nomadic livestock.

The local population either does not know how to use their pastures with sustainable environmental management, or their economic situation is forcing them to use the pastures too intensively. This can lead to desertification and poverty and can fuel the progression of rural population migration [3].

Historically, only a few members of the village knew all the nuances and peculiarities of natural cycles and the geographical location of seasonal pastures. They also were aware of the shortest routes to the pastures and water bodies, cycles of vegetation productivity, the fattening processes and the physical condition of the animals, precipitation and inundation rhythms, snow settling time and loss of snow cover. The accumulation of such knowledge may need the lifetimes of several generations [6]. Most of the members of pasture committees have little education and are simply pasture users. Because of the lack of experience in planning of pasture management certain problems can arise [5].

During the Soviet Union period, some of the arable land was used for growing fodder crops with irrigation. Lack of experience and knowledge about the cultivation of fodder crops, together with the breakdown of irrigation systems, has led to lower yields compared to opportunities for basic fodder such as sainfoin (French grass), barley, and forage grasses [3].

Pasture Distribution

Although since 1991 pastures have been under the jurisdiction of the Federal Registration Agency State Committee, pastures were often distributed on the local level. In fact, the villagers lived outside the law before the adoption of the Law On Pastures in 2009 [18]. It can be assumed that some agricultural land was distributed on the basis of nepotism [5]. Current legislation, in fact, increases the opportunities for these kinds of corrupt transactions (because now the government officially presents an opportunity to deal with all the matters related to pastures on the local level) and needs to be improved.

Some farmers receive the right to graze cattle on pastures near settlements, including grazing in the summer period. At the same time, not all farmers receive pastoral areas with water, infrastructure, and access to roads.

Another problem is the illegal construction of sheds and barns for animals on pastures. It is de facto a form of privatization and leads to limited access to pastures and migration routes [19].

Before the 2009 Law On Pastures, any farmer could take a pasture for a long-term period, which limited the opportunities of other farmers. Now it is written in the Constitution that the owners of the pastures are the people of the Kyrgyz Republic, and technically any farmer can buy the right to pasture on any field. However, this can be viewed from the other side: now the elite with their power have an opportunity to choose the best pastures on a yearly basis.

The Degradation of Pastures

The first two challenges are closely linked to the third—the degradation of pastures. Here two extreme options can be traced. Near-village (winter) pastures are used too intensively because they are easily accessible. This leads to a reduction in natural productivity and degradation of these lands. On the other hand, highland summer pastures are often not used in practice, which leads them to become overgrown with weeds and sometimes poisonous vegetation. It also leads to degradation and reduced productivity of the pasture, although of a very different kind: in the

case of insufficient grazing, the ecological balance is broken because it starts overgrowing pasture grasses and bushes [23]. In the coming years the Kyrgyz Republic may have an additional factor that contributes to pasture degradation—the greater number of dry years as a consequence of climate change [3].

But the most common cause of pasture degradation is overgrazing. This leads to a reduction in productivity, loss of biodiversity, dominance of inedible food plants, soil erosion, and other processes [24]. It may also lead to soil compaction and an increased susceptibility of animals to diseases [25].

Access to Pastures for Unprotected Farmers

Access to pastures for unprotected categories of farmers is another serious issue. More than 80 percent of farms have fewer than 10 head of cattle, so they are called *small farmers*. For small farmers, access to remote pastures is limited because it is unprofitable to move to remote pastures on their own and they cannot afford to hire a shepherd. This, as well as the poor condition of roads to remote pastures, is often the cause of overgrazing of land located closely to the village. The situation is complicated by the fact that, because of the extensive type of farming (as opposed to intensive farming), the costs of maintaining large herds in a period when natural vegetation is plentiful (summer) are almost the same as the costs for maintaining a small herd, but the revenues, on the contrary, can be significantly higher for only large herds [3].

Less wealthy livestock owners (for example, single women or persons with disabilities) are not able to increase the size of their herd because of a lack of funds. Women are rarely represented in the pasture committees, which greatly reduces their role in decision-making. At the same time, these single women are often forced to manage a herd of their own because their male partners are working in Russia and Kazakhstan.

Furthermore, city dwellers engaged in animal husbandry do not always have the opportunity to use the pastures, especially remote pastures [19].

Thus, despite the fact that pastures are considered to be a public good, in fact not all interested persons have the access to them.

Maintaining a Healthy Herd

The incidence of cattle diseases is very high in the Kyrgyz Republic, especially when compared with advanced countries. This is partly the result of farmers' lack of knowledge and lack of understanding of the need for regular check-ups and vaccinations of cattle. It is also a consequence of overcrowding and lack of sufficient food for animals on near-village pastures.

Along with the lack of knowledge of veterinary best practices another problem emerges: non-optimal calving and lambing. The calves and lambs should be born in the spring so that they can gain weight and prepare for the winter (when their mothers decrease lactation). Currently many calves and lambs are born in the summer or the fall when there is a lack of grass, which naturally leads to high rates of mortality among the young.

Absence of Reliable Statistics

All these issues are not reflected in official statistics. For example, despite the fact that in reality almost 100 percent of the pastures located near villages are used, in terms of the official statistics they are used by only 17 percent [5]. The negative effect of these incorrect statistics lies not only in the fact that the budget loses the relevant taxes (their share in the total budget of the country is negligible), but also in the fact that reality is misrepresented when looking at official numbers. This may lead to wrong decision-making.

In the Kyrgyz Republic, the monitoring of the state of pastures is carried out at the local level by the pasture committees and at the national level by the Institute of Land Management (Kyrgyzgiprozem). At the moment these two systems are not interconnected [19].

Farmers often hide information about the real number of their cattle to pay less in taxes and tickets. The actual number of cattle in the Kyrgyz Republic could be 30 to 50 percent higher than indicated in the official statistics [5].

Lack of Infrastructure in Remote Pastures

The remote pastures, as a rule, have a lack of any infrastructure. Farmers have to live in these remote locations in a yurt without electricity. In the 21st century, few villagers are willing to spend their time

in such conditions for several months at a time—an unwillingness that also leads to the greater use of pastures near the villages.

After the privatization process in Kyrgyz agriculture most of the facilities, such as bridges and wells, in the pastures were disabled because of a lack of funds for their repair and maintenance. Almost 40 percent of pastures (especially remote summer pastures) are not used because of the erosion of livestock roads and bridges by mudflows. Infrastructure repairs are conducted at an insufficient pace. For example, from 1997 to 2010, only 99 out of 1,368 wells and dams were repaired in the entire country [17].

Providing Sufficient Feed in Winter

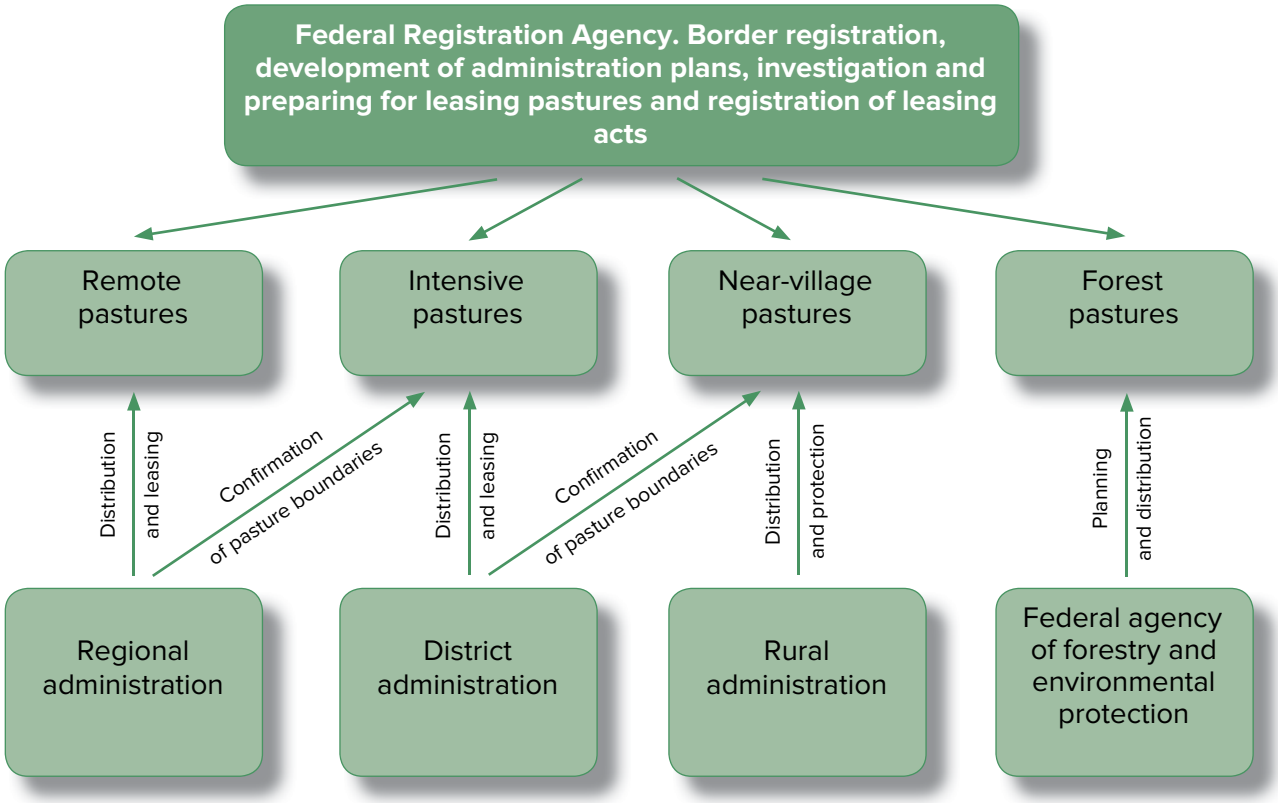
Since land has been depleted near the villages, additional feed is needed in winter. The potential of winter pastures cannot always provide sufficient fodder for the herd, and farmers have to use additional feedstuff. The production of fodder in the Kyrgyz Republic after the Soviet collapse decreased significantly [3]. Cropland in the country makes up only 7 percent of the total area of agricultural land [5] and the feedstuff, especially high-protein feedstuff, is a scarce commodity.

Prior to the adoption of the *Law On Pastures* in 2009, the use of pastures in the Kyrgyz Republic was haphazard [5]. Near-village pastures were managed by local governments, intense pastures (for autumn and spring grazing) were rented to regional state administrations, and remote (summer) pastures were managed by federal public administrations. This arrangement meant that farmers had to pay rental fees to three different governmental bodies! Official rental contracts were not issued, and payments were often made in kind or in cash without being registered as budget revenue [17].

Prior to the introduction of the new legislation on pastures in 2009, local people were faced with many problems in attempting to ensure enough feed for the winter. These include a lack of access to pastures for small farmers as a result of their inability to enter into a lease agreement, and the need to apply to various authorities to register their rental contract (see Figure 1) [19].

Since 2009, the responsibility for pasture management has been transferred to the local authorities in the *aiyl* (rural) districts (see Figure 2).

Figure 1. Previous System: Allocation of Responsibility among Various Government Bodies to Manage Different Types of Pastures, before 2009



The pasture management system has undergone significant changes and has become much easier since2009. Assigning value and distributing pasture tickets for all three types of pastures is now conducted locally. Thus one of the major difficulties—the administrative one—has been almost solved by now.

Pastures located in the forest area are now classified into a separate category and are the responsibility of the federal agency of forestry and environmental protection. These pastures, as before, can or may be rented. Their registration in the State Register is no longer required, which has significantly simplified the situation from the administrative point of view.

Stakeholder Groups

Farmers with Large Herds

As a rule, it is wealthy villagers who have been engaged in livestock breeding for many years who have a large herd. They may handle the herd on their own, but often hire shepherds for this purpose, including hiring less affluent family members.

This category of users can afford grazing in several types of pastures: distant (summer), intense (spring), and near-village (winter). Many of these farmers can afford additional winter feed for livestock, but actually prefer to use near-village pastures. Despite the small number of farms (less than 5 percent), this category of farmers owns approximately 30 percent of cattle [5].

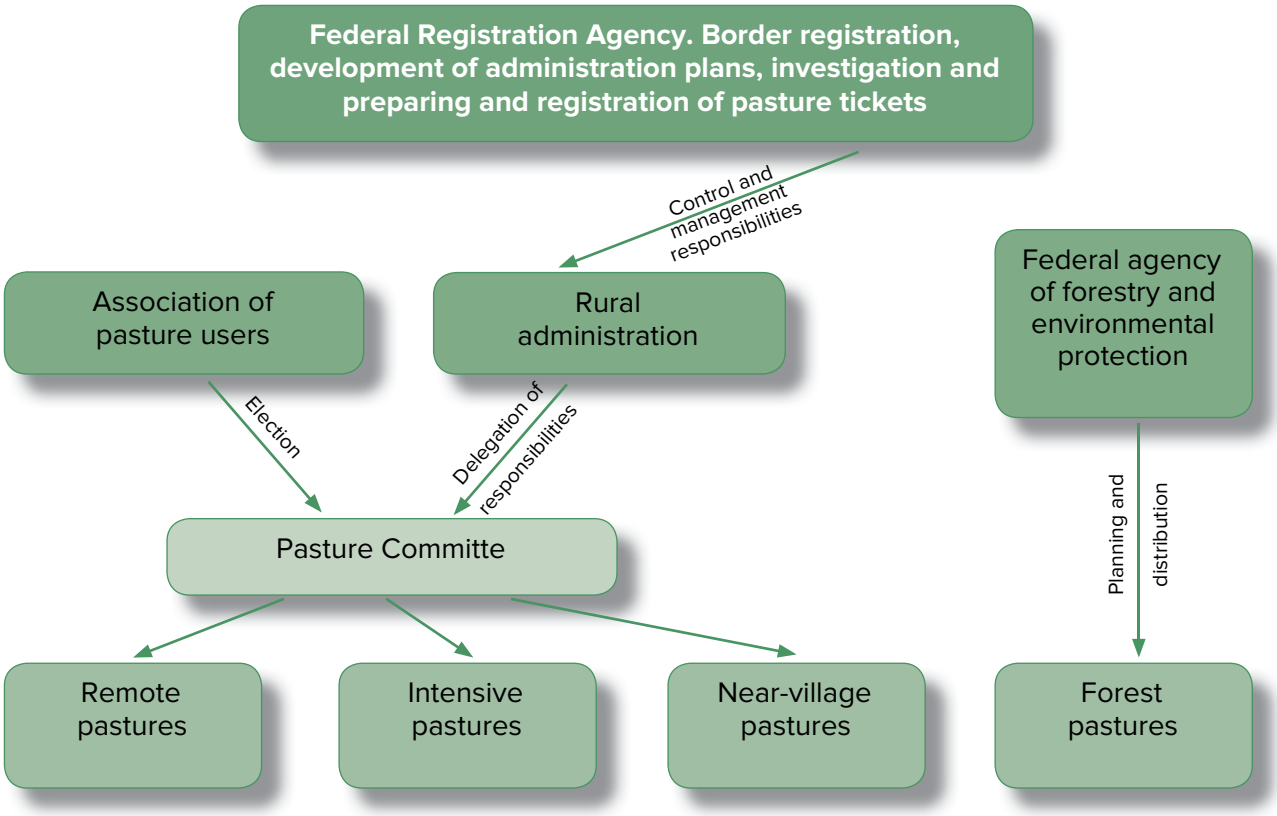
These users tend to increase the number of livestock as much as they can (without any regard for the condition of the pastures), and often use their special position and power to get access to the best land.

Farmers with Small Herds

This is the largest group of farmers in the Kyrgyz Republic. Because they do not have enough funds they cannot use the labor of hired shepherds, and for them moving a small number of livestock over long distances is not efficient.

The share of farmers with fewer than seven head of livestock in a herd accounts for about 40 percent of the total number of livestock. The share of small farmers among the total number of farmers is more than 80 percent [5].

Figure 2. Current system: Allocation of Responsibility among Various Government Bodies to Manage Different Types of Pastures, after 2009



A significant part of this category is comprised of women whose husbands work in Russia and Kazakhstan. These women have much less capacity than other farmers, in part because their interests are hardly taken into account in the decisions of pasture committees (women are rarely included in these committees).

Small farmers only use near-village pastures, and do not have enough funds to purchase winter fodder. This naturally leads to increased morbidity and mortality of livestock belonging to this user group.

Farmers with Average Herds

This is a vague group of farmers that may include the owners of hundreds of animals, although the official number will be only 10 head. About 15 percent of pastoralists have medium-size herds while such farmers own about 30 percent of the total number of livestock. Their interests and opportunities are in the middle between the two other groups of farmers, although their interests are more like those of rich farmers with large herds.

State Authorities of the Kyrgyz Republic

Since 64 percent of the Kyrgyz population lives in rural areas [16] and the share of agriculture in the Republic's GDP is 14.7 percent [1], the state should be interested in the development of this sector. At the same time, there is a shortage of funds for implementing and developing state programs in agriculture.

In 2009 the Law On Pastures was implemented. This law suggests ways to solve many of the challenges listed above, and it is constantly updated with additional secondary legislation. There is a movement in the direction of gradually improving policy regarding livestock, and in some instances the Kyrgyz Republic is the most advanced of the Central Asian countries (for example, only the Kyrgyz Republic has adopted a special law concerning pasture resources). Currently, at the state level there is an understanding that the further development of agriculture depends on the effective and efficient use of pasture resources [17].

Before 2010 many government programs related to livestock had been proposed, but none of them have been implemented in full [17]. This is both because of a lack of funds and because this issue must be approached comprehensively. In addition, some of the provisions of the state programs contradict each other, which signals the absence of a focused long-term policy in this direction.

Since 2009, when *On Pastures* was implemented de facto, all matters relating to pasture have been transferred to the local level. This simplified the lives of farmers, because it reduces red tape. At the same time, it increases the risk of making incorrect decisions dictated by short-term needs and increases the possibilities that the elite will obtain the most convenient pastures.

Although the restoration of roads and bridges and making water available for animals in remote pastures could significantly improve the situation and reduce the pressure on constantly used pastures, this does not happen because of both a lack of funds and a lack of political will. For the same reasons, other reforms that could lead to positive changes are not carried out.

Organizations Representing the Interests of Farmers

In the Kyrgyz Republic several professional associations and unions are represented at different levels (for example, the Breeders Association of the Issyk-Kul Region, the Kyrgyz Republic Association of Sheep Breeders, and so on.). These organizations have a very little power and practically cannot influence the situation in the country's agricultural sector. The situation might change if the local farmers knew of the existence of these organizations (at the moment they are usually unaware of the fact that there are organizations that defend their rights).

Donors and Organizations with Interest in the Region

There are more than 10 organizations that provide assistance to farmers and conduct case studies in the region (including the World Bank; the Deutsche Gesellschaft für Internationale Zusammenarbeit, or GIZ; the German Society for International Cooperation, or GmbH; the University of Central Asia, etc.). Assistance and research carried out by these organizations have a narrow focus and are poorly coordinated; these organizations do not cooperate either between themselves or with public policy in the region. But these organizations do have some positive impact in solving local problems.

Neighboring States

In addition to conflicts that arise periodically in the border areas because of the lack of international law relating to grazing resources, there are opportunities from neighboring countries for positive interaction with the Kyrgyz side. For example, Russia is an exporter of wheat and an importer of beef, while the Kyrgyz Republic has a lack of fodder and there are opportunities for beef exports. A possible exchange of relevant products between these states, including in the form of barter, is possible.

Policy Options

The Kyrgyz Republic has great potential for the development of animal husbandry. There are significant opportunities for the realization of meat products in the domestic market (especially considering the growing prosperity of the population, and as a result the increasing demand for meat), as well as great potential for export to neighboring countries. At the same time, the potential of Kyrgyz livestock is not fully exploited either in terms of genetics or in terms of the use of natural resources. The state is interested in the development of the agriculture sector both from a financial point of view and from the point of view of employment.

At the moment, there are several options for the development of the situation.

1. The State Does Not Intervene: The Situation Is Developing by Itself

Many farmers are not aware of the existence of problems with pasture, and convincing them that "you need to take some measures" is not always easy [5]. Probably the preservation of the current situation will lead to further degradation of pastures. This, together with factors such as climate change, could lead to an environmental disaster.

2. Learning from and Adopting Other Countries' Experiences

In many Asian countries with vast pasture lands, for the past 25 years there has been a transition from state control to a system of individual and common ownership. In this transition there are often similar problems and challenges (creation of wealth, access to pastures for poor users, environmentally sustainable management, etc.). Currently the potential benefits to be derived from the experiences of other countries with similar conditions and problems are the most promising .

Listed below are just some of the solutions adopted in other countries in the region, which can be taken into account or applied to the Kyrgyz Republic.

In Mongolia, the government subsidizes the construction of roads and wells based on the proposals of local pastoral committees. At the same time, farmers are actively involved in the work as a labor resource. Also Mongolian herders contributing to pasture degradation pay fines, but the shepherds with rational use of pasture resources receive federal subsidies.

In China, support mechanisms were provided by religious organizations. In some cases all farmers in a certain area swore an oath in a Buddhist monastery that they would not increase the number of cattle above a certain level. This mechanism increases accountability and could be applied with certain modifications in the Kyrgyz Republic [19].

Combining state- and local-level monitoring systems can lead to a better understanding of the current status of degradation of pastures in the Kyrgyz Republic. Other countries' experiences should be taken into account in this process. For example, in Mongolia, the union of these systems did not immediately become a success—the key for the success of the monitoring technology is that it must be easy to use. At the same time, in Switzerland this practice of associating state- and local-level information about the condition of pastures has shown its effectiveness. In addition, the Swiss system is very efficient, cost-effective, and quite reliable because a mechanism of public control was introduced by the members of the cooperative [19].

The condition of pastures in the Kyrgyz Republic is much better than it is in some neighboring countries. For example, in Tajikistan, more than 90 percent of pastures are degraded and inedible grasses and shrubs make up 75 to 90 percent of the grass cover [26]. At the same time, Tajikistan uses several mechanisms that exhibit high efficiency in pasture management and can be successfully used in the Kyrgyz territory. For example, many households use the common grazing system. In the spring and autumn when cattle graze near villages, locals come together in groups of up to 15 people. The group members alternate every day, keeping an eye on the cattle that belong to all of them. In the summer the group sends cattle to graze on the high

pastures, tended by a shepherd who gets paid for this. Shepherds often take their families with them and get payment in dairy products [19].

One of the best ways to maintain the productivity of pastures is to control the movement of animals and the composition of mixed herds, so that different animal species can feed on different plants [23].

The experience of the Republic of Buryatia (in Russia) shows that one of the major problems in rural areas is the agricultural producers' lack of knowledge about their rights and the opportunities they possess. Information on existing national and regional programs is usually located on the Internet and in local offices of the administration. As a result, and because several dozen regional programs may be in effect simultaneously, agricultural producers may not be aware of the existence of specific programs. To solve this problem, the installation of information boards is necessary (e.g., near the central store settlement) [27].

3. Changes at the National Level

Many remote pastures are not used because of destroyed or missing roads and flooded territories. Restoration of infrastructure can contribute to a more sensible redistribution of pressure between different types of pastures. Project or focused investment in the water supply of pastures can promote the use of large areas of pasture that are currently ruined. This will reduce the pressure on pastures where an excessive number of livestock is grazed.

The Kyrgyz Republic has a great need for the creation of pasture plans based on scientific understanding, because at the moment this activity is often based on short-term needs. Pasture management plans must contain guarantees that the best grazing lands will not be entirely at the disposal of the elite. Pasture plans outlining regulations for an equitable distribution of pastures could be developed. In addition, a special controlling organization dedicated to this task could be set up. It is also necessary to review the legislation concerning the construction of pasture facilities and improved enforcement mechanisms.

The main difficulties for households occur in winter, the period of adverse weather conditions and low productivity of pastures. Assisting farmers to sell meat in the fall through an especially established organization can help to avoid a too high concentration of livestock on pastures near villages and related veterinary complexities.

In the fall and early winter the price of meat and livestock usually decreases, so many farmers are reluctant to sell their animals in this period, even considering the lack of feed conditions. Fodder can be offered in the form of micro-credits during this period, which one will have to pay back after selling the livestock when meat prices are high. Central government support should be available in the form of livestock procurement at guaranteed prices (for the prevention of seasonal price reductions).

Compensating for the decline in pasture productivity by producing additional fodder in the territory of the Kyrgyz Republic is impossible since arable land is severely limited and the irrigation system is largely destroyed. Arable land should be used to produce crops for human consumption. The federal government may exercise the wholesale purchase of winter fodder (including from other countries) so that the prices for winter feed are not too high for farmers. This technique has been shown to be very effective in Inner Mongolia [19].

Organization of the wholesale purchase of fodder with the subsequent sale or issuance of a long-term loan on livestock could significantly improve the situation with the winter feeding of livestock and reduce the pressure on pastures.

In the Kyrgyz Republic, at the legislative level there are conversion coefficients of the number of animals of different species to the "animal unit." Cattle, horses, donkeys, and camels are accounted for as 1 animal unit, young cattle are considered 0.7 animal units, and goats and sheep are 0.2 animal units [18]. This ratio is roughly equivalent to animal feed needs—that is, the same amount of dry matter to feed one cow is needed to feed five sheep [2].

The legislation does not forbid entering one's own conversion coefficients in the animal unit calculation. Perhaps a recalculation of coefficients will help with a more sensible distribution of pastures. The food type and preferred types of vegetation differ for cattle and sheep (even if the same amount of dry matter is fed), so one of the solutions for reducing pasture pressure would be recommendations of species composition in a herd grazing at the same time on a particular pasture.

Fines imposed on users contributing to the deterioration of pasture conditions could be used to organize a lottery among the shepherds who use pasture resources efficiently. The lottery committee could also use the prize money to improve pasture

infrastructure (road rehabilitation, water meadows, etc.) of the aiyl (rural) areas where violations were recorded in the current year. Methods based on organizing lotteries have been shown to be highly effective in other fields [28].

The state can assist in marketing and branding livestock products. For example, the state could certify products derived from the meat of animals reared by nomadic farming to be both healthy and high-quality. The state could also promote tourism in the summer pastures (jailoo-tourism).

4. Taking into Account Local Peculiarities

Each settlement could have its own special situation. For example, some settlements may not have near-village pastures, and some pastures may belong to the national forest fund and thus not be used for grazing (in this case it is possible to lease the land for grazing purposes). The approach to the distribution of pastures should be individual—the situation in each individual case can be totally different. In this sense, we can only welcome the transfer of pasture management on the level of aiyl (village).

Livestock grazing is highly dependent on the geographical features of the area. For example, in areas with stable snow cover, winter should be spent in a stationary arranged camp for livestock, even if the herd spends most of the year migrating from pasture to pasture. In the areas with little snow, nomadic farming is possible throughout the year [6].

Weather conditions must be considered in the distribution of pastures. Droughts may lead to local grazing areas becoming unusable. In this case, the local government must provide alternatives for grazing.

Pastures have varying degrees of stability depending on their geographical location. Lowland pastures are located in more arid conditions and their vegetation is well adapted to droughts. These pastures are relatively resistant to grazing. But highland pastures are more influenced by grazing and tend to degradation [5]. Thus geographical features should be considered when grazing is planned among community members.

Getting precise data on the number of animals is very difficult because farmers try to hide evidence of the size of their herds. Creating pasture committees and introducing pasture tickets is a right step in this direction. Without knowledge of the exact number of animals involved it is impossible to calculate correctly their pressure on pastures. It is necessary to develop monitoring mechanisms to determine the relevance of the data provided by the pasture committees.

In some cases, up to a quarter of the livestock grazing on pastures belonging to the department of forestry agency or other aiyl (rural) districts is not reflected in official statistics [5]. Combining information databases from both the national level (the database of the State Agency for Environmental Protection and Forestry and Kyrgyzgiprozem) and the local level (data obtained from pasture committees) could solve this problem.

In the Kyrgyz Republic, many urban residents are engaged in animal husbandry. Some of the pastures are managed by urban municipalities. At the same time, city dwellers usually do not have access to remote pastures. In this context, rural pasture committees could expand access to their pastures outside the local community, providing pasture tickets for urban residents, but for a higher fee [19].

There are also problems and issues of cross-border access to pastures. At the moment there are no international agreements on the use of pastures, which is why conflicts may arise in the border areas [19].

On average, one cow (animal unit) consumes about 7.5 kilograms of dry matter per day [2]. Knowing this value and the food resources of village pastures, the need for feed for winter can be calculated and the farms can ensure a sufficient amount of food for their livestock to survive during the cold period. If farmers do not have the appropriate feed stock, they should be encouraged to sell their animals in autumn because the lack of feed significantly increases the probability of disease or loss of animals. Currently many farmers seek to increase the number of livestock without regard to the consequences of a lack of food, death of animals, and so on. Therefore such a measure could have a significant positive effect.

Despite the very small quantity of winter fodder, part of it is also lost as a result of poor storage conditions. Information and assistance in constructing facilities for storing winter fodder could also have a positive impact on the situation. Often hay is stored outdoors, so the construction of even simple sheds could significantly improve the situation.

5. Adjusting the Number of Livestock

The total number of livestock should not exceed the capacity of pastures and the quantity of winter feedstuff needed to meet the local ecological balance. Therefore, in addition to reclaiming unused pastures; constructing infrastructure, roads, watering, and irrigation systems; and increasing the production or purchasing of winter fodder, there is another mechanism available—the regulation (reduction and control) of the number of animals.

Although quotas for the number of livestock could be a suitable tool, the government is not ready to take that step. Currently, all questions on the regulation of pasture use are delegated to the local authorities. Thus, at the moment, the only instrument for the control of livestock numbers is implementing quotas at the local level [5].

Despite its potential effectiveness, the quota mechanism has a number of significant drawbacks. It may meet resistance or lack of understanding among farmers. For centuries, a family's wealth has been measured by the number of animals they owned. The need to reduce the number of animals runs counter to these traditions.

Livestock is practically the only investment opportunity in rural areas. It is necessary to provide some alternative investments if the mechanism of livestock quota is introduced. The introduction of a quota mechanism can lead to an increase in the number of cases of fraud and corruption. For the animals belonging to the rich farmers, fictitious owners from among poor families can be assigned. The actual number of animals would be hidden on even greater scale than it is now.

The mechanism of quotas is contrary to the current policy of the government. Currently, the government provides benefits to the owners of herds of more than 300 head of cattle and 500 head of small cattle such as sheep and goats [29].

These and other factors suggest that implementing the quota mechanism in the Kyrgyz Republic would be at least premature, if possible at all. Perhaps the introduction of different levels of taxation—higher taxes for the use of degraded pastures and lower taxes for grazing on remote and underutilized pastures—could be a good option.

Assignment

Your task is to assess the pros and cons of the various policy options from the perspective of each of the stakeholder groups and assess the recommendations made.

Policy Recommendations

Based on the options suggested above, the following steps are recommended:

1. Continue transferring regulating rights for pasture resources to the local level. This would take into account local peculiarities and ways of distributing pastures. The immediate step in this direction could be the integration of the databases of the federal authorities concerned with pasture distribution, and the monitoring carried out at the local level.

2. Simplify the leasing system for pastures located in the forest areas. The members of pasture committees should include not only the shepherds but also other categories of users (e.g., beekeepers) and single women who are running farming businesses, so everyone who receives income from pastures is involved. This will take into account the interests of all potential users of pastures.

3. Change the general policy of the state from supporting large farmers to helping farmers with small numbers of livestock. Additional mechanisms for monitoring the decisions taken at the local level could be introduced to counter corruption. Letting the pasture committees make all of the decisions at the local level could increase corruption, so establishing a special organization for controlling purposes could solve this issue.

4. Assist farmers in a particularly difficult period—in the winter, when there is a lack of fodder. This may be in the form of a micro-credit mechanism for purchasing feedstuff or the wholesale purchase of fodder, including from neighboring countries, in order to reduce prices. All of this requires appropriate research and legislation.

5. Investigate the experiences (including negative experiences) of neighboring countries with similar geographical conditions. Implement best practices and distribute pamphlets with recommendations at the local level.

6. Commission remote pastures via the construction or reconstruction of roads, bridges, and irrigation facilities. Animals grazing on these pastures would reduce the burden on the near-village pastures and improve the epizootic situation.

Additional Readings

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Appendix 1

Suggested Teaching Methodology Based on the Cornell Case Study Approach

The case studies presented in this publication and others available at http://cip.cornell.edu/gfs were developed for use in graduate and undergraduate teaching at Cornell University and subsequently adopted by other universities in the United States, Africa and Asia, using a participatory social entrepreneurship teaching methodology developed by Professor Per Pinstrup-Andersen, Cornell University. The overall objective of the methodology is to strengthen the analytical capacity of the students within the context of a simulated food policy context. Evaluations by students during the 12 years the methodology has been used have been consistently positive and enthusiastic. To be successful, the methodology requires preparations by both students and instructors prior to each class. The case(s) to be discussed should be made available to the students at least a week prior to the class and it is critically important that all students have read the case study prior to coming to class and be prepared to discuss the pros and cons of various policy options from the point of view of each stakeholder group identified in the case study.

The class should be run as a simulated role-playing meeting of stakeholder group representatives interested in the particular food policy issue to be discussed. One or two students, who should simulate the role as external consultant(s), should give a 10 to 15 minute overview presentation of the case, with emphasis on the policy options identified in the case study and a policy recommendation. Each of the remaining students should be assigned the role of a stakeholder group representative. The assignment may be made a week ahead of the class session or at the beginning of the class session. Then follows a debate moderated by the instructor in which each stakeholder representative expresses his/her position about the various policy options and the consultants' recommendation.

The moderator should guide the debate by following up on the points made and seek the response from other stakeholder groups. The moderator should call on specific representatives as needed to maintain an exciting, cohesive, and fast-moving debate. Attempts should be made to arrive at a consensus around the consultants' recommendation or one or more policy options. In cases when no consensus can be obtained (likely to be the majority of cases), a brief discussion should be held on the relative power of each stakeholder group and which one is likely to make the final decision about the policy option to be pursued. The length of the debate section of the class depends on the length of the class session. In a 50 minute class session, the debate portion should be limited to 25 minutes, leaving the last 10 to 15 minutes of each class session for the instructor to pull the findings of the debate together and relate them to the broader food policy issue within which the case study belongs. Such a "mini-lecture"—in which the students' experience from the debate and the written version of the case study is placed in a broader food policy context—is critically important.

In order to ensure that all students participate actively, it is recommended that the class size be limited to 20–25 students. Although the methodology was developed for real-time classroom instruction, it could also be used in online distance learning, particularly if real-time video-based interaction among the students could be included. While the above-mentioned mini-lectures would help ensure a cohesive food policy course, experience at Cornell University indicates that the integration of a few lectures based on a textbook would further strengthen the cohesiveness of the course. The textbook used at Cornell is *Food Policy for Developing Countries* by Per Pinstrup-Andersen and Derrill Watson, Cornell University Press, 2012.